Fraunhofer

IFF

FRAUNHOFER INSTITUTE FOR FACTORY OPERATION AND AUTOMATION IFF

ANNUAL REPORT
2009

ACHIEVEMENTS AND RESULTS
2009 ANNUAL REPORT

CONTENTS

FOREWORD

Esteemed Ladies and Gentlemen,
Dear Business Partners and Friends,

Just as in the previous year, 2009 was once again marked by the global financial and economic crisis, which each business and institution experienced differently. For the Fraunhofer-Gesellschaft, the situation was comparable to 2008 when industrial revenue fell by six percent. At the same time, our budget expanded by two percent. Nevertheless, we managed to balance costs and earnings so that we did not need to tap into our reserves. Fortunately, the industry's interest in Fraunhofer's research work has not lessened. We have noticed, however, that project volumes are often divided up and put forward as smaller packages. Some projects were postponed altogether in hopes for a financially brighter future. Overall, 2009 challenged us to focus increased public funds on particular topics and services. In this light, it is all the more impressive that scientists at Fraunhofer IFF can celebrate continuous successes and implement mind-boggling research projects together with long-standing partners.

Especially in times when the going gets tough, the Magdeburg Fraunhofer researchers are keen on reaching the top. An initiative by the German government entitled "Advanced Research and Innovation in the New Länder" has motivated the researchers from Magdeburg to deliver top performances. The "ViERforES" project, one of the projects of the "Virtual Technologies Innovation Alliance" has served as a great example across all divisions of the institute: Whether in logistics or automation, virtual engineering or energy technology, researchers at the Fraunhofer IFF surpass the limits of their fields of research and strive together to make technical systems considerably safer and more reliable. In 2009, they not only conquered new research-related frontiers, but also overcame institutional boundaries. In collaboration with their colleagues from Magdeburg's Otto von Guericke University, they founded the Center for Digital Engineering CDE (still in progress) in March 2009. This academic center aims at advancing the development of virtual technologies. For the first time, the initial

status conference of the "Virtual Technologies Innovation Alliance" brought all the scientists involved in the project to Magdeburg in September 2009. In order to further develop and make these cutting-edge technologies usable, the German Federal Ministry of Education and Research (BMBF) is funding the Innovation Alliance's "Virtual Technologies". The German Minister of Research, Dr. Annette Schavan, is convinced that "with the help of these virtual reality technologies, we will be able to create an important base for fostering the compatibility of our economy. Without efficient production, Germany would not be able to be the world's leading exporter. Virtual reality shortens and facilitates the development phases of new products". However, creating new products is both expensive and risky: In many instances, it takes as much as a prototype to show if a good idea can be translated into practice. A way out of the dilemma is the use of virtual technologies in the design and construction stage. The innovation cluster "Virtual Development, Engineering and Training" (VIDET) intends to increasingly open up these technologies to machine building and plant engineering in Sachsen-Anhalt. Since the start of "VIDET" in 2007, 36 projects have been completed and a further 21 are in the design phase. Throughout Germany, 16 projects have been completed with 10 still under way.

Specialized in energy technology, another group of researchers looks far ahead into the future, too. With their finger on the pulse of time and the sun "on board", these pioneers want to make the most efficient use of the enormous potential of renewable energies. Until now, energy efficiency and information and communication technologies (ICT) have had little in common. This, however, is changing. The "E-Energy" initiative by the German government intends to intelligently fuse energy generation, its distribution, consumption and trade with ICT technologies. As expert teams, researchers at the Magdeburg Fraunhofer Institute and their partners are currently testing how this might look in the future via six model regions across Germany. One of these test regions is the "Harz model region" in the Harz Mountains. The team plans to implement possible solutions to link energy and communication networks

Prof. Michael Schenk
Director of the Fraunhofer Institute for Factory Operation and
Automation IFF
Photo: Dirk Mahler

by 2012. Their focus is to combine the use of a variety of renewable energy sources and controllable loads together in virtual power plants. Dardesheim, a small town with big plans, forms the core of the renewable model region. In the mid-term, it plans to supply more than 250,000 people living in the region with a large share of renewable energies. Today, the region already generates some two thirds of the energy consumed in the entire county from renewable sources. With its mixture of wind, solar, hydro power and bio mass they are already top-of-the-class. The "Renewable Model Region" initiative intends to further boost the share of renewable energy in the Harz Mountains without compromising efficiency, supply security and environmental compatibility.

The long-standing and unique collaboration with the Emscher Genossenschaft/Lippeverband serves as a third example of the Fraunhofer researchers' strive for top positions in research and development. Since 1990, the Emscher Genossenschaft/Lippeverband has worked on restructuring the existing above-ground sewage system. The partners have been busy developing a unique fleet of robots since 2001. The experts plan to channel the water through an underground sewer so that clean water will soon flow again in the Emscher river. Scheduled for completion by 2017, the beating heart of the Ruhr Valley's future sewage disposal system is presently the largest hydraulic engineering project in Europe.

The Emscher sewer system has been designed to consist of only one pipe which will permanently contain water during operation, thus making it impossible to inspect and clean it by walking through it as commonly done in the past. Sewer inspection and clean-up of a one-pipe-system – which saves the costs of a second pipe – can only be done using special robot systems designed by Fraunhofer IFF.

These three examples from different fields of research by Fraunhofer IFF stand for a wide range of projects. Researchers at Fraunhofer IFF are ambitious, as best illustrated by their scientific work as well as by their drive for internationalization.

For example, the institute opened an office in Thailand's capital Bangkok in August 2009 as a gateway to the Asian market.

As different as our projects in the fields of automation, logistics, virtual engineering, and process and plant engineering may be, they all have one thing in common: They all focus on the real needs of businesses. Researchers at Fraunhofer develop tailor-made concepts for application in everyday business life. Our researchers help translate new ideas into innovative products and processes to benefit society, people and the environment. May the present annual report inspire new ideas.

Prof. Michael Schenk
Director of the Fraunhofer Institute for Factory Operation and Automation IFF

OPENING REMARKS
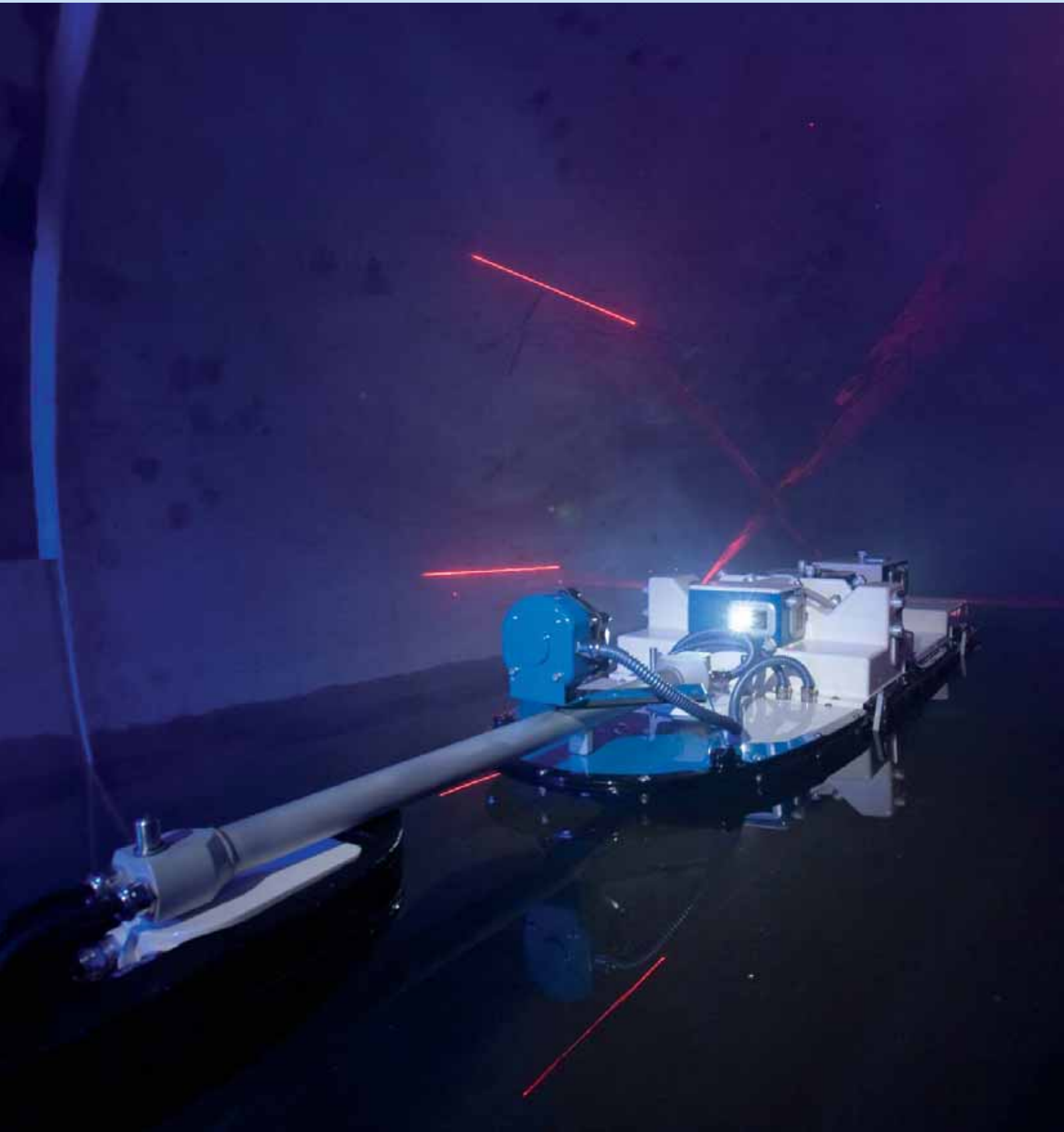
Dr. Jochen Stemplewski
Chairman of the Board of Emscher-Genossenschaft/Lippeverband
Photo: Emscher-Genossenschaft/Lippeverband

As river managers of the Emscher and Lippe rivers, we are responsible to the public for advanced water management. Our activities focus on creating the best technical and economic solutions. Using cutting-edge technology is just as important to us as cost-efficiency. Our comprehensive know-how and rich experience ensure the reliability and ecological sustainability of water supply systems.

We are able to respond quickly to changing conditions and current water management issues. With the help of business specialists and technical experts we design concepts and conceive regional action strategies for future water management challenges.

Our collaboration with the Fraunhofer Institute for Factory Operation and Automation IFF is a prime example of the successful linkage of research and practical application. Together we have developed an automatic inspection and cleaning system that meets all technical and legal requirements of modern sewer inspection – and this, for the first time, during operation and without the need for men.

Reconstructing the Emscher system is a formidable endeavor, both in technical and financial terms. The Emscher sewer is the most important building block of a new Emscher river management system. Contrary to commonly combined wastewater sewers, the water in the sewer is high even in dry weather because it mainly carries sewage to treatment plants. There is no way to enter the sewer for checks or maintenance work during operation. An innovative solution had to be found to be able to perform regular inspections of the century-old construction.

A three-step inspection and cleaning system was designed to ensure safety in the sewer. A floating damage detection system detects defects and conspicuous areas above and below the waterline. The robot's sensors catch everything. Once a problem zone is detected, a cleaning system will remove it thoroughly using hydro-jet technology. A damage measuring system will then perform a detailed assessment of the defective areas using sensors developed especially for this purpose.

Even under the special conditions of the Emscher sewer we succeeded in improving safety notably. The system even set new technical standards defining the latest state of the art in its field.

This outstanding project has demonstrated how important it is to link research and practice. Thanks to the close cooperation between the science and the business world, it is possible to implement the latest scientific findings and research results quickly in real life, and in the end, to benefit society as a whole.

Dr. Jochen Stemplewski
Chairman of the Board of
Emscher-Genossenschaft/Lippeverband

Damage detection system
for the pre-inspection of
large sewers.
Photo: Bernd Liebl

MISSION

The Fraunhofer Institute for Factory Operation and Automation IFF is a decentralized scientific institute working within the network of the Fraunhofer-Gesellschaft.

As a regional, national and international partner, the mission of the Fraunhofer IFF is to make a contribution with its applied research work to the direct benefit of the economy and in the interest of society.

The institute develops and optimizes innovative and client-oriented solutions in the fields of:

– logistics
– automation
– process and plant engineering
– virtual engineering

As a global actor, the Fraunhofer IFF pursues a market-oriented approach.

To meet the demand for holistic solutions, the Fraunhofer IFF is integrated in an international research network of partners from the scientific and business communities.

In order to take advantage of our own creativity and external impulses to guarantee an ongoing exchange of knowledge and experience, a network of associated academics and representatives of leading industries actively supports the work of the Fraunhofer IFF.

The Fraunhofer IFF actively represents interests on national and international bodies in specialized fields and thus fundamentally shapes the processes of innovation in the Land Saxony-Anhalt.

As a research service provider based in Saxony-Anhalt, the Fraunhofer IFF takes on valuable social responsibility by developing future generations both for regional business and for challenging positions in academia and research.

Striking a balance between economy and ecology as well as implementing the rules of excellent scientific and technical practice are the basis of all our researchers' work and their individual responsibility.

Our researchers' combination of technical-technological expertise and soft skills typify the quality of our products and services.

Our researchers work in interdisciplinary teams and cooperate closely with our clients. Such collaboration is characterized by mutual trust, integration as partners, practical application, and user orientation.

*Building of the Fraunhofer
Institute for Factory Opera-
tion and Automation IFF.
Photo: Viktoria Kühne*

THE INSTITUTE IN FIGURES

Operating Budget and Earnings Trend

In 2009, operating budget expenditures amounted to
€16.050 million. Total revenues rose to €12.219 million.
Business revenues totaled €4.281 million.

Investment Budget

Investments totaling €946,000 were made in 2009.

Personnel Development

At the end of 2009, the Fraunhofer IFF had 157 employees.
Our research managers are predominately engineers and
industrial engineers. Degree holding computer scientists,
mathematicians, physicists and business people ensure that
our work is interdisciplinary.

Training and Qualification

Over 138 student assistants and interns support the institute's
work.

The Fraunhofer IFF provided advising for thirty-eight Diplom
theses and seven doctoral dissertations in 2009. Six trainees
completed their traineeship at our institute.

In addition, we offer internships for institutions of continuing
education and high schools.

Development of the Fraunhofer IFF budget
from 2000 to 2009

€ million

- institutional funding
- publicly financed projects
- industry/businesses
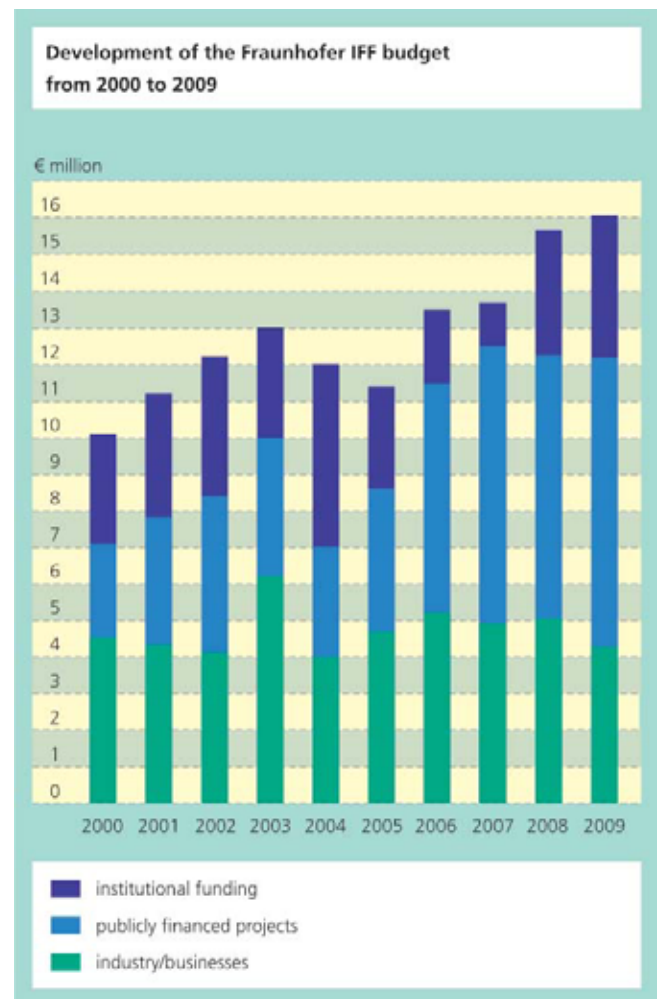
Facilities

At its main building on Sandtorstrasse, the Magdeburg Fraunhofer IFF utilizes 5,000 m² of office space and high-tech EDP labs and conference rooms. A testing facility of 1,300 m² houses and provides technologies – RFID and telematics, industrial image processing, robotics and rapid prototyping – for research and development.

The Fraunhofer IFF has another 2,755 m² of floor space (including testing facilities, labs and offices) for virtual and augmented reality technologies and process and plant engineering at the VDTC in Magdeburg's so-called "Port of Science" ("Wissenschaftshafen"). The heart of the VDTC is the Elbe Dom, a large projection system with a cylindrical, 360 degree laser projection surface of 327 m², a diameter of 18 meters and a height of 6.5 meters.

The hardware and software equipment at the Fraunhofer IFF encompasses tools and environments for the application of geographic information systems, for idea generation and evaluation, for information and communications management, for interactive factory and systems engineering, for multimedia communication and for software development.

Increase in research staff at the Fraunhofer IFF from 2000 to 2009

number of employees

ADVISORY BOARD

The Members of the Advisory Boards of the individual Fraunhofer Institutes support the institute management and the Fraunhofer-Gesellschaft's Executive Board in an advisory capacity. Members include prominent figures from academia, research, business, and government.

Chairman of the Advisory Board
Prof. Burghard Scheel
Vice chairman of the Advisory Board of IBG Beteiligungs-gesellschaft Sachsen-Anhalt mbH

Dr. Frank Büchner
Siemens AG

Peter Claussen
BMW Werk Leipzig

Dr. Stefan Robert Deibel
BASF Belgium S. A.

Prof. Jürgen Döllner
Hasso-Plattner-Institut für Softwaresystemtechnik GmbH

Felix Fiege
Fiege Deutschland Stiftung & Co. KG

Dr. Klaus Hieckmann
SYMACON Engineering GmbH

Andreas Hiltermann
InfraLeuna Infrastruktur und Service GmbH

Participants of the Advisory Board's annual meeting in Magdeburg in 2009 (from lower left to upper right): Prof. Scheel, Prof. Witten, Dr. Feldhütter (guest), Prof. Schenk (Director of the institute), Dr. Dombrowski, Prof. Jugel, Dr. Büchner, Dr. Hieckmann, Dr. Gorzawski (guest), Mr. Brassart, Prof. Pollmann, Dr. Ude, Mr. Smyth, Dr. Ruprecht, Dr. Schreiber, Dr. Deibel, Mr. Müller, Prof. Döllner, Mr. Hiltermann, Mr. Reinboth, MinDirig. Schaper, Mr. Fliege. Photo: Viktoria Kühne

Prof. Albert Jugel
VMP Venture Management Partners GmbH

Bernd Liepert

Klaus Müller
Kranbau Köthen GmbH, Köthen

Klaus Olbricht
Magdeburg Chamber of Industry and Commerce

Prof. Klaus Erich Pollmann
Otto von Guericke University Magdeburg

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Dr. Werner Schreiber
Volkswagen AG, Wolfsburg

Richard Smyth
European Institute of Cognitive Sciences and Engineering

Dr. Jürgen Ude
Innovations- und Gründerzentrum Magdeburg GmbH

Dr. Joachim Welz
Ministry of Education and Culture of the Land Sachsen-Anhalt

Prof. Peer Witten
Logistik-Initiative Hamburg

FRAUNHOFER IFF ASEAN
REGIONAL OFFICE BANGKOK, THAILAND

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2

Review

Since as early as 1999, the Fraunhofer Institute for Factory Operation and Automation (IFF) Magdeburg has been successfully leading transfer, qualification, and implementation projects in Asia, focusing on Thailand, Indonesia, Malaysia, the Philippines, Vietnam as well as China and India. Among the main project topics were renewable energies, information technology, logistics and virtual engineering.

During these ten years of successful project work conducted by the Fraunhofer IFF in the ASEAN region, a valuable regional network of experienced partners from scientific, governmental and non-governmental institutions (NGOs), industrial associations and industry could be built and further expanded. Local partners include, for example, the Federation of Thai Industries (FTI), Thailand; the Asian Society for Environmental Protection (ASEP), Thailand; the National Science and Technology Development Agency (NSTDA), Thailand; the Department of Public Works and Town & Country Planning (DPT), Thailand; the Sirindhorn International Thai-German Graduate School of Engineering (TGGS) in North Bangkok, Thailand; the Vietnam Productivity Centre (VPC), Vietnam; and the Standard and Industrial Research Institute of Malaysia (SIRIM), Malaysia.

The excellent network and longstanding project experience coupled with promising business development capabilities in the Southeast Asia region encouraged the Fraunhofer IFF to take the strategic initiative and establish an IFF Regional Office in Bangkok (Thailand). The opening ceremony of the IFF Regional Office was held in Bangkok in August 2009.

Objective

The aim is to expand existing regional partnerships and establish new ones while focusing on interdisciplinary research collaborations and industrial implementation projects. The IFF Regional Office will be assuming responsibility as hub for regional technology and know-how transfer for the Fraunhofer-Gesellschaft in the ASEAN region for the long-term, thereby supporting innovative German businesses entering the markets in the ASEAN region.

1 The Fraunhofer IFF office branch is located on the 29th floor of the "State Tower" amidst the megacity Bangkok. The skyscraper's golden dome can be seen from all over the city.
2 View from the IFF Office of the Thai megalopolis.
Photos (2): Anna-Kristina Wassilew
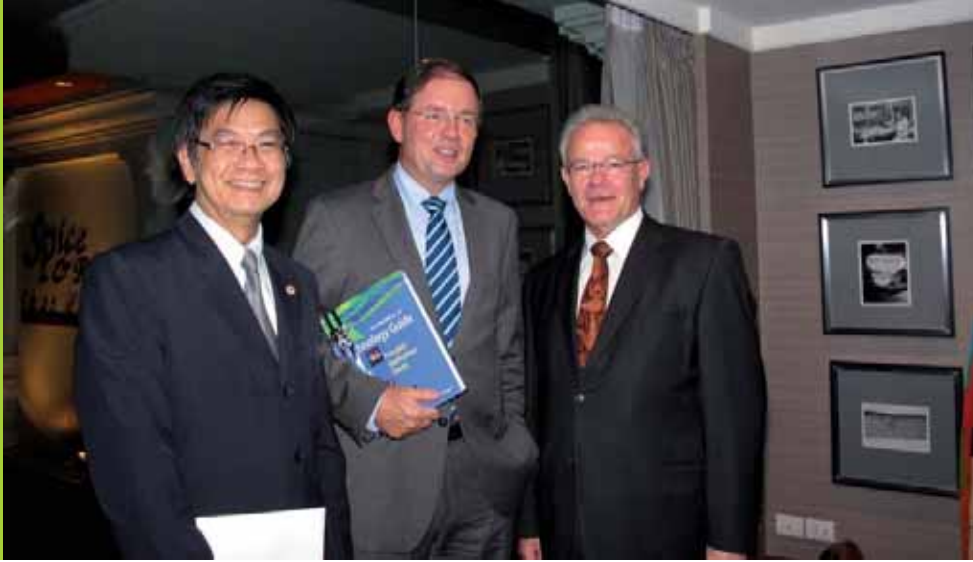
Potentials

Bilateral trade relations between Germany and Thailand have a longstanding tradition. The German Hanseatic Cities Hamburg, Lübeck and Bremen concluded the first commercial treaty with the Kingdom of Siam, today's Thailand, in 1858. To this day, German technology is well reputed in Thailand, which explains why there is a promising market for companies. Thailand's strategic potential as the "Gateway to Asia" is underpinned by a number of factors. Thailand, which is currently chairing the "Association of Southeast Asian Nations" (ASEAN), has a strong economic emphasis in the region. It is a member of the "ASEAN Free Trade Area (AFTA)" and the "Asia-Pacific Economic Cooperation (APEC)" and has entered into several regional cooperation agreements, such as the "Economic Cooperation of the Greater Mekong-Sub-region (GMS)", the "Economic Cooperation Strategy of the nations situated in the drainage basin of the three rivers Ayeyawady, Chao Phraya and Mekong: Thailand, Laos, Cambodia, Myanmar and Vietnam (ACMECS)" and finally, the "Indonesia-Malaysia-Thailand Growth Triangle (IMT-GT)".[1]

There is large potential for bilateral cooperation agreements and business relations. Among the thematic priorities laid down in the 10th National Development Plan (2007-2011) are: sustainable economic development, a higher degree of competitiveness through innovation, and expansion of international collaborations. The Thai Ministry of Energy has, moreover, made the decision to increase the proportion of renewable energies from currently six percent to a total of 20 percent by the year 2022, offering again a profitable opportunity for German technology companies that concentrate on biomass, biogas and solar energy.[2]

A cooperation agreement was signed in November 2009 between the Fraunhofer-Gesellschaft Germany and the "National Science and Technology Development Agency (NSTDA)" Thailand to expand regional research groups and networks. The aim is to pool and link the expertise in the field of research and development of the Fraunhofer-Gesellschaft and the NSTDA in selected thematic fields. On this basis, the strategic innovation clusters as defined by the Thai Ministry of Science and Technology (MOST) can be filled with particular research and project activities. An example for one of the first concrete activities in this context was the Thai-German Science Days event held in Bangkok in mid-2010 aimed at bringing together German and Thai technological expertise and know-how, jointly developing and realizing bilateral research, and implementation projects.

Evening event in celebration of the signing of the cooperation agreement between the Fraunhofer-Gesellschaft and the NSTDA, Bangkok Thailand, in November 2009. F.l.t.r. Dr. Thaweesak Koanantakool, Vice President NSTDA; Dr. Hanns Heinrich Schumacher, Ambassador of the Federal Republic of Germany to Thailand; and Prof. Dr. Hans-Jörg Bullinger, President of the Fraunhofer-Gesellschaft.
Photo: Ralf Opierzynski

Competence

The Fraunhofer IFF Regional Office in Thailand is open to partnerships and collaborations. Take advantage of the multitude of opportunities:

– Access to an excellent, project experienced partner network consisting of science and governmental institutions, industrial associations, NGOs as well as industry in the ASEAN region;
– Familiarity of local markets regarding culture, business practices, project development capabilities;
– Building transnational partnerships in the field of applied research such as interdisciplinary topic areas, national innovation clusters, access to national research, and development (R&D) networks;
– Initiation and realization of international R&D, as well as implementation projects like know-how and technology transfer, industry collaborations and market access for German technology companies.

Contacts

Ralf Opierzynski
Phone +66 2630-8644 | Fax +66 2630-8645
Phone +49 172 319 8506 | Phone +66 812 855 465
ralf.opierzynski@iff.fraunhofer.de

Head of Office Bangkok
Fraunhofer IFF ASEAN Regional Office NGO Thailand
State Tower (RCK Tower)
1055/550 Silom Road, Floor 29th
Khwaeng Silom, Khet Bangrak
Bangkok 10500
Thailand

Opening ceremony of the Fraunhofer IFF Regional Office in Bangkok, Thailand, in August 2009. F.l.t.r. Ralf Opierzynski, IFF Bangkok, Head of Office; Prof. Dr. Sudip K. Rakshit, AIT Vice President for Research; Dr. Noppawan Tanpipat, NSTDA Assistant President; Ms. Peesamai Jenvanitpanjakul, TISTR, Deputy Governor R&D; Dr. Pranee Nantasenamat, DPT, Senior Expert; Dr. Gerhard Müller, Deputy Director Fraunhofer IFF; and Ms. Mashuriati Abd Rahim, Project Manager, IFF Bangkok. Photo: www.photoiam.com

References

[1] German Embassy Bangkok, Foreign Office

[2] Thai Government Public Relations Department

PROJECT REPORTS FROM THE AUTOMATION BUSINESS UNIT

LiSA, Fraunhofer IFF's assistant robot, receives new instructions from a colleague for the next operations to be executed in a life science company laboratory in Magdeburg.
Photo: Markus Fritzsche

1

ASSISTANT ROBOTS OPERATE IN LIFE SCIENCE COMPANY LABS

Motivation

Robots are fast, diligent, reliable, precise and often dangerous. It is not without reason that industrial robots are confined to factory areas with steel barriers. As long as their field of application is limited to industrial bulk production, there is no significant problem in sight. The technological progress achieved today, however, allows for a variety of applications for service robots and assistance systems in the direct vicinity to humans, as for instance in the field of medical engineering or in private households. Thereby, focal points, such as cognitive abilities, multi-modal interaction, and safety aspects have moved into the spotlight. In the case of the "LiSA project – an assistant robot in life science company labs" (Life Science Assistant) – such challenges were addressed. The objective of the LiSA project was the development, construction and testing of a mobile assistant robot suitable for everyday use in a biotechnology research lab. The assistant robot was designed to interact with laboratory staff and to independently assume routine tasks such as transporting multiplates and loading stations.

Results

The mobile platform of the LiSA robot was developed in the course of the project and specially adapted to the conditions prevailing in a laboratory environment. The platform is equipped with an omnidirectional motor with two steerable wheels to enable the robot to approach tables in a lab's cramped space or to perform diversion maneuvers to avoid collisions with other objects. Moreover, the platform is equipped with a total of six laser scanners, which form a protective shelter

around the robot and provide the system with three-dimensional sensor data to locate and avoid obstacles.

A stereo camera system for object recognition is integrated above the gripper to enable the LiSA robot and the robotic arm to pick up multiplates and load lab equipment.

Since the LiSA robot operates directly in a human environment, immediate contact between humans and robots is feasible. For this reason, particular importance was attached to the safety components of the assistance system. The centerpiece developed in the course of the project's safety concept constitutes an "artificial skin": a planar tactile sensor system able to detect contact locally and force resolved. The sensor system was entirely realized on a textile basis to achieve the highest mechanical reliability possible. In spite of ordinary wires, textile conductor strips span a sensor matrix consisting of flexible sensor cells. The system's construction moreover allows for the integration of application-specific cushioning zones. These zones, developed from special energy-absorbent materials, control the robot's deceleration and stopping in the event of an accidental contact.

1 *Human and robot sharing a work environment.*
Photo: Dirk Mahler
2 *LiSA during a lab operation.*
Photo: Markus Fritzsche

2

The sensor system is tailored to the individual case of application. In addition to the cushioning properties, the shape and size of the individual sensor cells and force range can also be adjusted to suit the application. To protect the sensing elements from environmental impacts, the system can additionally be cocooned with a robust water-resistant material if required, ensuring operability even under adverse environmental conditions.

The communication between the LiSA robot and its operators can occur by means of a touchpad or via a microphone. The graphic and oral modes work independently of each other and allow for the operation of basic functions. Both modes are closely interlocked, i.e. input on the touchpad can affect the system's next activity, and alternatively, voice input can impact the visual image.

This service robot system has been successfully tested under real conditions within the scope of the project.

Project partners

The project consortium consisted of eight partners who handled different subprojects:
– Fraunhofer IFF: management and development of the manipulator, safety requirements and safety modules, artificial skin, recognition and handling of objects, integration and test of the overall system, project coordination
– University of Osnabrück, Institute of Computer Sciences, Knowledge-based Systems Working Group: self-localization, path planning and three-dimensional obstacle avoidance of the mobile platform
– Götting KG, Lehrte: development and construction of a mobile platform for navigation in narrow laboratory environments

– SCHUNK GmbH & Co. KG, Lauffen: component development for a robotic arm for the purpose of handling multiplates and loading lab equipment
– Jenaoptik LOS GmbH, Jena: camera technology and image processing for object recognition
– Sympalog Voice Solutions GmbH, Erlangen: human robot interaction through natural language
– [project: syntropy] GmbH, Magdeburg: visualization and graphic user interface
– KeyNeurotek AG, Magdeburg: requirement definition, overall system test

Contact

Erik Schulenburg
Phone +49 391 4090-221 | Fax +49 391 4090-250
erik.schulenburg@iff.fraunhofer.de

1

ULTRASONIC MICROPLATE LEVEL MEASUREMENT SYSTEM FOR LIQUIDS

Motivation

Thus far, the complete monitoring and documentation of filling microtiter plates (well plates) or the automated evaporation monitoring in long-time experiments, concerning for instance stem cells and tissue engineering, have only been carried out to an insufficient and incomplete degree. Previously employed fluid level measurement procedures or LLD – Liquid Level Detection methods, either come into contact with the liquid medium (capacitive), or they are placed above the plates (optical, airborne sound). In each case, these methods bear the risk of contamination or cross-contamination. The long measuring time renders these methods ill-suited for application in High-Throughput Screening procedures (HTS).

Solution

The ultrasonic microplate level measurement system essentially consists of an ultrasonic sensor head with electronic measuring (UltraSoundSystem I, USSI) and three-dimensional positioning kinematics with a corresponding control unit. The modern clamp-on technology quickly and highly precisely measures the fluid level in the wells of microtiter plates (MTP) without direct contact with the liquid medium. The system is connected to a computer via USB, which monitors and logs measurements. The sensor head is automatically positioned at the bottom of the microtiter plate (dry coupling) in such a way that the ultrasound sensors mounted in the sensor head can accurately measure the level in the wells from the bottom of the microtiter plates. A risk of cross-contamination with the liquid medium is eliminated since there is no direct contact

with the latter. The measured levels in the wells are saved and documented in data sets for each microtiter plate.

Technical Implementation

From the very beginning, research work was geared toward developing a scalable solution for the application in High-Throughput Screening procedures because laboratories employ different MTP formats.

The arrangement of ultrasound sensors mounted in the sensor head allows for several wells to be measured simultaneously by three different MTP formats. A special coupling mat was developed for the secure insertion of the ultrasound signal through the bottom of the microtiter plates. The mat prevents measurement errors resulting from air trapped between the sensor and the bottom of the plate. To ensure precise and fast positioning of the sensor head, a three-dimensional kinematic

1 *Level measurement using clamp-on technology.*
2 *Presentation at the BIO-TECH-NICA 2009.*
Photo: Dietmar Kunst
3 *Demonstrator for automated level measurement.*
Photo (1/3): Bernd Liebl

feed was developed with a control element that communicates with the operating and evaluation software.

The ultrasonic microplate level measurement system was set up as demonstrator and can be employed both as one-channel system for evaporation monitoring in long-time experiments, as for instance during stem cell research, or as a scalable multi-channel system for fast fluid level measurement in High-Throughput applications as, for example, in blood analysis machines. Depending upon the used MTP format (well shape and size), filling levels can be detected in the micrometer range. In the case of evaporation tests involving slightly transient solutions (180 microliters), the filling level changed in the single-digit micrometer range.

Prospects

The innovative fluid level measurement system was presented at the BIOTECHNICA, the European flagship trade fair for biotechnology and life science, in October 2009.

Of interest to manufacturers of laboratory automation systems should be the ultrasonic microplate level measurement technology functioning in the form of a stand-alone system and also as integrable system component. Until now, the quantities of liquids to be filled, such as in many pipetting stations, have only been determined by the time the magnetic valves remained open in the filling machine, however, they have not actually been measured and documented, constituting a gap in the quality management.

Other fields of applications for the ultrasonic level measurement system can be found in the biotechnology industry, in bioanalysis technology, and medicine development within the pharmaceutical industry.

Project partner

Fraunhofer Institute for Biomedical Engineering IBMT, St. Ingbert

Contacts

Holger Althaus
Phone +49 391 4090-268 | Fax +49 391 4090-250
holger.althaus@iff.fraunhofer.de

Peter-Karl Weber
Phone +49 391 4090-227 | Fax +49 391 4090-122
peter.weber@ibmt.fraunhofer.de

≋ **Fraunhofer**

AUTOMATICALLY RECONFIGURABLE ADAPTIVE GRIPPING SYSTEM FOR INDUSTRIAL ROBOTS

Motivation

Robots often handle a large variety of different sheet metal components for assembly, separation and joining processes. These components may show differences in design and form and can have simple, plane or complex geometries of diverging sizes. Such a multiplicity of products requires a speedy reconfiguration of employed gripping systems for the individual geometric components. Nowadays, robots are equipped with gripping systems that are specifically adapted to a particular component. These gripping systems largely consist of a rigid base frame on whichjaw or suction grippers are mounted; a reconfiguration to a different component is either not possible at all or it would involve a tremendous manual effort. For this reason, a vast number of gripping systems are often kept in stock for different products, however, custom-made production with smaller batch sizes is economically unfeasible. A previously applied method for adapting gripping systems is the integration of additional active adjustment axes to readjust individual grippers to modified geometries. This method, however, entails a high technical effort and numerous disadvantages including reduced loads and rigidity.

Solution

The adaptive gripping system for robots developed by Fraunhofer IFF provides for high flexibility without having to rely on additional drives. The adaptive gripping system is mounted on the robot's Tool Center Point (TCP) and consists of several passive gripper arms with vacuum and/or clamping grippers at the end of each arm. Each gripper arm is equipped with an

adequate combination of passive rotation, translation, and/or spherical joints that are flexible and require no active engine to carry out a movement. The hydraulic effect of the clamping device allows each joint to be locked in any position. The joint position to be taken is contingent upon the component that is currently handled.

Robot movements initiate an automatic relocation or reconfiguration of the passive gripper arms, hence adapting to a different component. In the process, the free end of the gripper arms is clamped or locked into a stationary point, temporarily creating a closed kinematic chain. It can be fixated either by the grippers mounted at the end of the gripper arms or separate stationary gripper elements. During fixation, certain individual or several of the gripper arms' clamping devices are unlocked to allow free mobility of these joints. The robot adheres to the kinematics on a previously calculated path, changing from one configuration to another. During this step, joints are moved passively. Afterwards, the kinematics is fixed through the clamping device in the new configuration.

A separate path planning software was designed for controlling the robot. The software automatically generates the required trajectory based on the component's CAD data while taking into consideration potential collisions.

1 *Robot with adaptive gripping system.*
2 *Adaptive gripping system during reconfiguration.*
Photo (2): Torsten Felsch

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Results

The adaptive gripping system features the following properties:
– virtually unrestricted flexibility of the gripping system due to adjustment options in all translatory and rotatory axes;
– high precision in the positioning of the grippers as the clamping of joints virtually produces zero backlash;
– high forces can be absorbed because the clamping generates a high force transmission, which is not constrained by existing transmissions, engines or the like, but only by the joints and released clamping force;
– low technical effort and very high flexibility at the same time;
– fewer collisions achieved through minimal disturbing contours.

The passive gripper arm concept and corresponding procedure for reconfiguration are patent-protected.

Benefits

The adaptive gripping system's high flexibility represents a great advantage as the system can be reconfigured automatically and immediately for different components. The gripping system, therefore, offers a more cost-effective alternative to conventional gripping technology that should be of particular interest to small and medium-sized companies for production of lower quantities. The adaptive gripping system can be utilized to complement existing gripper construction kits for a range of different assembly tasks with industrial robots.

Project partners

Fraunhofer Institute for Laser Technology ILT, Aachen; Leibniz Universität Hannover; Babock Lasertechnik e.K., Klein Mühlingen; Laserfact GmbH, Aachen; LBBZ Laser Bearbeitungs- und Beratungszentrum – NRW GmbH, Geilenkirchen; Reis GmbH & Co KG Maschinenfabrik, Obernburg

Contact

Torsten Felsch
Phone +49 391 4090-223 | Fax +49 391 4090-250
torsten.felsch@iff.fraunhofer.de

GEFÖRDERT VOM

Bundesministerium
für Wirtschaft
und Technologie
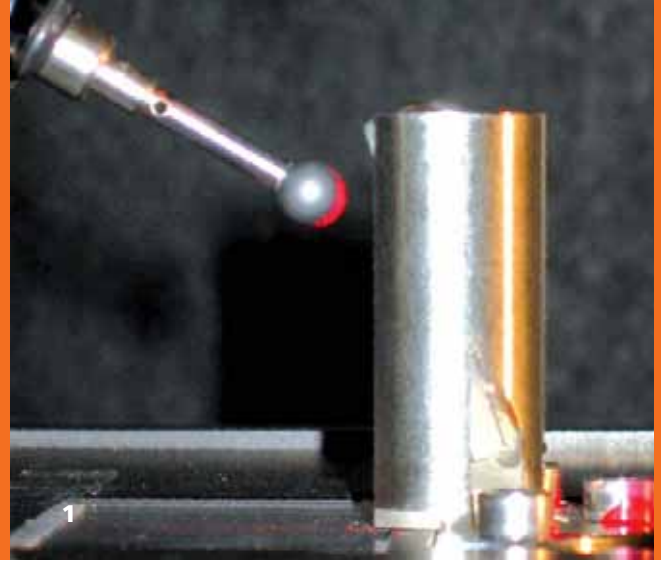
LABORATORY FOR OPTICAL DIMENSIONAL METROLOGY

Motivation

Production plants will only be able to ensure future success by adapting themselves to changing conditions. The early re-cognition of process deviations and prompt response to these changes will lead to a significant economization of resources. Fast, robust, non-wearing sensors are required for detecting such kind of deviations. Optical technologies are ever-incre-asingly fulfilling these requirements and have been making a growing impact in the field of industrial metrology.

The laser triangulation procedure has established itself as fast, reliable, and robust method of measuring in the field of optical dimensional measurement engineering. The use of the latest laser technology and optics as well as precision positio-ning systems for measuring are necessary due to steadily rising product requirements and a reduction in measurement uncer-tainties and errors required for assuring quality standards.

State of the Art

A laser triangulation sensor projects a diversified light beam via a laser light source onto the object to be measured. The resulting light plane cuts the object along a profile line and is projected under a fixed angle on the light-sensitive sensor of a camera. The detected course of the line in the camera image varies depending upon the object geometry. A mathematical formulation of this imaging process enables a dimensional measurement of the object geometry.

The mathematical correlations are either derived from a model of actually occurring physical imaging processes or from an absolute mathematical transformation relationship between the sensor signals and sought after geometric information. In each case, both approaches have advantages and disadvanta-ges and should be pursued further in the future.

Unavoidable production deviations cause each laser triangu-lation sensor to exhibit individual values for the parameter of the employed mathematical model. These values are identified during a measuring procedure by comparing familiar geomet-ric information with the corresponding sensor signals.

Tasks and Objectives

New fields for the application of laser triangulation sensors require resolutions in the lower micrometer range or measure-ments in hardly accessible object geometries. New applications can only be developed through novel approaches in terms of structure and modeling of laser sensors. Examples are the application of laser light sources with more advantageous chromatic properties or reduced coherence, a task-adapted arrangement of sensor components, special measurement procedures utilizing high-precision positioning systems, and

1 *Calibration and testing of a laser triangulation sensor. Photo: Thomas Dunker*
2 *Sensor arrangement for the measuring of interior contours.*

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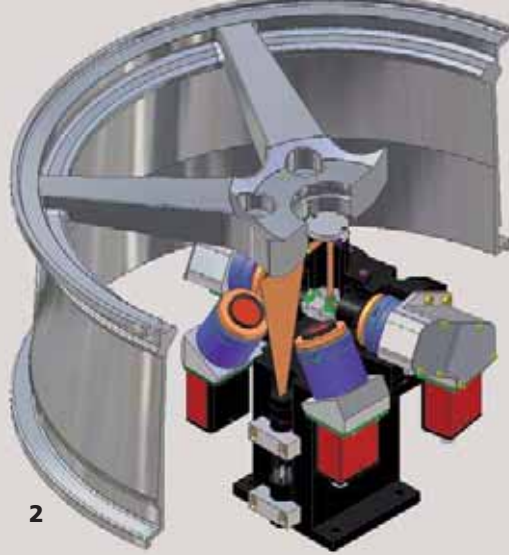
high-resolution camera technology. The disturbing effects of technical materials during measuring, such as the material's radiance, surface roughness, or semi-transparency (volume scattering) are going to be more closely examined and methods developed for correcting the results.

A crucial goal is the creation of an accredited testing laboratory for optical dimensional metrology on the basis of laser triangulation sensors. The testing laboratory is to be used also by sensor manufacturers and system integrators for conducting standardized test series. Generally recognized performance parameters derived from these test series could be confirmed via test marks and certificates, and recommendations could be given for the applications.

The laboratory is, moreover, conceived as an application and demonstration center for industrial users. Technical possibilities would be demonstrated there and the most diverse scenarios, employed for instance in the field of industrial quality assurance, can be evaluated with little effort. It is further planned to more closely explore the technological limits of laser triangulation for special applications.

Prospects

Hardware requirements for the laboratory have been met with the acquisition of two precision positioning systems, modern laser components and further reference standards, as well as the extension of functions of an already existing coordinate measuring device in 2009. The current work is concentrated on the development of software components to be able to flexibly manage the equipment in preparation of conducting test series.

The set-up of a first application for measuring internal contours is planned until mid-2010. A modified arrangement of laser triangulation sensor components is expected to enable

the acquisition of highly accurate measurement data despite cramped spatial environments. Appropriate verification must be safeguarded. Standardized and automated tests for inspecting measurement uncertainty of laser triangulation sensors are in preparation. As a first step, self-developed sensors will be employed, and other customary sensors from different manufactures integrated in the tests as soon as possible.

Contacts

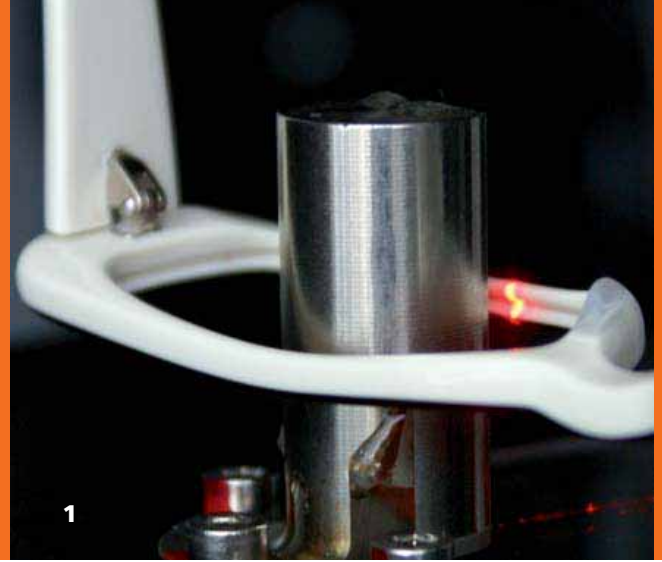Dr. Dirk Berndt
Phone +49 391 4090-224 | Fax +49 391 4090-93-224
dirk.berndt@iff.fraunhofer.de

Erik Trostmann
Phone +49 391 4090-220 | Fax +49 391 4090-250
erik.trostmann@iff.fraunhofer.de

Fraunhofer

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CONCEPT KIT FOR THREE-DIMENSIONAL MEASUREMENTS OF INTERIOR CONTOURS

Initial situation

Scientists of the Fraunhofer IFF designed a prototype for the contactless measurement of interior contours of eyeglass frames with laser light section in the course of the InnoNet project "OptoTracer" funded by the Federal Ministry for Economics and Technology. The contour data are required for the precision cutting of the lenses. The current state of the art involves mechanically contacting tracers which fail to provide optimal measurement results for easily malleable and sharply curved frames.

To be able to measure inside the frame, the beam path of a laser light section sensor, i.e. laser projection and observing camera eye, must be redirected through a mirror. A sensor head was developed which can be inserted into frames with a height of only 20 millimeters. The laboratory set-up providing for X, Y, and rotation axes allows the measuring range of the sensor head to scan along the frame's interior contour. That way, the spatial curve described by the frame's groove base can be measured at a sufficient number of locations. A crucial aspect was addressed in a test regarding the kind of impact the different materials, such as transparent plastics or glossy metal, have on the measurement result.

Solution

A "concept kit" was designed during the development of the sensor head. This concept kit can be utilized for other tasks as well, being that the detection of geometrical features inside components with limited external accessibility is often

challenging. Examples are grooves and channels in drillings, internal threads, or the interior contours of extruded profiles with burrs.

Tactile measurement tools, measuring microscopes, or profile projectors are typically employed for the quality testing of interior contours of such kind. Disadvantages exist, however, for the in-process application because the automation of such systems renders it difficult. A potential solution to this can be provided by custom-made, contactless, three-dimensional interior contour measuring systems which use laser light section sensors. These systems quickly detect the object's surface with a high measuring point density. The acquisition of measurement data and geometric features can be automated, thus offering direct machine or production integration.

Accessibility determines whether the path of the laser's and camera's beam will detect the feature transversally from outside or by a redirected beam inserted into the cavity. In a first conceptual step, the appropriate triangulation angles and measuring ranges are determined. The smallest breadth of the component opening, within which the measurement is to be conducted, limits the size of the measuring range in the cavity. Larger triangulation angles offer reduced measurement uncertainty, but require more spatial freedom to secure accessibility.

1 *Measurement of groove base contour in an eyeglass frame.*
2 *Measuring procedure with precision spheres.*
3 *Measuring the internal contours in a casting component.*
Photos (3): Thomas Dunker

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The second step comprises the selection of suitable image sensors (image rate, pixel quantity, sensitivity), lens (image scale, working distance), as well as laser line projectors and the configuration calculation for the required resolution. The specific placement of mirrors provides for an appropriate redirection of the beam, which enables the components' arrangement depending on the available space. The results of this conceptual step are the parameters of the components' geometrical arrangement (camera with lens, laser projector, beam redirection). These parameters are the basis for creating a CAD model and for the production and assembly of components into an arrangement for a laser light section sensor.

A single measurement along the profile section is normally insufficient for the majority of test criteria to be determined. Motion systems involving rotation and translation axes facilitate the capturing of surfaces in a planar dimension via scanning. Contingent upon the application, either the object to be measured or the sensor arrangement is moved. Multiple sensor arrangements allow fast measurements without relative motion between sensor and measured object.

The calibration of the image between the pixel array and the pixels of the measuring range in sensor coordinates can, for instance, be carried out on coordinate measuring equipment using a suitable sensing sphere. After integrating the sensors into the measuring system, they are calibrated with regard to the axes' coordinate systems or concerning other sensors with perpendiculars composed of precision spheres.

Benefits

Available tools of the concept kit help automate the design process and enable efficient development and realization of adapted arrangements for a light section sensor, as well as measuring systems of interior contours based on such technology.

Project partners

TU Ilmenau, Faculty of Engineering, Quality assurance; Breitfeld & Schliekert GmbH, Karben; pro:sym engineering GbR, Magdeburg; MRB Automation GmbH, Ilmenau; design:lab weimar GmbH, Weimar; STZ Qualitätssicherung & Bilderverarbeitung, Ilmenau
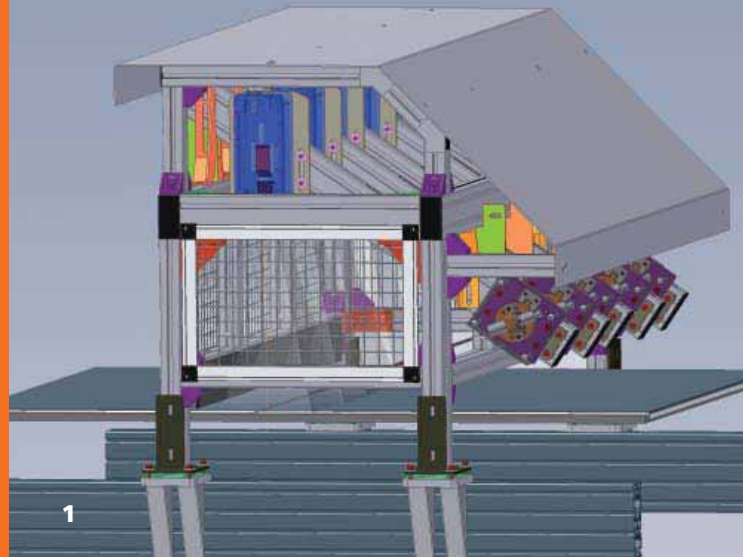
Contacts

Dr. Dirk Berndt
Phone +49 391 4090-224 | Fax +49 391 4090-250
dirk.berndt@iff.fraunhofer.de

Dr. Thomas Dunker
Phone +49 391 4090-217 | Fax +49 391 4090-250
thomas.dunker@iff.fraunhofer.de

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PROCESS-INTEGRATED GEOMETRICAL QUALITY TESTING OF CONCRETE PARTS

Initial situation

Structural fire protection measures are required in modern buildings for safeguarding security in the event of a fire. Fire protection standards are particularly crucial for underground transportation infrastructures, airports, and for public and se-curity-related buildings. To guarantee adequate fire resistance rating, supporting structures such as columns and ceilings, but also escape and emergency routes, ventilation, and cable ducts are equipped with fire resistance rated materials. The boards used for fire protection are truly high-tech products. In a continuous production process, light-weight concrete boards are made of expanded glass granulate, cement mortar, and an alkali-resistant glass fiber. The sandwich technique applied during construction involves stable top layers and a core with a small gross density, ensuring light-weight boards with sound structural capabilities.

Based on the quality features of the materials, high standards also exist for the production process to avoid defective pro-ducts or a larger reworking effort. A key parameter constitu-tes the required thickness measurement for the subsequent sanding process in order to manufacture the final strength of the plate.

The project task consisted of developing a system for con-tinuous tracking of the plate profile's cross section and a graphic visualization aimed at providing information used for taking direct influence on the process and to be integrated into the multilayered production process.

Solution

The manufacturing of the boards is a continuous production process. The plate's sandwich structure is achieved by incor-porating the components layer by layer in a mold. During this process, the final boards are reinforced by means of a special fiber injection procedure directly into the mortar composition. A conveyor belt moves the filled molds to a saw, which sepa-rates the strand into single boards. Following the cutting, the geometrical quality testing is initiated.

The measuring system is built in the form of a portal frame above the conveyed boards. While the boards are continuously moved along under the measuring portal, the board surface is monitored by the laser light section procedure, developed by the Fraunhofer IFF within the scope of the "OptoInspect3D" technology and already employed in many industrial appli-cations. Five sensors aligned in a row ensure that the entire board width is covered. One of the great challenges of this is determining measurement uncertainty within a range of 50 micrometers across the entire board width during the boards' continuous movement. For the detection of the surface profi-le, the required precision is applied by resorting to a specifically designed sensor configuration and a custom-made measuring and calibration method.

1 *CAD model of the measuring system.*
2 *Laser projection on the board. Photo: Ralf Warnemünde*

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In order to determine the height profile cross sections, the data of the five individual sensors are combined. After that, the margins of the molds' frames are extracted to identify the reference height for the board profile. With consideration for the motion information from the conveyor belt, the individual cross sections of the board profile serve the incremental reconstruction of the entire shape of the board surface. The plant operator can view the result on a monitor as a color-coded height display (binary or gradient) and as a good/bad classification. The displayed result aids the plant operator to detect various process deviations, allowing him to take corrective action, if necessary. The linkage to the operating data logging provides for the storage of results so that the quality of each individual board can be backtracked.

Results

New technology was developed in the course of the project for an automated contactless measurement of thickness profiles in a continuous process implemented in a production-ready measurement system. The system was successfully integrated into the production line at the Fermacell GmbH plant in Calbe.

Benefits

The development of this measurement technology has paved the way for performing a geometrical quality testing during the manufacturing of light-weight concrete fire protection boards. The in-process integration and online acquisition and analysis of measured data allows for continuous and immediate visualization of any process deviations. Rapid process intervention and parameter adjustments aid in the prevention of defective products and substantially contribute to enhancing the quality of the finished product.

The system also contributes to improving the operating efficiency of the production process and to optimizing resource efficiency.

The ability to backtrack product quality additionally establishes process transparency.

Project partner

Fermacell GmbH, Werk Calbe

Contact

Ralf Warnemünde
Phone +49 391 4090-225 | Fax +49 391 4090-93-225
ralf.warnemuende@iff.fraunhofer.de

MULTIMODAL INTERACTION WITH TECHNICAL SYSTEMS

Initial situation and motivation

Common interaction patterns between humans and technical systems are characterized by simple input modes and procedural actions. Keyboards, computer mice, joysticks or simple push buttons serve as input instruments. Typically, interaction patterns are determined by defined procedures and menu controls which cater rather to the needs of machines than of humans. When people encounter difficulties or errors occur while using a machine, the desired function can often not be performed at all. This problem is particularly prominent in speech-based interactive applications such as automatic service and information systems because users experience lingual interaction as natural. Their expectations of the machine's or the system's interactive behavior is therefore very high. In other words, they expect it to "understand" them in the limited sense of the desired application. Obviously, a machine can do this only to a very limited extent. It can neither analyze a user's behavior nor anticipate his or her intentions. And it cannot adapt to the user's needs.

The joint project "Multimodal Interaction with Technical Systems" has studied this problem from a scientific point of view. It aims at exploring the fundamental problem and related issues and developing methods to improve the quality of speech-based interactive technical systems.

Solution

To solve the problem, the Fraunhofer researchers utilize the emotional component of any interaction in addition to the semantic information transported by language to facilitate a more comprehensive dialog. In addition, the technical system will also record the user's facial expressions and intonation (prosody). This information allows the machine to detect the user's emotional state and anticipate his or her rough intentions. The fundamental mechanisms of dialog control rest on neurobiological principles. The behavior models required have been or will be developed in neurobiological experiments.

In this research project, the Fraunhofer IFF acts as the system integrator, i.e. we are responsible for integrating and combining the results and findings of all sub-projects. That means, for instance, developing functional models for speech, prosody, facial expression and intent detection for purposes of knowledge representation and dialog control to create an overall functionality in the shape of a demonstrator with various application scenarios. As a synthetic test standard, the demonstrator is responsible for providing a test and evaluation platform for technical and biology-related algorithms as well as for facilitating the presentation and documentation of project achievements for all sub-systems.

Principle design of the demonstrator. Photo: Holger Schulz/OvG University Magdeburg

A speech-controlled adaptive assistance system for a variety of graphic-based games served as an application scenario. The assistance system has been designed to help the user solve problems presented by the system. User and system interact by lingual input. In addition to semantic information uttered by the user, the system registers intonation and a video camera records facial expressions. Based on this information, the dialog control is able to recognize the emotional state (cooperative or helpless) of the human dialog partner. It analyzes and anticipates his or her needs and intentions and provides support depending on the situation and state-of-being through texts or speech.

Results

As part of the project, we have developed and built a demonstrator for a speech-controlled adaptive assistance system for graphic-based games. For communication purposes, the system uses an extended dialog integrating the user's facial expressions and prosody, in addition to semantic speech information, to recognize emotions and intentions. This allows the system to adapt to user needs to assist him or her depending on the situation.

Benefits

Speech-based control and communication based on facial expressions and gestures provide the basis for the efficient and intuitive interaction between humans and machines in numerous applications, such as information and learning systems, shared human-robot work areas in industrial fields, assistance systems in assisted living environments or for research in biotechnical and pharmaceutical labs. Research findings provide new important insights for describing emotion-influenced

dialogs and shaping speech-based human-machine interaction using an extended dialog.

Project partners

Otto von Guericke University Magdeburg; Leibnitz Institute for Neurobiology, Magdeburg.

Contact

Ralf Warnemünde
Phone +49 391 4090-225 | Fax +49 391 4090-93-225
ralf.warnemuende@iff.fraunhofer.de

SACHSEN-ANHALT

Europäische Kommission
Europäischer Fonds
für regionale Entwicklung
INVESTITION IN IHRE ZUKUNFT

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AUTOMATIC TIME-RECORDING OF MANUAL ASSEMBLY WORK

Motivation

Recording the time required for manual assembly processes is part and parcel of business organization. It entails the recording and analysis of work sequences and the time required to complete a particular step. As a prerequisite, each work process needs to be broken down into basic segments such as reaching out, picking up, arranging and preparing, joining or letting go to assess and evaluate the process and to iteratively shorten the total time required by cutting down on individual elements that can be influenced. In the past, these time segments were determined under the subjective influence of the time recorder using mechanical or electronic time recording systems.

The project's objective was to develop a measuring system for more objective time recording and to optimize manual manufacturing processes in assembly sequences.

Solution

To solve the problem, it is necessary to automatically record the movements of particular extremities of a machine operator while working and to model them. The tasks performed by the operator are reflected as specific trajectories of his/her extremities. In a next step, it is possible to derive a number of process parameters from these trajectories such as lengths of movements, pick-up positions and angle of rotation. Subsequently, typical elements of the sequenced assembly process can be arranged in terms of time.

In order to develop a small and easy-to-use measuring system, we used miniature inertial sensors for motion detection. Inertial sensors record acceleration, rotations and magnetic fields at three pivot points directly on a moving object. The fact that inertial measuring technology does not require reference systems or infrastructure presents a real advantage. Some motion recording systems such as cameras and ultrasound systems must be elaborately calibrated, which can be time-consuming, while others require additional markers that do not deliver any motion data when the object to be recorded is hidden from view. Inertial sensor modules the size of a matchbox allow users to determine an object's spatial orientation and position without the need of a reference system or other infrastructure.

As part of this project, we have developed special sensor sleeves containing three interlinked sensor modules each for the upper arm, lower arm and hand. Due to the snug, yet comfortable fit of the anatomically shaped sleeve, the sensors precisely follow the worker's movements during the manufacturing process. A biometric model of the human body and intelligent correction algorithms are used to compensate for the orientation and position errors that result from the considerable drifting of the sensor signals typical of inertial sensors.

1 *Analysis of manual work sequences.*
2 *Inertial sensor module, acceleration process and modeled motion, and rotation sensors determine the spatial position and orientation of objects.*
3 *Automatic time-recording.*
Photos (3): Martin Woitag

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Results and Benefits

A computer application completes the system consisting of two sleeves and six inertial sensors. The computer calculates and reconstructs movements based on sensor data, the broken down movement sequences, and the determined time segments allocated to each sequence.

The system offers an easy option for structuring a manufacturing process as well as a tool for teaching-in the measuring points directly at the assembly workplace. The computer manages the assembly steps and motion structures recorded, helping the user to document and analyze time recording. The system developed can represent logistical (sorting, packing), manufacturing (manual and machine work) and assembly scenarios for sit-down workplaces.
A complete time recording cycle can be subdivided into the following four steps:
1. Preparation: Analyzing the manufacturing process and entering process segments into the computer application.
2. Recording data: The operator performs the work cycle using the sensor system.
3. Analysis: Automatic analysis of motion data; the computer application calculates time segments.
4. Evaluation: Exporting data for statistical evaluation purposes and for optimizing the total time required.

The solution offers the user the following advantages:
– more objective analysis of assembly processes requiring a minimal system setup
– automatic determination of all necessary distribution times and
– simultaneous time-recording at several workplaces.

Prospects

So far, use of the system is limited to stationary seated workplaces. The next development steps will focus on workplaces with an extended radius of action. Then the system will be able to analyze assembly sequences where the worker moves from one workplace to the other to perform various tasks.

Project partner

Dr. Gruendler®, engineering consultant, Magdeburg.

Contact

Martin Woitag
Phone +49 391 4090-231 | Fax +49 391 4090-93-231
martin.woitag@iff.fraunhofer.de

AiF
Ideen eine Zukunft geben

PROJECT REPORTS FROM THE PROCESS AND PLANT ENGINEERING BUSINESS UNIT

Process engineering lab at
Fraunhofer IFF.
Photo: Dirk Mahler

PROCESS AND PLANT ENGINEERING BUSINESS UNIT

LINKING PRODUCERS, CONSUMERS AND STORAGE
FACILITIES OF RENEWABLE ENERGY IN INTELLIGENT
WAYS

COMBINING ELECTRICAL, LOGISTICAL AND ICT
INFRASTRUCTURES

DECENTRALIZED INCINERATION PLANTS FOR BURNING
STRAW COMBINED WITH COGENERATION (CHP) PLANTS

HOLISTIC OPTIMIZATION OF SMALL-SCALE BIOMASS
GASIFICATION PLANTS

BIOFUEL DESIGN – MIXED PELLETS MADE FROM
AGRICULTURAL WASTE

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LINKING PRODUCERS, CONSUMERS AND STORAGE FACILITIES OF RENEWABLE ENERGY IN INTELLIGENT WAYS

Motivation

In light of ever-scarcer fossil fuel deposits and the need to reduce CO_2 emissions to fight climate change, the need to switch from traditional energy generation to largely renewable energy production is more important than ever. However, most renewable energy sources are not available on a continuous basis, that is, the supply fluctuates. At the same time, the number of competitors and the volume of transmitted electricity are on the rise due to the liberalization of the energy market. This puts enormous strain on electricity grids and requires new instruments for monitoring, controlling and protecting energy production, distribution and usage. What matters most is the secure supply of individual players, i.e. consumers as well as the entire energy system, while making the most of the renewable energy produced.

Solution

The Fraunhofer IFF is a participant in the "Renewable Model Region Harz" (RegModHarz) project, one of six E-Energy model projects. The area around the county, also known by the same name, already enjoys a high degree of renewable energy production reaching more than 60 percent. Due to the geographic location of the Harz Mountains, wind energy makes up the largest share of renewable energy: amounting to some 85 percent. In addition to that, numerous solar plants have been put into operation as well as plants for biomass processing. Wind and solar energy, however, are those sources of

energy whose availability is particularly prone to fluctuations. That is why their daily and weekly energy supply frequently does not match actual energy demand. Depending on the balance of energy production and demand, it may become necessary to transmit electricity to individual regions.

Attempts to avoid energy transports may include: controlled load transfer depending on the availability of renewable energy by influencing consumers and producers of electricity, as well as storing electrical energy in the region. The Harz region has the possibility to use a pumped storage plant as a stationary energy storage facility and the batteries of an electric vehicle fleet as distributed local energy storage media. Such energy storage facilities can absorb both generation peaks and peak loads.

1 *An energy provider's transformer station.*
Photo: envia Verteilnetz GmbH
2 *Installation of a phasor measurement unit as an instrument to precisely measure grid parameters at the Fraunhofer IFF.*
Photo: Thoralf Winkler

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Decentralized energy producers and storage facilities existing in the region are linked to a virtual power plant through the electricity grid. The balanced interplay of all participants (producers, consumers, and storage facility) inside the virtual power plant lets it appear as a well-balanced functioning unit on the outside. This requires market players to communicate in coordinated ways and business models catering to these needs. By using information and communication technologies to link electricity grids, producers, and consumers throughout the region, existing grids become so-called smart grids, i.e. intelligent electricity grids. Due to a heavily fluctuating supply and demand, these grids must be monitored at every level of the grid. Phasor measurement units (PMU) are used to determine the health and stability of the grid in real time by taking measurements at several distinctive points.

Results

In a first step, we studied, among other things, the potential for energy production and storage existing in the model region and explored scenarios to best test the effectiveness of various measures. We developed models for individual elements of the virtual power plant required to simulate operations at a later stage. Among other things, the Fraunhofer IFF provides models of the electric vehicles as storage facilities in the electricity grid and prepares a potential analysis for the use of such cars as possible storage media for the virtual power plant.

Project partners

The project partners are a strong consortium of numerous partners from the business and science sphere – to which grid operators, who make the entire power line system available, belong, as well as innovative companies specialized in energy technology, scientific research institutions and universities. A list of all 19 project partners is available on www.regmodharz. de under "Partner".

www.regmodharz.de

Contacts

Dr. Przemyslaw Komarnicki
Phone +49 391 4090-373 | Fax +49 391 4090-370
przemyslaw.komarnicki@iff.fraunhofer.de

Prof. Zbigniew A. Styczynski
Phone +49 391 67-18 866 | Fax +49 391 67-12 408
sty@ovgu.de

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COMBINING ELECTRICAL, LOGISTICAL AND ICT INFRASTRUCTURES

Motivation

To create further rapid and sustainable economic growth, it is essential to ensure the safe, stable and reliable operation of electric energy supply systems. The German government has opened new roads in the field of energy provision that stimulate the production of renewable energy in particular. To reach long-term objectives, it is particularly important to find answers to the problem of how to deal with the volatility of renewable energy sources. In this context, managing distributed supplies and loads plays an important role, as well as the problem of storing energy and uncoupling generation and consumption. Electric vehicles present a promising solution offering a great potential for the distributed storage of electricity.

Solution

This project investigates opportunities for using electric vehicles as a promising option for balancing electricity demands in the Harz model region which already enjoys a high degree of renewable energy supply. Now we need to find solutions to such challenges as the public acceptance of electric mobility, its market share, and the use of electric vehicles to improve the integration of renewable energies in the grid. An answer might be an open, modular system based on open electric and ICT interfaces that combines electric, logistical and information and communication (ICT) infrastructures. The modular ICT infrastructure will be linked to navigation-based mobility and logistical systems to ensure unlimited mobility. When drivers communicate their mobility needs, advanced ICT and forecast

processes will not only consider those electric vehicles hooked to the grid at a given moment, but they will also determine the storage potential available in the short and medium term represented by the electric cars currently used throughout the region and their current state. Exemplary application scenarios specific for the region that consists of typical rural and urban areas will be investigated and evaluated together with representative traffic, transportation and grid infrastructures and user profiles. To this end, a vehicle fleet of some 25 electric cars is available.

First, we will test the ICT-based integration of the system components in the lab before it is tested in the field. We will also assess the scalability of the solution by implementing a combined communications and electricity grid simulator.

1 Test car hooked to the Fraunhofer IFF's charging station. Photo: Thoralf Winkler.
2 The German government invests in electric mobility, as stressed by Sigmar Gabriel, former Federal Minister for the Environment, Nature Conservation and Nuclear Safety at the kick-off event on September 7, 2009.
3 Presentation of the letter of intent on the occasion of the Harz.EE-mobility kick-off event on September 7, 2009; from left to right: Prof. Styczynski, Otto von Guericke University Magdeburg, Dr. Müller, Fraunhofer IFF; Sigmar Gabriel, Federal Minister for the Environment, Nature Conservation and Nuclear Safety Mr. Hunecke, E-ON Avacon AG. Photos (2I3): Dirk Mahler

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In addition, individual business models for innovative e-mobility services for the use of electric cars in everyday life will be investigated, evaluated and tested as prototypes for a variety of market players.

Benefits

The main objective of the project is to establish ICT-based key technologies that are paramount for the efficient implementation of electric mobility. This approach will not only ensure unlimited electric mobility, but also contribute to the stability of power grids comprising large quantities of renewable energy.

The project's aim to improve grid efficiency in order to incorporate more renewable energy, which is boosted by the integration of electric cars in electric grids, matches the objective of the German government to cut greenhouse emissions by 40 percent by 2020 compared to 1990. It also corresponds to EU guidelines to step up the share of renewable energy in total energy consumption to 20 percent throughout Europe by 2020.

The insights gained are combined with economic objectives to devise new business models for all market participants involved for the practical use of electric cars.

Project partners

The "Harz.EE-mobility" consortium consists of 15 partners, including colleges, universities, and research institutes, as well as businesses specialized in vehicle management, information and communication technologies and energy supply.

www.harzee-mobility.de

Contact

Dr. Przemyslaw Komarnicki
Phone +49 391 4090-373 | Fax +49 391 4090-370
przemyslaw.komarnicki@iff.fraunhofer.de

1

DECENTRALIZED INCINERATION PLANTS FOR BURNING STRAW COMBINED WITH COGENERATION (CHP) PLANTS

Motivation

To help prevent further climate change, energy generated from renewable sources is gaining increasing importance. According to estimates, Germany might be able to meet eight to ten percent of its demand for primary energy by using biomass energy. While the potential for wood fuel products has been exhausted by approximately 55 percent, some 100 to 130 petajoule (PJ) of straw per year remain mostly untapped.

Although large quantities of straw would be available for burning, its use is rather slow in coming. There are few incineration plants in the 20 to 1000 kW range. Most are imported and do not work satisfactorily. Incineration plants working on the principle of cogeneration do not yet exist in Germany. The country's renowned manufacturer of steam and heat generators has been hesitant to further develop this technology despite the fact that other countries have had positive experiences with incinerating biological waste such as bagasse, a waste product of sugar cane processing. The few existing straw incineration plants are rather small and belong to newcomers to the field.

The reason why straw is used to a limited extent only has to do with its special properties. It differs considerably from other biofuels such as wood, especially because of its low bulk and energy density, its higher content of alkali and halogens, as well as its low ash melting points. This makes fuel transport, storage, and supply a particular technical challenge.

The low ash melting points caused by the formation of eutectic compositions and comparably high halogen emissions, primarily chlorine compounds, present a special problem when it comes to developing an incineration plant. Since incineration plants operated at high incineration temperatures produce massive vitreous caking when burning material with low ash melting points, they need more frequent cleaning and subsequently shorten the plant's life. Additionally, this causes other incineration problems such as the accumulation of caking, slag and corrosion on the heating surfaces by alkaline reactions in the flue-gas, and in some instances significantly higher emissions of respirable dust and chlorine.

Since biomass is available only in particular places and due to straw's low energy density and steep transportation costs for large-scale use, it seems to make sense only to utilize biofuels within an output range of one to maximum ten megawatts. CHP plants are best suited for such an output because their efficiency is up to 90% higher than that of electrical power plants and they utilize fuels more efficiently. However, their operation only makes sense if there are suitable customers such as district heating networks or consumers of large quantities of process heat.

1 *Ripe grain crops shortly before harvest.*
2 *The straw left over after harvest will be further processed to make fuel.*
Photos (2): PhotoDisc

2

Problem

The project aims at developing an improved plant design for decentralized straw incineration compared to existing facilities in order to help tap the potential of straw for providing energy (electricity and heat). Part of the project plan is to develop a fluidized bed incineration system for the thermal use of straw, ideally in the output range of one to ten MW. Such a system should preferably be designed as a stationary fluidized bed.

Within this joint project, the Fraunhofer IFF is responsible for researching the ideal conditions for operating straw incineration systems based on studies of incineration technology used in existing lab systems and small-scale fluidized bed incineration plants for test purposes. The IFF researchers involved in the project will then use the results of the study to design a fluidized bed incineration plant for industrial application within the envisioned output range.

Fundamental insights regarding the properties and behavior of straw in fluidized bed incineration systems will be published and made available for further research and development work in this field.

Prospects

Following the project, a pilot power plant for culmiferous biomass is to be built based on project results. A potential operator has already voiced interest in building and running such a pilot plant. If the demonstration plant proves to be a success, we may expect the profitable sale of the technology both nationally and internationally.

Project partner

Deutsches Biomasseforschungszentraum gGmbH Leipzig, Arbeitsgruppe Biomasseverbrennung (Working group on bio mass incineration).

Contacts

Dr. Helmar Tepper
Phone +49 391 4090-368 | Fax +49 391 4090-370
helmar.tepper@iff.fraunhofer.de

Dr. Matthias Gohla
Phone +49 391 4090-361 | Fax +49 391 4090-366
matthias.gohla@iff.fraunhofer.de

HOLISTIC OPTIMIZATION OF SMALL-SCALE BIOMASS GASIFICATION PLANTS

Motivation

As energy provision is becoming more environmentally-friendly in times of solid biofuels, experts see thermochemical gasification as particularly promising. By connecting small-scale biomass gasifiers to efficient gas engines it is possible to make maximum use of these valuable fuels by way of cogeneration. Especially in comparison to traditional low-output combustion processes where one source of energy is used to produce heat only, thermochemical biomass gasification has clear ecological advantages because it provides both heat and electrical energy.

However, there are still a few technical and economic obstacles to overcome before small-scale biomass gasification concepts will conquer the market. Currently, a number of system developers are trying to find solutions to technical issues, such as the tar problem or uninterrupted fuel supply. However, they all work exclusively on their own systems. There is no transfer or exchange of knowledge to speak of between developers and scientific institutions, even though they work on very similar problems.

Based on the systematic analysis of different gasification systems, an overview of successful development approaches, and a discussion of fundamental insights, this project intends to coordinate and finally speed up development work in the field of small-scale biomass gasification among various system developers and the scientific world.

Furthermore, potential investors lack objective reviews and uniform assessments of gasification plants. Only when investors have independent proof that plants operate reliably will they confidently invest in this "young" technology. This project is designed to provide the currently missing, crucial practical foundations which will pave the way towards commercial use of small-scale biomass gasification plants.

Approach

To contribute to the rapid and effective market introduction of small gasification systems and to solve the problems mentioned above, a research program funded by the German government has been initiated to acquire, document, exchange, and scientifically assess practical experiences with relevant, currently implemented designs.

1 *Leftover wood processed into wood chips stored in a heap.*
2 *High voltage power lines transmit electricity generated from wood chips to consumers.*
Photos (2): PhotoDisc

1

2

As part of the project, a number of different existing plant designs will be reviewed from a scientific perspective and analyzed using methodologically uniform long-term measurements, a model-based evaluation, and system-specific intense detailed studies of selected problems.

The measuring results will be used to set up a database and assess and evaluate various process designs from a technical, economic, and ecological point of view. In addition to past and future funding and the scientific monitoring of individual plants, this should accelerate technical, economic, and ecological optimization steps and simultaneously cut the number of expensive development mistakes and double developments. The results will also provide potential investors with a basis for decision-making that objectively evaluates system operation based on systematic measurements.

Prospects

The results of the project are to be used in a second program phase to develop and implement improved components and to present optimized plant concepts and designs.

Project partners

Deutsches Biomasseforschungszentrum gGmbH Leipzig; Zentrum für angewandte Energie Bayern (Center for Applied Energy of Bavaria), Garching; University of Applied Sciences Zittau/Görlitz.

Contact

Dr. Helmar Tepper
Phone +49 391 4090-368 | Fax +49 391 4090-370
helmar.tepper@iff.fraunhofer.de

BIOFUEL DESIGN – MIXED PELLETS MADE FROM AGRICULTURAL WASTE

Motivation

Funded by the German Federal Ministry for Education and Research (BMBF), this joint project focuses on the production of mixed pellets made of biomass whose potential has so far been untapped. It systematically investigates characteristic fuel parameters as compared to wooden pellets and the individual ingredients used. In the end, farmers should be able to produce fuel from agricultural waste products that are otherwise often rather costly to dispose of. These biofuels can then be sold for direct use or as energy to run co-generation plants (electricity and heat). Based on the results of this project, German manufactures can further develop common heating technologies to adapt incineration technology to the characteristics of mixed pellets and offer the market optimized technology.

Approach

The project consists of three phases. In the first phase, essential biomass ingredients, as well as additives, were selected based on an analysis of available potentials. In this regard, the researchers considered the local availability and possible alternative uses of the agricultural waste products concerned. The individual fuels were characterized according to the currently effective norms for biofuels.

In the second project phase, the individual fuels were formed into mixed pellets. First, binary mixed fuels were made from the three basic ingredients wood, wheat straw, and miscanthus. Mixture variations followed in intervals of 20 mass percent. Based on DIN 51731, ÖNORM M 7136 and the DINplus

certification program, the binary fuel mixes were initially evaluated according to the following criteria: bulk density, abrasion, water content, ash content, fuel value, sulfur, nitrogen and chlorine content, as well as the pressing agent used.
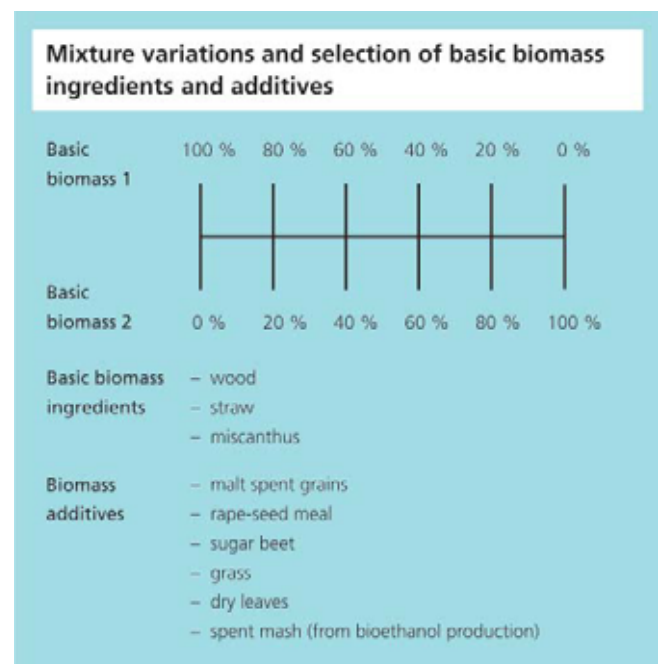
Selection of biofuels for lab trials. Photo: Peter Förster

In the third phase of the project, the binary fuel mixes were systematically examined in terms of their thermo-chemical properties, including an analysis of their gasification and burning behavior and an assessment of their ash behavior. Important assessment parameters include ignition and emission behavior and their cold gas efficiency factor. The ash behavior analysis determines ash composition and ash softening points. The researchers not only studied the effects of binders such as common starch (flour) but they also added a mixture (10 percent by weight) of seasonal biomass such as dry leaves. The pellets produced from this mix were examined according to the same criteria as other binary mixes.

Results

First trials revealed the difficulties entailed in producing these novel biofuel pellets. Expected problems such as corrosion, slagging, and increased emissions occurred during firing. The main problem as compared to wood, for example, was not only the higher quantities of critical substances such as potassium and chlorine, but also their high variation limit.

Project partners

Otto von Guericke University Magdeburg; University of Siegen; Deutsches Biomasseforschungszentrum gGmbH Leipzig; Center for Solar Energy and Hydrogen Research Baden-Würtemberg, Stuttgart.

Contacts

André Herrmann
Phone +49 391 4090-355 | Fax +49 391 4090-370
andre.herrmann@iff.fraunhofer.de

Dr. Sascha Thomas
Phone +49 391 4090-374 | Fax +49 391 4090-370
sascha.thomas@iff.fraunhofer.de

PROJECT REPORTS FROM THE LOGISTICS BUSINESS UNIT

Air freight containers equipped with RFID on their way to the plane.
Photo: Dirk Mahler

NEW CHANCES FOR SMALL AND MEDIUM-SIZED BIOMEDICAL ENGINEERING ENTERPRISES

Motivation

Small and medium-sized enterprises (SME) are the backbone of the European economy. The German medical engineering market is by far the largest in Europe. Globally speaking, only the USA and Japan perform better than Germany in this industry. For this reason the growth potential of the German market is judged to be extremely promising. If Austria, German-speaking Switzerland, and the neighboring European countries are included, this evaluation gains even greater significance. Small and medium-sized enterprises are, however, increasingly subject to rising international competition due to emerging national economies. Furthermore, single small and medium-sized enterprises are often fragmented which leads to a risk of competitive disadvantages and a declining number of employees. The companies' own potential and European funding more often than not remain unutilized.

Only an intensified European collaboration can meet this challenge. Different funding programs of the European Union provide an important framework for encouraging small and medium-sized enterprises to research more intensively and thereby become more competitive. Yet the funding terms and a lack of own resources often make access to funding programs difficult for small and medium-sized enterprises meaning that they rarely use these tools.

Solution

The small and medium-sized enterprises in the field of biomedical engineering need a platform which informs them on a regular basis about research funding programs within the European Union. Furthermore, they need access to the latest calls for tenders for relevant topics immediately after their release. In addition, innovative small and medium-sized enterprises are interested in and need information about developments and prospects in their industry. The project SM-BIO-POWER gathers, summarizes, and fulfills these needs. Small and medium-sized enterprises, researchers, and research institutes can register at www.smbiopower.eu under their corresponding topic of interest and use it to network. This enables them to integrate their research topics on a Europe-wide level. Furthermore, they can find international project partners for future projects.

SM-BIO-POWER connects biomedical engineering enterprises.
Photo: Yoram Lev-Yehudi/ Beacon Tech Ltd., Israel

Results

The small and medium-sized enterprises are organized into special interest groups according to their topics of interest. A project partner guides them within these groups and the latest information is made available on a regular basis. They can express their specific requirements within the discussion forums. At the time this report went to press, 286 companies and research institutes had already registered at SM-BIO-POWER and were benefitting from the offers and benefits. 13 international workshops and events organized by SM-BIO-POWER alone or in cooperation with other networks already took place. In addition, the project is featuring at a number of biomedical engineering conferences.

Benefits

The project focuses on fostering research and innovation in small and medium-sized enterprises in biomedical engineering. The use of EU funding programs will ultimately allow for more economy-based research projects. Furthermore, the small and medium-sized enterprises benefit from enhancing their own sales markets and getting access to more skilled employees via the international network and the cooperation within the EU domestic market. Moreover, it is precisely research and development that enable the creation of new, highly-qualified jobs in Saxony-Anhalt. Participating in this project allows small and medium-sized enterprises to become more marketable and to learn about future trends in the industry, even internationally. It also facilitates companies' access to new, innovative technologies and methods.

Prospects

To offer the benefits described to even more companies in the future, suitable public relations tools have to be used to attract participants from the local economy and research. In doing so, we mainly concentrate on a stronger mutual interaction of small and medium-sized enterprises. SM-BIO-POWER is intended to become an autonomous network in the future.

Project partners

The project SM-BIO-POWER is a cooperation of nine European project partners headed by the Israeli partner.

www.smbiopower.eu

Contact

Katrin Reschwamm
Phone +49 391 4090-625 | Fax +49 391 4090-93-625
katrin.reschwamm@iff.fraunhofer.de

RFID-BASED LOGISTICS SOLUTIONS FOR THE PROVISION OF INDUSTRIAL TIMBER

Motivation

The provision chain for timber from the forest for use as material or as an energy source is a very complex one. A large number of agents and service relationships within this chain cause complex information flows and processes. This results in problems like information losses due to repeated data acquisition, a loss of quality and timber due to organizational issues, as well as difficulties in assigning timber quantities for accounting purposes. For several years, efforts have already been underway to use RFID technology in the forestry and timber industry to improve the material and information flow in roundwood logistics. Developments to date, however, have left many questions unanswered and the RFID has not been practical enough. The aim of the Fraunhofer IFF is therefore to advance RFID technology sufficiently for it to establish itself further in timber logistics. Innovative solutions are to reduce technical barriers especially in the bulk timber segment, increase acceptance, and create economic benefit for owners of woods and for the timber industry.

The project partners of this group research project are working on a tagging system for industrial timber and bulk assortments. In the future the RFID technology is to enable the selective and therefore economic tagging and tracking of larger woodpiles or truck loads. The need arises among other things from the fact that bulk purchasers of the timber industry have to fulfill very short process times at the plant entrance. Therefore, it is hardly possible to read the information of individual trunks.

Approach

During this project the Fraunhofer IFF will develop an RFID gate which a timber-laden truck can pass through in its entirety. The aim is to scan all tags at once at the entrance of a roundwood processing industrial plant. In addition, we are working on suitable transponders with new substrates that do not impair the subsequent processing steps of the timber, e.g. in paper production. For this, transponders based on paper and lignin are currently being developed. A further subproject is identifying the specific demands of the collection, management, and exchange of RFID data in timber logistics. The aim is to achieve positive effects by saving time and effort as well as cutting accounting and controlling costs. These saving effects are not only relevant for wood owners and the timber industry, but also for the service provider who is interested in the fast invoicing of his services.

Results

The developed functional models were tested in the laboratory as well as under real-life conditions in a large-scale test. We are currently organizing further tests with selected stakeholders. We conducted a demand analysis for the use of RFID technology in the forestry and timber industry considering

1 *A timber-laden truck passes through the RFID gate of the Fraunhofer IFF.*
2 *Roundwood with RFID transponders. Photo (2): Mike Wäsche*

2

process and information-related aspects. The results limit the potential materials and shapes that can be used. Specific physical, chemical, and static tests were realized to determine appropriate materials and configurations. The outcomes were taken into account in developing the functional models. In field tests with timber-laden trucks we gained practical experience concerning the identification rate of the timber tag with an RFID gate of approx. 4 x 4.5 x 3 meters. We now need to adapt and realize further technical developments for an optimal screening of the RFID transponders at the gate.

Benefits

The project promotes the increased use of electronics in agriculture and forestry within the context of resource-efficient provision of the raw material timber. By eliminating specific barriers in the electronic tagging of bulk timber the project contributes to an increased economic acceptance of the use of RFID in the timber provision chain. Due to the difficult ambience conditions for the RFID technology in this field of application (i.e. humidity, metals) we furthermore expect results that open up new application fields in other industries..

Project partners

The Fraunhofer Institute for Reliability and Microintegration IZM, Berlin; GICON – Großmann Ingenieur Consult GmbH, Dresden; Wahlers Forsttechnik GmbH, Uffenheim; metraTec GmbH, Magdeburg; Advisory Board for Forest Work and Technology (KWF) registered association, Groß-Umstadt; Thuringian Institute for Wood, Hunting, and Fishing (TLWJF), Gotha

Contacts

Holger Seidel
Phone +49 391 4090-123 | Fax +49 391 4090-93123
holger.seidel@iff.fraunhofer.de

Dr. Ina Ehrhardt
Phone +49 391 4090-811 | Fax +49 391 4090-93811
ina.ehrhardt@iff.fraunhofer.de

Mike Wäsche
Phone +49 391 4090-364 | Fax +49 391 4090-93364
mike.waesche@iff.fraunhofer.de

www.intelligentes-holz.iff.fraunhofer.de

PERSPECTIVES OF THE INDIAN LOGISTICS INDUSTRY

Motivation

The Indian logistics market is currently growing by about 15% annually. The industry's size, however, is still marginal compared to others. The reason for this is the Indian gross national product that has been constantly increasing by more than 9% in recent years. The challenge for the logistics industry is to become much more efficient while growing in an accelerated way. Today, 40% of Indian manufacturing costs are transportation expenses! The growth potential of the logistics industry becomes clear considering the high costs, amounting to 13% of the gross domestic product, currently incurred for transportation and logistics. This is 3% more than in the USA.[1]

It is astonishing that, despite these high costs, low profit margins are typical. Furthermore, due to the fragmentation of the logistics industry there are no economies of scale even in the organized part. The effect is intensified by the fact that different taxation applies to the individual Indian provinces. Along with this, there are taxes for goods that are due when a certain region is entered or left and certain "expenditures" for accelerating administrative procedures. Furthermore, the individual provinces have different bureaucratic regulations which cause high operating costs and long waiting periods.[2] One example of this is the sea ports which, like the streets, have checkpoints where the documents are checked, which creates waiting time. For exporters it is thus difficult to fulfill the terms of delivery.[2] Unfortunately, the traffic and communication infrastructure also requires significant improvement. As there is mostly no modern communication infrastructure, delays make high efforts of coordination necessary. The procedure and the costs are not transparent for the client which increases the mutual distrust.[3] If clients ask for added-value and

full services from one source, small transportation companies often cannot offer this. That is why most Indian companies still have in-house logistics. The Indian logistics dilemma is further intensified by a lack of qualified workers.

Approach

This short overview describes the current situation in the Indian logistics sector and suggests ways in which it could be improved. The main task is to organize support by European companies in identifying, defining, setting priorities, and realizing approaches and measures. These activities require support from politics and the industry as well as consistent implementation and realization. One important condition is that the Indian government creates the legal foundations for fair competition and facilitates the access of foreign investors to the Indian market. Further priorities are to improve and expand the infrastructure. The top priority is to expand the highways. Furthermore the possibility should be examined as to whether alternative transportation routes like inland navigation and rail transport should be funded with subsidies.[1] The communication infrastructure also requires extensive expansion.

1 / 2 Typical street scenes in India: many road users, cows running loose, roadways in a bad condition. Photos (2): Anna-Kristina Wassilew

Tasks and prospects

The EBTC project started in October 2008 and will initially continue until 2013. Its task is to facilitate entry into the Indian market for European companies. The project focuses on biotechnology, energy, the environment, and transportation. The Fraunhofer IFF is responsible for transportation. We are focusing on initiating cooperation between Indian and European companies and research organizations to enable the European organizations to access India's potentials and to transfer know-how from Europe to India. In 2009, studies and conferences took place within the context of this project which helped to reduce information and contact barriers between Europe and India in the transportation and logistics industry. In 2010 we are realizing several market analyses as well as making and supporting initial business contacts for 25 European companies.

The successful realization of this project will lead to a better integration of the European and Indian economies. This integration can then improve the Indian transportation sector in a sustainable way and make the Indian market more attractive to European manufacturers as a production location and sales market.

Project partners

The project is headed by Eurochambres of the European Chamber of Commerce and acts jointly with a group of more than 30 European organizations.

www.ebtc.eu

Contacts

Holger Seidel
Phone +49 391 4090-123 | Fax +49 391 4090-93-123
holger.seidel@iff.fraunhofer.de

Kay Matzner
Phone +49 391 4090-159 | Fax +49 391 4090-93-159
kay.matzner@iff.fraunhofer.de

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DEMAND ANALYSIS FOR SUPPORTING MANUAL WORK WITH VR/AR

Initial situation

Targeted cooperation is a prerequisite for successful transnational projects with many partners. The first work package for the business unit Virtual Interactive Training (VIT) of the Fraunhofer IFF, one of the main partners of the research project "ManuVAR", involved a process-oriented demand analysis. Process experts of the Logistics and Factory Systems business unit (LFS) headed this work package.

Problem

This project, which will end in April 2012, aims at developing an innovative technology platform and at defining framework conditions to support high-quality manual labor for the complete product life cycle. We want to achieve this by involving all stakeholders like clients, managers, designers, and factory workers in the development process. The first work package laid the foundation. In this work package we focused on analyzing standards and established tools for supporting manual labor as well as requirements of the industry for making manual labor more efficient and effective. In addition, we evaluated the respective potentials and required technologies. Furthermore, we analyzed whether existing standards and tools could be integrated into the technology platform we plan to develop and we defined the general conditions for the industrial surveys that will be realized later in this project..

Solution

Headed by the logistics experts of the Fraunhofer IFF a multi-level concept was developed to achieve the project aims. We analyzed the relevant literature and conducted interviews with different stakeholders of the industry. Furthermore, an online survey and specific questionnaires helped to enlarge upon detailed technological questions.

Initially, we wanted to highlight all relevant aspects using complex questionnaires and interviews. However, the collection of the project partners' information needs showed quite early on that this would result in a huge and unmanageable number of relevant factors. So we realized a test interview at the University of Nottingham which helped to identify some relevant key questions for the interviews. We adapted these questions to the profiles of the individual stakeholders. These interviews mainly concentrated on strategic issues. Simultaneously, an online survey and interviews with specific questionnaires concerning the technological aspects of the individual project partners were realized.

The project group for the analysis at MetsoMinerals, Tampere, Finland. Photo: Sauli Kiviranta, VTT, Finland

Results

The comprehensive analyses of the first work package identified seven relevant user requirements concerning skill-sensitive and high quality manual labor. The companies' needs can be illustrated as follows:

– Better support of communication during the complete product life cycle
– Improvement of interfaces
– Improvement of the design process
– Promotion of knowledge management
– Increase in productivity
– Increase in acceptance of technologies
– Reduction of physical and cognitive stress situations

Working together as process and technology-oriented partners, we were able to go beyond the technological approach and analyze the needs of the industry from the perspective of use as well. The combination of these two aspects enabled the best possible integration of the results into the overall project, forming a solid foundation for the further progress of the project.

All project partners esteemed it to be very positive and productive that this basic work package was headed and realized by experts that were not connected with the subject. They succeeded in pointing out to the technology specialists that, in addition to technologies, it is important to focus on the user's needs and demands to achieve optimal project results and reveal potentials for later applications.

The results form the basis for all future developments and research projects within this project. They are therefore the key to continuing successfully.

Project partners

18 European partners from industry and research belong to the project group.

www.manuvar.eu

Contacts

Corinna Kunert
Phone +49 391 4090-620 | Fax +49 391 4090-93-620
corinna.kunert@iff.fraunhofer.de

Dr. Daniel Reh
Phone +49 391 4090-143 | Fax +49 391 4090-93-143
daniel.reh@iff.fraunhofer.de

Matthias Strauchmann
Phone +49 391 4090-114 | Fax +49 391 4090-115
matthias.strauchmann@iff.fraunhofer.de

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AUTOMATIC WAREHOUSE MANAGEMENT IN A SCRAP METAL RECYCLING CENTER

Motivation

The task was to install an intelligent random storage system with automated goods input and output control in the warehouse of a scrap metal recycling center. This system is supposed to register all amounts coming in and going out promptly and location-based as well as to enter them automatically into the database of the warehouse management system.

Problem

During operation, the forklift driver is to send the storage and retrieval output data at the touch of a button on his factory data acquisition terminal to the warehouse management system. The warehouse management system then sends a request to a tracking system which determines the coordinates and the orientation of the forklift, thereby identifying the exact position of the input or output goods. From this we derived requirements for the system to be developed.

The forklift position and orientation in the hall have to be located accurately so that the position and orientation of the scrap bales are automatically, indirectly detected as well. If the forklift to be detected is outside of the warehouse the system has to send a feedback signal. Due to the dimensions of the scrap bales and the planned warehouse logistics the tracking system has to work accurately up to ± 0.25 meters.

Following the request of the warehouse management system, the system has to provide the requested coordinates and orientation of a certain forklift within a maximum of five seconds.

The walls and the ceiling of the warehouse are made of aluminum sheet, the roof and the supporting structure of steel. In the hall, pressed aluminum scrap, which can be stacked up to a height of 3 meters, is handled; the forklifts are at least 2.70 meters high.

The acquisition and expansion of the system have to be as cost-effective as possible.

Solution

The requirements resulted in two potential solutions: The use of a UWB tracking system based on radio technology or the development of a hybrid solution with a combination of opto-electronic and radio technology.

To guarantee accuracy in the area to be covered, the use of a normal UWB tracking system would require a high number of receivers due to the metal environment. In addition, the smaller forklifts would obscure the receivers due to the maximum warehouse height of 3 meters.

1 *Forklift with fiducial on the roof.*
Photo: Martin Kirch
2 *Hall layout with camera positions.*

60

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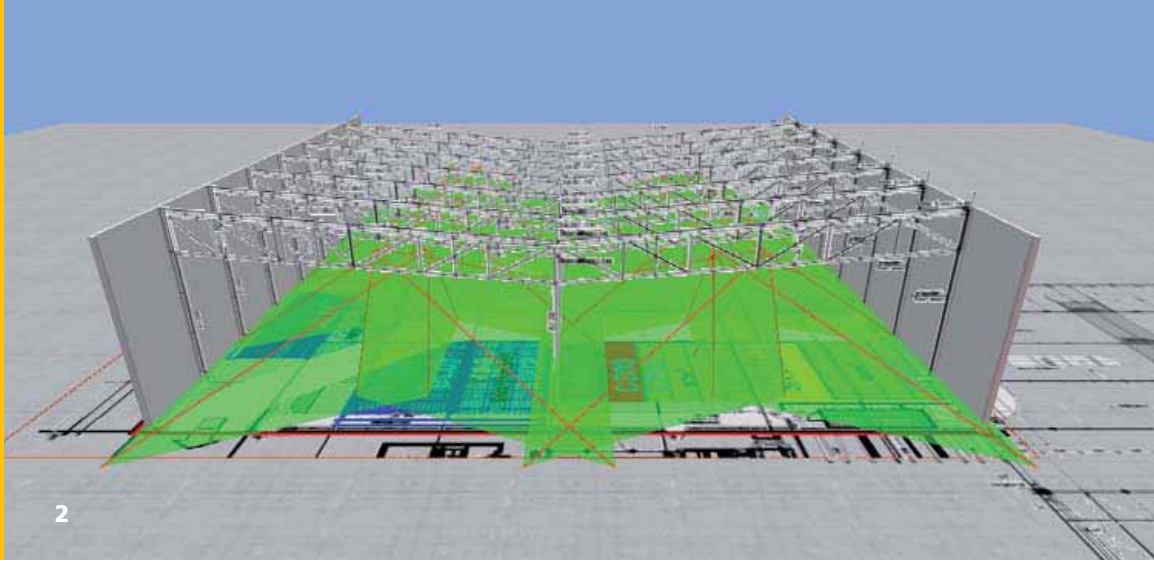
The necessary optical contact between the receiver and transponder of a UWB system cannot be guaranteed and reception problems might occur. Many receivers mean high acquisition costs, also in the case of the system being expanded to cover further areas.

Therefore we decided to develop a hybrid solution that guarantees the required tracking accuracy in pre-defined, smaller areas via an optoelectronic identification and localization procedure. The forklifts are tracked on the basis of a field strength fingerprint tracking system which uses WLAN and is therefore very cost-effective. This enables the integrated analysis of the logistics processes in the company. The advantage of the WLAN tracking method is that it can be expanded flexibly to further buildings or grounds without causing additional costs if these areas have WLAN.

The WLAN fingerprint tracking method uses the existing WLAN facilities and enables rough tracking with variations of up to 10 meters. In the recycling center, this method is used to pre-select those cameras that are then used for the optoelectronic analysis. In the course of investments made to the hall, WLAN antennas were installed, optimized for WLAN tracking due to their small directional lobe. They are the basis for meaningful fingerprints.

The rough position of the forklift triggers the determination of its exact position and orientation within the warehouse by video tracking. For this purpose only camera pictures from the area determined by WLAN tracking are used. They are analyzed with image recognition algorithms. In order to be able to track and distinguish the forklifts from one another clearly, they all had a fiducial fitted to the roof. This fiducial enables the exact determination of the position in the hall (orientation; XY coordinates). In order to determine the optimal camera positions on the warehouse ceiling, we analyzed the distinguishability of the fiducials under certain inclination angles and resolutions. Furthermore, we developed a virtual reality (VR) model representing camera positions and viewing

areas. In this way we minimized the effort of installing the cameras on the ceiling and the changes in camera position and inclination angle.

Prospects

The development showed that a combination of radio-based and optoelectronic technologies for identification and tracking creates new system solutions that fulfill the customers' high requirements and are very cost-effective. The use of VR scenarios for the detailed planning of video systems brings considerable savings as nearly no corrections are necessary after the installation of a system.

Project partner

ALUNorf GmbH, Neuss

Contacts

Martin Kirch
Phone +49 391 4090-487 | Fax +49 391 4090-93487
martin.kirch@iff.fraunhofer.de

Bernd Gebert
Phone +49 391 4090-412 | Fax +49 391 4090-93412
bernd.gebert@iff.fraunhofer.de

IMPROVING THE READING PERFORMANCE OF TAGGED CONSIGNMENTS IN THE DHL SMART TRUCK

Motivation

The cooperation started with the local traffic project "Smart Truck", a result of research and development of Deutsche Post DHL and various partners of the group project "Smart Truck" funded by the Federal Ministry of Economics and Technology (BMWi). This pilot project was successfully carried out in Berlin between April and December 2009. During this project two DHL trucks were equipped with RFID technology which enables the complete scanning of the interior for RFID transponders. Then, the best route for delivery is calculated based on the results of the inventory check combined with dynamic route planning using the latest traffic data.

After this pilot phase, further research and development needs were detected in the field of continuous inventory of smart trucks with RFID technology. The main focus was on equipping all transported goods with the technology and on automatically detecting loading and unloading processes of individual consignments.

Approach

In general, a RFID system consists of a reader with antennas and one or more transponders on the goods. That is why several points have to be taken into account during optimization. As Deutsche Post DHL does not or cannot specify the position of the transponders on the goods to be identified, the reader with the antennas' orientation and the software which controls the reader and antennas and processes the data can be optimized.

Taking this into consideration, in a first step we analyzed all DHL smart trucks already fitted with RFID technology and compared the results with the functioning principle of the reverberation chamber in the swap container of the Fraunhofer IFF. Following this technical analysis, we identified potential for improvement which we implemented into the hard- and software and tested in the DHL Innovation Center in Troisdorf in the second project phase.

Results and Benefits

During the technical implementation in the laboratory, the principle of the reverberation chamber from the swap container of the Fraunhofer IFF was partly applied to the smart truck. The principle of stirred modes means that standing waves are avoided by means of random field distribution in which phases

1 *RFID supported loading of the "Smart Truck" during laboratory tests.*
2 *Laden test vehicle "Smart Truck" in the laboratory; DHL Innovation Center.*
Photos (2): Martin Kirch

and amplitudes are varied. New hardware was built in and ambient conditions were defined. During this, the stirred modes were used to define scan areas in the interior which can be activated selectively. This method enables a nearly complete inventory of the test consignments transported in the vehicle. The method of partial scanning facilitates the assignment of the goods per shelf which makes it easier for the delivery person to find individual consignments in the vehicle. This proves that the radio-based "Pick-by-Light" can be realized technically.

In addition to the improved inventory of the interior, the integrated hardware structure is used to detect if consignments are loaded or unloaded to evaluate or correct the inventory results.

In the project "Smart Truck" a new kind of telematics software was used to connect the consignments supervised by RFID with intelligent route planning. Using the latest traffic data enables real-time route planning, allowing for the efficient navigation of the DHL trucks in city traffic. This intelligent navigation even facilitates a rendezvous management which means that consignments are exchanged between two trucks during the current tour so that they reach their target as fast and efficiently as possible. This concept is especially useful for areas with a low population density.

Optimizing delivery routes and the capacity of the vehicles decreases transportation costs, the consumption of raw materials, and CO_2 emissions. Furthermore, DHL can react more flexibly to customers' orders. Vehicles that are close to the customer who sent a new order can be assigned automatically to so-called ad-hoc orders.

Project partners

Deutsche Post DHL, DHL Solutions and Innovations, Troisdorf; 7ID Technologies GmbH, Graz, Austria

Contact

Martin Kirch
Phone +49 391 4090-487 | Fax +49 391 4090-93487
martin.kirch@iff.fraunhofer.de
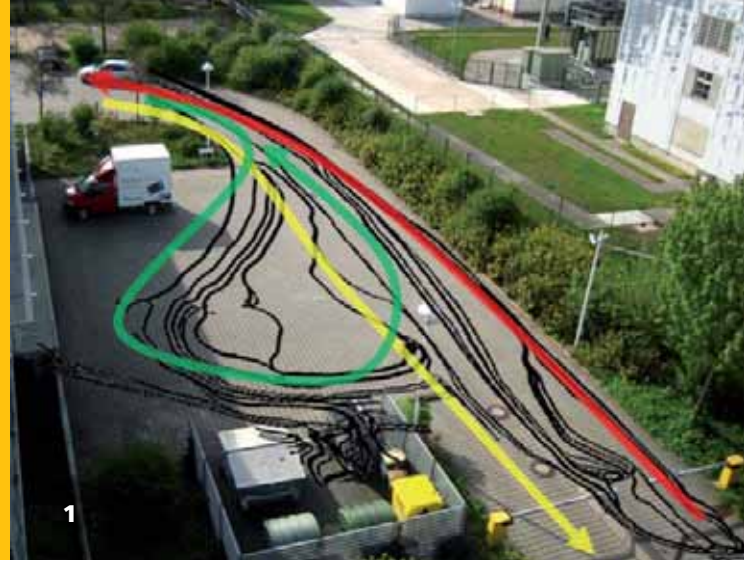
VIRTUAL REALITY SCENARIOS FOR RELIABLE VIDEO ANALYSIS

Motivation

The number of available data is increasing significantly due to the growing use of information and communication technologies (ICT) for tracking, identification, and monitoring of conditions in the field of logistics. The increasing data flood requires new methods of data analysis that, on the one hand, aim at identifying in real time irregularities during transport, handling, and storage processes and that, on the other hand, guarantee the tracing of goods.

The data to be analyzed come from different sources. In addition to telematics modules that are directly carried with the goods in transit or the transportation means, handling operations are monitored with sensor technology in the logistic hub. Logistic hubs in the air and sea freight segment, in particular, are critical in transportation chains due to the internationality of the commodity flows. Therefore, they use locally installed monitoring facilities to gather information.

The materials handling engineering/logistics subproject of the group research project "ViERforES" focuses, in addition to analyzing radio-based sensor systems, on the use of image-based sensor information. Video data can be analyzed automatically as to object movements using suitable algorithms. But they are especially prone to environmental disturbances. Virtual reality (VR) based scenarios with logistic procedures are suitable for evaluating and verifying the vulnerability to design and weather influences of these systems even in the planning phase of video-based sensor systems.

Solution

Within the project "ViERforES" basic research concerning processing and analyzing video-based movement data is realized in the laboratory. Movement trajectories are created from the basic movements of mobile objects using difference image analysis. In this way references are defined. The aim is to automatically classify the movements and states of logistic objects in order to be able to identify critical states (safety) and possible manipulations or falsifications (security). To analyze the movement data, approaches from the use of neuronal networks are used, as well as the approach of the topological skeleton.

When putting the analysis methods into practice, many restrictions and environmental influences have to be taken into account. Therefore, respective VR scenarios with specific environmental conditions and influences are created as a pre-check environment. The VR environment facilitates a control of the developed analysis methods by bringing the analysis algorithms into the VR sequences and then evaluating whether the analysis of the situation was successful. This means we do not have to use the real operation structure in the phase of developing and testing. In addition, VR environments facilitate the testing of special conditions like fog, rain, or certain

1 *Classification of object movements by analyzing movement patterns.*
Photo: Olaf Poenicke
2 *Camera view in a VR scene.*

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lighting conditions to optimize the robustness of the analysis method and to determine the Quality of Service (QoS) level. Furthermore, using the VR technology, the user can verify the functional reliability of the video sensor technology in identifying objects and goods or increase it by optimizing the sensor system.

A model library especially made for typical problems in logistic hubs facilitates the definition of logistic VR scenarios. The created VR environments are not only used to validate the analysis algorithms but also to plan the sensor system structure in the specific environment as they also reveal the weak spots of the picture coverage of the installed video sensors. The use of VR environments thereby enables integrated planning and testing of the use of sensors in a logistic hub.

Prospects

In a next step the method has to be validated in real test environments. A real process environment is used for that. The sensor infrastructure is installed on the company grounds of the Magdeburger Hafen GmbH and used within the test area and development laboratory for logistics and transportation/ mobility (Galileo test area Saxony-Anhalt). The analysis results of the productive process environment are compared to the planning model in order to be able to optimize iteratively the VR-based validation procedure.

In the future, the use of movement analysis systems in air freight hubs will be a strategic task as the high security requirements in the air freight industry require a very robust and precise analysis of object movements. Within the project "ViERforES" appropriate VR environments are already being developed for the specific environmental conditions of an air freight site.

Contact

Olaf Poenicke
Phone +49 391 4090-337 | Fax +49 391 4090-622
olaf.poenicke@iff.fraunhofer.de

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FINAL PRESENTATION OF GNSS-INDOOR AT THE DHL AIR CARGO HUB LEIPZIG

Motivation

Within the project "GNSS-INDOOR" the project partners intensively analyzed and tested different technologies for tracking people, vehicles and goods in different usage scenarios and types of buildings as well as in their direct environment.

Within the project group, the project partners treated and solved various subproblems related to tracking in and close to buildings. Right from the start, the aim was to demonstrate a combination of selected components in a realistic usage scenario. The Fraunhofer IFF suggested an application to improve the process security in the logistics environment which was adopted during the selection process. DHL was gained as a partner for the support required.

Approach

The project group developed components of the GNSS-INDOOR tracking system which were tested successfully in the RFID and telematics laboratory LogMotionLab of the Fraunhofer IFF. Then the performance of the system was tested in a field test at the DHL Air Cargo Hub in Leipzig together with the logistics partner DHL. During these laboratory and field tests we observed the interaction of the tracking technologies GPS, WLAN, and video tracking, which we analyzed within the project, and the RFID glove, developed by the Fraunhofer IFF, as well as the dynamic MapMatching of the DHL Air Cargo Hub Leipzig in a demanding application environment during operation.

We analyzed and evaluated the criteria of accuracy, availability, reliability, data transfer rate, and tracking frequency. In doing so, we had to consider the special safety and security requirements of the airport. They required special training and safety assessments of the involved colleagues of all project partners before entering the grounds.

Final presentation

In a final presentation in a DHL conference room with a view of the airport ramp, we demonstrated live the process steps of ULD handling that are supported by the GNSS-INDOOR tracking system. This way, all participants were able to observe directly the work with the original equipment of the airport equipped with tracking components. The corresponding analysis diagrams of the developed monitoring systems almost simultaneously presented the logistic operations in a virtual environment.

1 *Observation of the demonstration on the airport ramp.*
2 *Demonstration of ULD handling with the RFID glove.*
3 *Explanation of the design and the procedure of the demonstration in front of representatives of DLR and DHL. Photos (3): Dirk Mahler*

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Even a simulated process error was detected and corrected early on using the tracking information. The software promptly showed a warning message that the transport had been interrupted. This made it possible to continue transportation and reach the starting point in time.

During the demonstration, the temperature in the individual dollies was measured with radio temperature sensors and transferred to the database via the mobile terminal which was developed in this project. The permanently updated temperature curve in the application software showed how the condition of the goods can be controlled using sensors.

Results and Benefits

The responsible representatives of the funding institution German Aerospace Center (DLR) and the logistics partner DHL participated in the first demonstration. They gave such positive feedback that we arranged a second demonstration for the technical decision-makers of the airport. During this demonstration we discussed the potential for further developments and the use of the presented tracking and RFID components and concepts.

Furthermore, the demonstrations made public the competence and commitment of the Fraunhofer IFF in the field of airspace logistics.

Prospects

Via the successful cooperation with DHL on the DHL Air Cargo Hub we attracted a further partner for future projects in the airport environment and in the courier, express, and parcel logistics sector.

This forms the basis for further research about process security in the strategically important field of airport logistics.

Project partners

VEGA IT GmbH, Darmstadt; OECON GmbH, Braunschweig; Center for Satellite Navigation Hessen (CESAH), Darmstadt; Scheller Systemtechnik GmbH, Wismar; Friedrich-Schiller-University Jena

Contacts

Martin Kirch
Phone +49 391 4090-487 | Fax +49 391 4090-93-487
martin.kirch@iff.fraunhofer.de

Bernd Gebert
Phone +49 391 4090-412 | Fax +49 391 4090-93-412
bernd.gebert@iff.fraunhofer.de

DLR

PROJECT REPORTS FROM THE VIRTUAL ENGINEERING BUSINESS UNIT
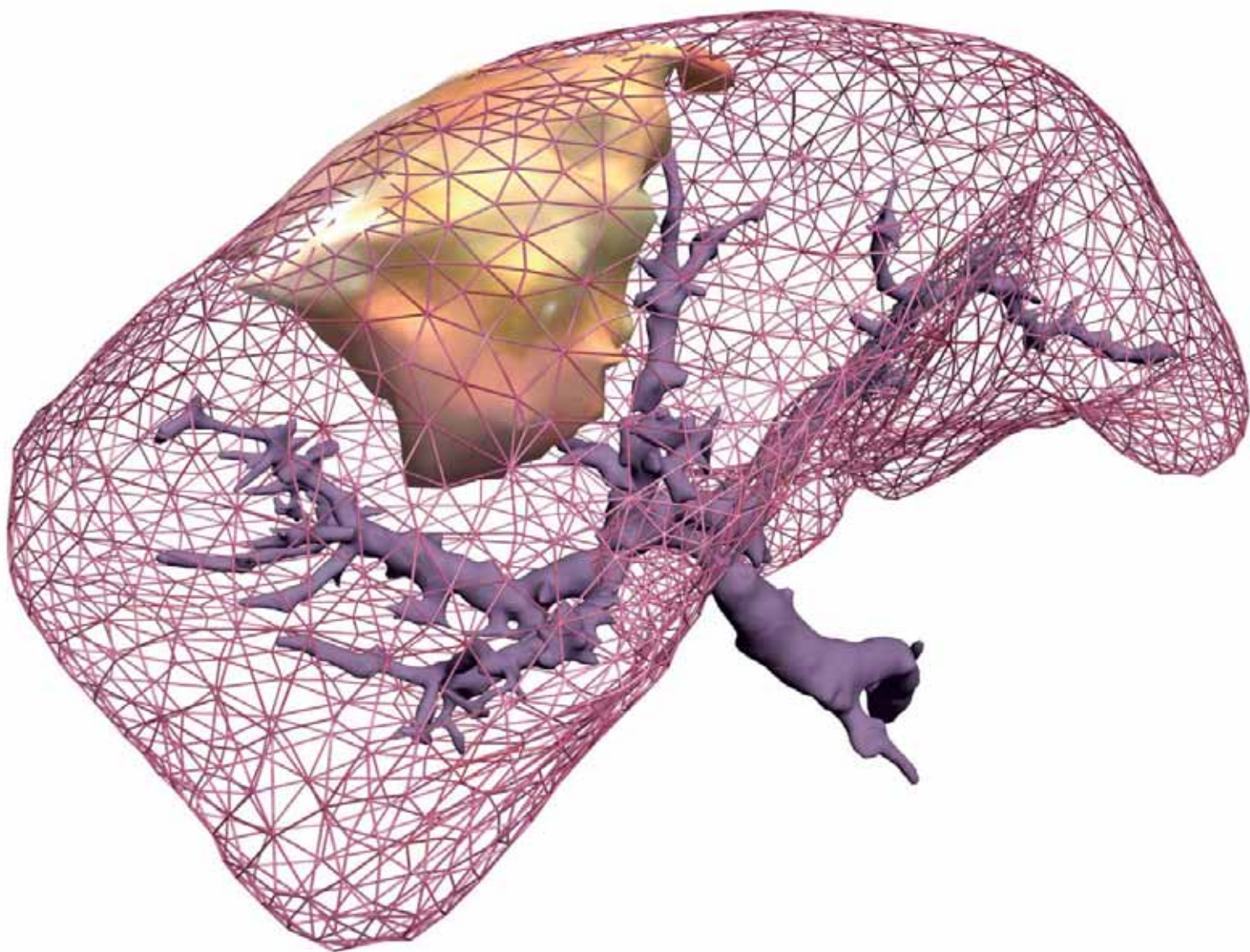
VIVERA/AVILUSPLUS BRANCH

INNOVATIVE TECHNOLOGY DEVELOPMENTS FOR THE FUTURE

VIERFORES BRANCH

INTERDISCIPLINARY COOPERATION AT THE CENTER FOR DIGITAL ENGINEERING

VIDET BRANCH

PROGRESS MADE AT VIDET INNOVATION CLUSTER

VIRTUAL INTERACTIVE TRAINING BUSINESS UNIT

DISTRIBUTED SIMULATION COMMANDER FOR BUILDING DISTRIBUTED SIMULATION MODELS

MAKING ALLOWANCE FOR HUMAN FACTORS TO ENHANCE SAFETY IN THE PROCESS LIFE CYCLE

VIRTUAL-INTERACTIVE MAINTENANCE IN POWER ENGINEERING

TRANSFER OF VIRTUAL TECHNOLOGIES IN COMPANIES OF THE LAND SAXONY-ANHALT

NEW METHODS AND TOOLS TO SUPPORT CE MARKING

3D organ model showing blood vessels and a tissue change

VIRTUAL-INTERACTIVE ADJUSTMENT INSTRUCTIONS FOR A LASER WELDING UNIT

SHORT-TERM SKILL ENHANCEMENT THROUGH VIRTUAL-INTERACTIVE STAFF TRAINING

VIRTUAL ENGINEERING EXPERT GROUP

DEVELOPMENT OF A DESIGN SOFTWARE TO OPTIMIZE VEHICLE PARTS

GENERATIVE MANUFACTURING PROCESSES TO MAKE CUSTOMIZED SPORTS SHOES

EFFICIENT PLANNING OF MODULAR AUTOMATION SYSTEMS

REALISTIC VIRTUAL SYSTEMS TO IMPROVE VOCATIONAL TRAINING

VIRTUAL PROTOTYPING EXPERT GROUP

LONG-TERM OPERATION OF AUGMENTED REALITY-BASED SYSTEMS ASSISTING MACHINE OPERATORS

VISUALIZATION PLATFORM FOR PRESENTING AND PLANNING ELECTRIC NETWORKS

REAL-TIME SIMULATION OF PATIENT-SPECIFIC ORGAN MODELS

BIOSYSTEMS ENGINEERING EXPERT GROUP

GEOMETRIC 3D MODELS FOR BIOLOGICAL APPLICATIONS

1

INNOVATIVE TECHNOLOGY DEVELOPMENTS FOR THE FUTURE

Motivation

The AVILUS technology group of partners from business and science develops highly competitive processes embodying virtual and augmented reality. Early on the group became aware that there was a demand also for technologies requiring longer-term research and set up "AVILUSplus – Applied virtual technologies with a long-term focus on product and capital goods life cycles". The project unites nine renowned establishments specializing in applied and basic research. The first status conference of the Virtual Techniques Innovation Alliance, a highlight in 2009, featured first results of technology development. Industrial partners of the group are now testing selected prototypes to gather experience for improvement.

Key subjects

For AVILUSplus subprojects these conform to technologies specified by AVILUS partners. Fraunhofer IFF research under AVILUSplus concentrates, among other things, on information concerning product lifecycle management, simulation and rendering, tracking, interaction and geometric monitoring.

Efficient authoring systems for the smooth acquisition and modification of models are vital if digital information in product life cycles is to be used continuously. One subproject deals with the semi-automatic generation of assembly and dismantling instructions using geometric properties and function charts from PDM systems.

One of today's challenges is the interactive representation of flexible objects. Algorithms which correctly map deformations of bodies when a force is applied are well known but normally need more computing time than is available for display buildup in an interactive environment so that accuracy suffers. The problem is undergoing optimization in a subproject which uses the processing power of modern graphics cards and the architecture of multi-core processors to parallelize computations.

Tracking real objects to gain information on their movement and position is a necessary condition for virtual and augmented reality (AR). In this connection, Fraunhofer IFF is adapting image processing algorithms for use in actual factory buildings especially to monitor the positions of mobile robots. Such position data is suitable for visualization in virtual or augmented environments.

1 *The use of modern AR systems calls for new interaction techniques. At the status conference in Magdeburg the Deutsche Forschungszentrum für Künstliche Intelligenz introduced image-based interaction.*
2 *Fraunhofer IFF is developing robust algorithms on the basis of AR technologies for the cost-effective and flexible determination of the position of driverless transport systems and autonomous robots in factory buildings and warehouses. Photo: Sven Kutzner*
3 *Service technicians will in future be assisted by fading over, in correct position, information needed to maintain technical systems. For this purpose, the Fraunhofer IGD is working to improve markerless tracking algorithms. Photos(1/3): Dirk Mahlerweiter*

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AR provides new openings for assistance systems such as projecting virtually presented data in correct position onto a real environment for a machine operator in a manufacturing department. To ensure accurate projection, the AR system needs to be calibrated but still remains quite sensitive to shifts particularly in mobile equipment. AVILUSplus is therefore working on techniques for the detection and automatic compensation of deviations during calibration. A prototype is currently being tested by an industrial partner of the project.

An essential condition for planning in virtual worlds is access to three-dimensional geometric data for real objects. Data is often acquired with laser scanners which generate scatter plots with high data volumes. AVILUSplus is now looking into ways of reducing these volumes for specified accuracies and at the same time working on the semi-automatic recognition of basic geometric solids for eventually returning them to the surface and volume models common in real worlds. The technique is used, for instance, to detect design errors through the overlay of CAD data and real models.

Project partners

Fraunhofer Institute for Industrial Engineering IAO, Stuttgart; Fraunhofer Institute for Experimental Software Engineering IESE, Kaislerslautern; Fraunhofer Institute for Computer Graphics Research IGD, Darmstadt and Rostock; Fraunhofer Institute for Production Systems and Design Technology IPK, Berlin; Fraunhofer Institute for Machine Tools and Forming Technology IWU, Chemnitz; German Research Institute for Artificial Intelligence DFKI, Saarbrücken and Kaiserslautern; Munich Technical University TUM

Contact

Marco Schumann
Phone +49 391 4090-158 | Fax +49 391 4090-115
marco.schumann@iff.fraunhofer.de

www.avilusplus.de

INTERDISCIPLINARY COOPERATION AT THE CENTER FOR DIGITAL ENGINEERING

Motivation

Embedded systems with their enormous technological and economic potential mostly perform networked functions in complex products and thus communicate with a variety of other networks at various levels. The software installed in these systems largely controls their security, reliability, availability and, in many cases, their competitiveness. This is particularly evident in such applications as automotive, production, materials flow and medical engineering, and energy technology.

As the importance of software grows, new methods have to be used in product development. Software quality, for example, can not be visualized in concrete terms and therefore not assessed by conventional measurement and testing. This is where VIERforES comes in with virtual techniques designed to create three-dimensional images of properties that are normally not visible and to demonstrate software functions integrated into machinery and equipment. The aim of the project, then, is to enhance the security and reliability of complex technical systems.

Activities

VIERforES research is undertaken by partners in Kaiserslautern and Magdeburg where there is close networking between Otto von Guericke University and the Fraunhofer Institute for Factory Operation and Automation IFF. The 30-plus strong project team in Magdeburg unites research workers from six university departments and experts from five business units and expert groups of Fraunhofer IFF, a truly interdisciplinary approach.

A primary concern in 2009 was to ensure the continuity of research initiated by VIERforES, as reflected in the opening, on March 30, 2009, of the Center for Digital Engineering (CDE). The establishment is to serve as a higher education center at Otto von Guericke University Magdeburg so that interdisciplinary efforts in digital engineering can be closely coordinated. At the opening ceremony, departmental head Dr. Wolf-Dieter Lukas said that BMBF approved of this approach. In establishing the Center its two spokespersons, Prof. Michael Schenk and Prof. Gunter Saake, can rely on support from executive director Dr. Veit Köppen. Research findings and plans for other

1 *Prof. Michael Schenk (l.), head of the Fraunhofer Institute IFF and Dr. Werner Schreiber (r.) of Volkswagen AG opening the exhibition to accompany the status conference.*
2 *Surgery simulator from the medical equipment section of the VIERforES project.*
3 *Magic lens to explore virtual sets of information. Photos (3): Dirk Mahler*

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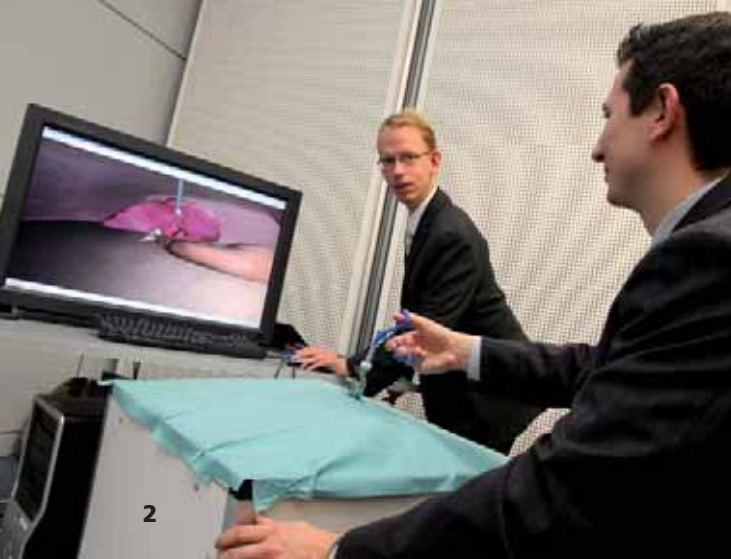
projects are regularly evaluated by an advisory group compri-
sing all VIERforES subproject managers. Beyond the scope of
the VIERforES project, the CDE aims to pool efforts directed at
strengthening Magdeburg's research standing. In this context,
close cooperation between university departments and Fraun-
hofer IFF has led, for instance, to planning an interdisciplinary
"Master of Digital Engineering" study course scheduled to
begin in the 2010/11 winter term. Finding new Digital Engi-
neering projects was another aspect of the buildup.
Looking forward to 2010, the establishment of CDE as a high-
er education center at Otto von Guericke University Magde-
burg has been a promising development.

A particular highlight in 2009 was the first status conference
of the Virtual Techniques Innovation Alliance where infor-
mation was exchanged between the four projects involved
– AVILUS, AVILUSplus, VIERforES and Endoguide. At the same
time, interim results were featured for project administrators
and BMBF. The conference held at the Fraunhofer IFF on Sep-
tember 17/18, 2009 heard 31 lectures on the latest research
findings from Alliance projects including three from
VIERforES entitled "Safe human-robot interaction in pro-
duction", "Visualization of uncertainty-prone flow data",
and "Quality models for safety and security and visualization
techniques based thereon". A summary presentation was also
delivered.

Eighteen exhibits from Alliance projects impressively de-
monstrated the research progress that had been made, with
VIERforES showing a surgery simulator from the "Medical
engineering" subproject (Fraunhofer IFF) and magic lenses for
exploring virtual sets of information as part of the "Interac-
tion" subproject (Otto von Guericke University Magdeburg).

Project partners

Fraunhofer Institute for Experimental Software Engineering
IESE, Kaiserslautern; Otto von Guericke University Magdeburg;
Technical University Kaiserslautern

Contact

Marco Schumann
Phone +49 391 4090-158 | Fax +49 391 4090-115
marco.schumann@iff.fraunhofer.de

www.vierfores.de

GEFÖRDERT VOM

Bundesministerium
für Bildung
und Forschung

PROGRESS MADE IN THE VIDET INNOVATION CLUSTER

Motivation

The techniques and tools of Virtual Engineering (VE) enable the uniform digital description, modeling, simulation and optimization of a product throughout its life cycle, from design, development and manufacture to final use. Product characteristics are thus guaranteed at an early stage and product and manufacturing costs optimized in the course of production planning. At the same time, virtual models can help users of plant and machinery gather first experience.

Knowledge gained in the virtual world can help optimize proposed products and processes at the design stage, with drastic cuts in development times, costs and risks. In addition, weak points are detected early so that quality and safety are improved.

Apart from providing VE methods and tools, VIDET can help engineering and plant construction companies with
– time-saving design strategies from the "inspiration" stage through virtual and real prototypes to implementation,
– product and system modeling and simulation,
– the virtual commissioning of plant and equipment,
– the development and optimization of product models, and
– digital design tools to help introduce digital engineering.

Methods

All of VIDET's R&D is conducted through technology platforms for virtual product development, virtual process design, and virtual reality (VR) based training and skill enhancement. The platforms are built around the "V model" of VDI guideline 2206 as used in software development. With the aid of VIDET's virtual engineering methods, the model has been consistently applied to the entire process chain.

Reference solutions bring less duplication of modeling work in development, create new efficient interfaces between various applications in a company and at the same time provide a continuous database for the virtual testing of products and processes. This is the only way to tap the potential of VE technologies also in future and to make sure that results are reproducible.

Progress made

Since mid-2007, the VIDET innovation cluster has dealt with as many as 36 projects in the Land Saxony-Anhalt, 21 of them in the design stage. In Germany as a whole, 16 projects have been completed and 10 are in the planning stage.

Efficient development and presentation of new products through Virtual Engineering.
Photo: Dirk Mahler

Milestone plans for development in the VIDET innovation cluster in the Land Sachsen-Anhalt (LSA) and beyond

The experience gained at the VIDET innovation cluster was that most of the companies involved were using VE/VR techniques for the first time and clearly benefited from the advantage of minimizing development costs and risks. Some reduced setup and process times by up to 80% (for instance pro-beam AG & Co.KgaA) and many said they realized during project implementation that there were more applications for VE/VT. To tap the related potentials, these companies will work together with IFF in future.

The development of new products and processes, not least through the use of highly efficient VE/VR based tools, along with product improvement and optimization has added to the economic strength of the Land Saxony-Anhalt. At the same time, the skills of company staff have been enhanced.

Cooperation with research establishments has had the gratifying result of attracting postgraduate students, graduands and interns who have made important contributions to VIDET projects and are continuing to do so. At the same time, a number of deficits in academic training have become evident, particularly when it comes to mastering virtual techniques. Improvement is expected from a future course of "Digital Engineering" studies.

Prospects

In the words of Dr. Reiner Haseloff, Minister of Economics of the Land Saxony-Anhalt, "we want to include more companies over the remaining funding period and extend the cluster to chemicals and plastics manufacture. We wish to continue the innovation cluster and may even widen its range to other Lander." As things stand now, VIDET is to end in 2010 but is at the same time attracting more interest from companies at home and in other Länder, reason enough to let all of Germany participate in this success story.

Contact

Thomas Schulze
Phone +49 391 4090-820 | Fax +49 391 4090-250
thomas.schulze@iff.fraunhofer.de

DISTRIBUTED SIMULATION COMMANDER FOR BUILDING DISTRIBUTED SIMULATION MODELS

Motivation

Material flow simulation has for years been accepted as a tool for planning and operating complex production and logistics systems. Depending on preferred applications, it uses simulation models in a variety of sizes and with different degrees of detail.

At Deere & Company, simulation experts emulate in-house processes such as making vehicle bodies, painting and final assembly with a number of SLX-based generic simulation systems. Factory departments are modeled and simulated separately. While retaining the degree of detail obtained, more complex simulations for more than one division were conducted as early as 2008 under a joint project entitled "HLA-based distributed production simulation for utility vehicles". This integrated existing models of factory departments as proto-types into more complex distributed models, with monolithic simulation models coupled on the basis of High Level Architecture (HLA) that has been standardized to generate distributed simulations.

However, methods implemented in a prototypic manner can only be integrated into the day-to-day work of simulation teams if there is a user interface through which the project partner's simulation experts can generate and evaluate their own distributed simulation models. It is of key importance here to enable users who know little about distributed simulation and HLA to link existing simulation models and carry out experiments.

Solution

To solve the a.m. problems, Fraunhofer IFF has been commissioned by Deere & Company to develop a Distributed Simulation Commander (DISC), an application which provides future users with mechanisms to describe the structure of distributed simulation models, followed by simulation and evaluation.

With a configuration module, existing simulation models can be imported and placed in the layout by drag & drop. They can then be linked making allowance for their internal parameters and including descriptions of material and data flows between models as well as the integration of goods and information to be transferred into receiving models.

Once configuration has been completed, the generic model can be automatically implemented and simulated using the DISC simulation module. As a first step, the HLA Run-Time Infrastructure (RTI) is initialized, followed by creating what is known as a Federation and generating configuration data for each simulation model involved. Then the individual simulation models are started and automatically combine with the Federation as Federates via the RTI, for which they use an SLX-HLA interface. The DISC registers an additional observer federate on the RTI which does not interfere with the simulation but monitors its run-time progress and collects and prepares data

Definition of material flow via the configuration module.
Photo: Marco Danneberg

from simulation models so that statistics can be produced later. Distributed simulation takes place with allowance made for the synchronization of individual submodels over time and their contents using conservative synchronization procedures.

Coupling individual simulation models over the HLA run time infrastructure

Results und Prospects

For Deere & Company, DISC is an application which makes it possible to couple existing heterogeneous simulation models for looking into more complex questions and at the same time retain the degree of detail obtained. While its operability has so far been evaluated only for a few prototypic simulation projects, the number of software users is to rise over the next few months as Deere begins to evaluate real problems at several manufacturing sites.

Future projects for DISC upgrading will seek to improve the assessment of simulation runs and the integration of more complex coupling strategies.
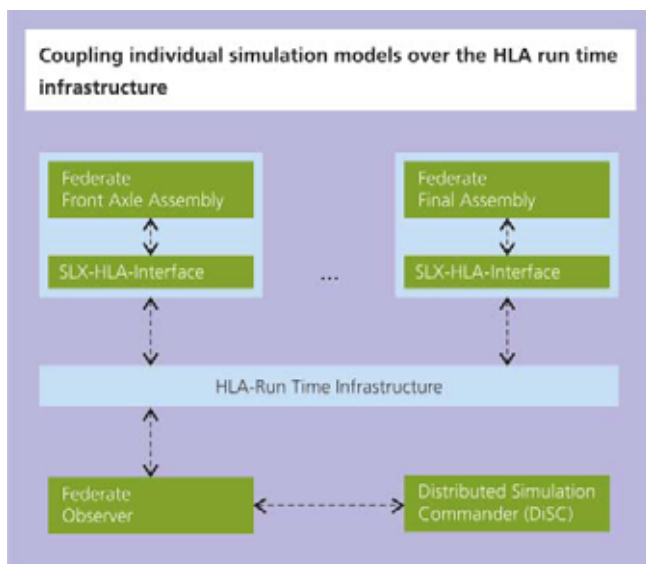
Project partner

Deere & Company, Moline, USA

Contacts

Steffen Masik
Phone +49 391 4090-127 | Fax +49 391 4090-93-127
steffen.masik@iff.fraunhofer.de

Michael Raab
Phone +49 391 4090-122 | Fax +49 391 4090-93-122
michael.raab@iff.fraunhofer.de

MAKING ALLOWANCE FOR HUMAN FACTORS TO ENHANCE SAFETY IN PROCESS LIFE CYCLES

Motivation

The behavior of human players such as pilots, cabin and ground crews, maintenance technicians etc. is becoming an ever more critical factor in complex systems such as aviation. Human error may jeopardize a particular operation and, often enough, the entire system. For accident prevention it is not enough to simply make requirements on the players in question by issuing conventional guidelines. A new approach is needed which from the outset allows for human failure, related mistakes and their effects.

Against this background, 40 European research and industry partners got together under the roof of HILAS, an EU project for "Human Integration into the Lifecycle of Aviation Systems", to develop a holistic model of proven methods for integrating human factors throughout the life cycle of such systems. The accent was on four areas – knowledge integration, air traffic, flight desk functions and maintenance operations. In the latter field, the Fraunhofer IFF worked on new software solutions for making maintenance operations safer and aircraft more reliable.

In the scope of "Maintenance Operation" the Fraunhofer IFF was responsible for developing new software solutions to improve safety in maintenance work and to increase the operability of aircrafts.

Solution

HILAS integrates human factors into the life cycle of aviation systems by studying people's behavior at work and ways of helping them reach performance standards through user-oriented design, better planning, competitive management and quality and safety management systems. This calls for an integrated approach which systematically generates an understanding of human factors in the operation and use of complex systems. This is then transferred into an interactive knowledge base to make processes more efficient, improve systems and promote innovative design. The contents of such a knowledge base should be available as process-oriented and contextual information reflecting the current status of activities on the basis of multimodal, animated, multi-media and interactive data.

The Fraunhofer IFF concept for "maintenance operations" describes these with a view to human factors while integrating VR models as interactive and dynamic links between various tasks to be performed as part of maintenance and repair processes.

1 *Service technician checking an aircraft drive system.*
Photo: MEV Verlag GmbH
2 *Training to perform maintenance procedures on a virtual aircraft.*
Photo: Viktoria Kühne

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The basic idea is to use VR modules that are linked to the documentation and data in all phases of the process life cycle, provide for training and may be adjusted to satisfy the safety-related needs of individual players.

Results

As an intelligent knowledge store, the VR module can integrate newly generated or modified information. At every stage of the life cycle, the VR module container is a source of data collected throughout the product life cycle, such as design specs, RFID-assisted historical data, and workplace comments from engineers, pilots and technicians. This "data from experience" is evaluated and serves as a basis for ongoing design and improvement.

The prototype devised and implemented by the Fraunhofer IFF incorporates
– two VR mockups (A400 overhead cockpit unit and A320 integrated drive generator) built around virtual-interactive support tools which have been developed,
– one Remote Communication Module with a Centralized Maintenance Interface (CMI), and
– a coupling facility between the VR module and the CMI.

Field studies in maintenance companies involved in the project have shown the expected benefits – better process safety due to improved staff motivation and the assumption of responsibility beyond a single process, and better cooperation and understanding between players. As a result, errors are reduced at all stages, with time and cost savings during maintenance.

Project partners

HILAS has brought together a total of 40 European partners in research and industry. For a detailed list see the web page.

www.hilas.info

Contact

Dr. Eberhard Blümel
Phone +49 391 4090-110 | Fax +49 391 4090-115
eberhard.bluemel@iff.fraunhofer.de

VIRTUAL INTERACTIVE MAINTENANCE IN POWER ENGINEERING

Motivation

Maintaining high-voltage equipment requires a skill in electrical engineering, specialist knowledge with regard to appliance and instrument functions, basic data and limit values, and reliable know-how when it comes to assessing status reports and defining and explaining the need for action.

Related knowledge is taught in an extra-occupational cycle of 6-12 months with training sessions lasting a max. of 15-20 days, each session deals with particular types of appliances. Teaching aids include presentations, instructional films, visual aids such as (material) samples, and hands-on exercises with models and mockups. For the reliable performance of maintenance jobs, however, good specialist knowledge is not enough. Maintenance staff also need to practice operating procedures and find their own solutions to problems. The interpretation of defects and detection of errors make particular demands on skilled personnel. This is why training sessions are accompanied by intensive workplace instruction which is both labor and time intensive.

In addition, for safety reasons and because the equipment and systems in question are often regionally and internationally integrated into energy networks, they are rarely available for training. Requirements for strict adherence to all relevant safety rules make realistic training difficult.

Solution

Staff who are supposed to take problem-solving action need to handle realistic tasks. As regards maintenance, the a.m. problem of equipment availability has been addressed by Technik Center Primärtechnik of RWE Rhein-Ruhr (TCP) and AREVA T&D. Both have decided to give staff and trainees a realistic approach to work functions through the use of virtual interactive equipment models. During training courses, situational tasks are to be assigned so that complete jobs can be handled. This is in keeping with the didactic principle of learning by completing an activity.

Results and Benefits

The interactive system of learning developed together with industrial partners is used by staff undergoing (advanced) training and by service technicians on the job and is at the same time seen as providing a technical infrastructure for the transfer of experience-based knowledge.

1 *3D representation of a power breaker.*
2 *Stored-energy spring actuation visualized.*

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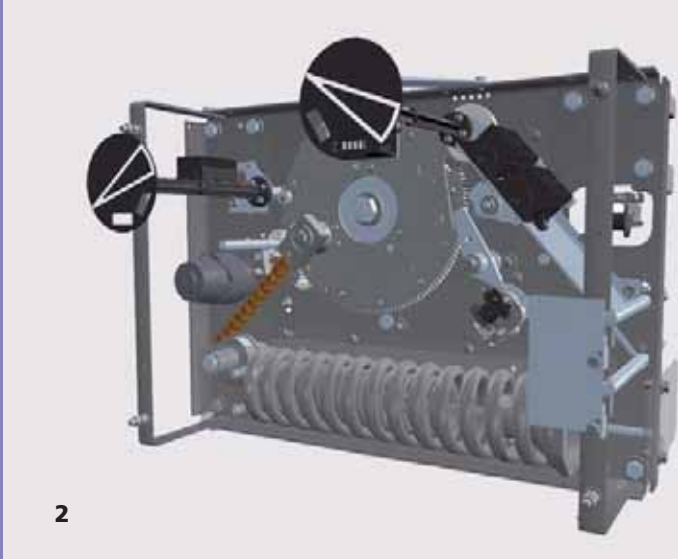
In a virtual environment, the phases of a complete activity are reflected as follows:

1. Obtaining information
   Learners can obtain information on appliance construction and functions by accessing a variety of media such as interactive 3D animations, videos and technical documents.

2. Planning
   Job scheduling is a step where required tools, materials and auxiliaries are selected and the learner has to tackle an assignment deciding on necessary tools and aids.

3. Decision-making
   The user needs to select steps necessary for his assignment from a multitude of individual operations visualized in 3D, identify them and schedule his job by choosing the right operations and arranging them in the right order.

4. Implementation
   Planned operations now have to be carried out by the learner in an interactive 3D environment either by way of free navigation or by exercising options for interaction.

5. Monitoring
   While carrying out the assignment the user gets feedback on the steps undertaken so that he may check on, and correct, his decisions. In addition, several types of result testing may be integrated into the application, such as multiple choice or association tests.

6. Assessment
   In this last phase of a complete activity, learners review planned and actual operations with a view to possible optimization and alternative approaches. Counterchecking against a Best Practice can be helpful.

Prospects

Industry uses this system of learning both as a knowledge base and training medium, and the industrial partners intend to exploit the potential of VR technology for advanced training on a larger scale. They are therefore improving the learning environments by deriving tasks from the overall process of maintenance and them as units for skill enhancement. In this process, the experience gained by long-serving technicians is a major source of procedural skills and engineering competence.

Project partners

AREVA Energietechnik GmbH, T&D Technical Institute, Regensburg; RWE Rhein-Ruhr Netzservice GmbH, Technik Center Primärtechnik, Wesel

Contacts

Tina Haase
Phone +49 391 4090-162 | Fax +49 391 4090-115
tina.haase@iff.fraunhofer.de

Marc Winter
Phone +49 391 4090-768 | Fax +49 391 4090-115
marc.winter@iff.fraunhofer.de

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TRANSFER OF VIRTUAL TECHNOLOGIES IN COMPANIES OF SACHSEN-ANHALT

Motivation

The project aims at the work-related transfer of VR technologies in a world of rapid technological advance and globalized markets where small and medium-sized manufacturers face new challenges. VR is becoming ever more important and has been discovered as a means of skill enhancement by many large companies. It can help personnel deal with complex machinery and plant and guarantees high levels of quality and efficiency in (advanced) training. ViReKon is a project designed to support small and medium-sized enterprises in the gradual introduction of VR technologies. As Dr. Reiner Haseloff put it at the ViReKon meeting on May 14, 2009, "companies in the Land Saxony-Anhalt can keep up with international competition only if they adopt the concept of progress and innovation. VR now is what used to be the CAD programs of the past, and day-to-day operations in future can hardly be imagined without VR."

The practical and demand-oriented use of VR makes it possible for companies to
– present new products which are at the design stage in a realistic virtual function, enabling the planning and optimizing of the next operations such as manufacturing, assembly, operation and maintenance at the same stage and to train potential operators,
– restructure processes, involve staff in the reorganization, train staff, and
– enhance the skills of staff in job scheduling, CNC programming or machine operation without disturbing actual production.

Solution

ViReKon has been funded by the EU and the Land Saxony-Anhalt and will make it possible for Technologie- und Berufszentrum Magdeburg gGmbH and Schweißtechnische Lehr- und Versuchsanstalt Halle GmbH to train engineers and technicians on virtual machines. Fraunhofer IFF is to design virtual training scenarios together with these training centers and instruct R&D staff from companies involved in the use of VR technologies. The project is coordinated by RKW Sachsen-Anhalt GmbH.

Results

To increase awareness among companies, the project initially pointed out starting points and applications such as assembly support and training in production and assembly lines, virtual commissioning or the development and testing of real control systems using a virtual model.

By July 31, 2009 a total of 60 trainees from 41 companies had attended five informative meetings to learn about VR and the large number of application projects the Fraunhofer IFF had worked on.

1 *Fraunhofer research manager André Winge and tbz instructor Michaela Gräf preparing for the use of virtual models during training at tbz.*
2 *VR technologies help with planning the assembly of motors and generators. Photos (2): Dirk Mahler*

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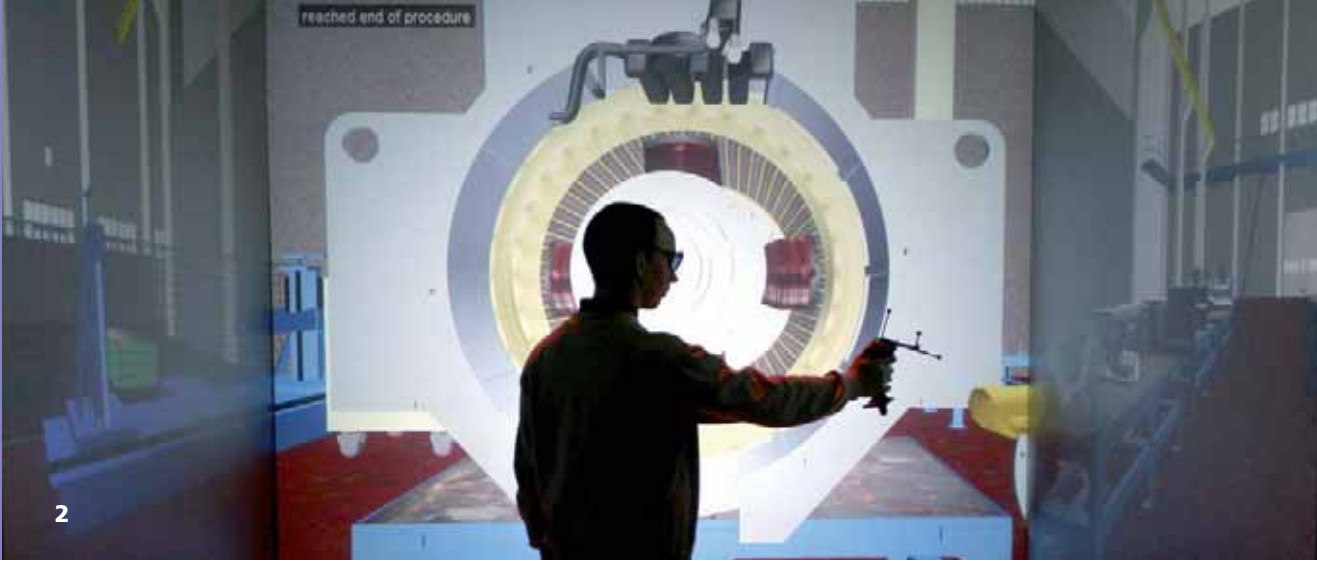
Follow-up discussions and workshops in individual enterprises analyzed the needs of the companies involved and produced outlines of subprojects. At the same time, VR tools were designed for TBZ Magdeburg and SLV Halle, the educational service providers and project partners. The gradual implementation of subprojects raised the qualifications of skilled and managerial staff. A five-day course taught VR basics, skills for operating a VR scenario and ways of generating such a scenario with the VR author of the Fraunhofer IFF (VR system).

Benefits

VR technology transfer aimed at raising the qualifications of technical staff in an efficient and purposeful manner will acquaint companies and people in the region with a new promising development. While the technology alone guarantees a high level of sustainability, integration into regional networks will encourage widespread use. An interdisciplinary team of competent partners will make sure that generally accepted solutions are found and the applications of VR, and its limits, are defined in objective terms.

Prospects

The VR solutions generated will be used permanently by the educational providers involved. Companies sharing in the project will have long-term uses in different product life cycle areas such as sales support, assembly planning and systems for skill enhancement and assistance.

Project partners

RKW Sachsen-Anhalt GmbH, Magdeburg; Technologie- und Berufsbildungszentrum Magdeburg gGmbH; Schweißtechnische Lehr- und Versuchsanstalt Halle GmbH

Contacts

Helge Fredrich
Phone +49 391 4090-129 | Fax +49 391 4090-115
helge.fredrich@iff.fraunhofer.de

Melanie Thurow
Phone +49 391 4090-332 | Fax +49 391 4090-93-332
melanie.thurow@iff.fraunhofer.de

SACHSEN-ANHALT

Europäische Kommission
Europäischer Fonds
für regionale Entwicklung
INVESTITION IN IHRE ZUKUNFT

NEW METHODS AND TOOLS TO SUPPORT CE MARKING

Motivation

Manufacturers of machinery in the EU have to adhere to guidelines and standards. At the beginning of 2010 a revised machinery directive imposed new legal requirements on manufacturers with regard to the CE marking process. For Manufacturers, conforming to legal obligations is a barrier in itself because there are, firstly, uncertainties in drawing up a risk evaluation and applying standards. Secondly, numerous companies have not yet named persons in charge for specific tasks in the process of CE marking. Last but not least, there is no suitable forum for effective and qualitative design assessment and the determination of hazards and residual risks from complex machinery and plants before these are put into practice.

Solution

A clear display format for machinery is needed to promote the exchange of information for CE marking before a machine is manufactured and in order to point out hazards at an early stage. A suitable approach is a virtual interactive 3D model which makes few demands on the mechanical engineering qualifications of the observer and leaves little room for misinterpreting the machine's design and function. The model uses a company's existing 3D CAD data which is represented in the VDT platform of Fraunhofer IFF. Functions such as movement, time sequences, procedures etc. may be added to this platform.

This is the basis for a tool in which an IT structure creates functions for identifying, classifying, describing and assessing hazards in accordance with the law. Other functions help derive necessary steps, identify residual risks and generate machine-specific documents. Action sheets and certificates of conformity can thus be issued in standard office formats and further processed for CE marking or for the life cycle of a machine.

A procedure model and suitably structured input masks help users meet the requirements of the machinery directive, for instance by entering product data. A description of danger spots, a standardized catalog of hazards, aids for systematic risk assessment and references to current standards are also provided. Users may also deposit detailed information such as descriptions of potential hazards, symbols, comments and design-related data at any machine component both as texts and graphics.

After the input of component-specific data, a catalog may be compiled to support data reuse in case of redesign or modification. Functional descriptions and the assessment of risks in the tool create a functional 3D model which may also serve to generate documentation or train machine operators.

1 *Immersive representation of danger spots.*
2 *Virtual 3D model of a printing facility with anthropometric human model and CE guideline.*

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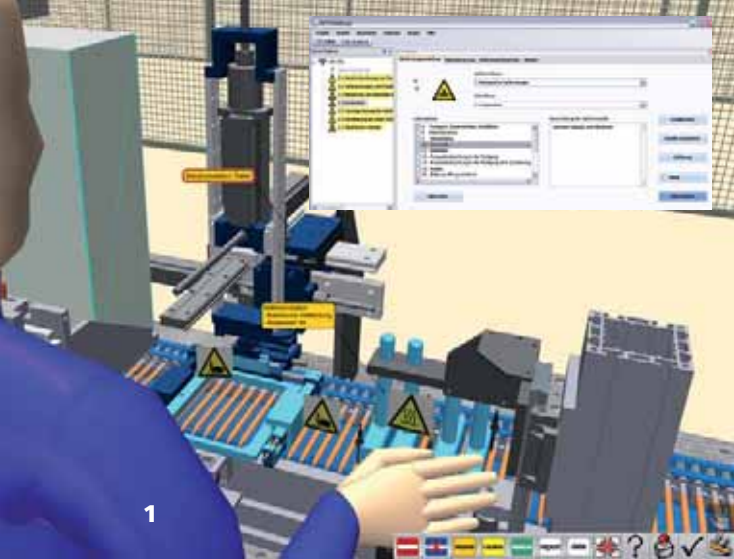
Results and Benefits

Using three different types of machines as a basis in coopera-
tion with manufacturers, the project has developed prototype
software which meets the requirements of the new machinery
directive. This makes risk evaluation in terms of the DIN EN
14 121 risk graph possible before the machine is manufactu-
red. When risks for the three machine models were assessed,
nearly all mechanical hazards were identified beforehand.
Based on the specification sheet, safety aspects may now be
discussed early on and hazards described and then resolved at
the design stage. This will save cost and time-intensive rework
which leads to a pressure of time and detracts from finding
innovative and sustainable solutions.

The prototype is a universal aid in promoting the coopera-
tion of players active in the CE marking process. At the same
time it encourages problem solving in a team. Language-
independent demonstrations of danger spots/residual risks and
machine functions may be added to the documentation on
data carriers. In addition, the virtual interactive 3D models for
different types of training may be improved for such purposes
as instruction and briefing for startup, operator training and
assisting maintenance personnel.

Project partners

BIT e.V. Berufsforschungs- und Beratungsinstitut für interdis-
ziplinäre Technikgestaltung, Bochum; Otto-von-Gericke-Uni-
versität Magdeburg; Staedtler-Mars GmbH & Co. KG, Nurem-
berg; Schiess GmbH, Aschersleben; Hegenscheidt-MFD GmbH
& Co. KG, Erkelenz

Contact

Alexander Kroys
Phone +49 391 4090-724 | Fax +49 391 4090-115
alexander.kroys@iff.fraunhofer.de

VIRTUAL INTERACTIVE ADJUSTMENT INSTRUCTIONS FOR A LASER WELDING UNIT

Motivation

LASAG AG is a leading supplier of industrial Nd:YAG lasers for material processing including drilling, cutting and welding of metals. The company, with manufacturing sites in Switzerland and branches in the U.S., Japan and Germany, sells its products worldwide. This makes it necessary, as part of after-sales services, to provide instructions in a precise, visual format which can be used regardless of location for the startup and maintenance of laser systems.

These systems have the excellent radiation characteristics and pulse powers needed particularly for fine blanking, drilling, notching and precision welding in a variety of applications. These functions require correct alignment and operation. Laser beam adjustment in particular must be error-free as the operator has to use a number of aids to accurately align several lens components relative to each other. To do so, the operator must be aware of the effects various adjustments may have, and of the impact a laser beam may produce under certain conditions. Such background knowledge and patterns of action can not be fully learned from training courses and manuals, and visual interactive media can be quite helpful in situations where handbooks and telephone support are no longer sufficient.

Solution

3D visualization can support the startup and application of complex products, while VR technologies produce virtual interactive learning environments. These environments can be handed over to the customer, together with the product, to be used for preparing adjustment steps or as an illustrative reference manual.

An interactive VR scenario has been developed to demonstrate and improve the aligning procedures for a selected laser system. As a first step, a realistic 3D model was generated from the design data of the unit. Then the sequence of adjustment steps was translated into animated virtual instructions. This involved integrating conventional media such as digital documents and component drawings into the learning environment to make it easier for the operator to relate to established manuals. At the same time, photos and videos were embedded to give the operator a choice of how to demonstrate the various steps.

Eventually the operator may view the lens alignment steps as an animated virtual presentation at optional speed and from a number of angles. In addition, individual procedures may be practiced in interactive form.

Virtual interactive instruction for aligning a laser welding unit.
Photo: Ronny Franke
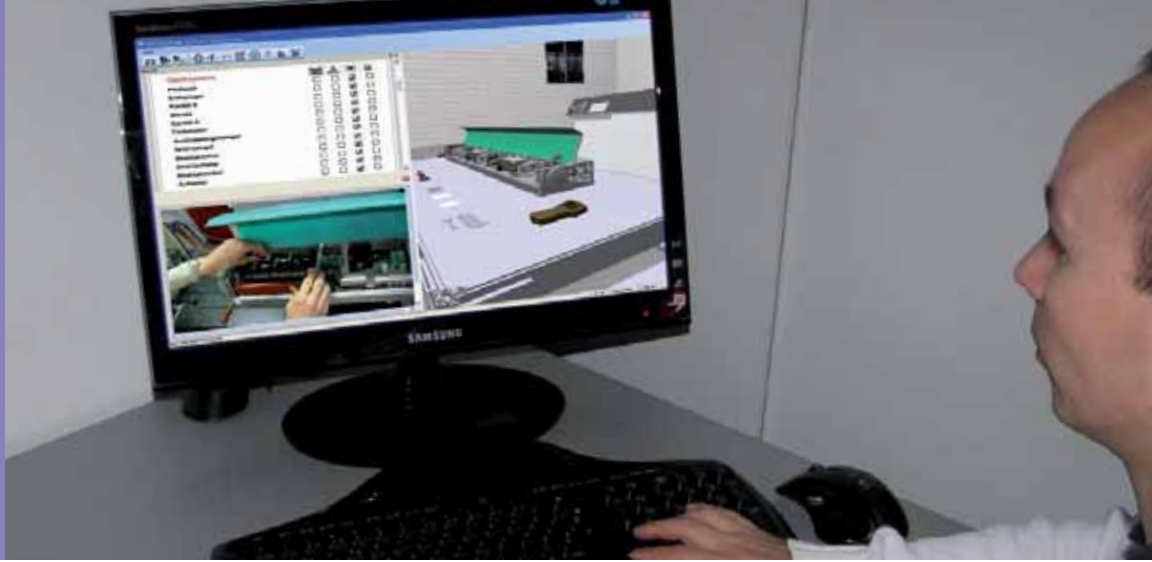
Particular effort went into the visual simulation of the laser beam during adjustment. It is very easy and simple for the operator to detect changes in the orientation and appearance of the laser when particular screws are set or lenses/mirrors introduced into the beam.

Results

The Fraunhofer IFF has generated a VR-based demonstration and training scenario for alignment operations in a selected laser system. LASAG AG can use the medium to pass on patterns of action which make adjustment more efficient so that customers may go through all necessary steps without creating hazards for themselves or the equipment.

Prospects

Project results have been evaluated in the field of after-sales services and are to be applied to other work functions with similar requirements to be performed by customers and service personnel. In the medium term, maintenance and repairs of different product versions are to be simplified through the use of virtual interactive media.

Project partner

LASAG AG, Switzerland

Contact

Ronny Franke
Phone +49 391 4090-144 | Fax +49 391 4090-115
ronny.franke@iff.fraunhofer.de
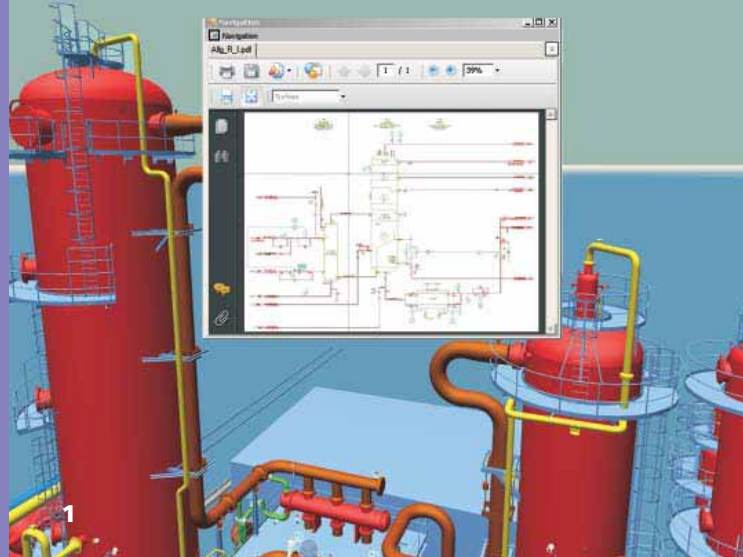
SHORT-TERM SKILL ENHANCEMENT THROUGH VIRTUAL INTERACTIVE STAFF TRAINING

Motivation

The operation of process plants requires competent and skilled personnel, particularly in risky situations. Safe and error-free working at all times will result in high availability of equipment and reduction of costs for plant operators. A major challenge is the redesign and/or conversion of existing plants where personnel have to understand functions preferably before startup and need to understand and learn the operating sequences. When a plant is new, what one needs to know for its safe operation is not only the interaction of its parts but also the place itself with locations of components (and how to reach them safely), the arrangement of measuring or control points, etc.

Conventional training methods can not quite familiarize personnel with a new plant in time. This leads to failures due to operating errors and creates a need for modern training concepts which safely prevent malfunctions during startup and immediately thereafter.

Solution

One starting point for skill enhancement is to add virtual interactive learning environments to conventional methods so that passive upfront teaching, as in the presentation of transparencies and videos, is replaced by the interactive operation of virtual models of complex machinery and plant. The participants thus interact with the virtual model and become

knowledgeable through action. These environments are also ideal for self-controlled learning where users can acquire knowledge whenever and wherever they please. Depending on their background, they may repeat learning steps as often as they like and skip others.

Results

Under the concrete project, a virtual model to train future operators was generated on the basis of the new plant's 3D planning model. In a first step, the new facility was explored with the help of the virtual model which, apart from 3D representations of apparatus, tanks, pipelines, valves and fittings, contains detailed information for instance on the medium carried in a particular pipeline, apparatus numbers, etc. Conventional documents such as technical drawings or presentations used for training purposes can also be found in the model and are linked to 3D models of related components.

This gives users complete data for understanding the facility. Basic relationships within the new plant can be easily explained using integrated text and information prepared for media presentation.

1 *Detail from the training scenario.*
2 *Future operators training on the virtual plant model.*
Photo: Dirk Mahler

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Plant operation can be trained on a PC, laptop or modern VR station so that accidents are prevented and efficiency is improved.

Benefits

As early as in the construction phase, the virtual model can help users become knowledgeable in plant commissioning so that failures from operating errors are avoided, costs are reduced and availability is increased. Staff members can familiarize themselves with the new facility before it is started up, which creates confidence and reduces maloperation.

In future, the virtual plant will be able to design, present and teach work functions, e.g. for maintenance steps, in the specified order, with instructors and course participants being able to use the learning scenario as required.

Prospects

Robert Lenz, deputy manager of the nitric acid compound plant at BASF Ludwigshafen, has found these words on behalf of the project partner BASF SE: "We intend to use the model throughout the life cycle of the plant. While it is somewhat costly to maintain the model as-built, it is certainly worth it. The advantages are plain to see. Execution times are reduced, plants are put into operation more quickly and redesign is possible at shorter notice. Last but not least, staff can familiarize themselves with the plant much more quickly." To which Axel Franke, Senior Engineering Manager at BASF, added: "In future, there will be a digital plant for each plant in the real world."

As a joint vision, the scientists from Fraunhofer IFF and BASF SE wish to model the plant design in the near future and, at the same time, simulate the process complete with process streams.

Project partner

BASF SE Ludwigshafen

Contacts

Andrea Urbansky
Phone +49 391 4090-321 | Fax +49 391 4090-93-321
andrea.urbansky@iff.fraunhofer.de

Sabine Szyler
Phone +49 391 4090-121 | Fax +49 391 4090-93-121
sabine.szyler@iff.fraunhofer.de

Ronny Franke
Phone +49 391 4090-144 | Fax +49 391 4090-115
ronny.franke@iff.fraunhofer.de

DEVELOPMENT OF A DESIGN SOFTWARE TO OPTIMIZE VEHICLE PARTS

Motivation

The process of developing a vehicle undergoes different phases, with the design and concept emphasized early on and the technical implementation of the product and its manufacture coming to the fore later. At the concept stage, engineering parameters are already defined which serve as development guidelines. To avoid having to develop a completely new vehicle, preliminary design involves dimensioning which often uses parameters of existing components from earlier models. Unfortunately, the data of developed modules is never current since developments in a current series run parallel with the preliminary design for the next series. In addition, the new module configurations to be identified and calculated as part of preliminary design have never been calculated before. This is why requirements deriving from preliminary design are kept vague or the module configurations provided as development input remain suboptimal because too much computing time is needed.

Problem

The results of preliminary design can be improved with a software that calculates and selects possible module configurations. This is to serve as a tool for optimizing results at the early development stage so that a technical department may join a project at a higher design level and reduce related expenditure. This problem was successfully handled by Fraunhofer IFF and IGS Development GmbH in a joint project. Using the example of an exhaust line, they developed a system for evaluating technical and physical design criteria and optimizing module configurations. The technical department can then work at a high level of development and produce a more detailed set of assignments.

Solution and Results

Simulating the exhaust line is necessary for optimization so that parameters in the operating room can be determined. The description to be formulated was to enable very efficient and sufficiently accurate calculation. For this purpose, physical relationships were studied in detail and calculations made in fluid mechanics (CFD). This resulted in characteristic curves which describe the quasi-static transmission behavior of individual modules throughout the workspace. These curves were approximated by three-dimensional polynomials. This enables an efficient calculation of each module.

Retroaction is a factor to be considered when linking modules up into an exhaust line. This is why the language chosen for models was Modelica. The models were then managed, wired up and simulated with a "Dymola" simulation tool which also helps the developer assemble the exhaust line. The modules can be freely linked to form an exhaust line from a variable number of modules in any order desired and with one or more flues. The assembled exhaust line then forms a model which is ready for simulation and parametrization as a basis for design optimization using specific series modules.

Product optimization at an early design stage.
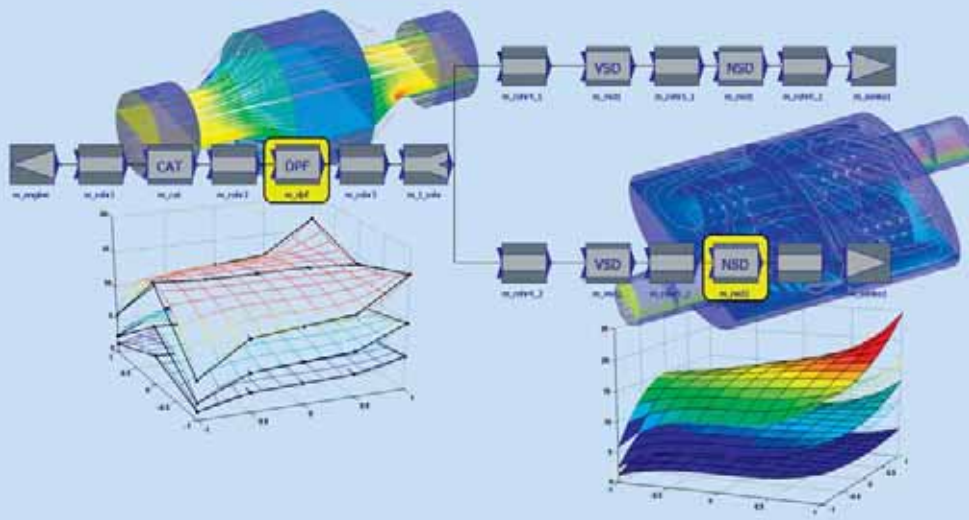
The Dymola simulation tool alone is neither suitable for the dynamic linking of different modules into an exhaust line, nor can it calculate them without user intervention. A software tool with a special graphic surface to suit the problem was therefore developed for controlling the simulator. It enables the developer to make a number of requirements affecting the choice of modules for the exhaust line. The tool which has been generated then produces all valid versions and calculates them with the help of Dymola while including general parameters such as module spacing and the swept volume of the engine.

After simulation the assembled exhaust lines which best conform to specified targets are automatically selected. Several optimization targets can be weighted against one another, with calculation results for selected lines made available both as tables and in graphic form. In the end, modules of the selected line may be classified as "preferred", which again affects the choice of modules for projects in other model ranges..

Benefits and Prospects

A result of the project was the development of a software to simulate and optimize series modules of an exhaust line. The project is aware of the company's exhaust line modules and related requirements and can evaluate them. This may reduce the overall development costs of an exhaust line because the variance of its possible configurations can be limited at an early project stage and the design process optimized. The planning for the next step based on the results of this development project is an upgrade to a company software of IGS.

Project partner

IGS Development GmbH, Harbke

Contact

Torsten Böhme
Phone +49 391 4090-234 | Fax +49 391 4090-93-234
torsten.boehme@iff.fraunhofer.de

SACHSEN-ANHALT

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GENERATIVE MANUFACTURING PROCESSES FOR CUSTOM-MADE SPORTS SHOES

Motivation

Mass customization is becoming ever more important in the footwear industry, with lasts being instrumental for making such components as outsoles and stiffeners. Conventionally, lasts for series production are made by contour milling using hand-made samples. For this the lasts have to be digitized and the data thus generated at high cost transmitted to the milling machine. The expensive procedure has caused more and more manufacturers to move the production of lasts to low-wage countries. Against this background, the project sought to develop an alternative technology for making individual lasts that would streamline the production of sports shoes.

Solution

Using 3D CAD data of individual lasts generated by scanning from scatter plots, Laminated Object Manufacturing (LOM) produces lasts directly from layers of material coated with adhesive and glued onto a platform or semi-finished model. The contour of the component is then cut out by laser. Very complex geometries can thus be manufactured without any tools. The fabrication space of 800 x 600 x 600 mm is generously dimensioned to make production more efficient and can accommodate up to 50 lasts at a time for a variety of foot geometries. Apart from studying the basic suitability of the lamination method, the project also involved a cost comparison of the milling process.

Results

The mechanical and thermal properties of LOM lasts were determined on certified testing machines of the footwear industry, with specimens tested under production conditions for such main characteristics as temperature, moisture content, pressure and vibration behavior. During manufacture there is particularly high pressure on the heel which was therefore given particular attention. In addition, the fatigue strength of lasts was studied in loading tests.

In practical tests of current ranges from leading suppliers such as Ricosta, Steitz and adidas, prototype lasts were made under production conditions to suit the geometries of series production lasts. Similar to the original lasts milled from plastic, they had folding mechanisms and metal fittings for mounting the uppers.

Several times during a shift, the prototypes were exposed to typical production loads such as heat, moisture, pressure and vibration. Test results indicated that 90% withstood these loads. The remaining 10% failed due to poor infiltration of components in critical regions (undercuts) or delamination in component geometry due to material failure at points with max. loading.

1 Test stand for LOM prototype lasts. Photo: PFI Pirmasens
2 Lasts with folding mechanisms in place. Photo: Susan Gronwald
3 Individual lasts with integrated RFID tag. Photo: Uwe Klaeger

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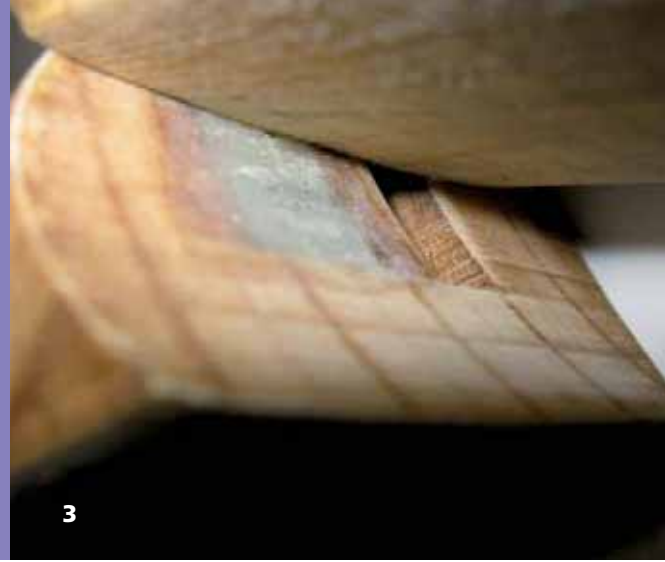
For the automatic identification of lasts in future series production, the integration of radio frequency identification (RFID) tags was tested. Any loads from heat or pressure were to be avoided here to keep the information carriers intact. For integration into the lasts, design-specific and production-specific requirements were therefore observed. As a result, RFID tags measuring 10 x 15 mm were imbedded in a recess immediately on the surface and held in place by single-component adhesive. The protective layer in this case was 1 – 1.5 mm which was structurally quite sufficient and did not interfere with the selection process.

Finally, tag functions in temperatures of up to 120°C as common in production were studied. As regards manufacturing costs, reproducibility and the probability of tags being damaged in production, the integration method used proved to be best suited as shown in several trials.

Prospects

First attempts to make laminated individual lasts have shown that the process can help reduce production costs, which makes it an interesting proposition also for mass customization. For the first time, an additive procedure could be used to make prototypes or lasts in series production.

Further studies will seek to validate the results obtained and, in particular, to improve the wear resistance of lasts. At the same time, the LOM process needs to be accelerated compared with conventional production by milling. This will require the optimization of design and manufacturing techniques in the plant as a whole (feeding/lamination/cutting systems), for which more studies will be required.

Project partner

PFI Prüf- und Forschungsinstitut Pirmasens e.V.

Contact

Dr. Uwe Klaeger
Phone +49 391 4090-809 | Fax +49 391 4090-250
uwe.klaeger@iff.fraunhofer.de

AiF
Ideen eine Zukunft geben

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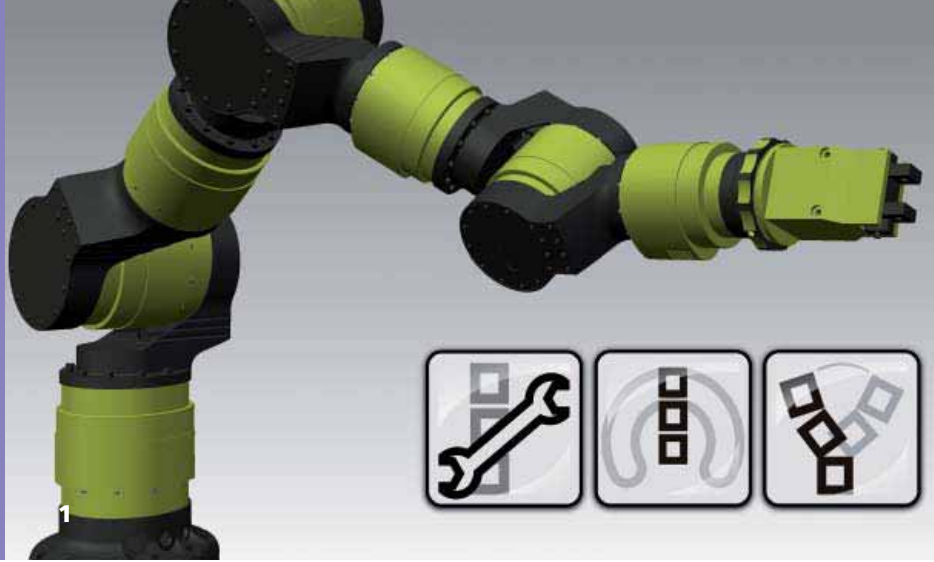
EFFICIENT PLANNING OF MODULAR AUTOMATION SYSTEMS

Motivation

Problems and Results

System providers wishing to make their mark in competition find themselves under constant pressure to integrate components, most of them already in existence, into new and innovative systems. The key to success here is a sharp customer focus and thorough knowledge of one's own system components. A flexible and confident response to customer needs therefore requires close cooperation between the development, manufacturing and sales departments.

Against this background, software solutions such as product configurators have proven their worth in a variety of industries as integral links between development, manufacture and customer specifications. the Fraunhofer IFF has gathered experience in the field by contributing to several projects and attached great importance to safeguarding the solutions found, which is more than is common when working with configurators. Apart from rules and conditions for configuration, methods for calculation, simulating physical interrelations and animation were also integrated.

Under a project conducted at Fraunhofer IFF, a program was to be developed for SCHUNK GmbH & Co., a market leader in automation and the world's leading provider of clamping systems which would make it possible to virtually assemble automation modules incorporating SCHUNK components and enable direct visualization and testing.

The proposed software would direct sales staff and customers toward on-site solutions for automation problems, with functions designed to
– configure an automation approach based on a component library with 3D visualization,
– enable problem-oriented validation of the robot's kinematic structure,
– calculate and visualize the work space,
– animate motion,
– detect collision, and
– perform inverse coordinate transformation.

The basic configuration element is the library with complete data on modules such as configuration rules, module geometries for visual representation, and simulation-related physical parameters including weights, moments of inertia, etc. for verifying the solution. In addition to actually existing modules, the library contains components for generating new customer-specified connecting elements. The resulting specifications are directly used for development and manufacture.

Configuration uses direct feedback through 3D visualization. Modules can be put together at specified interfaces, and their parameters such as travel, module lengths, etc. are editable.

1 *Virtually configured robot with seven degrees of freedom.*
2 *Calculated work space of a portal with three translatory and three rotatory degrees of freedom.*

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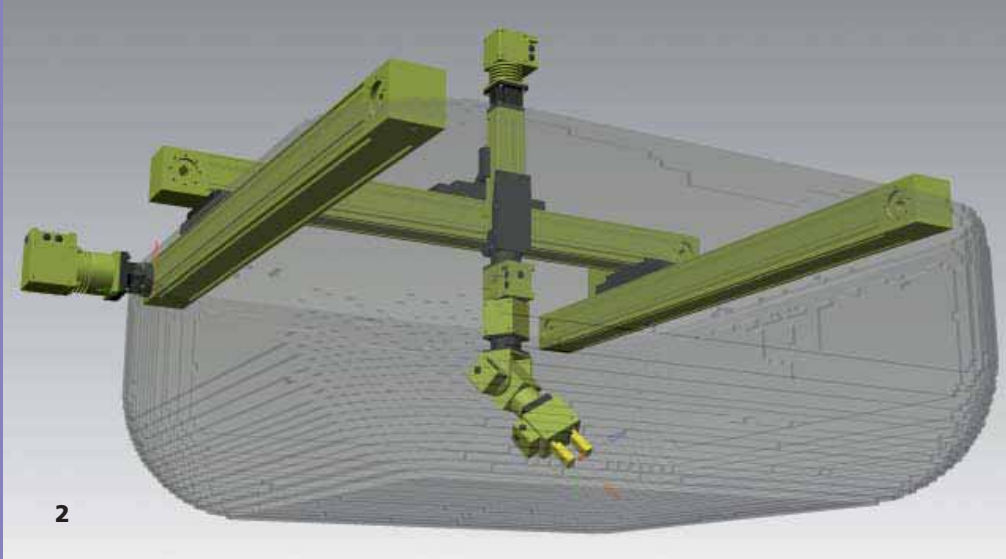
Configurations and their parameters may be adjusted at any time for an iterative approach to optimization and the incorporation of existing solutions.

The iterative method used to calculate work spaces for freely configurable solutions determines both their max. dimension and holes within workspaces and makes allowance for the robot's collisions with itself and the environment. The work space and robot are shown in 3D visualization.

Motion can be visualized through direct manipulation and by defining a motion sequence, the robot being moved either by driving the axles or manipulating the Tool Center Point (TCP) by way of inverse coordinate transformation. Here again a collision test takes place.

Benefits

The project partner has applied this software in practice for more than half a year and found it to be operative and useful. Benefits include big time savings in configuring robot systems, better support for decision-making in dealing with customers, and more effective safeguarding of automation approaches.

The project produced and improved partial solutions that are essential to virtual engineering. Thus the algorithms for calculating inverse coordinate transformation were upgraded, as was the know-how for real time collision detection on standard PCs which is now being used to advantage in other projects.

Prospects

Several expansion stages can be imagined in view of the progress made to date, one of a dynamic nature that would look into the loads acting on drives so that their dimensions can be optimized. Elasticity and vibration could be simulated later.

Another starting point for improvement is robot programming where a generated program is tested on a virtual robot and then transmitted to a real robot. This would make the software an engineering tool that could be used from the first customer contact through the planning stage to operation at the customer's premises.

Project partner

SCHUNK GmbH & Co. KG. Lauffen/Neckar

Contact

Eric Bayrhammer
Phone +49 391 4090-105 | Fax +49 391 4090-93-105
eric.bayrhammer@iff.fraunhofer.de

1

REALISTIC VIRTUAL SYSTEMS TO IMPROVE VOCATIONAL TRAINING

Motivation

While training at tbz (Technologie- und Berufsbildungszentrum Magdeburg gGmbH), prospective electronics and mechatronics technicians learn to combine mechanical and electronic components into complex systems and then, in a six-week course, how to control them by programming SPC (stored program control) units. To prepare trainees for practical requirements, tbz uses the model of a belt conveyor system. This, however, can only represent a fraction of a large industrial plant which in most cases is more complex. Thus trainees often find it difficult to integrate what they have learned from the model into an overall engineering context and then to apply it to industrial practice.

Solution

This is where the "Virtual training systems" subproject comes in. As part of "VIReKon", a project jointly completed and implemented with Virtual Engineering expertise and the VIVERA/AVILUSplus branch, it aims to make it easier for trainees to apply model-derived knowledge to a more complex installation. The required virtual facility has been designed together with tbz as an addition to the standard curriculum and is meant to illustrate the complex relationships governing a real world system. The virtual facility is to be SPC driven to demonstrate the effects of a realistic control program. At the same time, developers of the model facility were to make sure that the relationship to a realistic training model is not lost. In view of these requirements, the system chosen was a handling facility from the bio-engineering industry.

Approach

As a first step, the system was visualized using a virtual 3D model based on the design data of the original facility. The geometric axes had to be restructured relative to each other to suit their mutual kinematic dependencies because the hierarchic structure of individual objects in the CAD system did not match the real hierarchy of movement in the eventual virtual model. To represent paths of motion in the functional model, animation scenarios were generated for specific axes. The visualization system for the revised virtual handling facility is the Virtual Development and Training Platform of Fraunhofer IFF.

The "WinMOD" software tool was used to functionally represent in the model the real facility's logical interrelations in terms of physics. This signal simulation can be combined with SPC systems from different manufacturers and performs data exchange and the logic behavior simulation of the model in real time. This is necessary if the facility model is to be used for the specified training purposes. Once the real SPC is connected, the functional model will react as if it was real so that trainees can test control procedures and programmed parameters easily and without risk in a normal classroom. Any operating errors will have consequences only in the virtual world where nothing can be damaged or destroyed, which is a great advantage in the training process.

1 Trainees at tbz handling the virtual model of a real machine. Photo: Dirk Mahler
2 Virtual handling facility in a VR environment.

2

Results and Benefits

In the virtual sphere the most different examples may be practiced, trained and tested, which opens up numerous opportunities for trainees and instructors to engage in programming and operation. Specific error scenarios may for instance be set up to confront trainees with a variety of business-related cases to improve their skills at problem solving.

Whereas work on the PC is for individuals, the virtual world makes team training possible. For example, each trainee could be given a subproblem to solve for programming a facility, followed by integration. This would broaden and diversify the range of assignments and training options that can be expected from virtual systems.

Project partners

RKW Sachsen-Anhalt GmbH, Magdeburg; Technologie- und Berufsbildungszentrum Magdeburg gGmbH; Schweißtechnische Lehr- und Versuchsanstalt Halle GmbH

Contacts

André Winge
Phone +49 391 4090-782 | Fax +49 391 4090-115
andre.winge@iff.fraunhofer.de

Thomas Reek
Phone +49 391 4090-203 | Fax +49 391 4090-250
thomas.reek@iff.fraunhofer.de

SACHSEN-ANHALT

Europäische Kommission
Europäischer Fonds
für regionale Entwicklung
INVESTITION IN IHRE ZUKUNFT

LONG-TERM OPERATION OF AUGMENTED REALITY-BASED SYSTEMS TO ASSIST MACHINE OPERATORS

Motivation

In the life cycles of goods today there are challenges such as customized product versions and development cycles which grow shorter all the time. While ranges are becoming more complex, a trend to better product quality requires the adjustment of work cycles. Industry is therefore seeking to help operators doing manual work with IT assistance systems. A promising approach to dealing with stricter requirements particularly in the field of manual operations is Augmented Reality (AR) which presents information in the visual field of users as required by the situation, for example with head mounted displays (HMDs).

R&D in the past has mostly dealt with the technical side of AR systems whose potential can be tapped even better by emphasizing user aspects such as ergonomics, system acceptance and factors to do with long-time use and relating to occupational medicine, cognitive psychology and strain physiology.

Fraunhofer IFF is seeking better insights into the user-oriented design of mobile AR assistance systems which could then give productive long-time service in industry under optimized conditions of stress and strain.

Solution and approach

A reference unit for long-time studies recently established at Fraunhofer IFF provides reproducible conditions for the long-time analysis and comparison of AR systems, methods and processes. The max. period of continuous use at this time is four hours, and the design is modeled on an industrial order picking system where order pickers remove parts from storage and put them into a basket. Orders are displayed in two ways, firstly as complete orders on a paper list for sequential processing and secondly through a mobile AR system with HMDs as a combination of text and pointers. In order to establish long-time effects from the operation of an AR system, an interdisciplinary study involved the industrial partner as well as cognition psychologists and occupational physicians.

Objective and subjective stress and strain was determined in tests with 20 healthy test persons lasting two and four hours. At the same time, productivity was measured by the number of operations per unit of time and the number of picking errors per order recorded and evaluated. For the objective determination of stress and strain in test persons, a digital long-time ECG recorder worn by test persons monitored their heart rate variability (HRV). Subjective stress was captured by filling out questionnaires immediately before and after the tests.

Test person using an AR system for order picking at reference unit of the Fraunhofer IFF
Photo: Jens Grubert

Results und Prospects

For two-hour and four-hour tests alike, an analysis of heart rates and questionnaires showed no significant differences between working with AR systems and conventional methods. In the four-hour trial, the AR system brought a marked productivity increase compared with the use of paper lists, and a significantly greater number of parts was picked. At the same time, far fewer items were mixed up by the system than on the paper lists. There was hardly any difference between the two methods in cases where too few or too many items had been picked.

To help optimize the system, more practical tests of the new procedure in the reference unit are planned with greater emphasis on aspects of cognition psychology and subjective standards of stress and strain. The medium-term aim is to support the generation of human centered AR systems for industrial use.

Project partners

Otto von Guericke University Magdeburg; Ulm University; Volkswagen AG, Wolfsburg

Contacts

Jens Grubert
Phone +49 391 4090-715 | Fax +49 391 4090-93-715
jens.grubert@iff.fraunhofer.de

Dr. Rüdiger Mecke
Phone +49 391 4090-146 | Fax +49 391 4090-115
ruediger.mecke@iff.fraunhofer.de

Comparison of conventional procedure (paper list) with four-hour test using the AR system

Average no. of jobs

No. of jobs (15 parts per job)
- AR system: 85,05
- Paper list: 73,32

Mean error

Percentage error

- Mix-up error: AR system 0,3; Paper list 0,54
- Fewer parts: AR system 0,24; Paper list 0,17
- More parts: AR system 0,07; Paper list 0,07

■ AR system ■ Paper list

1
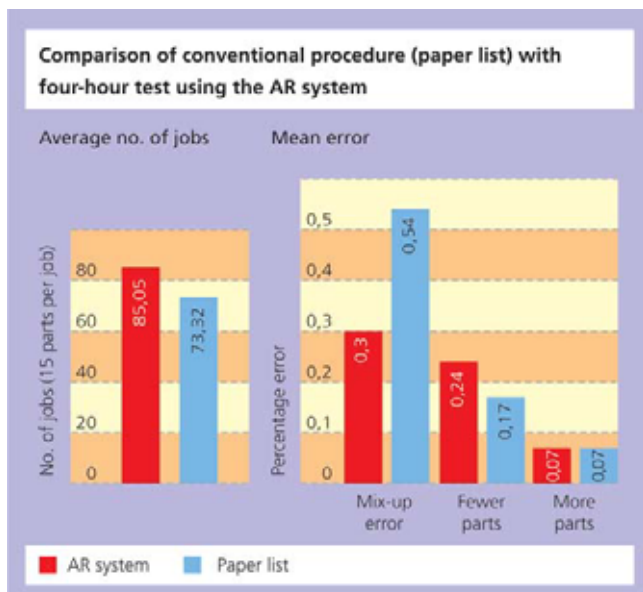
VISUALIZATION PLATFORM FOR REPRESENTING AND PLANNING ELECTRIC NETWORKS

Motivation

Electricity which is readily available nationwide has secured living standards in the past and promoted economic growth on a large scale. Of key importance in this connection is an infrastructure which can satisfy growing demand. Just what challenges the future holds in store can be seen from a rapidly rising interest in electromobility and renewable energies.

Network operators bear a particular responsibility for secure supplies, quality assurance and the intelligent extension of grids in future. In addition, they need to prepare for environmental protection, the involvement of local residents in the planning process, and in-depth exchanges with municipal bodies. A leading operator in northern and eastern Germany willing to face these challenges and embark on new paths is 50Hertz Transmission. In the circumstances described above, new VR techniques can provide intelligent answers to new problems.

Approach

The basic technology for innovative system solutions here is virtual interactive 3D visualization which can represent infrastructure improvements proposed for a particular location with a high degree of realism long before construction starts. This new approach could be described as interactive presentation and planning enabling, for example, real time comparisons of different versions and interactive planning modifications. In

this connection, additional measuring and analytic procedures in the 3D world help create a link between lucid, emotional perception and realistic inspection in terms of virtual reality so that visualization contents can be viewed objectively. Prior to any presentation and analysis, however, 3D modeling of in-situ conditions in the virtual space is required as a first step. This includes such elements as real estate, buildings, vegetation and a number of other factors. While ground modeling is based on geodata and particularly digital terrain models and orthophotos plus other data from an automated property map (ALK), further modeling of the required 3D buildings uses a digital urban base map and/or ALK as well as additional readings and information, e.g. from flyovers.

Once the textured models have been integrated into the virtual 3D world, a realistic element is added in the form of ambient patterns such as vegetation and street lighting. If necessary, a realistic soundscape can be incorporated into the virtual 3D model for better immersion of the interactive urban 3D visualization. Static 3D models alone, however, would not serve the purpose. To represent a proposed route in a realistic format, users may rely on a variety of system functions such as a library containing over 20 types of towers which may be

1/2 A VR toolkit is used to integrate the electrical infrastructure into the 3D model where it is faithfully reproduced.

2

optionally positioned in 3D. Differentiation into support/dead-end towers, etc. and various types of insulator mounting make the virtual route look realistic even in detail.

Other functions such as analytical tools help to objectively assess the contents shown. One of these, a visibility test, marks positions which afford an unobstructed view of the route so that areas affected by planning, and ways of minimizing possible inconvenience can be identified.

Results

The project described here has shown that virtual interactive 3D models can substantially contribute to infrastructure development and grid extension, their main potential being a graphic form of representation which promotes quick understanding of the subject. Approaches to implementation can be viewed and studied in a realistic environment for smoother decision-making. The added value of such types of presentation and communication stands out in this context.

Prospects

The successful prototype suggests a wider use of the technology for the a.m. application. If in future all parties concerned should accept these virtual tools as useful, the technical approach chosen may be extended to many other projects in the field of infrastructure development.

Project partner

50Hertz Transmission GmbH, Berlin

Contact

Andreas Höpfner
Phone +49 391 4090-116 | Fax +49 391 4090-115
andreas.hoepfner@iff.fraunhofer.de
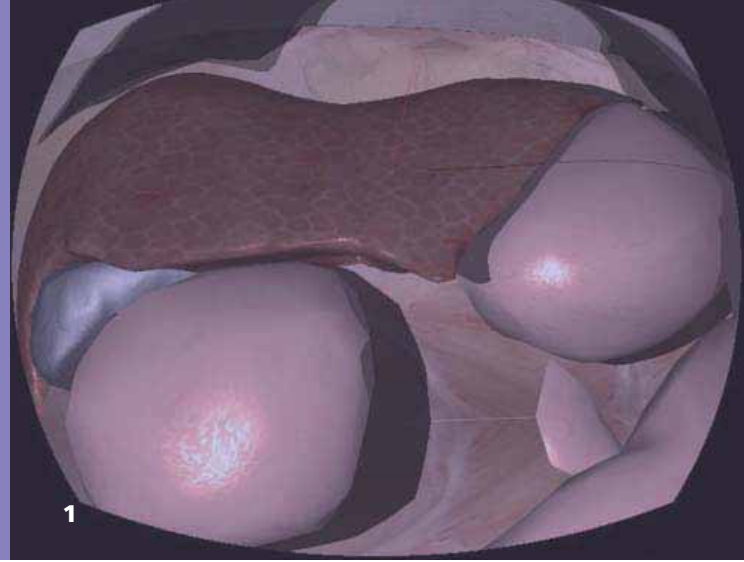
REAL TIME SIMULATION OF PATIENT-SPECIFIC ORGAN MODELS

Motivation

Surgeons are facing new challenges day after day. While their priority is to give patients the best care possible, there is also a need to use operating theaters to capacity and shorten the length of stay in hospitals to make room for new patients. In this connection, laparoscopy has paved the way for microinvasive operations which are very gentle on the patient. The surgeon introduces endoscopes through small holes and, for orientation, a special endoscopic camera which transmits an image from the inside of the patient to a monitor. The operation has many advantages for patients and for cost cutting in hospitals but at the same time makes ever stricter requirements on the attending physician. Laparoscopy is a complicated technique for learners, and even experienced surgeons need to practice with instruments for new types of operation constantly.

There is an urgent need for suppliers of ever more complex instruments, and physicians undergoing (advanced) training to test laparoscopic tools and techniques so that operations may be performed to the highest standards of safety and reliability.

Solution

This is to help physicians use new methods and instruments with computer simulations that are as realistic as possible and may serve not only to teach basic skills but also to familiarize experienced surgeons with the latest developments.

To make a simulation as realistic as possible, it has to start from true patient data, followed by the processing of models with advanced visualization methods to create a form of representation that resembles an operation in the real world. Apart from visualization, interaction with virtual organs also requires the physical simulation of tissue characteristics which should come as close as possible to real conditions so that training progress can be efficiently translated into practical use.

1 Site of an abdomen operation, with the liver (reddish brown) and intestines (pink) in the foreground. The endoscopic camera produces a typical distortion of the image which is emulated in the simulation.
2 Model of a liver with inserted vessels and a tumor. Physical simulation enables interactive tissue deformation.
3 Medical image data on which virtual models are based may be used in training to give instructions or improve navigation.

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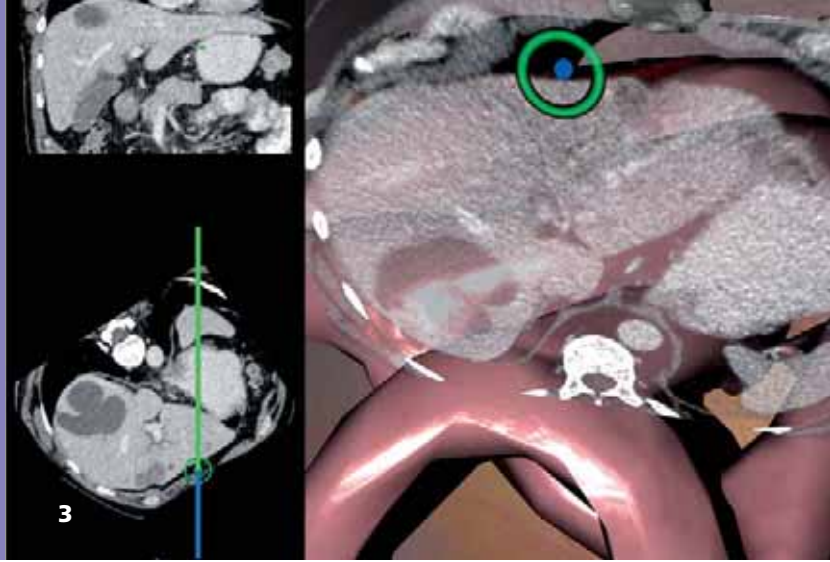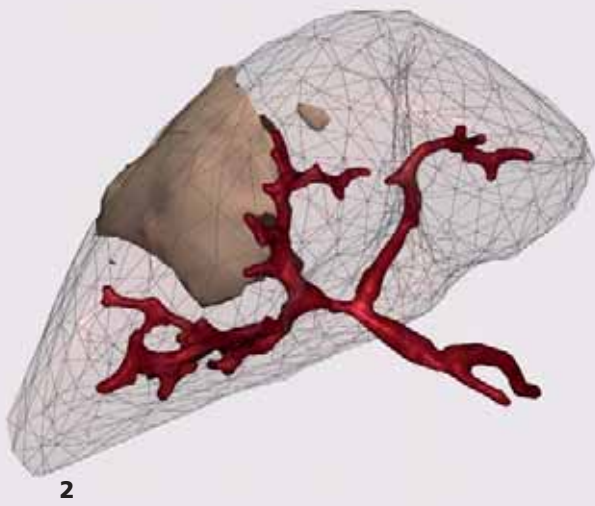
Approach und Results

The project aims at creating a general processing capability for generating, simulating and visualizing organ models and uses patient data from medical imaging procedures such as CT or MRT to produce and process surface models of organs. Together with photos of open surgical operations this enables realistic visualization of color, light and the image distortion that is typical of endoscopic cameras. The simulation parameters required for physical simulation can be determined from readings for various organ specimens and transferred to simulation models. Apart from homogeneous organ behavior, these can also show local characteristics such as firm tissue infiltrated, for example, by a tumor.

For training under concrete conditions, artificial simulation scenarios with a specific learning target may be generated apart from patient-specific ones. These may combine models of different patients so that simulation may, for instance, place a tumor at a specific point for training to operate this localized tumor.

Benefits

Simulating operations may familiarize surgeons with new methods and instruments so that they can gather experience and acquire necessary skills without any risk. Progress can be monitored because the application of forces and motion sequences can also be simulated. Instrument manufacturers may use simulation modules to have prototypes evaluated by surgeons at an early design stage and benefit from the resulting feedback.

Project partners

Universitätsklinik für Allgemein-, Viszeral- und Gefäßchirurgie; Institut für Simulation und Grafik (ISG); Institut für Elektronik, Signalverarbeitung und Kommunikationstechnik (IESK), Otto von Guericke University Magdeburg.

Contacts

Simon Adler
Phone +49 391 4090-776 | Fax +49 391 4090-115
simon.adler@iff.fraunhofer.de

Dr. Rüdiger Mecke
Phone +49 391 4090-146 | Fax +49 391 4090-115
ruediger.mecke@iff.fraunhofer.de

GEOMETRIC 3D MODELS FOR GEOMETRICAL APPLICATIONS

Motivation

The increasing availability of various novel measurement methods and technologies in the Life Sciences puts higher demands on analyzing, visualizing, linking and modeling the data collected. As a result properties such as objectivity, comprehensibility and particularly the demand for a high through-put attach increasing importance to the automation of the modeling processes.

The motivation for developing such models is primarily due to the following:
1. Gaining a comprehensive insight into and understanding of the physiology and histology of certain organs or tissues and their development over time, often connected with statistical information on biological diversity;
2. Using the models as (reference) maps for the preparation of spatial correspondence and the visualization of multi-modal experimental or diagnostic data;
3. Controlling model-based micro-dissection systems for precise cutting of defined tissues from organs.

Solution

As the range of imaging methods used for model generation is very wide, particularly high demands are made on the versatility of the algorithms and tools used for automatic model generation. Furthermore, for the modeling process biological expert knowledge is needed. However, typically this expertise is not available. For this reason the model is generated on the basis of data using characteristic reference patterns. Besides

traditional statistical approaches, particularly machine-based learning systems and artificial intelligence have proven successful for this type of data analysis and modeling.

When the pure models have been generated, applying them as atlases and linking them with other data is not only a scientific challenge, but provides specific potentials for the economic utilization of the methods and tools developed. To this end, powerful algorithms are being developed for recording data of diverse modality in the models previously generated

Results

Working closely together with experts from biology and medicine, we succeeded developing and implementing a pipeline for automatic model generation in line with the above requirements. It is only used as a platform to integrate specific data, e.g. on genomic, proteomic or metabolic level, into the relevant spatial context. The range of process applications varies from storage and transport organs such as seeds, roots and stalks in the area of plant biology, to the brains of mice with a prospect in medical applications.

1 *Typical microscope image of a leaf-stalk cross-section required a hundred to a thousand times for model generation.*
Photo: Udo Seiffert
2 *Three-dimensional model of a tobacco leaf-stalk.*

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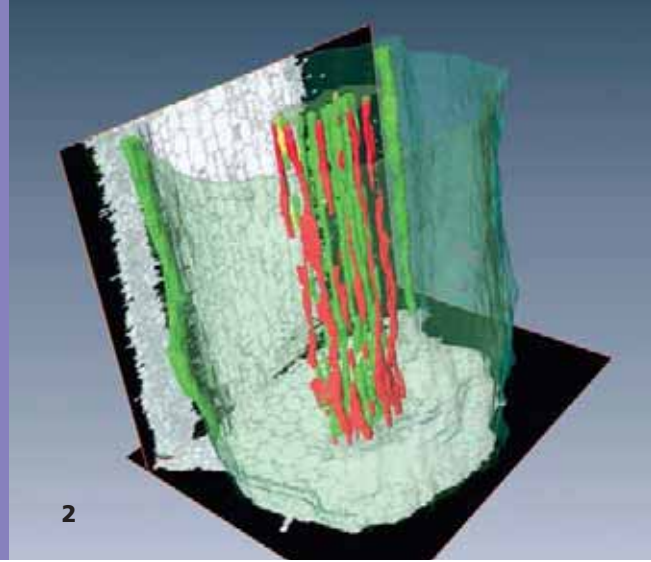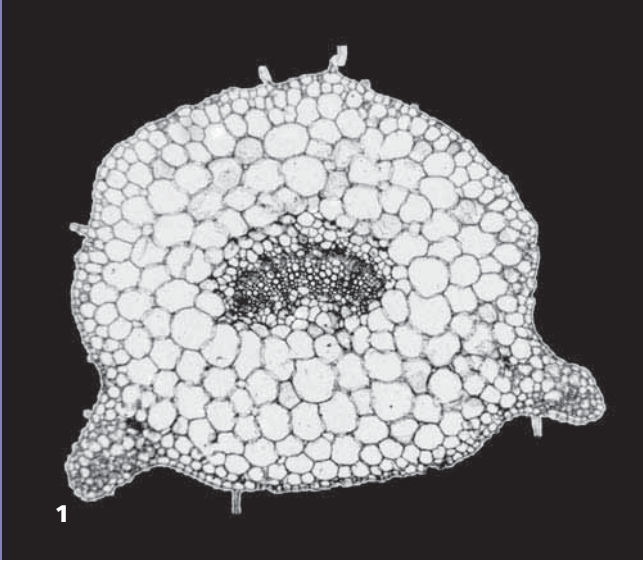
Benefits

Theses technologies offer the user a wide range of bene-fits. First and foremost the amount of manual work can be considerably reduced which does not only provide access to hitherto bound human resources, but also decreases the subjective factor and fault-proneness. However, the fact that novel biological questions profiting from the high through-put capability can now be addressed, is even more important because it extends the market potential of the developed tech-nologies considerably.

Prospects

Future work will primarily go in two directions. On the one hand, the technology will be further developed and tested so that a wider base of image data will be available. This in turn will open up new fields of application. On the other hand, the core algorithms will be further optimized so that they can also be applied to the available hardware, e.g. multi-core proces-sors and modern graphics cards. The final aim is to generate models in a shorter time and integrate the registered com-prehensive data into these models. This will help increase the acceptance and indirectly pave the way to further applications.

Project partners

MMI Molecular Machines & Industries AG, Eching; Leibniz-Institute for Plant Genetics and Cultivated Plant Research (IPK), Gatersleben; Scottish Crop Research Institute (SCRI), Dundee, Great Britain; the University of Adelaide, Australia

Contacts

Prof. Udo Seiffert
Phone +49 391 4090-107 | Fax +49 391 4090-93-107
udo.seiffert@iff.fraunhofer.de

Felix Bollenbeck
Phone +49 391 4090-790 | Fax +49 391 4090-93-790
felix.bollenbeck@iff.fraunhofer.de

HIGHLIGHTS, EVENTS AND TRADE FAIR PRESENTATIONS (SELECTION)

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January 27 – 28, 2009, München

BME-Forum "Purchasing cast members"

Organizer: Bundesverband Materialwirtschaft, Einkauf und Logistik e. V.

Lecture: Sicherstellung der Qualität durch optische Methoden

Contributors: Dr. Dirk Berndt

January 28 – 29, 2009, Düsseldorf

2nd Annual conference Condition Monitoring Forum 2009

Organizer: marcus evans (Germany) Ltd.

Contributors and moderation: Dr. Frank Ryll

February 11, 2009, Magdeburg

Kick-off workshop CEESA

Organizer: Agentur für Technologietransfer und Innovations-förderung GmbH Anhalt; Zentrum für Regenerative Energien Sachsen-Anhalt e. V.

Contributors: Dr. Gerhard Müller

The "Cluster for renewable energies in the Land Sachsen-Anhalt" (CEESA) took up its work in Magdeburg in February 2009. This association of regional companies and research institutions aims at strengthening the sector and consolida-ting the leading position of the Land in the field of renewable energies. The Ministry of Economy and Labor of the Land Sachsen-Anhalt is funding the project with 500,000 euros. During the kick-off event at the Fraunhofer IFF, Dr. Reiner Ha-seloff underlined: "Sachsen-Anhalt offers excellent conditions. In the field of renewable energies, particularly wind power and photovoltaics, we hold a leading position in Germany. With the cluster initiative we want to further consolidate this leading position in order to increase the competitive edge of the companies located in our region."

The agreement on future cooperation in the CEESA Cluster was signed by: Prof. Zbigniew Styczynski, CEO of Zentrum für Regenerative Energien Sachsen-Anhalt e. V. (ZERE), (Center for renewable energies); Cluster manager Frank Busch from ATI

GmbH Anhalt; Prof. Klaus Erich Pollmann, rector of Otto von Guericke University Magdeburg; Dr. Gerhard Müller, deputy director of the Fraunhofer IFF as well as Prof. Heribert Münch of the University of Applied Sciences Magdeburg-Stendal (FH) (photo 2, from left to right).

February 24 – 27, 2009, Leipzig

Intec 2009 (Fair)

Organizer: Leipzig Fair

Exhibit: An immersive engineer's workplace

Contributors: Dr. Eberhard Blümel; Martina Stöcker

February 25 – 26, 2009, Magdeburg

North German Maintenance Days 2009

Organizer: Industrieforum-Nordwest

Lectures: Introduction into Virtual Reality and Augmented Reality; Virtual development – coupling of real controls with virtual machines for parallel hardware and software develop-ment; Virtual interactive training to qualify the staff of RWE Rhein-Ruhr Netz-Service; RFID and localization in maintenance; LogMotionLab – Laboratory for testing RFID technologies and systems; Service robots in Facility Management

Contributors: Dr. Gerhard Müller; Dr. Eberhard Blümel; Dr. Norbert Elkmann; Dr. Frank Ryll; Prof. Klaus Richter; Wilhelm Termath; Cathrin Plate; Andre Winge

1 *A throng of people at the "Long Night of Science": Magdeburg's citi-zens want to discover the VDTC and willingly accept waiting times of more than two hours.*
Photo: Dirk Mahler
2 *Prof. Klaus Erich Pollmann, rector of Otto von Guericke University Magde-burg, on February 11, 2009 signing the CEESA agreement.*
Photo: Viktoria Kühne

February 26 – 27, 2009, Magdeburg
14th Magdeburg Logistics Meeting – Sustainable Logistics
Organizer: Otto von Guericke University Magdeburg
Contributors: Prof. Michael Schenk; Katja Barfus

March 3 – 5, 2009, Stuttgart
LogiMAT 2009 (Fair)
Organizer: Euroexpo Messe- und Kongress-GmbH
Exhibits: BlueBox; RFID based container management
Contributors: Helmut Röben; Tobias Kutzler;
Sven-Uwe Hofmeister

March 3 – 8, 2009, Hannover
CeBIT 2009 (Trade Fair)
Organizer: Deutsche Messe AG
Exhibit: Intelligent office chair
Contributor: Martin Woitag

March 16 – 17, 2009, Hundisburg
Workshop Wood Logistics 2009
Organizer: Fraunhofer IFF; Forstbetrieb Sachsen-Anhalt; Niedersächsische Landesforsten
Lecture: Haulers as integral partners in electronic data exchange in wood logistics
Contributors: Dr. Ina Ehrhardt; Mike Wäsche; Tobias Kutzler; Steve Schneider

The Wood Logistics Workshop focused on the fundamental issues of logistics, interfaces and efficient use of energy. Organized jointly by the Fraunhofer IFF, Forstbetrieb Sachsen-Anhalt (forestry enterprise) and Niedersächsische Landesforsten, the workshop attracted forest owners, haulers and wood processors to come Hundisburg in March. The experts discussed opportunities and prospects, but also potential fields for cooperation. A practical example from a pilot region in Niedersachsen (Lower Saxony) highlighted current day-to-day business issues. This popular expert forum will also be on the agenda in 2010.

March 18 – 19, 2009, Oberpfaffenhofen
Cergal 2009 (Messe)
Organizer: DGON
Lecture: Putting Galileo Applications to Test: A Localization, Navigation and Communication Development Lab and Test Field for Transportation and Logistics
Contributors: Prof. Klaus Richter; Corinna Kunert; Olaf Poenicke

March 20 – 22, 2009, Sofia, Bulgaria
International Scientific Conference on Management and Sustainable Development
Organizer: University Of Forestry, Faculty Of Business Management, Sofia, Bulgaria
Lecture: Services for Sustainable Forest Timber Supply Chain Planning and Control: Development, Implementation and Usage
Contributors: Mike Wäsche; Dr. Ina Ehrhardt

March 25 – 27, 2009, Solothurn, Switzerland
5th Conference on Professional Knowledge Management
Organizer: FH Nordwestschweiz (University of Applied Sciences); Fraunhofer-Gesellschaft
Lecture: Wissen greifbar machen – Praktikable Ansätze für KMU (Making knowledge tangible – practical approaches for SMEs)
Contributor: Stefan Voigt

1 *Popular expert forum on March 16 and 17, 2009; The annual Workshop Wood Logistics held at Hundisburg castle. Photo: Viktoria Kühne*

March 30, 2009, Magdeburg
Opening of the Center for Digital Engineering (CDE) in progress
Contributors: Prof. Michael Schenk; Dr. Gerhard Müller; Marco Schumann

The research and development of Virtual and Augmented Reality will be further expanded. To this end Otto von Guericke University and the Fraunhofer IFF jointly established the "Center for Digital Engineering" (CDE) in March. In the last few years the German Federal Ministry of Education and Research (BMBF) has subsidized several important research projects of the Fraunhofer IFF and its partners amounting to two digit million euros in total. Therefore, Magdeburg has become one of the German centers of research in the field of Virtual Reality. Undersecretary Dr. Wolf-Dieter Lukas from the BMBF specifically came to Magdeburg to address the audience stating: "As regards the hightech strategy in Eastern Germany we consistently focus on the strong points. Our program entitled "Top-class research and innovation in the new Länder" and the AKT 2020 – Research for innovation" help develop the capabilities of the best. In the Virtual Technologies Innovation Alliance the Magdeburgers form an excellent link."

March 30 to April 3, 2009, Berlin
Trade Fair "Water"
Organizer: Messe Berlin GmbH
Exhibit: Inspection and cleaning robot for sewers
Contributors: Dr. Norbert Elkmann; Jose Saenz

April 1 – 2, 2009, Magdeburg
Land-wide Competition "jugend forscht"
Organizer: E.ON Avacon
Contributors: Prof. Michael Schenk; Dr. Frank Ryll;
Dr. Uwe Klaeger; Steffen Masik; Holger Althaus; Justus Hortig;
Tobias Lietz; Jost Schnee; Sven-Uwe Hofmeister;
Sergej Serebranski; Sebastian Möser

April 3 – 4, 2009, Berlin
Working – Learning – Developing competences
Organizer: German Federal Ministry of Education and Research
Lecture: Presentation of the group project "Interactive module for implementing the Machinery Directive in the development and use of machines and plants (IMMMA)"
Contributor: Torsten Schulz

2 *On March 30, 2009 undersecretary Dr. Wolf-Dieter Lukas, German Federal Ministry of Education and Research, addresses the audience at the opening ceremony of the Centers for Digital Engineering (CDE) in development*
3 *The newly established Center for Digital Engineering and its partners on March 30, 2009: Prof. Dr. rer nat. habil. Gunter Saake, Otto von Guericke University Magdeburg; Prof. Michael Schenk, Director of the Fraunhofer IFF; MinR Dr. Gerhard Wünscher, Sachsen-Anhalt Ministry of Education and Culture; MinDir Dr. Wolf-Dieter Lukas, German Federal Ministry of Education and Research; Prof. Klaus Erich Pollmann, Rector of Otto von Guericke University Magdeburg; Dr. Werner Schreiber, Konzernforschung Volkswagen AG (from left to right).*
Photos (2): Viktoria Kühne

April 7 to June 9, 2009, Magdeburg

12th Guest lecture series on Logistics: Logistics – a future-oriented field of work

Organizer: Fraunhofer IFF

Patronage: Dr. Karl-Heinz Daehre, Minister of Regional Development and Transport of the Land Sachsen-Anhalt

Scientific management: Prof. Michael Schenk; Prof. Karl Inderfurth, Chair of business administration; Prof. Dietrich Ziems, Chair of Logistics; Prof. Hartmut Zadek, Institute of logistics and material flow technology (all from Otto von Guericke University Magdeburg)

Contributors: Annegret Brandau; Tobias Reggelin

April 16, 2009, Magdeburg

Logistics Day: Discovering Logistics

Organizer: BVL Bundesvereinigung Logistik e.V.

Guided tours of the LogMotionLab

Lecture in the framework of the guest lecture series on logistics: Discrete Time Analysis of Batch Processes in Material Flow Systems (Spokesman: Dr. Marc Schleyer)

Contributors: Prof. Michael Schenk; Dr. Gerhard Müller; Holger Seidel; Prof. Klaus Richter; Annegret Brandau; Tobias Reggelin; Helmut Röben; Katja Barfuss; Sebastian Trojahn

On April 16, 2009 the "Tag der Logistik" (Logistics Day) was held throughout Germany. Based on the initiative of Bundesvereinigung Logistik (BVL), achievements in the field of logistics are in the focus of general interest. In the morning the Fraunhofer IFF allowed interested parties to take a look behind the scenes. In the LogMotionLab, one of the leading European development, testing and certification labs for RFID and telematic technologies, visitors could learn a lot about most advanced logistics systems. In the afternoon visitors could attend a fascinating lecture in the scope of the guest lecture series on logistics at the Fraunhofer IFF.

In his lecture, logistics consultant Dr. Marc Schleyer, prizewinner of the 2007 German science prize for logistics, discussed specific methods for improving the waiting and run-through times in logistics systems.

April 16 – 17, 2009, Shanghai, China

2nd Sino-German Workshop "Virtual Reality & Augmented Reality in Industry"

Organizer: Shanghai Jiao Tong University; Heinz Nixdorf Institut Paderborn

Lecture: Numerically Controlled Virtual Models for Commissioning, Testing and Training

Contributors: Prof. Michael Schenk; Dr. Eberhard Blümel; Marco Schumann

April 20 – 24, 2009, Hannover

Hannover Fair

Organizer: Deutsche Messe AG

Exhibits: Damage detection system (SEK) for preliminary inspection of the Emscher sewer; Tactile skin for safe human-robot interaction; Phasor Measurement Unit Scenario; Fluidized-bed compact plant

Project presented by: RegModHarz

Contributors: Prof. Ulrich Schmucker; Dr. Sascha Thomas; Dr. Norbert Elkmann; Markus Fritzsche; Jose Saenz

1 *As its patron, Dr. Karl-Heinz Daehre, Minister of Regional Development and Transport of the Land Sachsen-Anhalt, opened the 12th guest lecture series on logistics on April 16, 2009.*
2 *Logistics Day on April 16, 2009: In the Log MotionLab the the Fraunhofer research managers explain the world of logistics with consummate ease.*
Photos (2): Viktoria Kühne

April 22, 2009, Moscow, Russia

Workshop "Industrial image processing and virtual reality"

Organizer: GosNIIAS

Lectures: In Process Quality Monitoring Using Optical 3D Metrology; An Innovative Method for Worker Assistance in Assembly Tasks; Applied Virtual Technologies with Long Term Focus in the Product Life Cycle (AVILUSplus)

Contributors: Dr. Dirk Berndt; Steffen Sauer; Marco Schumann

April 22 – 24, 2009, Bruge, Belgium

17th European Symposium on Artificial Neural Networks

Organizer: Universite catholique de Louvain, K. U. Leuven, IEEE Computational Intelligence Society, International Neural Networks Society, European Neural Networks Society

Contributor: Prof. Udo Seiffert

April 24, 2009, Magdeburg

7th IFF Colloquium

Organizer: Fraunhofer IFF

Lectures: Investigations on the separation of sulphur and halogen compounds from burning gases of biomass gasification; VR assisted method for risk assessment in CE marking of machines; Methanol production from canola residues; Calibrating laser light cutting sensors of low field depth; Use of motion pattern recognition and mesoscopic simulation in the context of safety-critical logistics hubs; Modeling the impact of design and technological parameters on the quality of bolt-rivet connections in aircraft construction; Mesoscopic modeling and simulation of logistics flow systems

Contributors: Prof. Michael Schenk; Dr. Sascha Thomas; Dr. Thomas Dunker; Dr. Andreas Schlinkert; Dr. Karsten Kube; Tobias Reggelin; Andre Herrmann; Ivan Pechenizkiy; Bernd Gebert; Alexander Kroys; Florian Karst; Olaf Poenicke; Mykhaylo Nykolaychuk

April 29, 2009, Magdeburg

Best4VarioUse International Kick-off

Organizer: Fraunhofer IFF

Lectures: Comprehensive project presentation

Contributors: Dr. Gerhard Müller; Christian Blobner; Dr. Ina Ehrhardt; Nadine Doden; Mike Wäsche

Waste material from agriculture and forestry, used in the past at best for composting, may be of value in the future. Together with their international project partners, research managers of the Fraunhofer IFF are developing new processes and technologies. Petra Wernicke, Sachsen-Anhalt's Minister for Agriculture and Environment, felt enthusiastic about the project: "Considering the large quantities of unused biomass in parks, on fields and in forests, a tremendous potential is waiting for us. We have to utilize this potential. It will help us save resources and safeguard the environment. Systematic utilization of the renewable energies is required in the future.

3 *Petra Wernicke, Sachsen-Anhalt's Minister for Agriculture and Environment, addressing the Kick-off event at the Fraunhofer IFF on April 29, 2009. On her right: Dr. Gerhard Müller, deputy director. Photo: Viktoria Kühne*

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May 5 – 8, 2009, Stuttgart
CONTROL 2009 (Fair)
Organizer: P E. Schall GmbH & Co. KG
Exhibits: Production integrated optical 3D measuring techniques; Worker assistance and quality control for assembly processe
Contributors: Dr. Dirk Berndt, Martin Woitag;
Ralf Warnemünde

May 11 – 15, 2009, Frankfurt am Main
ACHEMA 2009 (Fair)
Organizer: DECHEMA e. V.
Exhibit: Interactive 3D-Training for the transfer of flammable liquids
Contributor: Torsten Schulz

May 12 – 15, 2009, Munich
Transport & Logistics 2009 (Fair)
Organizer: Messe München International
Lecture: Optimizing routes in wood logistics
Contributor: Tobias Kutzler

May 14, 2009, Magdeburg
Entrepreneurial Day ViReKon – Virtual Reality in personnel qualification and applications for enterprises
Organizer: RKW Sachsen-Anhalt GmbH; SLV Schweißtechnische Lehr- und Versuchsanstalt Halle GmbH; tbz Technologie- und Berufsbildungszentrum Magdeburg gGmbH
Lecture: Virtual Reality in personnel qualification and applications in management processes Contributors:
Dr. Gerhard Müller; Dr. Eberhard Blümel; Thomas Reek;
Andre Winge; Ronny Franke; Tina Haase; Alexander Kroys;
Steffen Masik

In the future Technologie- und Berufsbildungszentrum Magdeburg gGmbH (a vocational training center) and Schweißtechnische Lehr- und Versuchsanstalt Halle GmbH (a training and testing institution specializing in welding) will provide training for engineers and mechanics on virtual machines in the ViRe-Kon project. To this end, experts from the Fraunhofer IFF are developing specific E-Learning methods. Cyberspace generates the virtual models of exactly the same machines which the operators and maintenance mechanics will have to work on later in practice.

At the ViReKon Entrepreneurial Day, held at the Virtual Development and Training Centre VDTC of the Fraunhofer IFF, Dr. Reiner Haseloff, Minister for Economy and Labor of the Land Sachsen-Anhalt expressed his conviction by saying: "Sachsen-Anhalt's companies can only keep pace with competitors worldwide if they make progress and innovation part of their day-to-day business. While CAD programs have been the challenge in the past, today's challenge is the virtual reality. A routine day of an entrepreneur without virtual techniques will be inconceivable in the future."

May 18 – 22, 2009, Hannover
LIGNA 2009 (Fair)
Organizer: Deutsche Messe Hannover
Lecture: Intelligent wood - RFID in mass-produced wood logistics
Project presentation: Intelligent wood - RFID in round wood logistics
Exhibit: RFID - Gate
Contributors: Dr. Ina Ehrhardt; Mike Wäsche;
Sven-Uwe Hofmeister; Sergej Serebranski

1 *At the ACHEMA 2009 the Virtual Interactive Training business unit presented a virtual interactive training model tailored to the training needs of skilled chemical workers.*
Photo: Dirk Mahler

May 26, 2009, Magdeburg
Digital Innovative Processes
Organizer: Landesinitiative NETWORK-KMU; Fraunhofer IFF;
Ingenieurkammer Sachsen-Anhalt; Bundesverband mittelstän-
dische Wirtschaft Unternehmerverband Deutschlands e.V.
Lecture: Innovation cluster Virtual Development, Engineering
and Training VIDET
Contributor: Thomas Schulze

May 29, 2009, Steyr, Austria
AGTIL Project kick-off
Organizer: FH Oberösterreich (University of Applied Sciences),
Logistikum – Competence center logistics and entrepreneurial
networks; MAN Nutzfahrzeuge Österreich AG
Exhibit: Mobile 3D-Projection with scenarios of Duerr, BG
Chemie, AREVA und HSB
Contributors: Prof. Michael Schenk; Dr. Gerhard Müller;
Marco Schumann; Andre Winge

June 4 to October 1, 2009
**MS Wissenschaft – Das Zukunftsschiff (Ship of the
future)**
Organizer: Science in Dialog
Exhibit: The intelligent medicine cabinet
Contributors: Helmut Röben; Martin Piontek;
Sergej Serebranski

The exhibit presented on board an inland cargo vessel offered
a look into the future. It showed very clearly how science is
changing our everyday life. Will robots tidy up our children's
rooms in the future? What will our schools and workplaces
look like? A total of 27 interactive exhibits from various sphe-
res of life showed in an enjoyable way how research might
influence our life in the future. Using a device referred to as
"Visionator" the visitors could learn what type of researcher
they would be. Likewise on board: the intelligent medicine
cabinet from the Fraunhofer IFF in Magdeburg.

June 8 – 9, 2009, Poznan, Poland
NAROSSA 2009
Organizer: Pilot Pflanzentechnologie Magdeburg e.V.
Institute of Natural Fibres and Medicinal Plants
Lecture: Best4VarioUse - Best Practices and Technologies to
Develop Green Wastes and Residues as Raw Materials for
Variants of Utilization
Contributors: Christian Blobner; Dr. Ina Ehrhardt;
Dr. Eyck Schotte; Mike Wäsche

June 13, 2009, Magdeburg
The Long Night of Science
Organizer: Landeshauptstadt Magdeburg
Contributors: Approximately 80 managers of the Fraunhofer
IFF

June 16 – 17, 2009, Baden-Baden
Automation 2009
Organizer: VDI Verein Deutscher Ingenieure
Lecture: LISA – A robot with feelings
Poster presentation: Enabling the Automated Inspection of
Large Sewers by Using Visual Odometry Contributors:
Markus Fritzsche; Christoph Walter

2 *Visiting the exhibit on MS
Wissenschaft, held from June
4 to October 1, 2009, allowed
a glimpse into the future.
Photo: Ilja Hendell
Science in Dialog*
3 *Young and old, curious
about research, attended
the Long Night of Science
on June 13, 2009. Nobody
seemed to get tired.
Photo: Dirk Mahler*

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June 16 – 18, 2009, Magdeburg
12th IFF Science Days 2009
Scientific management: Prof. Michael Schenk

Program:
June 16 – 17, 2009
3rd Expert Forum on Logistics
Patron: Minister Dr. Karl-Heinz Daehre, Ministry for Regional
Development and Transport of the Land Sachsen-Anhalt
Sections: Logistics brokering – Modern transport solutions for
SMEs; Expert forum on Logistics – Efficient and safe supply
chains

June 16 – 18, 2009
6th Expert Forum on Virtual Reality
Patron: Minister Dr. Reiner Haseloff, Ministry of Economy and
Labor of the Land Sachsen-Anhalt Sections: Digital enginee-
ring for planning, testing and operating technical systems;
Digital product development; Digital process development and
digital factory; Training and education; Tools and technologies

June 18, 2009
Expert Forum on Robotics: Safety in human-robot interaction
LISA Final presentation: Assistant robots for Life Science firms
Supplementary workshops: 11th Industry working group for
cooperation in plant construction; pattern recognition, data
analysis & modeling in biomedical applications

Contributors: Prof. Michael Schenk; Dr. Gerhard Müller;
Prof. Udo Seiffert; Dr. Eberhard Blümel; Prof. Ulrich
Schmucker; Dr. Norbert Elkmann; Dr. Christian Teutsch;
Dr. Frank Ryll; Helmut Röben; Holger Seidel; Tina Haase;
Erik Schulenburg; Marco Schumann; Markus Fritzsche;
Christoph Walter; Gunnar Strauß; Tilo Förster;
Katrin Reschwamm; Andrea Urbansky; Felix Bollenbeck;
Steffen Sauer; Jens Grubert

Even in times of tight travel expense budgets the Fraunhofer
IFF has succeeded in arousing the interest of numerous experts
in current research topics. Again, more than 500 guests from
business, science and politics met in Magdeburg from June 16
to 18, 2009. The program of the annual conference included
sessions on digital engineering, logistics and robotics.

Particularly the representatives from the machine building
and plant engineering sector and the automotive industry
showed great interest in the Fraunhofer specialists' expertise
in the field of digital engineering. For this reason director Prof.
Michael Schenk put the main emphasis on digital product
and process development, the digital factory and professional
qualification. Schenk stressed: "Virtual Reality has much more
to offer than pure 3D design. Every entrepreneur has to save
time and money. How virtual technologies will prove their
worth in the long run, that's what it is all about at the 12th IFF
Science Days."

1 *Beside topics on mobility and transport, advan-*
ced trends and prospects of green logistics were
on the agenda of the Expert Forum on Logistics.
Dr Karl-Heinz Daehre, Minister of Transport and
patron of the conference, used the opportunity
to present Saxony-Anhalt's logistics concept at the
12th IFF Science Days.
2 *At the third expert forum entitled "Safety in*
human-robot interaction" held on June 18, 2009
in the framework of the IFF Science Days the auto-
mation experts were familiarized with the assistant
robot LISA. Photos (2): Dirk Mahler.

June 24 – 25, 2009, Leipzig
30th VDI/VDEh Forum on Maintenance
Organizer: VDI Wissensforum GmbH
Contributors: Dr. Gerhard Müller; Dr. Frank Ryll; Cathrin Plate

August 24 – 26, 2009, New Delhi, India
IREE – International Railway Equipment Exhibition
Exhibit: Wheel set measuring equipment
Contributor: Dr. Dirk Berndt

August 25, 2009, Bangkok, Thailand
Opening of the Bangkok branch of the
Fraunhofer IFF
Contributors: Dr. Gerhard Müller; Ralf Opierzynski;
Tobias Reggelin; Andreas Höpfner

The opening of the branch is a milestone for the Magde-
burg research institute. First activities date back to the year
1995. Since 1999 several cooperation agreements have been
concluded with private and public research institutions such
as the National Science and Technology Development Agen-
cy (NSTDA), the Federation of Thai Industries (FTI) and the
Asian Institute of Technology (AIT). In the following ten years
numerous projects were successfully completed with Thai part-
ners, particularly business undertakings. To this end, experts
from the Fraunhofer IFF visited the entire ASEAN region.

At the opening ceremony held at the "State Tower"
congress center, Dr. Gerhard Müller, deputy director of the
Fraunhofer IFF, underlined the importance of the new branch:
"This branch will help us improve the quality of our activities
in the ASEAN region. We all live together on this planet – we
want to learn more from each other and advance technology-
related developments together."

August 26, 2009, Leipzig
1st Central German Logistics Forum

Organizer: Bundesvereinigung Logistik (BVL); Netzwerk Logis-
tik Leipzig-Halle; Automotive Cluster Eastern Germany
Patronage: Wolfgang Tiefensee, German Federal minister for
Transport, Building and Urban Development
Exhibits: Intelligent Logistics – Solutions for safe supply chains;
Harz.EE-Mobility – Linked with RegModHarz; KASSETTS – Cost
reduction and efficiency increase for logistics solutions for
SMEs applying transnational transport solutions
Contributors: Prof. Michael Schenk; Holger Seidel;
Corinna Kunert; Nadine Doden; Katrin Reschwamm

August 31, 2009, Charkov, Ukraine
**Conferring the title of honorary doctor
to Prof. Schenk**

*3 Dr. Gerhard Müller, deputy
director of the Fraunhofer IFF
(left) and Ralf Opierzynski, head
of the Bangkok office, open
the Fraunhofer IFF branch in
Thailand's capital.
Photo: Anna-Kristina Wassilew
4 Festive event on the occasion
of opening the Bangkok branch
on August 25, 2009.
Photo: wwwphotoiam.com*

September 7, 2009, Halberstadt
Kick-of event Harz.EE-Mobility
Organizer: Halberstadtwerke GmbH
Contributors: Dr. Gerhard Müller; Dr. Przemyslaw Komarnicki;
Bartolomiej Arendarski

On September 7, 2009, Sigmar Gabriel, German Federal Minister for the Environment, Nature Conservation and Nuclear Safety, handed over the certificate marking the kick-off (LoI) of the funding project "Harz Mountains. Renewable Energies Mobility" in the model region Harz. The ceremony took place in the presence of high-ranking representatives of the Land Sachsen-Anhalt and partners from industry. Integrated in a consortium of representatives from both science and industry, the Fraunhofer IFF investigates how the network integration of renewable energies generated in the region can be optimally linked with the needs of electric vehicle users for mobility and greenness.

September 14 – 16, 2009, Stockholm, Sweden
European Offshore Wind 2009
Organizer: European Wind Energy Association
Poster presentation: RIWEA - Robot to Inspect Rotor Blades of Wind Energy Converters
Contributors: Torsten Felsch; Tilo Förster

September 17 – 18, 2009, Magdeburg
First status meeting of the Virtual Techniques Innovation Alliance
Host: Fraunhofer IFF
Lectures: Introductory lecture AVILUSplus; User-related development and investigation of mobile AR worker assistance systems; AR assisted comparison of CAD models and measured data from optical 3D scanners; Safe human-robot interaction in production; The Innovation Alliance Virtual Techniques Roadmap
Exhibits: Commissioning, Tracking; AR assisted worker assistance; Surgery simulation; Hybrid commissioning

Contributors: Prof. Michael Schenk; Marco Schumann;
Dr. Rüdiger Mecke; Dr. Dirk Berndt; Dr. Norbert Elkmann;
Dr. Christian Teutsch; Andre Winge; Jens Grubert;
Markus Fritzsche; Simon Adler; Steffen Sauer; Steffen Masik

The first status meeting of the Virtual Techniques Innovation Alliance was held in Magdeburg at the Fraunhofer IFF VDTC on September 17 and 18, 2009. During the two day conference the research status of the projects AVILUS, AVILUS-plus, ViERforES and Endoguide was presented in various lectures and exhibits. Besides the members of the relevant project teams and other Fraunhofer IFF managers, also representatives of the German Federal Ministry of Education and Research (BMBF) attended the meeting. Furthermore, an exhibit showing the latest test facilities provided an excellent opportunity for the representatives of the press to meet the research managers and obtain first-hand information about the ongoing research work. Since the beginning of the project back in June 2008, the German Federal Ministry of Education and Research (BMBF) has supported the three group projects AVILUS, AVILUSplus and VIERforES financially and by 2011 will have spent approximately 39 million euros. Besides the funds from the BMBF, partners from industry have contributed to the projects by investing another 170 million euros.

September 20, 2009, Magdeburg
Cinema spot shooting "Das Hier Sind Wir" in the framework of the PR campaign "Sachsen-Anhalt. Wir stehen früher auf." in the Fraunhofer IFF building
Organizer: Investitions- und Marketinggesellschaft Sachsen-Anhalt mbH

1 The German federal government goes for electric mobility: On September 7, 2009 the project partners received the certificate marking the project kick-off (LoI).
2 / 3 / 4 The partners united in the "Virtual Techniques" Innovation Alliance presented first results of their research work at the first status meeting held on September 17 and 18, 2009. Photos (4) Dirk Mahler

September 23 – 25, 2009, Dresden
Wheel Rail 2009
Organizer: HS für Technik und Wirtschaft Dresden; DVV Media Group GmbH l Eurailpress
Lecture: Automatic in-process wheel set and wheel profile measuring technology and practical experiences
Contributors: Dr. Dirk Berndt; Erik Trostmann

September 24, 2009, Magdeburg
Entrepreneurial workshop "Functional Engineering"
Organizer: Fraunhofer IFF
Lectures: Engineering in special machine building and plant engineering: problem definition and new problem-solution approaches; Innovation cluster VIDET – In less time from the idea to the product to strengthen the regional economy
Contributors: Prof. Ulrich Schmucker; Thomas Reek

October 5 – 7, 2009, München
EXPO REAL 2009 (Trade Fair)
Organizer: Messe München GmbH
Exhibits: City scenarios of Lutherstadt Eisleben, Lutherstadt Wittenberg, Stassfurt; Scenario of Herrenkrug Parkhotel; Scenarios of the Piesteritz, Oranienbaum and Vockerode business parks Contributor: Andreas Höpfner

October 6 – 7, 2009, Yelahanka, India
International RWF Seminar
Organizer: RWF Yelahanka
Lecture: Automatic In-process Wheel Set and Wheel Profile Measurement
Contributors: Dr. Dirk Berndt

October 6 – 8, 2009, Hannover
BIOTECHNICA 2009 (Messe)
Organizer: Deutsche Messe AG
Exhibit: Ultrasound-based filling level measuring system
Contributors: Holger Althaus; Dietmar Kunst

October 8 – 9, 2009, Kaiserslautern
Fraunhofer Vision Technology Day 2009
Organizer: Fraunhofer Vision Alliance
Exhibits: Contactless 3D measuring of features in cavities; 3D measuring and surface inspection of unmachined castings; Optical assembly assistance and testing
Lectures: Contactless 3D measuring of features in cavities; Image-based assistance and testing systems for complex manual assembly work
Contributors: Dr. Dirk Berndt; Dr. Thomas Dunker; Steffen Sauer

October 9 – 10, 2009, Magdeburg
22nd HAB Research Seminar
Organizer: Otto von Guericke University Magdeburg
Lectures: Augmented Reality-based worker assistance
Contributors: Prof. Michael Schenk; Dr. Dirk Berndt; Dr. Rüdiger Mecke; Steffen Sauer; Jens Grubert; Sebastian Trojahn

October 13 – 15, 2009, München
MAINTAIN (Fair)
Organizer: M,O,C, München
Joint booth with TÜV Rheinland
Contributors: Dr. Martin Endig; Dr. Frank Ryll; Wilhelm Termath

October 21 – 23, 2009, Berlin
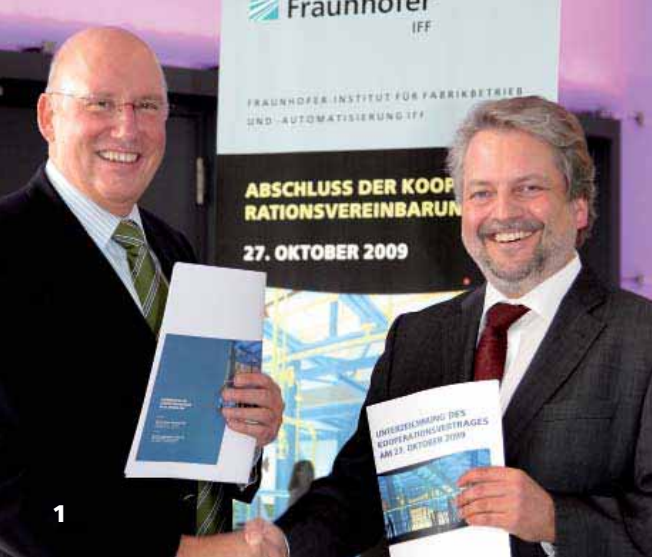**26th German Logistics Congress**
Organizer: Bundesvereinigung Logistik (BVL)
Chairman of the jury "Conferring the Logistics 2009 Science Award":
Prof. Michael Schenk
Exhibit: Efficient and safe logistics
Contributors: Holger Seidel; Helmut Röben; Nadine Doden; Corinna Kunert; Katja Barfuss; Annegret Brandau; Prof. Klaus Richter; Dr. Daniel Reh; Erik Dietzel

October 27, 2009, Magdeburg

Signing the cooperation agreement between LDT Laser Display Technology GmbH und the Fraunhofer IFF

Organizer: Fraunhofer IFF

Contributors: Prof. Michael Schenk; Steffen Masik

LDT Laser Display Technology GmbH and the Fraunhofer-Institut for Factory Operation and Automation IFF continue their successful cooperation. Together they have developed the laser projection system referred to as the "Elbe Dom" in the Virtual Development and Training Centre VDTC. As a result of the new cooperation agreement, the projection of virtual interactive worlds will reach a new quality.

October 28 – 30, 2009, Leipzig

SHKG Leipzig (Fair)

Organizer: Leipziger Messe GmbH

Exhibit: 3D Bathroom cinema

Contributor: Andreas Höpfner

October 28 to December 9, 2009, Magdeburg

6th Guest lecture series VR – Interactive Humans and Machines

Organizer: Fraunhofer IFF

Patronage: Dr. rer. nat. Reiner Haseloff, Minister of Economy and Labor of the Land Sachsen-Anhalt

Contributors: Prof. Michael Schenk; Prof. Ulrich Schmucker; Michaela Schumann

October 29, 2009, Wernigerode

8th Students Forum "Technik zum Anfassen und Begreifen" (Hands-on technology)

Organizer: IGZ Wernigerode and Wernigerode AG

Exhibits: Intelligent javelin; Inteligent office chair

Contributors: Stefan Gelb; Martin Woitag

October 29 – 30, 2009, Magdeburg

Innovation forum "Applying Haptics to Robot-assisted Surgery"

Organizer: Clinic for General, Visceral and Vascular Surgery of Magdeburg University Hospital Sessions: Haptic systems; Surgery simulation in minimally invasive surgery

Exhibit: Endoscopic surgery simulation for the training of surgical intervention; SM-BIO-POWER Contributors: Prof. Ulrich Schmucker; Dr. Rüdiger Mecke; Simon Adler; Katrin Reschwamm

November 3, 2009, Leverkusen

12th Industry Working Group "Cooperation in Plant Engineering"

Organizer: Fraunhofer IFF

Lecture: Risk management as an element for process improvement

Contributors: Dr. Daniel Reh; Andrea Urbansky; Melanie Thurow

November 3 – 5, 2009, Stuttgart

VISION (Fair)

Organizer: Messe Stuttgart

Exhibits: Integrated optical 3D measurement techniques in manufacturing processes; Worker-assistance and quality inspection for assembly processes

Contributors: Dr. Dirk Berndt; Ralf Warnemünde; Steffen Sauer

1 *Together they want to further develop the laser projection system referred to as the Elbe Dom: Prof. Michael Schenk, director of the Fraunhofer IFF (left), and Joachim Ostermann, managing director of LDT Laser Display Technology GmbH, on October 27, 2009.*
2 *Advanced image processing with Augmented Reality will make manual assembly processes easier in the future. Photos (2) Viktoria Kühne*

November 3 – 6, 2009, Düsseldorf
A+A 2009 (Fair)
Organizer: Messe Düsseldorf GmbH
Lecture: Interactive 3D Machine models supporting the implementation of the Machinery Directive
Contributors: Torsten Schulz; Alexander Kroys

November 5, 2009, Magdeburg
Colloquium on Medical Devices – Kick-off Event
Organizer: Otto von Guericke University Magdeburg
Scientific support: Prof. Michael Schenk; Dr. Rüdiger Mecke

November 6, 2009, Magdeburg
Marie Curie EST "Research Training @VDTC" - Final Event
Organizer: Fraunhofer IFF
Lectures: Advanced Solutions in Object-Oriented Mechatronic Simulation; Optimization of a Riveting Process for Reconfigurable Assembly; Methods of Data Acquisition for Reliability Forecasting of Technical Systems; Optimization of Frame Geometry under Unstable Thermal Loading; Maintenance of Complex Machines in Electric Power Systems Using VR-techniques; Visualization Techniques in Power Systems
Contributors: Prof. Michael Schenk; Prof. Ulrich Schmucker; Dr. Eberhard Blümel; Dr. Rüdiger Mecke; Dr. Frank Ryll; Dr. Przemyslaw Komarnicki; Dr. Tamas Juhasz; Bartlomiej Arendarski; Kamil Lipiec; Sergij Kolomiichuk; Carlo Belardinelli; Ivan Pechenizkiy.

November 19 – 20, 2009, Magdeburg
Optical 3D Measurement Techniques for Quality Assurance in Production
Organizer: Fraunhofer Vision Alliance
Contributor: Dr. Dirk Berndt

November 20, 2009, Magdeburg
8th IFF Colloquium
Organizer: Fraunhofer IFF
Lectures: Development of a coupling tool for combining structure simulation and model-based simulation; Layer-Laminate process for increasing the efficiency in manufacturing individual and series lasts for the footwear industry; Integrated knowledge and collaboration platform for SMEs based on Web 2.0 technologies
Contributors: Prof. Michael Schenk; Christian Lüdigk; Dr. Uwe Klaeger; Stefan Voigt

November 26 – 27, 2009, Frankfurt
14th EUROFORUM Conference Maintenance 2010
Organizer: Euroforum, Informa Deutschland SE
Contributors and Moderation: Prof. Michael Schenk; Dr. Frank Ryll; Tina Haase

November 30, 2009, Magdeburg
Logisticagermania- German-Italian Business Meeting on Logistics
Organizer: SBS systems for business solutions; Fraunhofer IFF
Contributors: Katrin Reschwamm

December 1 – 10, 2009, Paris, France
Humanoids 2009-Workshop on Tactile Sensing
Organizer: IEEE Association
Lecture: An Artificial Skin for Safe Human-Robot-Interaction
Contributor: Markus Fritzsche

3 *Junior researchers from various countries involved in the Marie-Curie program attended the final event at the Fraunhofer IFF on November 6, 2009. Photo: Dirk Mahler*

NAMES, DATES, PUBLICATIONS (SELECTION)

Committee Work

ACOD Automotive Cluster Ostdeutschland e. V.
Prof. Michael Schenk, Chairman of the Board

ALFA Fibre Composite Alliance "Innovative regional growth hub"
Susan Gronwald, Advisory Board Member

AMA Fachverband für Sensorik e. V.
Prof. Ulrich Schmucker, Member

ASEP Asian Society for Environmental Protection
Ralf Opierzynski, Treasurer and Member

ASIM Simulation Working Group
Dr. Juri Tolujew, Member of the "Simulation" Group
Dr. Marco Schumann, Member of the "Simulation in Production and Logistics" Group

Association for the Promotion of Materials Cycle Management
Frank Mewes, Representative of Fraunhofer IFF

Association of German Foundry Experts (VDG)
Prof. Michael Schenk, Member of the Research Advisory Board

Association of German Engineers (VDI)
Prof. Michael Schenk, Member of the Presidium and Chairman of the Regional Advisory Board

Association of German Engineers (VDI), Society for Industrial Engineering (ADB)
Dr. Gerhard Müller, Member of the Board and Head of the "Plant Management" Expert Group
Thomas Dengler, Committee Member and Contributor to the "Factory Planning Guideling" Working Group
Cathrin Plate, Member and Contributor to the "Maintenance" Committee in the "Preperation of Guidelines" Working Group
Dr. Daniel Reh, Nadine Doden, Member of the Expert Group of the "Holistic Production Systems" Committee, "Setup, Structure and Goals of Holistic Production Systems" Working Group

Association of German Engineers (VDI), VDEh Forum Maintenance Program Committee
Dr. Gerhard Müller, Cathrin Plate, Members

Association of German Engineers (VDI), VDI/VDE-GMA Society of Metrology and Automation
Dr. Dirk Berndt, Private Member in the "Optical 3D Measurement" Committee 3.32
Dr. Frank Ryll, Committee Member and Contributor to the "Plant Asset Management" Working Group of the Committee 6.23

Association of German Engineers (VDI), VDI-GPL Society of Production and Logistics
Cathrin Plate, Member of Maintenance Committee, Member of the "Thermography in Maintenance" Committee
Thomas Dengler, Committee Member and Contributor to the Working Groups of Factory Planning and Operation

Association of German Engineers (VDI), Saxony-Anhalt State Association
Prof. Michael Schenk, Chairman, Stefan Gelb, Member of the Board

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Dr. Dirk Berndt, Spokesman of Fraunhofer IFF, Member of the Coordination Council

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Dr. Ina Ehrhardt, Mike Wäsche,
Contributors to the Working Group

German Society for Operations Research (GOR)
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Katrin Reschwamm,
Head of Magdeburg Regional Group

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GCTP German Construction Technology Platform
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IA VT Fraunhofer Virtual Techniques Innovation Alliance
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IEEE Institute of Electrical and Electronics Engineers
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Dr. Gerhard Müller,
Fraunhofer IFF Representative

Maintenance Team RFID – MTR
Cathrin Plate, Member, Fraunhofer IFF Representative in the Consortium "RFID in Maintenance"
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Erik Dietzel, Member

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EURESEARCH, Bern, Switzerland

European Organisation for Security, Brussels, Belgium

European Process Safety Centre, Warwickshire, Great Britain

Facilitating Research co-operation between Europe and New Zealand (FRENZ), Christchurch, New Zealand

Faculdade de Egenharia da Universade do Porto, Porto, Portugal

Federation of Thai Industries (FTI), Bangkok, Thailand

FGL Handelsgesellschaft mbH, Fürstenwalde

Finnish Forest Research Institute (Metla), Vantaa, Finland

Fondazione Rosselli, Turin, Italy

Forest Research, Roslin, Great Britain

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Fraunhofer Representative Office Japan, Tokyo, Japan

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Indo German Chamber of Commerce, Bangalore, India

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INESC Porto, Unidade de Siste-mas de Informacao e de Comuni-cacao, Porto, Portugal

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INOVA+ SA, Lissabon, Portugal

Institute for Logistics and Warehousing, Poznan, Poland

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Institut National des Sciences Appliquées de Rennes (INSA), Rennes, France

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ITI Aristotle University Thessaloni-ki, Thessaloniki, Greece

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Johann-Heinrich-von-Thünen-Institut, Institut für Ökonomie der Forst- und Holzwirtschaft, Hamburg

Joint Research Company, Ispra, Italy

Joint Stock company "Sonex computers" (SONEX), Klaipeda, Lithuania

Jordan University for Science and Technology, Amman, Jordan

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Knowledge and Innovation Intermediaries (KiNNO), Athen, Greece

Kohlbach KCO Cogeneration und Bioenergie GmbH (Ing. Roskam), Wolfsberg, Austria

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KUKA Schweißanlagen GmbH, Augsburg

Kuratorium für Waldarbeit und Forsttechnik KWF, Groß Umstadt

Laboratory of Design, Production and Management, Universiteit van Twente, Twente, The Netherlands

LASAG AG, Thun, Switzerland

Latvian Intelligent Systems, Riga, Latvia

Leibniz-Institut für Neurobiologie (IfN), Magdeburg

Leibniz-Institut für Pflanzenbiochemie (IPB), Halle

Leibniz-Institut für Pflanzengenetik und Kulturpflanzenforschung (IPK), Gatersleben

Liophant Simulation Club, University of Genoa, Genua, Italy

Lithuanian Innovation Centre, Vilnius, Lithuania

Liverpool John Moores University Higher Education Corporation, Liverpool, Great Britain

Logitrans Consult Ltd., Tallin, Estonia

Louisiana State University, Center for Computation & Technology, Baton Rouge, USA

Louth County Enterprise Board, Dundalk, Ireland

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Maastricht University, Maastricht, The Netherlands

Maritime & Supply Chain Solutions (Europe) Ltd., Ballycarry, Great Britain

Martin-Luther-Universität Halle-Wittenberg, Halle

Massachusetts Institute of Technology, Massachusetts, USA

Mazowiecka Agencja Energetyczna, Warsaw, Poland

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Metla - The Finnish Forest Research Institute, Parkano, Finland

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Modena and Reggio Emilia University, Modena, Italy

Molecular Machines & Industries (MMI), Eching

National Agency for New Technologies, Energy and Environment (ENEA), Bologna, Italy

National Science and Technology Development Agency (NSTDA), Pathumthani, Thailand

Nemetschek, Sofia, Bulgaria

Netherlands Organization for Applied Scientific Research, Delft, The Netherlands

Newry & Mourne Enterprise Agency, Newry, Northern Ireland

Niigata University, Dept. Chemisty and Chem. Eng., Niigata, Japan

Norsk Treteknisk Institut, Oslo, Norway

platinn, Fribourg, Switzerland

Plato, Dundalk, Ireland

Plato Ireland, Dublin, Ireland

Policía Local de Valencia, Valencia, Spain

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Pymera, Valencia, Spain

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Semantic Systems, Derio, Spain

SenterNovem, Den Haag, The Netherlands

SFERA – Societa per la Formazione e le Risorse Aziendali per Azioni, Italy

Sheffield Hallam University, Sheffield, Great Britain

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Skogforsk, The Forestry Research Institute of Sweden, Uppsala, Sweden

Southwest Jiaotong University-Opto-Electronic Engineering Institute, Chengdu, China

SPRU at the University of Sussex, Brighton, Great Britain

Staatliches Forschungsinstitut für Flugsysteme (GosNIIAS), Moskau, Russia

Stackelitz Group of Firms, Stackelitz

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Technical University of Kosice, Kosice, Slovakia

Telefónica Investigación y Desarrollo (Mr. Vicente), Madrid, Spain

TESEO Sprl, Brussels, Belgium

Thai-German Institute (TGI), Chonburi, Thailand

Thales Aerospace Division, Toulouse, France

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The Open University, Milton Keynes, Great Britain

Thessaloniki Port Authority, Thessaloniki, Greece

TP Technoplus Industrial and Trading Ltd, Budapest, Hungary

Trans-European Consultants for Transport, Development and IT (TREDIT), Thessaloniki, Greece

TRIMOS-SYLVAC S. A. (PTY) Ltd., Waterkloof, South Africa

Trinity College Dublin, Dublin, Ireland

T-SOFT spol. s r.o., Prag, Czech Republic

T-Systems, Frankfurt am Main

TÜV Rheinland Industrie Services GmbH, Köln

Universidad Complutense de Madrid, Dept. Chem. Eng., Madrid, Spain

Universidad Politecnica de Valencia (UPVLC), Valencia, Spain

Universita Cattolica del Sacro Cuore di Milano, Mailand, Italy

Universita degli Studi di Genova, Genua, Italy

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UNIVERSITETET I STAVANGER – HOGSKOLENI STAVANGER, Stavanger, Norway

University College of Borås, Borås, Sweden

University of Applied Sciences Karlsruhe

University of Applied Sciences Karlsruhe, Institute of Applied Research (IAF), Karlsruhe

University of Athens, Athen, Greece

University of Birmingham, Birmingham, Great Britain

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University of Glasgow, Glasgow, Great Britain

University of Helsinki, Helsinki, Finland

University of Malaga, Malaga, Spain

University of Michigan, Virtual Reality Laboratory, Ann Arbor, Michigan, USA

University of Nottingham, Nottingham, Great Britain

University of Oulu, Oulu Yliopisto, Finland

University of Oulu, Dept. Process and Environm. Eng., Oulu, Finland

University of Oulu, Neural Network Group, Oulu, Finland

University of Rome "La Sapienza", Rome, Italy

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University of Ulster, Ulster, Great Britain

University of Zilina, Zilina, Slovakia

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Virginia Modeling, Analysis and Simulation Center (VMASC), Norfolk, USA

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Monographs and Editorships

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Mertins, K. ; Seidel, H. (Publ.):
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6. Gastvortragsreihe: Virtual Reality – Mensch und Maschine im interaktiven Dialog.
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Schoor, W. ; Seiffert, U.:
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Voxel Data to Inter-individual
Probabilistic Atlases of Biolo-
gical Objects by an Interlea-
ved Registration-segmentati-
on Approach.**
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CONTACTS

Photo: Viktoria Kühne

General Management

Director
Prof. Michael Schenk
Phone +49 391 4090-470 | Fax +49 4090-93-470
michael.schenk@iff.fraunhofer.de

Office of the Director / Office Manager
Ines Trübe
Phone +49 391 4090-471 | Fax +49 391 4090-93-471
ines.truebe@iff.fraunhofer.de

Deputy Director
Prof. Gerhard Müller
Phone +49 391 4090-401 | Fax +49 391 4090-93-401
gerhard.mueller@iff.fraunhofer.de

Secretary's office
Sabine Gerlich
Phone +49 391 4090-444 | Fax +49 391 4090-93-444
sabine.gerlich@iff.fraunhofer.de

Organization and Communication Team (OKT)

Organization and Communication
Sabine Conert
Phone +49 391 4090-481 | Fax +49 391 4090-93-481
sabine.conert@iff.fraunhofer.de

Media and Public Relations
Anna-Kristina Wassilew
Phone +49 391 4090-446 | Fax +49 391 4090-93-446
presse@iff.fraunhofer.de

Marketing
Erik Dietzel
Phone +49 391 4090-140 | Fax +49 391 4090-93-140
erik.dietzel@iff.fraunhofer.de

Administrative Services

Manager
Karla Zorn
Phone +49 391 4090-598 | Fax +49 391 4090-93-598
karla.zorn@iff.fraunhofer.de

Business Units

Robotic Systems (RS)
Dr. Norbert Elkmann
Phone +49 391 4090-222 | Fax +49 391 4090-93-222
norbert.elkmann@iff.fraunhofer.de

Measurement and Testing Technology (MPT)
Dr. Dirk Berndt
Phone +49 391 4090-224 | Fax +49 391 4090-93-224
dirk.berndt@iff.fraunhofer.de

Virtual Interactive Training (VIT)
Dr. Eberhard Blümel
Phone +49 391 4090-110 | Fax +49 391 4090-93-110
eberhard.bluemel@iff.fraunhofer.de

Logistics and Factory Systems (LFS)
Holger Seidel
Phone +49 391 4090-123 | Fax +49 391 4090-93-123
holger.seidel@iff.fraunhofer.de

Process and Plant Engineering (PAT)
Dr. Matthias Gohla
Phone +49 391 4090-361 | Fax +49 391 4090-93-361
matthias.gohla@iff.fraunhofer.de

Expert Groups

Material Handling and Engineering and Systems (MFT)
Prof. Klaus Richter
Phone +49 391 4090-420 | Fax +49 391 4090-93-420
klaus.richter@iff.fraunhofer.de

Virtual Engineering (VE)
Prof. Ulrich Schmucker
Phone +49 391 4090-201 | Fax +49 391 4090-93-201
ulrich.schmucker@iff.fraunhofer.de

Virtual Prototyping (VP)
Dr. Rüdiger Mecke
Phone +49 391 4090-146 | Fax +49 391 4090-93-146
ruediger.mecke@iff.fraunhofer.de

Biosystems Engineering (BIO)
Prof. Udo Seiffert
Phone +49 391 4090-107 | Fax +49 391 4090-93-107
udo.seiffert@iff.fraunhofer.de

Central Offices

ViVERA/AVILUSplus
Dr. Marco Schumann
Phone +49 391 4090-158 | Fax +49 391 4090-93-158
marco.schumann@iff.fraunhofer.de

VIDET
Thomas Schulze
Phone +49 391 4090-820 | Fax +49 391 4090-93-820
thomas.schulze@iff.fraunhofer.de

ViERforES
Dr. Marco Schumann
Phone +49 391 4090-158 | Fax +49 391 4090-93-158
marco.schumann@iff.fraunhofer.de

Fraunhofer IFF in the ASEAN Region
Ralf Opierzynski
Phone (Thailand) +66 812 855-465 | Fax +49 391 4090-93-901
ralf.opierzynski@iff.fraunhofer.de

Institute of Logistics and Material Handling Systems at Otto von Guericke University Magdeburg

Chair of Logistics Systems
Prof. Michael Schenk
Phone +49 391 67-18601 | Fax +49 391 67-12646
michael.schenk@ovgu.de

Logistics Process Analysis
Dr. Elke Glistau
Phone +49 391 67-12660 | Fax +49 391 67-12646
elke.glistau@ovgu.de

Logistics Process Modeling
Dr. Juri Tolujew
Phone +49 391 4090-310 | Fax +49 391 4090-445
juri.tolujew@iff.fraunhofer.de

Galileo Test Field for Logistics and Transport Telematics
Andreas Müller
Phone +49 391 67-12126 | Fax +49 391 67-12646
mueller.gate@ovgu.de

Fraunhofer IFF Competence Centers with Otto von Guericke University Magdeburg

Visualization Techniques
Prof. Bernhard Preim
Phone +49 391 67-18512 | Fax +49 391 67-11164
preim@isg.cs.uni-magdeburg.de

Training and Technology
Prof. Klaus Jenewein
Phone +49 391 67-16602 | Fax +49 391 67-16550
klaus.jenewein@ovgu.de

Virtual Engineering
Prof. Ulrich Gabbert
Phone +49 391 67-18609 | Fax +49 391 67-12439
ulrich.gabbert@mb.uni-magdeburg.de

Prof. Roland Kasper
Phone +49 391 67-18607 | Fax +49 391 67-12656
roland.kasper@ovgu.de

Simulation Techniques
Prof. Thomas Schulze
Phone +49 391 67-12825 | Fax +49 391 67-11216
schulze@iti.cs.uni-magdeburg.de

Machine Vision
Prof. Bernd Michaelis
Phone +49 391 67-18860 | Fax +49 391 67-11231
bernd.michaelis@ovgu.de

Power Systems and Renewable Energies
Prof. Zbigniew A. Styczynski
Phone +49 391 67-18866 | Fax +49 391 67-12408
sty@e-technik.uni-magdeburg.de

Prof. Evangelos Tsotsas
Phone +49 391 67-18784 | Fax +49 391 67-11160
evangelos.tsotsas@ovgu.de

Robotics and Embedded Systems
Prof. Jörg Kaiser
Phone +49 391 67-18829 | Fax +49 391 67-11161
kaiser@ivs.cs.uni-magdeburg.de

RobotsLab
Prof. Frank Palis
Phone +49 391 67-18598 | Fax +49 391 67-12481
frank.palis@e-technik.uni-magdeburg.de

EDITORIAL NOTES