Fraunhofer
IFF

SAFE HUMAN-ROBOT INTERACTION

Physical contact between humans and robots is inevitable and even desired when they share a common workplace or even work hand in hand. Such scenarios often generate a potential hazard for humans. Assuring safety is a major element of our research and development in the field of physical human-robot interaction.

Collision Avoidance
One safety concept is based on eliminating contact between humans and robots. New technologies developed at the Fraunhofer IFF make such separation superfluous by monitoring workplaces with optical sensors that track people and their movements, compute dynamic safe zones and also adjust a robot's speed and direction of movement to the given situation.

Contact Detection
Direct contact between humans and robots is not always preventable and is even desirable or necessary in some scenarios. Two-dimensional tactile sensors applied to a robot like an artificial skin reliably detect contact, measure active forces and safely stop a robot's movements. The same sensor may also be employed as an input device to control and guide a robot by touch.

Hazard Assessment
The risk of injury during a collision basically depends on the acting forces. We measure these forces in our lab for safe human-robot interaction and use measurement and test benches to configure cushioning and protective zones and test the effectiveness of safety measures.

FRAUNHOFER INSTITUTE FOR FACTORY OPERATION AND AUTOMATION IFF

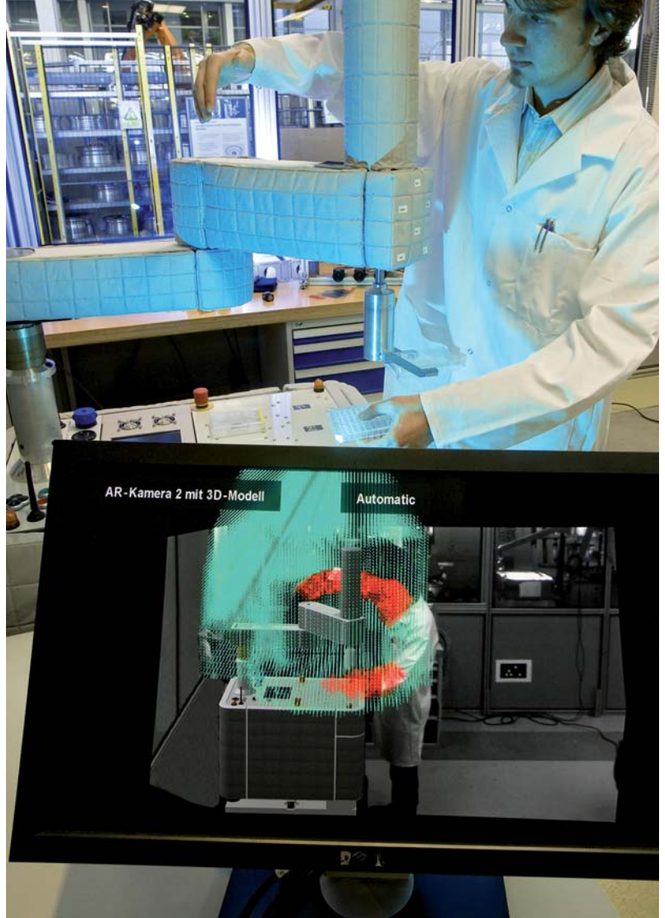
Director
Prof. Michael Schenk

Sandtorstrasse 22 | 39106 Magdeburg | Germany
Phone +49 391 4090-0 | Fax +49 391 4090-596
ideen@iff.fraunhofer.de
http://www.iff.fraunhofer.de | http://www.vdtc.de

Contact
Robotic Systems Business Unit
Dr. Norbert Elkmann
Phone +49 391 4090-222 | Fax +49 391 4090-250
norbert.elkmann@iff.fraunhofer.de

Photos: Title photo Uwe Völkner | FOX; 1 - 5 Fraunhofer IFF; 6 Andreas Lander

SAFE HUMAN-ROBOT INTERACTION



HUMAN-ROBOT INTERACTION

In addition to the classic application scenarios for robots in industrial settings, new fields of application are opening up for service robots and assistance systems in manufacturing, the service industry and the household sector. In the future, robots will, for instance, assist with small batch production and mobile robots will take over transport and routine tasks in the household and healthcare sectors.

Such fields of application require new forms of user-friendly and safe human-robot interaction (HRI). Important aspects include:

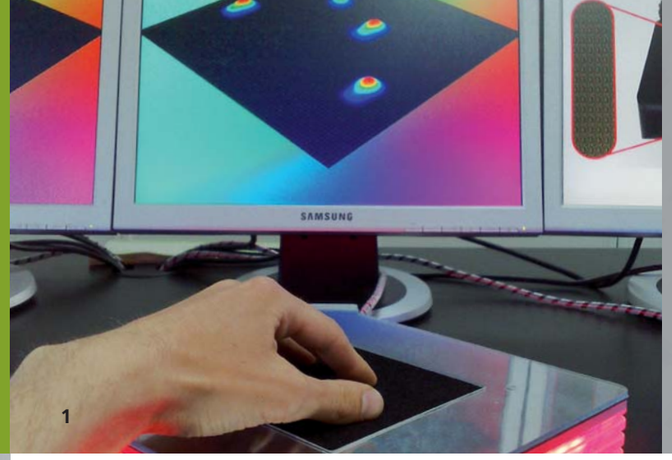
– intuitive and multimodal interaction with robots (e.g. language, gestures, guidance and much more),

– direct physical interaction in a shared workplace and

– technological developments that reliably prevent minor injuries to humans and damage to the environment should a collision occur.

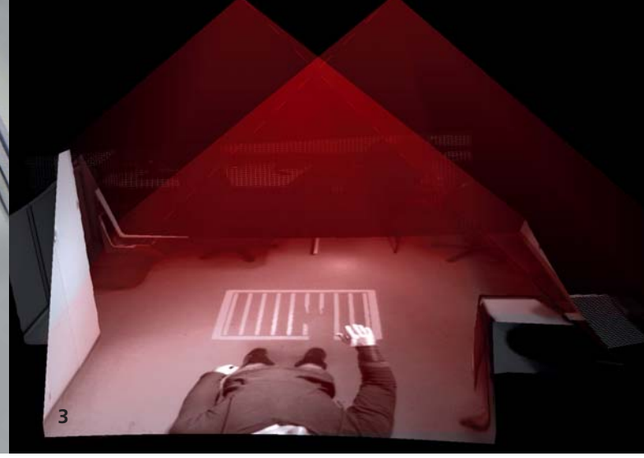
The Fraunhofer IFF's Robotic Systems Business Unit develops solutions for all these aspects. One important emphasis of technological development is safe human-robot interaction. Priorities include new optical systems for flexible workplace monitoring, sensors for reliable detection of collisions with robotic systems and intrinsically safe and flexible manipulators. We use measurement and test benches in our lab for safe human-robot interaction to evaluate the safety of robots and mobile systems.

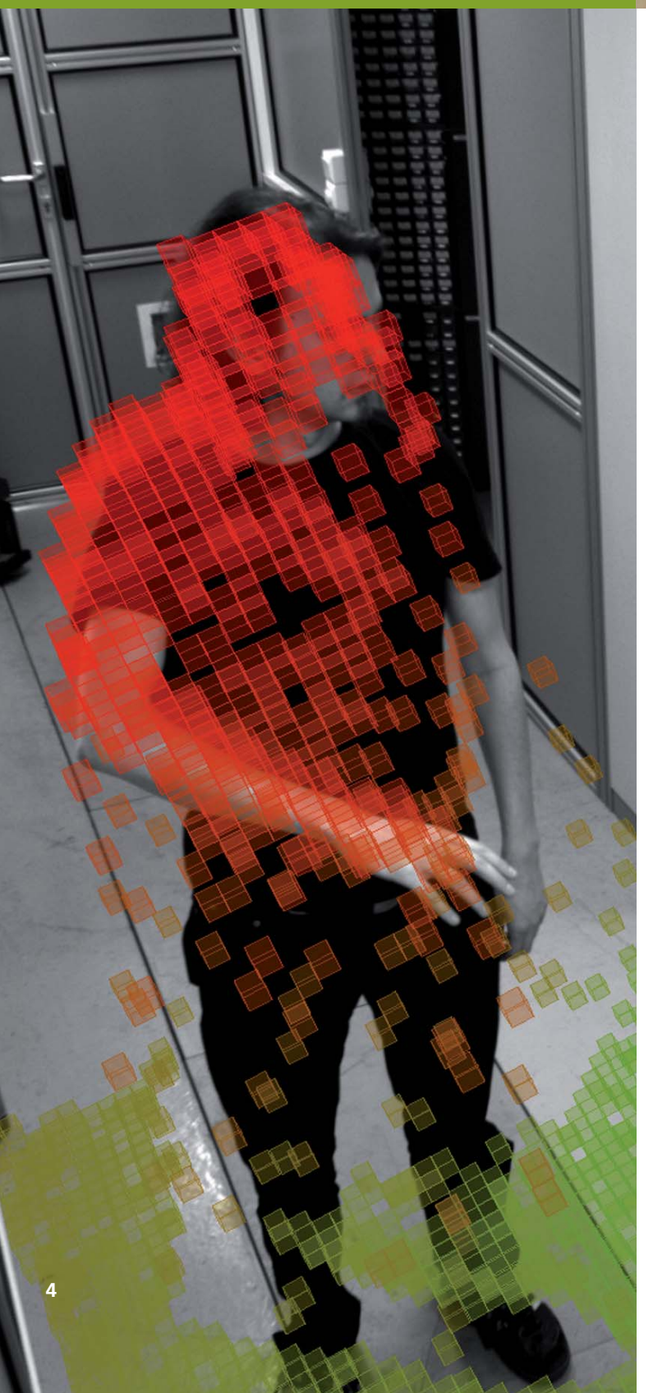
SAFE HUMAN-ROBOT INTERACTION



1


2


3


4

CURRENT ISSUES

Fundamentals of Human-Robot Interaction

In response to current developments related to autonomy and cognitive skills in the field of robotics, we are developing basic technologies for intelligent systems. This work includes pattern recognition, environment perception, principles of multimodal interaction and software structures.

Mobile Robots

Many applications in the field of service robotics require a robot's mobility. Therefore, we develop solutions for such systems' position detection and autonomous navigation.

Safe Human-Robot Interaction

We develop components and concepts that make robots and machinery safe to protect users. This includes optical sensors that scan workplaces three-dimensionally, tools that visualize and plan safe areas and safe tactile sensors that detect collisions.

Force and Momentum Measurement

The Fraunhofer IFF has a lab fors afe human-robot interaction to evaluate safety measures. Among other things, it is equipped with state-of-the-art measuring units that capture forces, force characteristics and contact times during a collision with a robot system. High-precision force measuring sensors capture transmitted momentum and force pulses highly temporally resolved. The goal is to perform standardized and reproducible collision tests. In addition, a high speed camera can be used to analyze collisions.

CURRENT PROJECTS

BROMMI: Bionic Arm Kinematics for Safe Robotic Applications in Human-Machine Interaction

Supported by the Federal Ministry of Education and Research and started in April 2009, the objective of the joint project "BROMMI" is the development of a bionic robot system modeled after an elephant's trunk. Novel manipulators that satisfy the most stringent safety requirements are being developed on the basis of serial modular kinematics. (www.bionische-innovationen.de)

Tactile Sensor Systems for Collision Detection

Tactile sensors can be used to equip technical system with haptic and sensory capabilities. The patent pending tactile sensor system developed by the Fraunhofer IFF is being employed in a wide variety of applications, e.g. safe human-robot interaction (collision detection and cushioning), intelligent flooring and contact and pressure distribution sensing.

Novel Tactile Skin Input Device for AR and VR Environments and Real Machines such as Robots (AVILUSplus SP 4.2)

This project is researching novel options for interaction based on the pressure-sensitive tactile skin developed by the Fraunhofer IFF. The tactile skin is being implemented in two scenarios to facilitate human-robot interaction through direct robot guidance and as a tangible interface. (www.avilusplus.de)

Development and Experimental Evaluation of a Novel Optial Workplace Monitoring System (ECHORD – EXECELL)

The objective of this project is the development and demonstration of safe human-robot interaction in order to facilitate new robot applications in workplaces shared with humans. A patent pending 2½D sensor system developed at the Fraunhofer IFF serves as the basis for optical monitoring of workplaces in which humans and robots interact.

Flexible Manufacturing through Safe Human-Robot Interaction (ViERforES SP 1 Production)

This project is developing complex distributed sensor systems that make workplaces shared by humans and robots safe. In addition to safe robot control systems, technologies are needed, which reliably detect people and their movements in the robot's workplace. At the same time, the project is establishing effective dynamic safe areas as a function of the robot's position and its concrete work step. (www.vierfores.de)

LiSA: Assistant Robot in Life Science Company Labs

The objective of this joint project LiSA supported by the Federal Ministry of Education and Research was the development of a mobile assistant robot suitable for everyday use, which interacts with staff in life science company labs and independently takes over routine tasks such as transporting multiplates and loading stations. (www.lisa-roboter.de)

1 *Tactile sensor system for collision detection*
2 *Safe robot kinematics (BROMMI)*
3 *Optical workspace monitoring*
4 *Workspace monitoring*