

- 1 No intrusion in a projected safe zone.
- 2 Detected intrusion in a projected safe zone.
- 3 Examples of possible safe zone geometries. Photos: Christian Vogel

PROJECTION AND CAMERA BASED SYSTEM FOR OPTICAL WORKPLACE MONITORING

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Overview

The vision of humans and machines collaborating in a shared workplace will become reality in the near future. Novel technologies will monitor workspaces where protective barriers now separate humans and, for instance, robots, and reduce a robot's speed or stop it when a human approaches, for instance. In addition to the industrial sector, a variety of other domains will also need safe optical workplace monitoring systems in the future. These systems will furnish the basis for new robot applications.

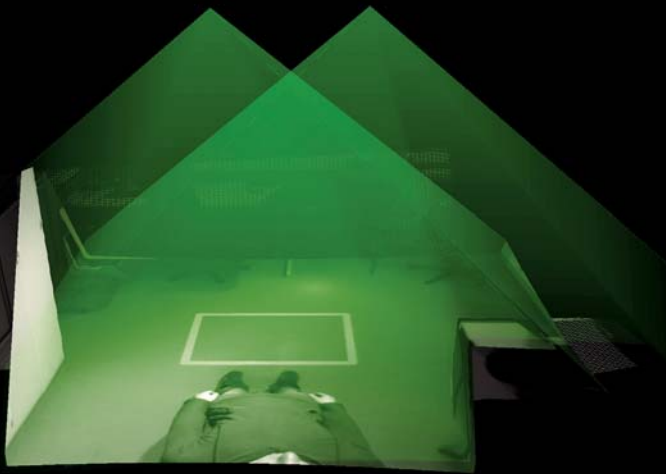
Advancing the flexibility and dynamism of manufacturing and work environments, the Fraunhofer Institute IFF developed a novel and innovative sensor system that monitors workspaces, which is based on projectors and cameras. Its distinctive features are its low cost, high reliability and

flexibility and invulnerability to effects of external light. Moreover, unlike present optical workplace monitoring systems, this system makes danger and/or safe zones fully visible to humans all the time, thus boosting transparency for users tremendously. It can also project information for users. The Fraunhofer Institute IFF has filed a patent for its system.

Technology

This novel workplace monitoring system is distinguished by its projection of monitored safe zones directly into the environment (danger and/or safe zones), e.g. onto the floor. Surrounding cameras reliably detect intrusions in safe zones whenever projection rays and planes are disrupted. Thus, users see both active safe zones and intrusions at all times. At the same time additional information, e.g. on a robot's condi-

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tion, can be inserted and communicated to users. Rapid analysis algorithms that detect intrusions in the safe zone allow response times that predestine the system for use in time-critical applications.

The precisely aligned camera and projector and a special system that suppresses external light minimize the influence of ambient conditions, e.g. changing light conditions or suddenly appearing shadows. In addition, the workplace monitoring system allows ongoing performance checks of all components and thus the overall system.

Applications

The workplace monitoring system furnishes a variety of options to monitor safe zones. Safe zone size, shape and pattern and planar or framing projections or safe zones allow its use in the widest variety of scenarios and open new possibilities for workplace monitoring. In addition, the system allows innovative user interaction by inserting information. The flexible combination of several projectors and cameras make it easy to adapt the size of a potential monitored zone to the requirements of specific applications. Likewise, a zone's shape, size and position are dynamically and individually adaptable, e.g. as a function of a variety of ambient conditions such as robot position or movement. Optionally, a stripe projection system may be employed to scan the three-dimensional geometry of objects in the monitored zone.

In addition to safety-critical human-machine scenarios, this technology can be used wherever wide ranging protection might be needed.

The system's capability to project invisible light also makes it the right solution whenever safe zones do not have to be clearly discernible.

The work presented here is the outcome of Subproject 1 "Flexible Manufacturing through Safe Human-Robot Interaction" in the project ViERforES "Virtual and Augmented Reality for Maximum Embedded System Safety, Security and Reliability".

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For more information on the joint project ViERforES, visit www.vierfores.de.

ViERforES

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Safe zone and camera's visual cone from a virtual camera perspective

4 *without and*

5 *with an intrusion in the safe zone.*