HRC WITH HEAVY-DUTY ROBOTS

Although lightweight robots primarily possess the designs and intrinsic safety functions that meet safety standards for human-robot cooperation in shared workspaces, the majority of HRC applications require payloads of more than 20 kg and large workspaces to improve ergonomics for workers, thus necessitating the use of conventional industrial robots. Since the potential danger is substantial, new safety concepts have to be developed to ensure that humans and robots with high payloads cooperate safely.

The Fraunhofer IFF has developed a safety concept, which combines tactile sensor flooring with spatial resolution with a visualization system suspended from the ceiling as the basis for cooperation between humans and robots with high payloads in compliance with TS 15066 (Speed and separation monitoring). Workspaces shared by humans and robots are outfitted with the tactile flooring, which detects the location of people in a workspace robustly and reliably. What is more, the flooring’s sensor cells can be assigned to different safety zones (danger or safety zones). The robot reduces its speed whenever a person is detected in the danger zone. The robot stops immediately whenever a person enters the critical zone. Safety zones can also be generated dynamically as a function of the current positions and speeds of a robot’s joints as well as by factoring in a person’s direction and speed of movement.

A projected visualization system is employed to make the current boundaries of dynamically generated safety zones visible to people.
This innovative workplace monitoring system with dynamic safety zones for HRC applications is based on tactile flooring that detects people’s location and movements accurately and a projection system that visualizes data specific to a process, a robot and safety.

**PROJECTED VISUALIZATION SYSTEM**

The projected visualization system that displays data specific to a process, a robot and safety adds functions that expand the flooring’s safety features. This technology projects essential and useful information for people simply and directly onto their workspace.

**Safety Data**
In combination with the tactile flooring’s dynamic safety zones, the projected visualization system displays inactive and active safety zones at any given moment. This enables people to avoid entering hazardous areas proactively, thus further increasing the system’s availability.

**Robot Data**
The visualization of robot information alerts people early of a robot’s impending movements by displaying its direction of movement and target position, for instance. This increases transparency for people and reduces hazardous situations. In addition, errors that occur can be displayed directly for people.

**Process Data**
Another of the visualization system’s functions is worker assistance. Overlaying process information in the form of textual descriptions, diagrams or symbols on a workspace or directly on work in progress assists workers simply. What is more, people can also be notified of potential problems or errors.

**TACTILE FLOORING**

Patented by the Fraunhofer IFF, this technology of touch sensors with spatial resolution served as the basis for the development of novel tactile sensor flooring that reliably detects and localizes people and/or objects in a workspace. Depending on its intended use, an appropriately robust surface material can be selected so that even forklifts can drive over the tactile flooring without any problems.

**Ensuring Safety**
The tactile sensor systems developed by the Fraunhofer IFF consist of transducers based on a piezoresistive polymer composite. The resistive sensing principle this makes possible is combined with an innovative, patent-pending matrix to register pressure distribution with spatial resolution. Moreover, the closed-circuit principle implemented makes it possible to monitor the operation of every single sensor cell.

**Estimation of Movements**
The tactile flooring’s high spatial resolution makes it possible to use the sensor data to estimate people’s movements as well. Not only a person’s location but also the direction and speed of his or her movements can be determined.

**Dynamic Safeguarded Spaces**
Dynamic safeguarded spaces based on the robot’s movement and speed and factoring in the direction and speed of a person’s movements are continuously calculated with the formula for determining the protective separation distance from TS 15066 and activated. This gives people maximum freedom of motion in a robot’s workspace without any danger of a collision between people and the robot.

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1. Monitoring and visualization of dynamic safety zones.
2. Visualization of additional information and interactive elements.
3. Warning zone (yellow) and critical zone (red).