

CTPS - Capacitive Tactile Proximity Sensor

Multimodal Sensor Technology for Intelligent Industrial Robots

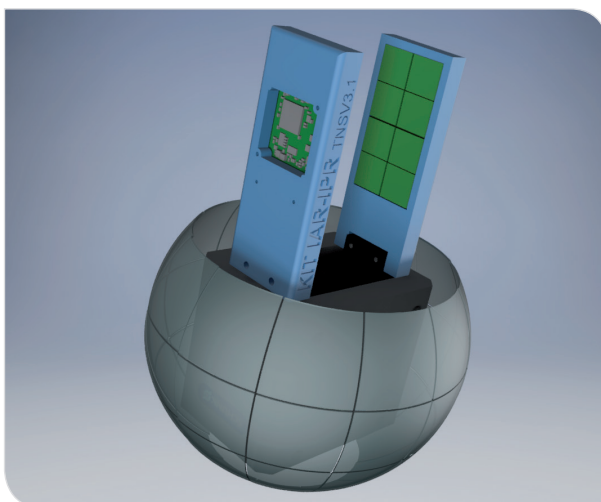
Intelligent robots are characterized by their ability to perceive their environment, derive a context model, and react to this model appropriately. Both in autonomous and permanently programmed robots, contactless detection of the surrounding objects contributes significantly to the safety and robustness of the respective action or interaction and, thus, additionally supports the performance of complex tasks e.g., especially in human-robot collaboration scenarios.

Multimodal Sensors

A sensor's multimodality refers to its ability to simultaneously detect different physical events. This allows a complementary perception of the environment and the exploration of unknown surroundings. The CTPS is a **capacitive tactile proximity sensor** which makes use of electrical capacitive coupling for contactless object detection and localization and which, in case of a mechanical contact, can measure the compressive force of the grip. Furthermore, the sensor is provided with a configurable spatial resolution. Arbitrary electrode grouping allows for a situative compromise between measurement range and spatial resolution.

Application of Sensor Technology in Industry

The intensive use of sensors is a key element of modern industry, which is characterized by intelligent automation and human-robot cooperation (HRC). Sensors, moreover, contribute essentially to the flexibility of processes and, hence, the agility of production. The role of such sensors is illustrated by means of a CTPS-equipped six-axis robot arm as used, for example, in teleoperation: The sensor data are represented on a haptic display enabling the user to track live the robot's environment perception. The aspect of safe human-robot cooperation is demonstrated by monitoring the robot's workspace by means of CTPS. The sensors are able to detect and localize approaching persons and generate warning signals as soon as critical or predefined safety distances are exceeded. The respective safety concept determines how the signals must be interpreted and whether e.g., acoustic or optical warnings should be triggered, speed should be reduced, or the robot should be brought to a standstill.



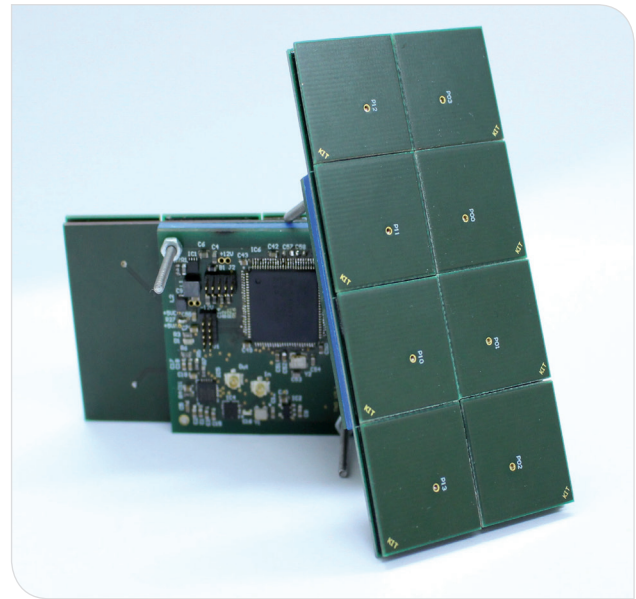
3D model of a CTPS-equipped HRC gripper



Six-axis robot arm with HRC gripper

Continuous Exploration

Both mobile and permanently installed robots often are equipped with optical environment detection systems, such as laser scanners and 2D/3D cameras. The dependence on light conditions and overlaps caused by the involved objects or by the robot itself entail major disadvantages impairing the system's safety and precision. The sensors developed at IAR-IPR complement the well-established optical systems, thus improving the perception in close range and enabling novel, multifaceted interactions of the equipped machines/robots with their environment or with a workpiece.



Modular tactile proximity sensor with 2 x 4 spatial resolution

Karlsruhe Institute of Technology
Institute for Anthropomatics and Robotics (IAR) –
Intelligent Process Automation and Robotics Lab (IPR)
Prof. Dr. Björn Hein
Group: Intelligent Industrial Robotics (IIROB)
Engler-Bunte-Ring 8
76131 Karlsruhe, Germany
Phone: +49 721 608-48935
Email: bjoern.hein@kit.edu
<http://rob.ipr.kit.edu/index.php>

Karlsruhe Institute of Technology
Institute for Anthropomatics and Robotics (IAR) –
Intelligent Process Automation and Robotics Lab (IPR)
Hosam Alagi
Group: Intelligent Industrial Robotics (IIROB)
Engler-Bunte-Ring 8
76131 Karlsruhe, Germany
Phone: +49 721 608-47118
Email: hosam.alagi@kit.edu
<http://rob.ipr.kit.edu/index.php>

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Karlsruhe Institute of Technology (KIT) · President Professor Dr.-Ing. Holger Hanselka · Kaiserstraße 12 · 76131 Karlsruhe, Germany · www.kit.edu