

Working on your Visions



Programming by Demonstration with the KUKA Light-Weight Robot

Motivation

With its light-weight robot KUKA has introduced a new robot generation that can lift its own weight and can be easily programmed. It offers new possibilities in automation for branches and applications, in which robots are not used today. Prospective users in these branches are seldom robotics experts, and hence there is a need for simple and intuitive robot programming and operation methods.

KUKA Light-Weight Robot

The KUKA light-weight robot is similar to the human arm with seven degrees of freedom, which results in advanced flexibility in comparison to normal industrial robots. Each of the light-weight robot's joints has a motor position sensor and sensors for joint position and joint torque. Together with the KUKA robot controller the robot can be operated position-, velocity- and torque-controlled. By processing the joint data at high rate and making use of the torque control the robot can compensate or respond to external forces applied. As such the robot can be used, e.g., in human-robot collaboration scenarios, as an advanced manipulator for force-torque controlled assembly of goods, or as a haptic input device.

Manual Guidance

Knowing the model of the robot and the attached tool in terms of their masses and inertia the torques applied to each joint can be controlled in such a way that the robot is keeping its current pose (so called "gravity compensation mode"). Externally applied forces along the whole robot structure can be detected. To move the robot within its workspace the user simply has to push, pull or turn the tool or the

joints. Based on these characteristics a first Programming by Demonstration test-bed has been set up within the EC-funded project *SMErobot*. Safety issues emerging from such close human-robot interaction are being addressed by the EC-funded project *PHRIENDS*.

Programming by Demonstration

The robot can be manually guided to a pick-up zone to grasp a Lego brick and to a construction zone, where the brick can be placed. By showing several pick & place operations it is possible to build user-defined Lego structures. The system memorizes this assembly process and repeats building the complete structure on different places on the application plate.



*The KUKA Lego cell with the light-weight robot.
A visitor is teaching the robot to build Lego brick assemblies.*

Conclusion

Programming by Demonstration enables even robotic laymen to teach industrial robots. In the presented KUKA Lego cell any visitor can easily program an assembly task. The presented system is used as a test-bed for research and development in safe human-robot interaction, manual guidance and Programming by Demonstration scenarios. It already shows vividly its promising potential.

The KUKA Light-Weight Robot is a validation platform for new technologies and not yet commercially available.

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