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Physical Human-Robot Interaction: Dependability and Safety



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Centro "E. Piaggio",
Università di Pisa,
Italy

Prof. Antonio Bicchi
bicchi@ing.unipi.it

Institute of Robotics and
Mechatronics, DLR,
Germany

Dr. Alin Albu-Schaeffer
alin.albu-schaeffer@dlr.de

KUKA Roboter GmbH,
Germany

Dr. Rainer Bischoff
rainerbischoff@kuka-roboter.de

LAAS, CNRS,
France

Dr. Rachid Alami
rachid.alami@laas.fr

DIS, Università di Roma
"La Sapienza",
Italy

Prof. Alessandro De Luca
deluca@dis.uniroma1.it

PRISMA Lab/DIS,
Università di Napoli
Federico II, Italy

Prof. Bruno Siciliano
siciliano@unina.it



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Goal

This project aims at developing robots that can co-exist and co-operate with people, enabling a physical human-robot interaction which is dependable and safe: in a word, to make robots and humans **PHRIENDS**.

Key Issues

PHRIENDS is about **developing key components of the next generation of robots**, ranging from industrial robots to assist devices (in particular, robots for the emerging market of non-industrial applications, e.g. for service, health-care, and entertainment), designed to share the environment and to physically interact with people. Such machines have to **meet the strictest safety standards, yet also to deliver useful performance**: this poses new challenges to the design of all components of the robot, including mechanics, control, planning algorithms and supervision systems. We propose an integrated approach to the co-design of robots for safe physical interaction with humans, which revolutionizes the classical approach for designing industrial robots – rigid design for accuracy, active control for safety – by creating a new paradigm: **design robots that are intrinsically safe, and control them to deliver performance**.

Results after One Year

- ✓ Mobile robot safety policy in terms of functional and degraded modes of operation
- ✓ Planning of safe and legible trajectories for a robot manipulator in vicinity of humans
- ✓ Exploitation of sensorless collision detection algorithms for robots with rigid or elastic joints
- ✓ Definition of fast and safe robot reaction strategies in the joint space
- ✓ Task-preserving reaction schemes in response to detected collisions
- ✓ Experimental verification on lightweight manipulator for collisions with testbed mechanism, crash tests with dummies, and contacts with human upper limbs and trunk
- ✓ Design, construction and testing of new single-DOF variable-stiffness actuator



Expected Impact

Safe and dependable human-centered robotics is not only ethical: it also pays off. Results of this project will deeply impact applications where successful task completion requires people and robots to collaborate directly in a shared workspace. The project is expected to have an important potential for **exploitation**. The DLR Institute of Robotics and Mechatronics and KUKA Roboter GmbH have currently a technology transfer cooperation for the commercialization of the DLR light-weight robot technology. The light-weight robot, with its mechatronic design and force-torque sensing and control along the entire robot structure will be the first robot dedicatedly designed and programmed for human-robot interaction in industrial environments, as a robot assistant. It is expected that it will have **a very high impact on enlarging the industrial and service robot applicability**. It could easily envisaged that even today's standard robots could be equipped with advanced control hardware and software. In particular, **new prototypes of compact and efficient variable impedance actuators to be used as joints of lightweight arms will be developed**. The interest from potential customers from industry and academia who clearly see the benefits from applying and using such robots, is very high already. While turning research prototypes into products, one of the major topics to be addressed is to ensure to the highest level possible the safety of the humans which are using these robots.