# Sharing the workplace with robots? New tool helps designers create safer machines

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A research team is helping robot developers design machines less likely to injure the humans they work with. How? With their novel 'safety map."

At one time only encountered in science fiction, interaction between humans and robots has attracted quite a bit of attention over the past few years. As technology advances, people are becoming more exposed to robots in their daily lives. Such exposure isn't only limited to robotic toys and household appliances like robot vacuum cleaners. It's also occurring in the workplace as these machines take on roles that free humans from dangerous and repetitive jobs. Further increasing the frequency of human-robot interaction (HRI), robots are being developed for use in areas such as education, the hospitality industry, eldercare, rehabilitation and robot-assisted therapy.

Human safety is a primary concern in HRI. When there is physical contact between humans and robots, dangerous collisions are likely. With partial support from two EU grants for the projects ILIAD and SoftPro, researchers from the German Aerospace Centre and Leibniz Universität Hannover teamed up to create a tool that helps robot developers analyse the safety performance of their robot designs. Their novel tool, called a "safety map," is described in their paper published in *IEEE Xplore*.

**Pointing the way to robot safety**

In previous work analysing robot safety, the team had linked a robot's collision behaviour to human injury data. Having advanced this idea, they now compare entire robot designs (i.e. the mass and velocity range of the robot's entire workspace or task-dependent subspaces) to human injury data. The injury data may come from different types of experiments and disciplines, and can take into account different body parts. It also considers whether the impact surface in a collision is blunt, sharp or edged, and whether the collision itself is constrained or unconstrained. This information is represented in a unified manner, referred to as a 'safety map."

The 'safety map' helps users to determine if the robot they are designing is capable of inflicting specific injuries during unexpected collisions. They can also pinpoint the most dangerous areas in the robot's workspace and compare their robot with others in terms of safety characteristics.

As a result, designers have clear information at their fingertips about the injuries most likely to occur during operation. This helps to guide the hardware design process, and also contributes to safe control and motion planning for the robot being designed.

The researchers tested their map with two robots, the PUMA 560 and the KUKA Lightweight Robot IV+. The injury data they used for the experiment originated from 50 years of biomechanics injury research.

The map is likely the first global dynamic and exact safety analysis tool for robot manipulators. It has

the potential to trigger significant changes in the way human-friendly robots are designed in the future.

ILIAD (Intra-Logistics with Integrated Automatic Deployment: safe and scalable fleets in shared spaces) is developing innovative robotic solutions for current warehouse facilities. The creation of a large injury safety database forms part of its efforts to ensure safe robot operation in environments shared with humans.

SoftPro (Synergy-based Open-source Foundations and Technologies for Prosthetics and RehabilitatiOn) is studying and designing soft synergy-based robotics technologies to develop new prostheses, exoskeletons and assistive devices for upper limb rehabilitation. It aims to create end products that are affordable, available, usable and economically viable.

**More information:** ILIAD project website: www.iliad-project.eu/

SoftPro project website: www.softpro.eu/

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