Approaching Asimov's 1st Law of Robotics

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The desired coexistence of robotic systems and humans in the same physical domain, by sharing the same workspace and actually cooperating in a physical manner, poses the very fundamental problem of ensuring safety to the user and the robot.

In order to quantify the potential danger emanating from the DLR lightweight-robot (LWRIII), impact tests at the Crash Test Center of the German Automobile Club ADAC were conducted and evaluated.

A collision detection and reaction scheme, based on a disturbance observer is used. It utilizes only the proprioceptive capabilities of the robot and provides a filtered version of the external torque $\boldsymbol{\tau_{\mathrm{ext}}}$. This torque estimation is further used as an adaptive scaling of time increments in the trajectory generation and allows the user to push the robot intuitively forth and back along its desired trajectory. Combined, these mechanisms are used to distinguish between desired cooperation and collision in physical human-robot interaction.

The outcome of the dummy crashtests indicated a very low injury risk posed by rigid impacts with the DLR LWRIII. This was confirmed by real human-robot impacts at robot velocities up to 2.5m/s.