

NIST National Measurement System Assessment

Measurement Need Datum (MN)

Technology at Issue: Safety Systems for Next Generation Robots

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Technological Innovation at Stake: The Next Generation Robot (NGR) is envisioned as a machine incorporating inherent safety design and benign operating features, which enable and promote lean manufacturing. The current state of robot technology has not changed significantly for the last ten years, and there are an increasing number of applications that could benefit from collaborative human-robot interaction.

Economic Significance of Innovation: Current means of addressing the human-robot interaction safety problem involve restricting human access to significant portions of valuable manufacturing production floor space and investing significant resources in protective equipment. NGR, with built-in safety technology, is an enabling technology, which can affect the development of markets in those many classes of products requiring repeatable autonomous operation, handling of hazardous or heavy loads, etc. For example, this technology can reduce the cost of automobile manufacturing, microelectronic manufacturing, surgical operations, rehabilitation and elderly care, etc. There are at least 100,000 industrial robots in use in the U.S. and approximately 700,000 throughout the world. Approximately 10% of them are replaced annually. Their cost ranges from approximately \$30K to \$50K per unit. However, the cost of protective equipment is approaching the cost of the robotic units themselves. Overall, the current size of this market is approximately \$4.2 to \$7.0 B.

Technical Barrier to the Innovation: A serious impediment of technological progress in this area is the potential for robots to cause serious injury when they come in close proximity to humans. Safety features must be built into the NGR and those features validated for effectiveness of protection.

Stage of Innovation Where Barrier Appears: R&D (primary), Production (secondary)

Measurement-Problem Part of Technical Barrier: Classification methods for the level of operating safety of a robot must to be established, as well as proof and certification methods that can be clearly communicated to regulators and users. The best safety equipment and standards will have no value if the regulators, managers and labor unions do not accept and promote them. Robot-human interface pain data need to be assessed as input to this classification scheme. There is also a need for sensors, controllers, or calibration tests that can prevent an unwanted robot arm motion and can measure the position and orientation of a 3D moving robot arm, even when it is obstructed from line of sight view in an industrial environment.

Potential Solutions to Measurement Problem: Solutions could include computer simulations and tests with instrumented dummies, which can be used to validate safety claims and perhaps even rate robots according to their accident prevention capability. Collision detection devices designed to prevent collision with hardware should be redesigned to include human collision detection capability. The development of personal protective equipment that also alerts the robot controller of the identity, presence, location, status, training, and health condition of a human who has entered its restricted space is another potential part of the solution.

Potential Providers of Solutions: Due to the multifaceted nature of the problem, it is most efficient if it is addressed by industrial, academic, and government laboratories research groups working together.

What is the role for Government, if Any?: Build prototype testbeds, tools, and measurement techniques, which will be available for testing and experimentation by users, manufacturers, and regulators. Provide research, leadership, and technology transfer to standards writing organizations and industry.

If There is a Government Role, Why Industry Says It Can't/Won't Pay for That Part of Solution: This is a broad technology, which promises to benefit several product markets. So it will be difficult for a single company to have funds or incentives to develop the necessary metrology and standard needs.