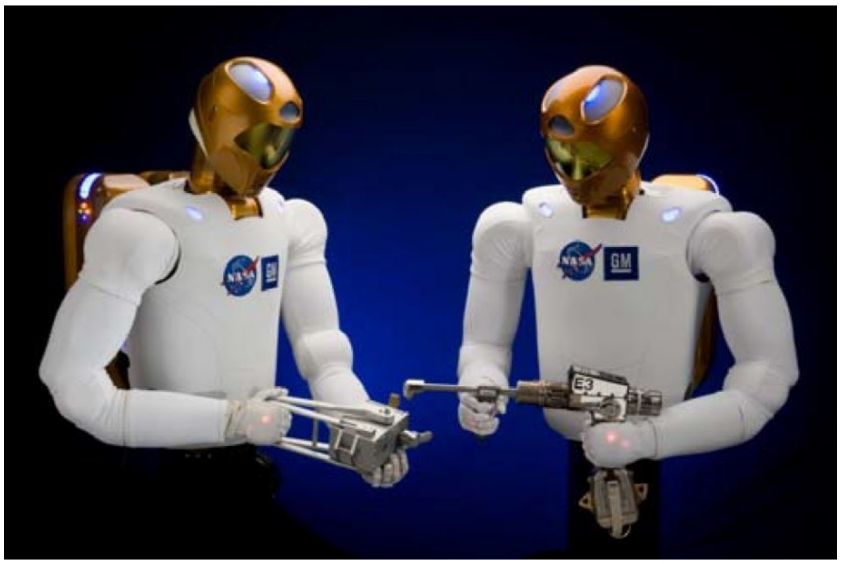


National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Robotics, Automation and Control

Advanced Humanoid Robotic Interface & Control

Cutting-edge systems for humanoid robotics

NASA and General Motors, two organizations at the forefront of autonomous robotics, have developed the Robonaut 2 (R2) – a state-of-the-art, dexterous, humanoid robot capable of performing tasks in an automated fashion (or via teleoperation). The technology developed throughout the project represents the cutting edge of autonomous, humanoid robotics. These technologies are available for licensing, both in a modular fashion or as an integrated system, to enhance your robotic products. Please see the Related Links section below for information on additional R2 robotics technologies, including those related to hands, arms, and sensor systems.

Advanced interface and control technologies, the topic of this flyer, allow R2 (and other humanoid robotics) to achieve safe and effective autonomous or teleoperation-based control. Interfaces enable simple control, while additional control systems ensure safe robot-human interactions, monitor the health of the robotic system, provide fail-safe breaks for robotic electric motors, and ensure electrical connectivity throughout a wide range of potential motions.

BENEFITS

- Safe robot-human interactions: A novel safety monitoring system, which satisfies even the stringent requirements of the International Space Station (ISS), was developed to ensure humans can work in proximity of, or interact with, humanoid robots in a safe manner.
- Advanced control architecture: A unique control architecture leverages high-performance impedance controllers located at the joint-level motor controllers with a model-based dynamic control system in the central processor to achieve performance requirements.
- Health management: A humanoid robot health management system that operates at all hardware and software levels of a robotic system to ensure system-wide observability, controllability, maintainability, scalability, and extensibility.
- Electromagnetic fail-safe braking: An advanced fail-safe braking system actively controls the power source of an electromagnetic braking system to enable selective braking of robotic electric motors (e.g., brushless DC motors), providing increased safety.

THE TECHNOLOGY

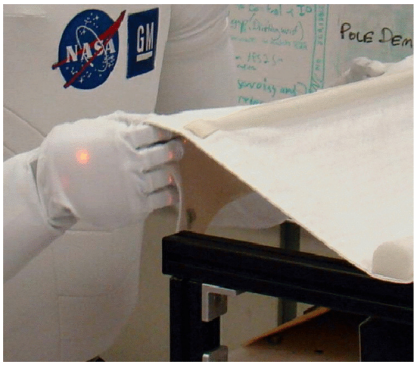
Technologies for Safe Workspace Control of Humanoid Robots: Safety is critical in scenarios where humans (e.g., factory workers or astronauts) are working in proximity to, or interacting with, R2. Methods for applying workspace limitations in velocity-controlled robotic mechanisms (U.S. Patent No. 8,676,382) and force or impedance-controlled robots (U.S. Patent No. 8,483,877) help to ensure such safety.

Autonomous Control Systems for Humanoid Robotics: A multiple priority operation space impedance control system (U.S. Patent No. 8,170,718) provides arm control, including programmable Cartesian stiffness. An interactive robot control architecture (U.S. Patent Nos. 8,364,314, and 8,260,460, and 8,706,299), including a simple GUI, provides an interactive development and work environment that integrates sensor data and feedback generated by R2. An additional system selects and controls appropriate manipulators to perform grasping operations (U.S. Patent No. 8,483,882).

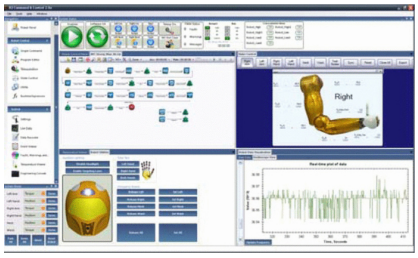
Humanoid Robotic Health Management System: A diagnostics, prognostics, and health management system for human robotics (U.S. Patent No. 8,369,992) operates at all hardware and software levels of the robotic system, enabling system-wide observability, controllability, maintainability, scalability, and extensibility.

Electromagnetic Motor Braking: Electromagnetic fail-safe brakes (U.S. Patent No. 8,067,909) allow for selective, reliable braking of robotic motors (e.g., brushless DC motors) to ensure safe and effective operation.

Highly Durable Connector Pin: To address the high failure rate of connectors in robotic systems with flexible members, a highly durable connector pin (U.S. Patent No. 8,033,876) was developed. The pin increases durability of connectors that are frequently flexed – a condition that causes deformation and compromises connectivity.



R2's advanced sensing and control systems enable the manipulation of soft goods.



R2's control GUI provides a baseline control interface for the robot and permits users to build up sequences using simple, reusable, control blocks.

APPLICATIONS

The technology has several potential applications:

- Ensuring safety for robot-human interactions
- Control of humanoid robots
- Industrial manufacturing & maintenance
- Space exploration
- Personal assistance & caregiving
- Emergency services & operations in hazardous environments
- Automation of repetitive tasks

PUBLICATIONS

Patent No: 8170718; 8,483,882; 8,364,314; 8,260,460; 8,706,299; 8,369,992; 8,067,909; 8,033,876; 9,120,224; 8,442,684; 8,525,460; 8,676,382; 8,868,234; 8,868,241; 8483877; 8,412,378; D628,609

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

MSC-24687-1, MSC-24750-1, MSC-24732-1, MSC-24746-1, MSC-25149-1, MSC-24744-1, MSC-25084-1, MSC-24752-1, MSC-24738-1, MSC-24742-1, MSC-TOPS-103

More Information

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