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Humanoid Robonaut ‘to boldly go’

Case Study

Ambitious NASA robot project relies on Harwin interconnect

The challenge is to build machines that can help humans work in, and explore space. Working side by side with humans, or operating where the risks are too great for people, machines like Robonaut - a humanoid robot designed by the Robot Systems Technology Branch at NASA's Johnson Space Center in a collaborative effort with DARPA - will expand our ability for construction and discovery. The Robonaut project has adopted the design concept of an anthropomorphic robot the size of an astronaut in a space suit and configured with two arms, two five-fingered hands, a head and a torso. Its dexterous pair of arms enables dual-arm operations and its hands can interface directly with a wide range of interfaces without special tooling. This concept enables intuitive telepresence control by a human operator.

The Robonaut team seeks to develop and demonstrate a robotic system that can function as an EVA astronaut equivalent. Robonaut jumps generations ahead by eliminating ‘robotic scars’, ie special grapples and targets, and specialized tools which are traditional in on-orbit robotics. However, it still keeps the human operator in the control loop through its telepresence control system.

Robonaut is designed to be used for tasks which were designed to be accomplished by humans, not robots. Central to that effort is a capability for dexterous manipulation - the ability to use ‘hands’ to do work - and the challenge for the development team has been to build machines with dexterity levels, motion, strength and endurance capabilities that exceeds that of a suited astronaut.

The manipulator and dexterous hand have been developed with a substantial investment in mechatronics design. The arm structure has embedded avionics elements within each link, reducing cabling and noise contamination. Unlike some systems, Robonaut uses a chordate approach to data management, bringing all feedback to a central nervous system, where even low-level servo control is performed. This biologically-inspired neurological approach is extended to left-right computational symmetry, sensor and power duality and kinematical redundancy, enabling learning and optimization in mechanical, electrical and software forms

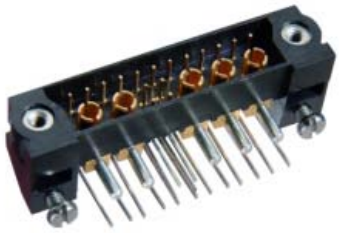
The theory that manufacturing tools caused humans to evolve by requiring skills that could be naturally selected has been applied to Robonaut's design. The set of EVA tools used by astronauts was the basis for the initial design consideration for the system, hence the development of Robonaut's dexterous five-fingered hand and human-scale arm that exceeds the range of motion of even unsuited astronauts. Packaging requirements for the entire system were derived from the geometry of EVA access corridors, such as pathways on the Space Station and airlocks built for humans.

Robonaut's broad mix of sensors includes thermal, position, tactile, force and torque instrumentation, with over 150 sensors per arm. The control system includes an onboard, real time CPU with miniature data acquisition and power management in a small, environmentally hardened body. Off-board guidance is delivered with human supervision using a telepresence control station with human tracking.

Space applications always call for highly reliable, rugged interconnects in a miniature, lightweight package. Robonaut's design team chose the mixed-technology version of Datamate, the i/o connector from leading hi-rel interconnection system company, Harwin, plc for this project, as connectors from this product range have been successfully used in other military and space projects that are subject to wide extremes of shock, vibration and temperature.

The team was looking for a board-to-board connector family that could handle fairly high currents of between 10 and 15A. That fact that Harwin's Datamate can handle signal and power in the same package was a real advantage. The team was under considerable time pressure and needed a solution in a small package. The deciding factor for Datamate was the versatility of the connector – Robonaut requires several different configurations - plus the fact that Harwin could turn around connectors exactly to the configuration required quickly and without having to consider a long tooling leadtime. Harwin committed to a five week leadtime, rather than the industry standard of eight to 10 weeks.

Harwin's Mix-Tek Datamate connectors are used all over Robonaut, specifically in the head and arms. Mix-Tek 2mm pitch Datamate connectors are available in more than 7.8 million different configurations of signal, power and coax, effectively allowing the customer to design their own Datamate connector, specific to their application. Turned contacts, used in conjunction with Harwin's four-finger Beryllium Copper contact clip, ensure contact reliability. Mix-Tek Datamate connectors are available in Male PC Tail, Female Crimp, Male Crimp and Female PC Tail options with a maximum of 50 low frequency contacts or 12 special (coax and power) contacts. They mate with known industry equivalents to allow retro fitting and are ideally suited to demanding, high vibration applications. Mouldings are polarised and have a UL94V-0 rating. Mix-Tek connectors comply with BS9525-F0033; CECC 75101-008; MIL C 55302 standards and are optionally available with jackscrew terminations for added security in applications which are subject to high vibration.



Useful Links:

- Visit the NASA Robonaut website