Mechanics/Machinery

Ultra-Compact Transputer-Based Controller for High-Level, Multi-Axis Coordination

Features include reduction in flex wear, streamlining of robotic structures, survivability, and uniformity in handling various types of servos.

Lyndon B. Johnson Space Center, Houston, Texas

The design of machines that rely on arrays of servomotors such as robotic arms, orbital platforms, and combinations of both, imposes a heavy computational burden to coordinate their actions to perform coherent tasks. For example, the robotic equivalent of a person tracing a straight line in space requires enormously complex kinematics calculations, and complexity increases with the number of servo nodes. The conventional method of executing these calculations is with a PC-style set of electronics including a powerful CPU (central processing unit) microprocessor, operating system, power supply, a number of peripherals, connectors to support each servo node, and a web of star-topology wiring across the machine (including flexing joints), generally exceeding 100 conductors. In industry, the most common implementation is one or more dedicated PC cards mounted on an ISA (Industry Standard Architecture), PCI (Peripheral Component Interconnect), or VME bus. These cards provide the I/O connectors and supplement the CPU to execute the massive kinematic calculations in real time.

A new high-level architecture for coordinated servo-machine control enables a practical, distributed transputer alternative to conventional central processor electronics. The solution is inherently scalable, dramatically reduces bulkiness and number of conductor runs throughout the machine, requires only a fraction of the power, and is designed for cooling in a vacuum.

The benefit of this innovation is total elimination of the central controller and reducing the heavy web of star-topology wiring across the machine to four wires along a shared serial bus. This scalable innovation results in decreased power consumption, decreased bulk, and vacuum compatibility.

This controller places a digital signal processor (DSP), instead of a microprocessor, at each motor axis, each with its own power supply, conduction cooling, etc. The DSPs communicate via CANbus over RS-485 hardware, forming the heart of the transputer.

Features of the device include reduction in flex wear in serial-articulating joints, streamlining of robotic structures (with reduced wire-harness bulk), survivability in the case of a single-processor failure, and uniformity in handling various types of servos (brushless, brushed, etc.) and sizes up to 300 W. Brushless compatibility supports elimination of brush-life limits and particulate generation. Power in the 2-wire bus flows directly between regenerative power nodes and motive power nodes, rather than traversing the round-trip star topology.

This work was done by Brian Zenowich, Adam Crowell, and William T. Townsend of Barrett Technology Inc. for Johnson Space Center. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

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Refer to MSC-24295-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Regolith Advanced Surface Systems Operations Robot Excavator

This design enables new ways of excavating for resources on planetary bodies.

John F. Kennedy Space Center, Florida

The Regolith Advanced Surface Systems Operations Robot (RASSOR) excavator robot is a teleoperated mobility platform with a space regolith excavation capability. This more compact, lightweight design (<50 kg) has counter-rotating bucket drums, which results in a net-zero reaction horizontal force due to the self-cancelation of the symmetrical, equal but opposing, digging forces.

This robot can operate in extremely low-gravity conditions, such as on the Moon, Mars, an asteroid, or a comet. In addition, the RASSOR system is designed to be easily transported to a space destination on a robotic precursor landing mission. The robot is capable of traversing over steep slopes and difficult regolith terrain, such as an impact crater on the Moon, and has a reversible operation mode so that it can tolerate an over-turning incident with a graceful recovery, allowing regolith excavation operations to continue.

The RASSOR excavator consists of a mobility platform with tread belts on the port and starboard sides that are each driven by electrical motors, but it could also operate with a wheel system to further reduce mass. Two batteries are