NASA Accelerates SpaceCube Technology into Orbit

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On May 11, 2009, STS-125 Space Shuttle Atlantis blasted off from Kennedy Space Center on a historic mission to service the Hubble Space Telescope (HST). In addition to sending up the hardware and tools required to repair the observatory, the servicing team at NASA's Goddard Space Flight Center also sent along a complex experimental payload called Relative Navigation Sensors (RNS). The main objective of the RNS payload was to provide real-time image tracking of HST during rendezvous and docking operations. RNS was a complete success, and was brought to life by four Xilinx FPGAs tightly packed into one integrated computer called SpaceCube.

SpaceCube is a compact, reconfigurable, multi-processor computing platform for space applications demanding extreme processing capabilities based on Xilinx Virtex 4 FX60 FPGAs. In a matter of months, the concept quickly went from the white board to a fully funded flight project. The 4"x4" SpaceCube processor card was prototyped by a group of Goddard engineers using internal research funding. Once engineers were able to demonstrate the processing power of SpaceCube to NASA, HST management stood behind the product and invested in a flight qualified version, inserting it into the heart of the RNS system. With the determination of putting Xilinx into space, the team strengthened to a small army and delivered a fully functional, space qualified system to the mission.

The SpaceCube team was able to combine Goddard's expertise in navigation and embedded science data processing to meet the demands of the advanced tracking algorithms and achieve mission objectives. Given the knowledge of the shuttle trajectory relative to the telescope, the Xilinx FPGAs were heavily utilized to accelerate the algorithms running on the embedded PowerPCs to successfully track HST during rendezvous and deploy maneuvers. SpaceCube also provided the command and telemetry path from the RNS payload to the mission operations team. More than 6 hours of imagery from three payload cameras were recorded on board, which were periodically compressed by SpaceCube and sent to Mission Control.
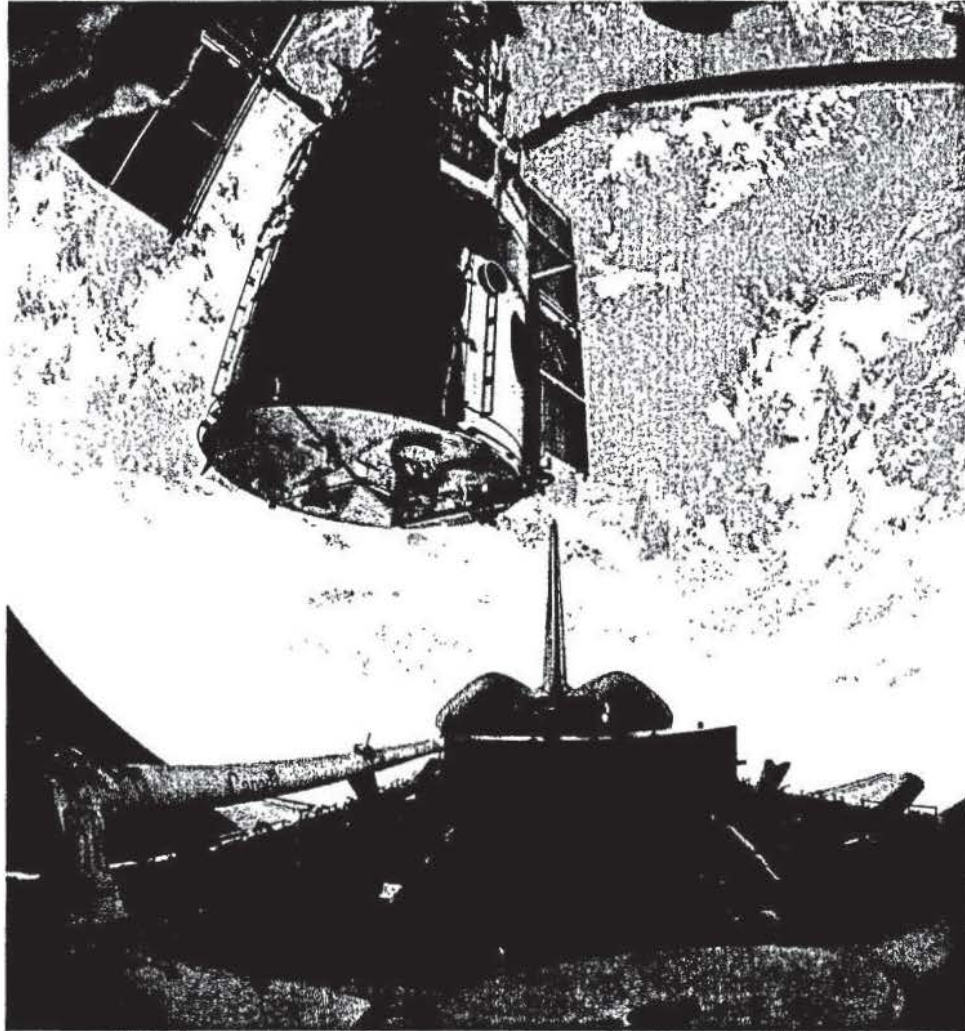

Real-time image tracking on SpaceCube

With the success of STS-125, the SpaceCube team remains at full throttle. Engineers made modifications to the flight spare SpaceCube from RNS, and transformed it into an on-orbit test platform for the International Space Station (ISS) to validate Xilinx radiation mitigation techniques. It was installed on the Express Logistics Carrier, an unpressurized external test rack in November 2009 during STS-129 and remains in operation. Currently, the team is reconfiguring the returned RNS SpaceCube and quickly putting it back into action to control a robotic demonstration scheduled to launch to ISS next year.

SpaceCube is a true success story of an emerging NASA technology that found a path to flight. NASA Goddard remains committed to being a leader in advancing space processor technology. The next generations of SpaceCube, based on Xilinx Virtex 5, are currently under development. Goddard plans to infuse this technology as the avionics for future missions like satellite servicing, sophisticated science instrument data processing, CubeSats, and a variety of aircraft payload systems.

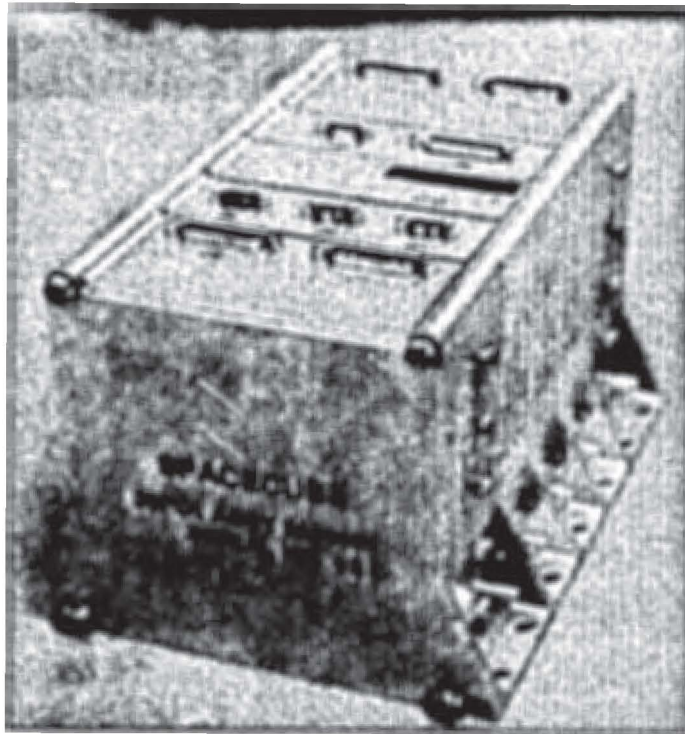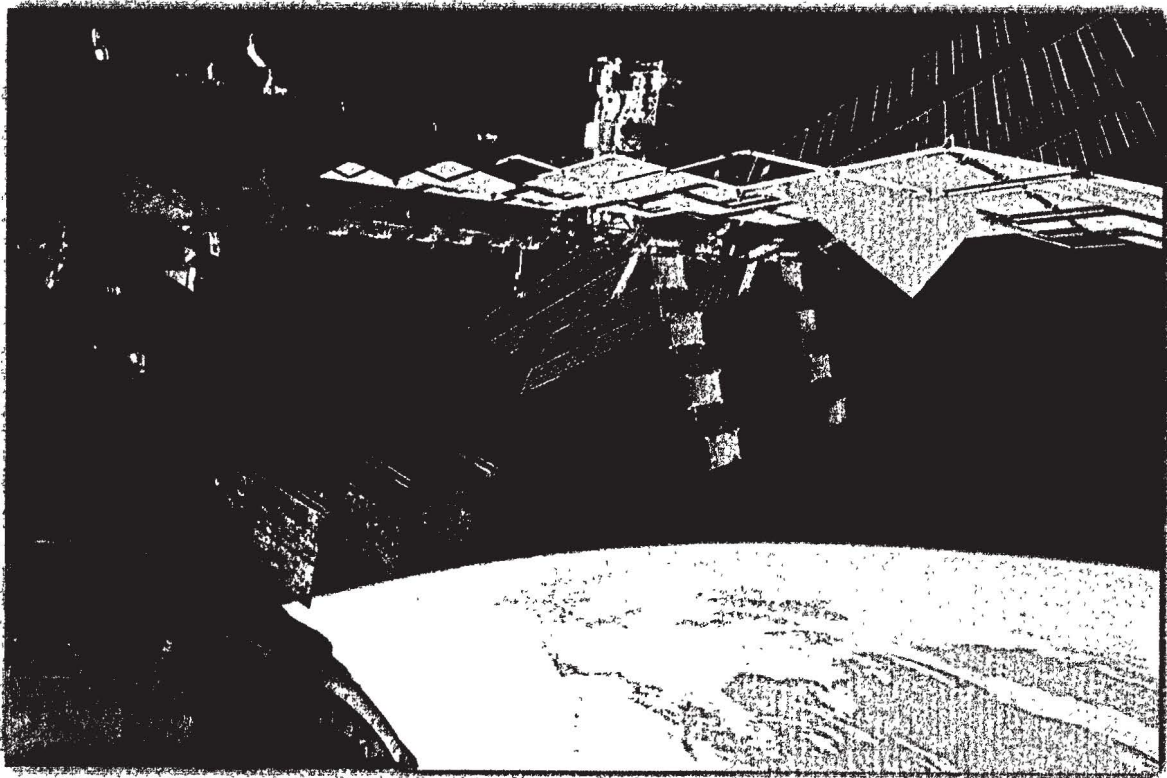*http://technology.gsfc.nasa.gov/SpaceCube.htm*

Docking with the Hubble Space Telescope during STS-125

HST rendezvous with tracking results processed by SpaceCube

SpaceCube flight computer – 5"x5"x7", 7.5-lbs.

SpaceCube flying aboard ISS on Express Logistics Carrier (top of picture)