SPHERES

MIT AEROASTRO

MIT AEROASTRO — Celebrating 100 Years of MIT Aerospace

Synchronized   Position   Hold   Engage   Re-orient   Experimental   Satellites

- Pressure Regulator Knob
- Thruster
- Control Panel
- Ultrasound Metrology Receiver
- Battery Door
- CO_2 Tank
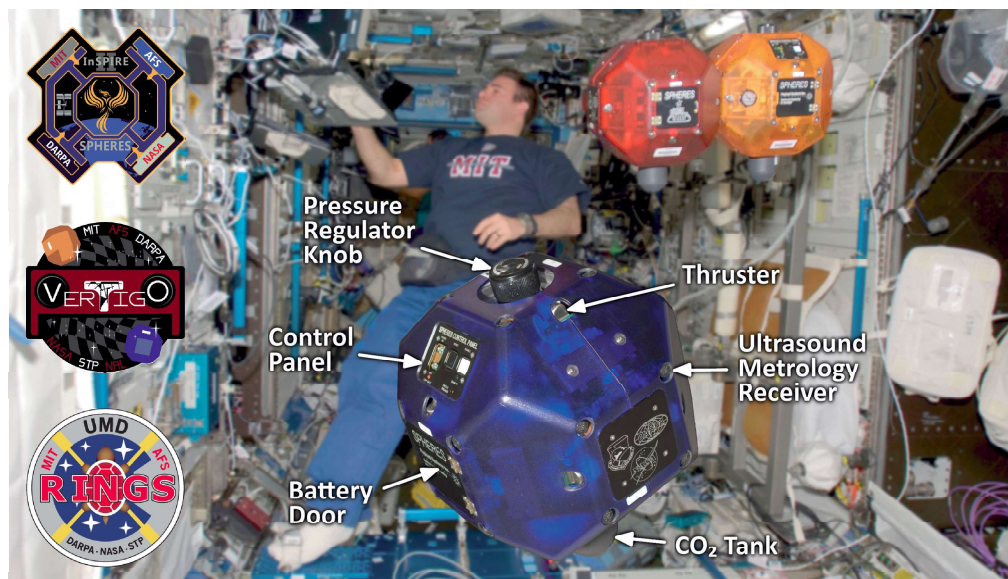
SPHERES is a facility for demonstrating **advanced satellite formation flight, docking, and autonomy algorithms** aboard the International Space Station (ISS).

In the **microgravity environment** inside the ISS, the three SPHERES nano-satellites are capable of controlled motion in six degrees of freedom. Supervised by crew members and operating in standard atmospheric conditions, they are a **low-risk testbed to assess key technologies of future space missions** and develop innovative research in microgravity.

The program began in 1999 as part of the first MIT Aero/Astro CDIO class and prototype satellites were built by the students in 2000. Flight satellites were delivered in 2003, then launched to the ISS in 2006. **SPHERES was one of the first educational programs that launched student-designed hardware to the ISS.**

TESTING ENVIRONMENTS

Ground Laboratory   Parabolic Flight   International Space Station

ZERO ROBOTICS
SPHERES ISS CHALLENGE

Zero Robotics is a robotics programming competition with SPHERES aboard the International Space Station (ISS). **High school and middle school students compete to solve an annual challenge by programming SPHERES.** Early rounds simulate the competition using a website interface. Finalists compete on the ultimate stage: a **live, microgravity event aboard the ISS, conducted by an astronaut**.
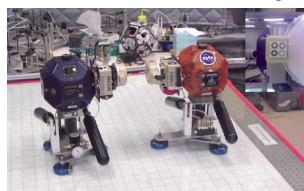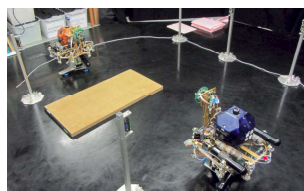
Want to program a satellite in space?
Learn how:
http://zerorobotics.mit.edu/

CURRENT PROJECTS

Visual Navigation   VERTIGO
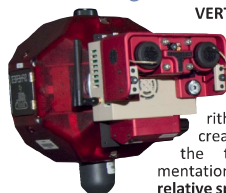
VERTIGO adds to the SPHERES satellites **a set of stereoscopic cameras** that sense different features on a target object in much the same way as human eyes. Computer vision algorithms evaluate the dynamics and create a three-dimensional map of the target, enabling the implementation of **autonomous, vision-based, relative spacecraft navigation**.

UDP   Autonomous Assembly

UDP is an **androgynous docking and berthing mechanism** that allows two SPHERES satellites to autonomously align and connect. Assembling multiple SPHERES together helps simulate and develop missions where **complex space structures are autonomously assembled and controlled using shared resources**.
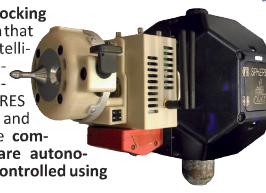
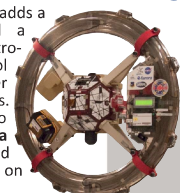### Reconfigurable Spacecraft   HALO
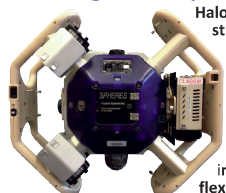
Halo is a **six-sided ring-shaped structure fastened** around a **SPHERES satellite** and electrically connected to the VERTIGO computer. It provides a standardized interface to six expansion ports where a wide variety of peripherals can be connected to the satellite, **increasing the capability and flexibility of SPHERES**.

RINGS   Electromagnetic Formation Flight

RINGS (in partnership with UMD) adds a **toroidal electromagnet** around a SPHERES satellite to test electromagnetic formation flight control algorithms and wireless power transfer between two satellites. These technologies are combined to **precisely adjust the positions of a sparse formation of satellites and** reduce their dependence on propellant.

Visit: http://ssl.mit.edu/spheres

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