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## **ISS R&D Conference Abstract**

ISS Robotic Student Programming

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### **ABSTRACT**

The SPHERES facility is a set of three free-flying satellites launched in 2006. In addition to scientists and engineering, middle- and high-school students program the SPHERES during the annual Zero Robotics programming competition. Zero Robotics conducts virtual competitions via simulator and on SPHERES aboard the ISS, with students doing the programming. A web interface allows teams to submit code, receive results, collaborate, and compete in simulator-based initial rounds and semi-final rounds. The final round of each competition is conducted with SPHERES aboard the ISS. At the end of 2017 a new robotic platform called Astrobee will launch, providing new game elements and new ground support for even more student interaction.

### **New Game Elements**

Astrobee will allow Zero Robotics to be able to go beyond virtual game elements and have students interact with real objects on board the ISS. These additional elements increase the ability of the student to see the motion and interaction of their code with the real world. These interactions are in two basic groups: sensing and manipulation.

#### ***Real world sensing***

Astrobee will be uniquely capable of sensing the world around it. Students will be able to program the robots to identify objects and look for physical games elements using cameras and an RFID sensor.

#### ***Real world manipulation***

Astrobee will also be uniquely capable of manipulating the world around it. A pan/tilt arm and gripper will allow Zero Robotics competitions to include grasping handrails, grappling other Astrobee units, and gripping real-world objects created for each game. Students will learn how to issue commands and how to coordinate motion of the vehicle with motion of the arm and gripper.

### **New Ground Elements**

#### ***Hands on hardware***

Because Astrobee is based on inexpensive cellphone technology, we plan to provide teams with a hardware development kit to allow students hands-on learning. Students



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will be able to see the results of code with their own eyes and experiment with the hardware.

### ***See a robot***

A planned in-school robotic platform is also being planned to allow demonstration and testing in a classroom or gym. While these will not be as inexpensive or plentiful as the hardware development kit, they will allow students to demonstrate their code and the robot behavior to other students and teachers. These demonstrations will help to foster interest in other students who are not directly involved in the competition, and may even lead to smaller school-level competitions.

### ***Ground testing***

Another new capability that will be part of the Astrobeer transition is the ability to run a round of the competition in a terrestrial lab. This will give the students the ability to see how to test on the ground before it is tested in space, and how those test results can differ. The ground lab is being outfitted with visual representations of the ISS lab walls, and lights and handrails for the vehicle to use for navigation and as part of the competitions.

### **Conclusion**

SPHERES and Zero Robotics is a unique opportunity for students to control a robot in space. Now with the more capable Astrobeer platform, students will be able to engage in more diverse challenges on the ground and on the ISS, and to see tangible results of their code.