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THE ZERO ROBOTICS PROGRAM USING ASTROBEE FREE FLYERS WITH HAND GESTURE RECOGNITION FUNCTIONS ON THE INTERNATIONAL SPACE STATION

Abstract

Zero Robotics is the first space robotics competition and has been operating since 2009. The program provides a platform for secondary school students to program an autonomous robot (currently the NASA Astrobee system) on the International Space Station (ISS). The Astrobee system includes three Astrobee robots that are operating in the ISS in the microgravity environment to conduct scientific research and space outreach activities. Each year, Zero Robotics offers a 5-week middle school summer tournament with a deliberately designed game challenge for students to collaborate and compete with the best performance. The Zero Robotics program is co-led by the Space Enabled Research Group at MIT Media Lab and the Innovation Learning Center, along with a wide array of collaborating non-profits, sponsors and technical support teams. Students in the program use the online Integrated Development Environment (IDE) to develop code and a browser-based simulation system to visualize the robots performing commands. The Zero Robotics program offers these tools freely to allow participants to design and build their game strategies, write scripts, and test their solutions through robot simulations. The final versions of student code are tested by the MIT team and implemented on the Astrobee robot. To celebrate the end of the program, MIT and NASA host a live Zero Robotics tournament that is live-streamed from the ISS. During June to August 2023, 581 middle school students and 146 educators participated in the 2023 Zero Robotics tournament. The game of the tournament is called "LUNABEE", in which students are asked to design a traveling path and control the Astrobee robot to simulate collection of a set of Lunar dust samples. The locations of the dust samples are informed by the hand gestures of the astronaut at the beginning of each game. This is the first demonstration of crew's hand gesture recognition using an Astrobee robot implemented with machine learning algorithms. Data from student pre- and post- program surveys shows that among 163 responses, 61% of the participating students are male and 37% are female. Nearly 85% of the students participated in Zero Robotics for the first time, and approximately 39% of the students had no experience in coding or robotics in any form. The preliminary results suggest that students' knowledge on programming basics has been improved from the program experience. Detailed analysis of the survey results are being conducted on student reflections in technical skills and their self-assessments.