SPACE EDUCATION AND OUTREACH SYMPOSIUM (E1)
On Track - Undergraduate Space Education (3)

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DEVELOPMENT OF A ROBOTIC MANIPULATOR ARM FOR THE EXPERIMENTAL MARS ROVER: A PROBLEM-BASED LEARNING IN SPACE ROBOTICS

Abstract

Australian Centre for Field Robotics (ACFR) has been involved in space robotics for some years and developed a number of experimental mobile robotic platforms. The Experimental Mars Rover (EMR) is one of these robotic platforms designed and developed for the government funded "Pathways to Space" project which encompasses both an education program for high school students and an academic scientific and engineering research program.

The EMR, which is also known as "Mawson" (named after Sir Douglas Mawson, an Australian scientist and explorer of the Antarctic) operates in the Mars Yard in the Powerhouse Museum, Sydney. The Mars Yard contains ancient fossils of microbial life obtained from the Pilbara and South Australia, demonstrating paleontological evidence of the early stages of life here on Earth. It is an analog for Mars and constitutes an ideal environment for scientific experiments.

In order to perform scientific experiment on the Mars Yard surface, the EMR needs to be equipped with a dexterous manipulator arm capable of close-up visual inspection, trenching, digging and sampling of the soil, and manipulation (picking, turning, and moving) of small rocks. We rendered these engineering requirements as the seed for a Problem-Based Learning (PBL) program in space robotics. Both undergraduate and postgraduate engineering students took parts in this hands-on, multidisciplinary program and developed a functioning robotic manipulator arm prototype.

This paper will present the multi-objective engineering design methodology used in the development of a dexterous manipulator arm for the EMR. It will also present how this engineering development work has been embedded into a project-based teaching and learning practice. This student-centred, active learning approach shifted the focus of activity from teacher to student and encouraged student to participate in multidisciplinary collaborations with the other stakeholders in the project. Our students have conducted comprehensive literature search, integrated theory and with the best engineering practices, and applied the body of collective knowledge and skills to develop a functioning prototype manipulator arm.