Removal of Space Debris objects using Robot technology.

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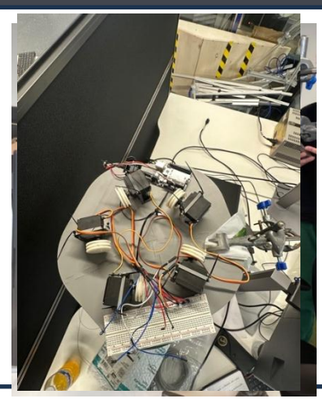
Research Overview

There is close to 6000 tonnes of space debris in Low Earth Orbit. This research aims at producing a succession of multi-armed robots whose purpose is to grab, hold and manipulate a piece of space debris. Once held, the debris can be removed from operational orbits and either reused or destroyed. The procedure of identifying and capturing an object, known as Rendezvous and Proximity Operation (RPO) missions are becoming increasingly popular in the field of sustainable space operations. There are considerable challenges involved in RPO debris removal missions, particularly in terms of observation and approach to catching space debris.
In this project, a second-generation multi-arm robot has been equipped with an operating system for object visualisation, detection and capture. The robot has successfully captured a range of cubesat sized objects of different shapes, approach speeds and compositions.

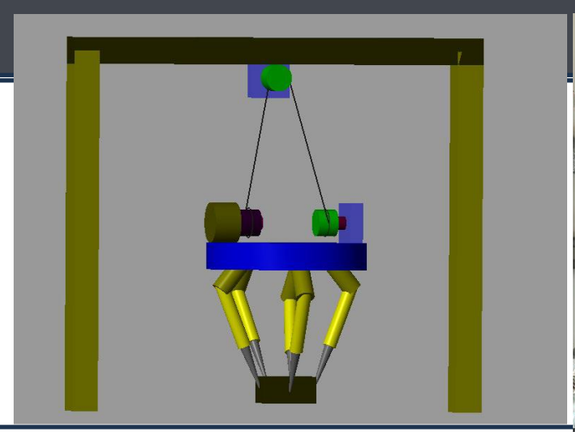


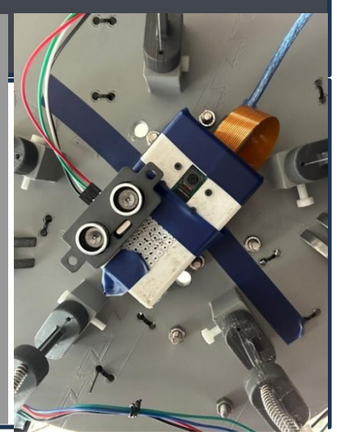
Industry Relevance

With space operations increasing and opportunities to benefit from space businesses in communications, manufacturing and observation growing, Space debris is an ever-increasing threat to spacecraft launch and operation. There are more than 40,000 debris objects in Low Earth Orbit greater than 10 cm and more than 140 million debris objects greater than 1 mm.
It is common for a spacecraft in Low Earth Orbit to need to be ordered to take avoidance action during its time in space.
The number of debris objects and mass needs to be reduced. One option is to enable the object's radius to decay until it burns up in the atmosphere. Another more recent view is that the debris should be moved to a graveyard orbit and the material reused in space. Not only is this safer but it is more sustainable and potentially more cost effective – putting objects into orbit from Earth is very expensive. Recycled debris material will, in the future, be used to make new and replacement parts for spacecraft, structures and habitats in orbit. Additive manufacturing techniques are ideal.

Methods & Technologies

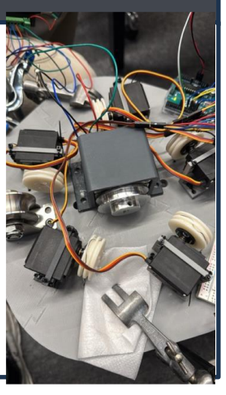
- Robot flexibility through individually powered servo-controlled PLA arms with multiple hinge joints.
- Distributed neural control for semi-autonomous operation using Raspberry-Pi and Arduino.
- Low force grasping due to a multi-arm enclosure with force dispersed contact.
- Self-repair/modularity because of its modular 3D printed design allowing isolated part replacement.
- Ultrasonic sensor detection to adjust each arm's distance from the object in real time.
- Static and dynamic capture options.
- Flask-based backend coordinates live video streaming & system command handling.





Innovations

- The robot arms can envelope an object, like an octopus.
- Machine vision observation of debris and recognition of when & how to grab the object.
- Individual action of each arm.
- Improved claw design for better hold.



Opportunities

- Seeking collaboration with an industrial partner to extend the robot's capabilities and construction for use in space.
- Opportunity for joint research in sensor technology, machine vision, object dynamics and touch robotics.
- Potential to co-develop a range of robots to integrate within spacecraft used to approach and contain the debris.

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