Gravity and the Robot Satellite Attitude Problem

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Using an in-orbit robot to capturing a malfunctioning satellite that is tumbling out of control is currently just a theoretical idea. However, research inspired by nature to be published in the forthcoming issue of International Journal of Mechanisms and Robotic Systems, could take us a small step towards making such science fiction science fact.

Angel Flores-Abad and Ou Ma of the Department of Mechanical and Aerospace Engineering, at New Mexico State University, in Las Cruces, explain that capturing a non-cooperative tumbling object in space, such as malfunctioning satellite for repairing, refueling or towing, is increasingly of interest to space agencies.

Unfortunately, the nature of orbital motion and the effects of gravity obeying Newton's Laws of Motion mean that a robot attempting to reach and grab such a tumbling object will succumb to changes in its own inertia that could either damage the equipment or result in the servicing vehicle itself which is the base of the space robot going out of control.

To find a solution to this problem, the team has turned to the way animals, including humans, naturally plot an approach trajectory based on the visual observation of the moving object - usually prey - and capture it. Their mathematical analysis offers a naturalistic way for a robot arm to reach and capture a tumbling satellite where impact forces between the two are minimal so that neither the stability of the servicing craft is disrupted nor the robot hand damaged by the impact.

The analysis also allows the connection between the robot hand and the captured object to occur in such a way that the resulting net contact force passes right through or as close as possible to the center of mass of the servicing vehicle and the robot combined system.

The team has studied their newly proposed technology using computer simulations. They simulated a rescue mission and demonstrated how capture can occur with zero relative velocity between the robot hand and tumbling satellite with a minimal contact force.

They are developing a robotics test bed to experimentally investigate the new technology. Once the technology is tested in the lab with simulated space conditions, it can be proposed for demonstration in a real space mission.

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