Space Junk: Cleaning Up Orbital Debris While Saving Rocket Fuel

Neumann, Julius (School: Manhattan High School)

Space junk, or orbital debris, poses an increasing threat to spacecraft and satellite-based infrastructure due to extremely high impact velocities, and any collision may result in thousands of additional fragments. To date, not a single piece of debris has been actively removed, and the first mission, planned for 2025, will destroy both the debris and the spacecraft during atmospheric entry. In this study, I investigated a method for removing orbital debris in which an autonomous spacecraft collects the debris and throws it into the atmosphere to burn up, while the spacecraft itself remains in orbit. I examined how the throwing process would change the orbit of the spacecraft, and if arbitrary orbit changes would be possible. I developed a computer simulation to calculate the trajectories of the debris and the spacecraft, and used it to systematically determine the minimum throw velocity required at each throw angle for the debris to enter the atmosphere. The results of this study show that the debris can be thrown in ways to either raise or lower the orbit of the spacecraft, while still entering the atmosphere. This could allow the spacecraft to reach the orbit of the next piece of debris without using much, or any, rocket fuel. The results also indicate that due to lower throw velocities, this method would be most viable in low Earth orbit, where most space debris is located. This study could contribute to solving the space junk problem, and help keep space usable and accessible for future generations.

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