Planning Made Easier: Engineers Develop Software Solution for Complex Space Missions

Sending an unmanned spacecraft to the outer fringes of the solar system requires extensive planning. At the University of Missouri, engineers have developed an efficient and highly sophisticated mathematical algorithm (implemented as software) that determines the most efficient path for a spacecraft's journey from point A to point B - no matter how many worlds or years away.

In testing and validating the algorithm, Craig Kluever, professor of mechanical and aerospace engineering in the College of Engineering, and Aaron D. Olds, a former MU graduate student who collaborated on the project, focused on the 1997 Cassini Mission, which was one of the most complicated explorations ever.

During a seven-year journey from Earth to Saturn, the orbiter flew past Venus, Earth and Jupiter. It twice flew by Venus. Along the way Cassini performed numerous gravity assists -close fly-by maneuvers that borrow energy from the planet and increase the speed of the spacecraft.

The trajectory generated by Kluever and Olds matched the one created by scientists at the Jet Propulsion Laboratory (JPL), which developed Cassini's route. Their mission-design software, which relies on optimization methods patterned from genetic evolution, makes sending a rover to Mars look relatively easy, Kluever said.

"You don't need complicated mission software for Mars missions," he said. "If you look at the trajectory, it doesn't require a lot of twists, turns and gravity assists. It's a straight shot. You need complicated mission software for ambitious missions to a comet, asteroid, moon of Saturn or beyond. We're talking about missions where an unmanned spacecraft would fly by Venus to do a gravity assist and then fly by Jupiter to do a gravity assist. Before that, it may have to coast a year and half to come back to Venus for another gravity assist. These very high-energy targets require orbital tricks. Timing all of these maneuvers to find the optimal solution is complicated."

Kluever said complex missions are launched roughly every three years with the goal of learning more about the origins of the universe. He said the mathematical principles behind the mission software developed at MU have been embraced primarily by the European Space Agency but thinks it could attract NASA's attention. He said when NASA begins planning future robotic missions "it will need software like this to solve those types of problems. But a lot of it depends on what NASA's going to do with human space travel over the next 10 to 15 years."

The study, "Interplanetary Mission Design Using Differential Evolution," was published in the *Journal of Spacecraft and Rockets*.

Source: University of Missouri