An Optimization Algorithm for Space Mission Design:
Dynamically Simulating Energy-Efficient Trajectories

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Introduction
This project focuses on the development of a software system that plans, optimizes, and simulates spacecraft trajectories. Its end goal is a dynamic space mission design system to automatically construct spacecraft trajectories between one planet and another with minimal energy expenditure by using the gravity of other planets as a form of propulsion.
Problem Statement
How can energy efficient spacecraft paths be automatically planned and effectively simulated?
Method and Results
This project uses a computer program developed by the researcher that incorporates both simulation and automatic data analysis for computerized space mission planning. The program refines the initial positions of spacecraft so their paths meet user specified requirements. This is accomplished by tracking the spacecraft's crossing of goal regions and using this data to direct the next iteration of refinement. This method allows the user to automatically find an accurate path for a spacecraft with specified itinerary. The use of mathematical concepts underlying gravitational physics help these paths be energy efficient. The software runs on multi-core processors and has been analyzed for scalability.
Conclusion
The current program has individually simulated launching into an L1 halo orbit, automatically transferring into an L2 halo orbit, and reaching both near and distant planets with gravity assist from intermediate planets. These trajectory segments may be connected with an energy-gaining transfer pattern which allows the spacecraft to achieve more distant destinations. The program makes effective use of 2- and 4-core processors and should show further performance increases with more cores.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check ALL that apply): ☐ human subjects   Potentially hazardous biological agents:
   ☐ vertebrate animals   ☐ microorganisms   ☐ rDNA   ☐ tissue

2. Student independently performed all procedures as outlined in this abstract. ✔ Yes   ☐ No

3. Student worked or used equipment in a site other than school, field or home. ☐ Yes   ✔ No

4. This project is a continuation of previous research.   ☐ Yes   ✔ No

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I/We hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year's research. I/We also attest that the above properly reflects my/our own work.

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