Trajectory Design Software for
Low-Cost Planetary Mission Fusibility Studies[†]

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ABSTRACT

The National Aeronautics and Space Administration is currently examining small low-cost planetary missions that would complement larger planetary missions and provide more frequent mission opportunities for the science community. As part of these activities comprehensive trajectory studies are being performed on many different types of planetary missions. Included in these studies are rendezvous and flyby missions to small bodies such as asteroids or comets which can involve the generation of trajectories for perhaps several hundred different objects. In addition complex trajectories may also be required that consist of one or more gravity assists of large bodies,

The requirements placed on the software used to perform the above mission studies are that the program be capable of generating these trajectories quickly and with sufficient accuracy to enable reliable estimates of spacecraft mass to be made. Because of the many constraints placed on the spacecraft and launch vehicle combination, it is also important to find the best transfer trajectory possible for a particular mission in order to maximize mission performance. The performance criteria used in selecting the best trajectory could, for instance, be either maximum science payload or maximum launch vehicle margin, An acceptable trajectory is commonly found by optimization of the available free parameters of the trajectory which may be event times such as launch date, arrival date, and planetary swingby date and by the inclusion of intermediate deep space maneuvers into the trajectory.

This paper describes a patched conic optimization program MIDAS that has been developed to investigate a wide variety of complex ballistic heliocentric transfer trajectories and has been used extensively for advance planetary mission studies at JPL,. This program includes the capability of optimizing trajectory event times and of adding or deleting either deep space maneuvers or planetary swingby powered maneuvers as dictated by the optimization process. The program includes the capability of handling different types of planetary missions such as rendezvous or orbiter missions, flyby missions, and sample return missions. This paper presents a comprehensive description of the capability of the program together with several examples demonstrating its use.