Geophysical Research Abstracts
Vol. 18, EGU2016-12296, 2016
EGU General Assembly 2016

Determining the mass of Didymos' secondary by visual imaging

Björn Grieger and Michael Küppers
European Space Astronomy Centre, Villanueva de la Cañada, Spain (Bjoern.Grieger@sciops.esa.int)

A critical requirement for the Asteroid Impact Mission (AIM) is the ability to determine the mass of Didymos' secondary with an accuracy of about 10 %. On one hand, this is necessary in order to plan the delivery of the lander MASCOT-2 with sufficient precision, on the other hand, it is needed to estimate the momentum transfer by the impact of the DART spacecraft and hence to verify the concept of asteroid deflection.

The conventional approach to estimate the mass of a solar system body through its gravitational effect by tracking the spacecraft trajectory is not viable for Didymos' secondary. With a diameter of only 163 m, its mass is too small to yield a significant impact on the spacecraft trajectory at reasonable fly-by distances. Instead, the idea to determine the mass of the secondary by measuring the "wobble" of the primary around the common centre of gravity has been put forward. The mass of the primary is about 100 times the mass of the secondary, thus the expected wobble radius is about one percent of the distance of 1180 m between the two, that is about 10 m. Such a wobble may be possible to measure either by means of using the optical communication device OPTEL-D as an altimeter or by direct observation with the visual imaging system VIS. Here, we investigate the latter approach.

The idea is to identify landmarks in VIS images and to simultaneously solve for the positions of the landmarks and the spacecraft in the body fixed frame of the primary. The temporary evolution of the spacecraft position comprises three components:

- the drift of the spacecraft due to gravitational disturbance and solar radiation pressure (and errors in the knowledge of the initial state),
- the apparent motion of the spacecraft around the primary (in the body fixed frame) due to its rotation,
- an apparent oscillation of the spacecraft position due to the wobble of the primary with a known period.

While the wobble component is quite small (about 10ṁ), its period is known and it is still possible to extract it under certain conditions.

In this preliminary investigation, we do not deal with the problem of landmark identification and the accuracy of landmark location in images. From the experience with the Rosetta mission, we know that landmarks locations can be measured with an accuracy of one pixel. We just arbitrarily generate landmark positions in the body fixed frame and simulate the viewing directions from the spacecraft (with some error), adding also some (unknown) spacecraft drift. We conduct Monte Carlo simulations for various scenarios and assess the accuracy of the determination of Didymos' secondary's mass.