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STATE ESTIMATION OF FLEXIBLE ASTEROID PROBERS BASED ON INTEGRATED MEASUREMENTS

Abstract

Cubesat-class probers with huge solar sails are desirable for future asteroid missions, due to their low cost, lightweight design and capabilities of providing continuous thrusts. Multiple cameras can be mounted on the flexible solar sail structure, as it is beneficial for visual navigation, and can also help obtain more scientific returns by taking advantage of the large size. The aim of this paper is to provide possible navigation solution for such flexible asteroid probers.

To look into state estimation problem of flexible probers under complicated coupled dynamics environment of asteroids, this paper proposes a distributed state estimation method based on the tight fusion of visual/IMU measurements. Since solar sails are prone to deform owning to the flexible structure, internal parameters, such as rigs between sensors, have to be considered time-varying. First, the integrated measurement model is established, consisting of the pin-hole camera model and the IMU kinematic model in asteroid proximity. Then, a cost function that combines the reprojection error of terrain landmarks in each camera frame and error terms from dynamic prediction is formulated. The pose of each camera is estimated in a distributed fashion by minimizing the cost function and ensuring estimation consensus. Prober states, as well as interested internal parameters, are obtained by means of iterative global optimization. Finally, numerical simulations are presented to validate theoretical results. The simulation results show that the proposed method can estimate absolute states and internal parameters of flexible asteroid probers with satisfying accuracy.