Paper ID: 46801
oral

IAF SPACE SYSTEMS SYMPOSIUM (D1)
Cooperative and Robotic Space Systems (6)

Author: Dr. Vincenzo Capuano
California Institute of Technology, United States, vcapuano@caltech.edu

Dr. Kyunam Kim
California Institute of Technology, United States, knkim@caltech.edu
Mrs. Juliette M. Hu
California Institute of Technology, United States, jmhu@caltech.edu
Mr. Alexei Harvard
California Institute of Technology, United States, alexh@caltech.edu
Prof. Soon-Jo Chung
California Institute of Technology, United States, sjchung@caltech.edu

MONOCULAR-BASED POSE DETERMINATION OF UNCOOPERATIVE KNOWN AND UNKNOWN SPACE OBJECTS

Abstract

Many of 15,000 known and catalogued orbiting objects are uncooperative. In addition to these, there are many more uncooperative objects, too small to be tracked by ground stations, with unknown geometric appearance. For the purpose of on-orbit servicing such as robotic manipulation, relocation, or simple observation of these objects, the servicing spacecraft is required to operate in their close proximity. In order to support spacecraft proximity operations, several vision-based techniques exist to determine the relative pose of an uncooperative orbiting object with respect to the spacecraft. Depending on whether the object is known or unknown, a shape model of the orbiting target object may have to be constructed on board by making use of only optical measurements. In this paper, we investigate two vision-based approaches for pose estimation of uncooperative orbiting targets: one that is general and versatile such that it does not require a priori knowledge and storage of any information of the target, and the other one that requires knowledge of the target's geometry. The former uses an estimation algorithm of translational and rotational dynamics to sequentially perform simultaneous pose determination and 3D shape reconstruction of the unknown target, while the latter relies on a 3D model of the target's geometry, which is assumed to be already available on board, to provide a point-by-point pose solution. The architecture and implementation of both methods are presented and their achievable performance is evaluated through numerical simulations. In addition, a computer vision processing strategy for feature detection and matching and the Structure from Motion (SfM) algorithm for on-board 3D reconstruction are also discussed and validated by using a dataset of images that are synthetically generated according to a chaser/target relative motion in Geosynchronous Orbit (GEO).