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Author: Prof. Eric Marchand
INRIA, France

Mr. Francois Chaumette
France
Mr. Thomas Chabot
Airbus Defence and Space, France
Dr. Keyvan Kanani
Astrium Satellites, France
Mr. Alexandre Pollini
Switzerland

RESULTS OF THE REMOVEDEBRIS VISION-BASED NAVIGATION FROM OPTICAL IMAGES

Abstract

EC FP7 RemoveDebris is a mission whose goal is to demonstrate Active Debris Removal key technologies. The vision-based navigation (VBN) experiment was carried out in October 2018. The VBN hardware and software (in short: the "VBN") is considered as a tool to observe and quantify the relative dynamics between an uncooperative debris and the platform preparing for its retrieval. To test the VBN, the RemoveDebris spacecraft released a CubeSat. The experiment goal was to localize a 2U CubeSat using optical images acquired by cameras and a LiDAR on-board the spacecraft and assess computer vision algorithms.

The experiment validated the VBN algorithms (along with the hardware) through ground-based processing of the actual images acquired in flight. Images (1280x1024 pixels, 12mm lens with 12mm square pixels) were acquired at 3Hz with successively 3 different aperture times, meaning that successive images at same aperture were acquired at 1Hz.

This paper focuses on the VBN algorithms and results. The proposed approach relies on a frame-to-frame model-based tracking in order to obtain the complete pose of the target (position and attitude) with respect to the vision sensor. It minimizes the error between the visual observation in the image and the projection of the 3D model of the CubeSat. Edge-based tracking are combined with other modalities such as texture-based features (Kanade-Lucas-Tomasi features), thus increasing the robustness of the tracker. Tracking and pose estimation are thus simultaneous. It can also be combined with an extended Kalman Filter to improve the navigation precision.

The tracking algorithm has been successfully validated with synthetic images prior to the actual mission and on the real images acquired in October 2018 during the RemoveDebris space mission. In particular, we will show that the CubeSat has been successively tracked and localized on 210 successive images (that is 210 s, i.e., 3.5 minutes).