Paper ID: 74248
student

20th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 20th IAA SYMPOSIUM ON SPACE DEBRIS (IP)

Author: Mr. Michele Bechini
Politecnico di Milano, Italy

Ms. Gaia Letizia Civardi
Politecnico di Milano, Italy
Mr. Matteo Quirino
Politecnico di Milano, Italy
Mr. Alessandro Colombo
Politecnico di Milano, Italy
Prof. Michèle Lavagna
Politecnico di Milano, Italy

ROBUST MONOCULAR POSE INITIALIZATION VIA VISUAL AND THERMAL IMAGE FUSION

Abstract

New classes of missions that envision a major role for autonomous close-proximity operations, such as Active Debris Removal, gained increasing attention in the last years, with a particular interest in non-cooperative objects. The high chaser reactivity that these scenarios impose make autonomous on-board pose (position and attitude) determination capabilities essential. Passive imaging sensors can provide high-quality data with relatively low mass and power requirements and thus navigation systems relying on monocular cameras operating in the visible (VIS) spectrum have been widely investigated and applied to rendezvous scenarios. However, the accuracy of the navigation is tightly linked to the illumination conditions, since an adequate sun incidence angle is required to collect meaningful measurements. Trajectory and operational planning may be exploited to mitigate this issue, but this could be extremely difficult for target in LEO orbit, for which a relevant part of the orbital period is spent in eclipse, hence relying on visible imaging only can jeopardize the performance of vision-based algorithms.

To overcome the aforementioned limitations, the paper investigates the possibility of achieving more robust data by performing pixel-level fusion of images acquired with a VIS camera with those acquired by a thermal-infrared (TIR) imager. While VIS images can be obtained through traditional rendering tools, TIR images have been generated employing a dedicated rendering tool internally developed at Politecnico di Milano and successfully tested in small celestial body exploration scenario.

Despite the improvement in the obtainable information from VIS/TIR fused images, especially in case of partial illumination, the scenario is challenging for classical image processing and pose initialization techniques, since most of them relies on image intensity gradients to identify the features from which the pose is reconstructed, while the fused images show extremely low gradients. Moreover, the signal-to-noise peak ratio of these images is low due to the different resolution of the images fed to the fusion algorithm and due to the image registration pre-processing step.

The work focuses on a comparative assessment of state-of-the-art pose initialization techniques for uncooperative targets, applied to the newly obtained fused images that are considered as input for this work. It is expected that this work will help assess the robustness of multispectral imaging for relative pose initialization, towards the development of dedicated pose initialization and tracking schemes capable of operating in a demanding environment like the active debris removal.