PhD Position

Vision-Based Non-Cooperative Rendezvous with Debris for Docking & Capture

Contacts

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Context

Near Earth debris has a growing population especially since the destruction of Fengyun-1C satellite in 2007 and the collision of Iridium-33 with Kosmos-2551 in 2009. According to ESA Space Debris Office, objects in orbit larger than 10cm are estimated to 21,000, and larger than 1m are estimated to 5000. Radar stations track 18,000 objects, only 7% are operational satellites. The rest is space debris. On average there is a high risk alert of a potential collision every week, and every ESA satellite has to be manoeuvred to avoid a collision once or twice a year.

Removing these debris is an open issue and a challenging process. Focussing on big-sized debris, we propose here to develop vision-based navigation embedded algorithms to estimate dynamics and 3D shape debris, based on a priori knowledge on the debris.

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Mission

Several robotics missions will involve image processing for challenging space applications:

- in-orbit assembly of flexible structures (space stations - CTH)

- in-orbit capture of debris (eDeorbit)

- in-orbit capture of passive devices (LPSR, PHSR)

- in-orbit capture of active spacecrafts (servicing, refueling, payload exchange)

These missions involve similar image processing algorithms with an a-priori knowledge of the target structure & optical characteristics, and requiring the same type of satellite architecture in terms of computing power & 3D sensing devices.

However, the state-of-the-art on such algorithms for space applications is currently at low TRL and requires a significant boost to face middle-term challenges (next 5 years) to run such an ambitious robotic mission representing a significant part of tomorrow's science & serciving market.

The current state of the art is the usage of mono-spectral images with either poor autonomous image processing or remote ground processing. These solutions are not compatible with the challenges to overcome in near-term future.

We propose to investigate several combinations of sensors that are today identified as key enablers:

- Dual usage of both VIS & thermal IR cameras and with or without LIDAR (conf 1)

- Mono configuration of VIS camera possibly with illumination device and with or without LIDAR (conf 2)

These configuration shall be analysed as a trade-off and, as far as possible, both investigated in the frame of the thesis and compared with cross-performance runs over a single scenario, with focus on configuration 2, bearing in mind the implementability over space resources. The element of novelty is to develop a reliable and validated vision based relative navigation approach for the rendezvous chaser using a LIDAR camera & investigating illumination devices in different modalities by introducing robust estimation techniques capable of dealing with outliers (Linfinity, Ransac, others...). Robust techniques based on this norm show remarkable capabilities of timely estimation of relevant information from large amounts of uncertain data. They have been widely applied in control systems theory but very little to problems related to information fusion and vision systems. Thus, analysing and designing robust estimation framework for problems related to optimal matching, pose, structure and motion must be investigated.

Finally, algorithms have to be embedded thus the performance of embedded algorithms have to be estimated on the process.

Profile of the candidate

The Candidate should have an MSc or equivalent in Science and/or Technology with some competencies in one or several of the following topics: **Estimation, Optimization, Computer Vision & Image Processing, Physics, Space Technology, Orbital Mechanics, Solid Dynamics**

Deadline: July 31st, 2017