

SPACE SYSTEMS SYMPOSIUM (D1)  
Enabling Technologies for Space Systems (2)

Author: Mr. Leonardo Regoli  
University Wuerzburg, Germany, regoli@informatik.uni-wuerzburg.de

Mr. Karthik Ravandoor  
University Wuerzburg, Germany, kravandoor@gmail.com  
Prof. Marco Schmidt  
University Wuerzburg, Germany, marco.schmidt@hs-bochum.de  
Prof. Klaus Schilling  
University Wuerzburg, Germany, schi@informatik.uni-wuerzburg.de

ON-LINE ROBUST POSE ESTIMATION FOR RENDEZVOUS AND DOCKING IN SPACE USING  
PHOTONIC MIXER DEVICES**Abstract**

Rendezvous and Docking (RvD) maneuvers in space have been performed since many years ago. Nowadays they play a vital role in bringing cargo to the International Space Station (ISS), like it is the case of the European Automated Transfer Vehicle (ATV), the Russian Progress or the Japanese H-II Transfer Vehicle. Especially the autonomous, unmanned docking procedure brought up new research challenges.

Currently, spacecrafts rely on complex bulky systems like the videometer used by the ATV. Additionally, the target body (the docking module of the ISS in the case of the ATV) needs to have retroreflectors placed in a specific pattern for the control system to correctly identify the relative position and pose during the close range docking phase. This paper deals with a new sensor type, the so called Photonic Mixer Devices (PMD), for the application in RvD scenarios. PMD sensors are a type of vision sensor capable of measuring the distance to a target by means of the Time of Flight (ToF) principle. In contrast with other currently used sensors, PMD cameras have the ability to extract the distance to every pixel within an image at high frame rates (up to 25 fps), avoiding the need to have previously installed structures in the target satellite and thus opening the doors to perform RvD to non-cooperative spacecrafts. In addition to this, its small size and low cost place it in a very interesting and promising position with possible applications in state-of-the-art missions such as DEOS, a planned DLR mission devoted to the on-orbit servicing and de-orbiting of satellites as an effort to minimize the presence of out-of-order satellites in space.

Throughout the last three years, different approaches have been studied in order to assess the performance of these novel devices when dealing with the determination of the relative pose between a target and a servicing satellite in the scope of cooperative and non-cooperative RvD maneuvers in space. By exploiting the state-of-the-art capabilities of PMD cameras several algorithms have been developed that allow the off- and online determination of the position and pose of a target.

The paper presents the latest developments and results achieved in this field, in which a combination of filters allows a robust online determination of the pose of a target object. Likewise, test protocols used for validating the performance of the algorithm and the corresponding results are presented.