Paper ID: 72090
oral
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations - IAF ASTRODYNAMICS SYMPOSIUM (IPB)

Author: Mr. Mewantha Aurelio Kaluthantrige Don
University of Strathclyde / Mechanical and Aerospace Engineering, United Kingdom,
mewantha.kaluthantrige-don@strath.ac.uk

Dr. Feng Jinglang
University of Strathclyde, United Kingdom, fjlangabc@gmail.com
Mr. Jesus Gil Fernandez
ESA, The Netherlands, Jesus.Gil.Fernandez@esa.int
Mr. Marcos Avilés Rodrigálvarez
GMV Aerospace & Defence SAU, Spain, maaviles@gmv.com

PSEUDORANGE MEASUREMENT AND SUN PHASE ANGLE ESTIMATION USING CNN-BASED IMAGE PROCESSING ALGORITHM FOR HERA MISSION

Abstract

The Early Characterization Phase (ECP) and the Detailed Characterization Phase (DCP) of the European Space Agency (ESA)'s HERA mission are two proximity operations that have the objective of conducting physical and dynamical characterizations of binary asteroid system (65803) Didymos. In these phases, an Image Processing (IP) algorithm is designed to estimate the position of the Center of Mass (COM) of the primary to enable Line of Sight navigation. However, standard IP algorithms need to introduce correction terms depending on the Sun phase angle (Sun-asteroid-spacecraft) to increase the accuracy of their estimation. To measure the range with Didymos, HERA uses the Planet ALTimeter, a LIDAR experiment that is not operating during the ECP and the DCP as it requires closer distances with Didymos. Within this context, this paper aims to measure the pseudorange with Didymos and to estimate the Sun phase angle by developing a Convolutional Neural Networks (CNN)-based IP algorithm and applying it to the images captured during the ECP and DCP of the HERA mission. For the first aim, the proposed algorithm regresses two diametrically opposed points of Didymos in the image, evaluates the primary's apparent diameter, which is used to measure the pseudorange with the spacecraft. For the second aim, the algorithm measures the Sun phase angle using the pixel position of the centroid of the primary and the pixel position of the intersection of the primary's surface with the Sun-primary vector. The choice of the CNNs over standard IP algorithms is based on two main reasons. Firstly, CNNs have the main advantage to be robust over adverse illumination conditions and over the irregular shape of the target. Secondly, standard algorithms would require to analyze each pixel of the image to measure the apparent diameter of the asteroid, which is time consuming and computationally expensive. The training, validation and testing datasets are generated with the software Planet and Asteroid Natural scene Generation Utility (PANGU). The High-Resolution Network (HRNet) is used as CNN architecture as it represents the state-of-the-art technology in keypoint detection. The performances of the HRNet-based IP algorithm are evaluated in terms of absolute error between the true range and the measured pseudorange and between the true and the estimated value of the Sun phase angle. The HRNet-based IP algorithm is expected to measure the pseudorange and to estimate the Sun phase angle with high accuracy, hence to improve the performance of the autonomous optical navigation strategy.