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ARTIFICIAL INTELLIGENCE BASED 6D POSE ESTIMATION OF UNCOOPERATIVE TARGETS FROM MONOCULAR IMAGES

Abstract

Proximity operations around non-cooperative targets has always been challenging owing to the non-availability of their pose data. Traditional pose estimation methods of uncooperative targets require several sensors, long observation periods and manual supervision. Compared to this, a camera is a relatively simple and inexpensive sensor that provides rich data about an object. It would be invaluable if this could be used for quick and accurate pose estimation. Previous approaches to visual pose estimation have suffered from a lack of robustness to various lighting conditions and camera angles. Recent developments in artificial intelligence, particularly Convolutional Neural Networks (CNNs) have demonstrated great generalization ability, making them suitable for this application. This work applies CNNs to the field of pose estimation of space targets from monocular images. A large and varied dataset is required to train accurate machine learning models. We create two datasets – a large dataset of synthetic images and a small dataset of real images. The synthetic images are used for training and the real images are used for testing the algorithm. For the real images, we mount a scaled down model of the target satellite on a robotic arm. In case of synthetic images, the ground truth can be easily derived from the simulation. In case of the real images, the correct pose can be derived from the configuration of the robotic arm. With this dataset we train a CNN model that takes an image as input and identifies object keypoints. Keypoints consist of easily discernible features on the spacecraft body, like antennas and solar panels. Finally, we use the Perspective-n-Point algorithm to match the image keypoints to object keypoints and derive the pose of the target. Neural network-based algorithms, however, have high computational cost. Hence to prove the efficacy of the developed model on embedded systems, we demonstrate the performance of this algorithm on the NVIDIA Jetson Nano. We envision that the developed model can be used for in-orbit satellite servicing and space debris mitigation missions.