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OBJECT DETECTION AND POSE ESTIMATION FOR NON-COOPERATIVE DOCKING USING DNN FOR SPACE APPLICATIONS

Abstract

The robust, reliable and accurate relative pose estimation is the prime requirement for non-cooperative satellite docking application. As technology advances in computation, image processing, and advances in DNN a vision based Object detection algorithms are appropriate for for non-cooperative targets where accuracy and speed can achieved. Vision-based guided spacecraft relative motion during close-proximity maneuvers applied using dynamic modeling as a spacecraft on-orbit. This research constructs a vision-based pose estimation model that performs image processing via a deep convolutional neural network based object detection. In this research, The spacecraft dynamic models are used to generate on-orbit images with different conditions i.e Synthetic Training images are constructed by using blender software and dynamic spacecraft models with different scenarios like lighting conditions and different distances. In the implementation, the DNN learns from the data samples to create correlations between the images and the spacecraft's six degrees-of-freedom parameters. In particular, in this paper, the speed of object detection and pose estimation is achieved using the YOLO4 algorithm. The verification of trained DNN carried out with test data and the performance of DNN is 98 percent matching with reference set in pose detection. In addition, this algorithm can be applied to spacecraft rate detection of tumbling satellites and tracking spacecraft problems. Although the finished vision-based model is specific to the environment of synthetic dataset, the model could be trained further to actual(real) docking operations in the future.

Key words : Spacecraft Relative pose estimation , vision based DNN algorithm and object detection