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MOTION PREDICTION OF NON-COOPERATIVE TARGET BASED ON AUTOREGRESSIVE MODEL

Abstract

The increasing demands of satellite maintenance, on-orbit update and space debris removal etc. servicing missions call for applications of space robots to perform tasks in the particular harsh environment. Normally, the servicing targets are defunct satellites or space debris and therefore can be treated as non-cooperative targets. Space robot first has to capture the non-cooperative target in order to execute further operations. Nevertheless, due to the target mass parameters are unknown before capture, the motion of the target cannot be predicted using its dynamic model. It is impossible for the space robot to complete such a capture task without the knowledge of the target motion prediction. Therefore, how to obtain the non-cooperative target motion prediction in finite horizon precisely is one of the challenging issues in space and has gained increasing recognition.

This paper describes a framework for predicting future positions and orientation of non-cooperative targets in the complex space environment employing autoregressive model (ARM). No constraints are placed on the target motion. Trajectories of the non-cooperative targets are not known a priori, but we assume that previous knowledge about position and orientation are available to the ARM from sensory devices. Based on the historical knowledge of the target motion, the parameters of the ARM are obtained with conditional maximum likelihood estimation. Once the parameters of the ARM are determined, the $(n + n_p)th$ (n_p is the prediction horizon) position and orientation of a non-cooperative target could be calculated in a truly dynamic sense based on its first n positions and orientations. Simulation results show the feasibility and performance of the proposed scheme when compared with the motion prediction using truly dynamic model. The prediction model will be an essential part in designing a trajectory planning algorithm for a space robot executing on-orbit capture activities.