 Paper ID: 80131
student

21st IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 21st IAA SYMPOSIUM ON SPACE DEBRIS (IPB)

Author: Mr. Prateesh Awasthi
Indian Institute of Technology Kanpur, India, prateesh@iitk.ac.in

Mr. Ayush Ranjan
Indian Institute of Technology Kanpur, India, ayranjan@iitk.ac.in
Mr. Vishrant Dave
Indian Institute of Technology Kanpur, India, vishrant@iitk.ac.in
Dr. Dipak Kumar Giri
Indian Institute of Technology Kanpur, India, judipakkumar@gmail.com

STABILIZATION OF TUMBLING SPACECRAFT VIA CONTINUUM ARM USING VISION-LANGUAGE HYBRID MODEL

Abstract

The reduction in launch costs in the last decade has led to increasing space activity which has in turn led to generation of space debris. In order to handle this debris, we need to stabilize and take control of the non-cooperative spacecraft. In this paper, we propose the use of a continuum arm for stabilizing and docking with a tumbling spacecraft. To accomplish this, the robotic arm must be capable of handling obstacles in the workspace and planning its motion around them. For these reasons, we choose a highly-redundant robotic arm that can outperform standard robotic arms in situations like holding and gripping non-stabilized space debris. In this paper, we apply a grounded vision-language navigation technique where our continuum robot with visual perception is guided via language to find objects in microgravity environments.

At each timestep, the visual-language navigation(VLN) model generates a language prompt describing the current environment. This language prompt and the image are input by the reinforcement learning agent to generate the actions required to reach the destination. Since the pre-trained vision-language navigation models(VLNs) have massive datasets available for object detection and localization, they are much better at localizing the position of the destination point. Thus, the prompts generated by the language model taken as priors for the reinforcement learning model avoid unnecessary exploration and improve the algorithm's sample efficiency and the agent's performance.

We investigate the performance and efficiency of our model in comparison to vanilla DDPG, and we demonstrate that the performance of the highly redundant continuum robot improves significantly over the vision-only-based models. This is a novel method for robotics as it has been only used to play simulation games. However, we demonstrate that this approach can be successfully applied to navigate continuum robots in complex environments and can be applied for stabilizing a tumbling spacecraft.