

SPACE DEBRIS SYMPOSIUM (A6)
Space Debris Removal Technologies (5)

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COMPACT IMAGE PROCESSING UNIT FOR NON-COOPERATIVE RENDEZVOUS

Abstract

Recently, space debris has come to pose a serious international threat. For sustainable and safe utilization of the orbit, it is critical to remove space debris. Further, even if we reduce the production of space debris, the number of space debris is still predicted to increase owing to additional debris generated from existing corroding debris. Therefore, there exists a need for developing a spacecraft to remove space debris. The most serious barrier against realizing such a space debris removal system is the associated costs, which may not be justified on account of it merely playing a supportive role. Recently, ideas to utilize small satellites for space debris removal systems have emerged as viable and cost effective. To realize the space debris removal system, it is essential to develop a compact and intelligent on-board computer system to handle image processing tasks and autonomous control. During a rendezvous between the system and the space debris, the space debris removal system will be required to recognize and approach the target autonomously because the communication link between the system and the ground station is limited. Furthermore, since the target debris can be deemed a non-cooperative object and the resources of the small satellite space debris removal system is too limited to utilize radar and/or LIDAR, the most viable means to recognize and approach the target debris is considered image processing. Therefore, high performance calculation capability is essential for space debris removal systems based in small satellites. Therefore, we developed an image processing system for space debris removal that uses high-performance compact on-board computers in small satellites. To realize a reliable and safe approach to target debris, at least two types of visual guidance technologies are required. The first is orbit estimation based on the relative motion of the target debris using labeling image processing technologies in relative far distance. The other is detailed relative motion detection such as optical flow in relative near distance. To implement these types of image processing, we decided to implement OpenCV in the on-board computer. OpenCV is an open source image processing solution widely used in laboratories. The use of OpenCV can reduce development costs because developers need not develop the image processing system from scratch. This paper describes the concept of a compact image processing system for space debris removal using small satellites and the image processing capabilities for the non-cooperative rendezvous of the autonomous space debris removal.