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

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DEVELOPMENT OF A CAMERA FOR AUTONOMOUS VISUAL GUIDANCE FOR SPACE DEBRIS REMOVAL

Abstract

In recent years, as space development has become more active, space debris problems have become more serious. Furthermore, because collisions among existing debris generate new debris, it is believed that the amount of debris will increase exponentially. Therefore, satellites for debris removal must be developed immediately. A mandatory function of a debris-removal satellite is that it be able to autonomously recognize and approach the target debris sensing distance and movement. We cannot expect the debris-removal satellite to communicate with debris, and owing to bandwidth limitation, it is impractical for the debris-removal satellite to communicate with a ground station. Visual guidance using image processing is being considered as an effective technology for guiding the debris-removal satellite toward non-responsive targets. For example, the distance between a debris-removal satellite and the debris or the movement of debris can be estimated using image processing. We have developed a camera system that is capable of performing on-board image processing. It was deployed on the small solar-electric power-sail demonstrator IKAROS launched in 2010. The IKAROS camera system can acquire high-resolution digital images, and it possesses high-calculation capability powered by a PowerPC processor and Linux operating system. Consequently, we decided to expand the IKAROS camera system for use in the visual guidance system of a debris-removal satellite. Visual guidance software was developed and implemented as a Linux application on the IKAROS camera system. In addition to software implementation, the system was expanded to address the multiple-direction image acquisition that is required during the rendezvous process. We plan to demonstrate the performance of our proposed system on the H-2 transfer vehicle (HTV) as a part of the electrodynamic-tether experiment. The camera system can perform two types of real-time image processing. The first is distance estimation of a tether-end-object during tether-end-object ejection. This corresponds to the approaching process of debris removal. The other is tether motion-recognition for detecting a marker that is attached to the tether. This corresponds to the target recognition and orbit estimation process during the homing phase. Finally, if permitted, we plan to acquire images of the International Space Station (ISS) using this camera when the HTV rendezvouses with the ISS. This paper presents a camera for autonomous visual guidance and an outline of the flight experiment on the HTV.