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NEW METHOD OF ECHO DETECTION FOR DIFFUSE REFLECTION LASER RANGING OF SPACE DEBRIS

Abstract

The use of orbital space has led to a growing hazard to navigation due to the risk of collision with space debris. Various studies estimate that there are between 200,000-600,000 uncontrolled objects of 1cm diameter or greater in Low Earth Orbits (LEO) .Each of these debris objects is capable of causing catastrophic damage to an active satellite. A accurate catalogue and orbits determination of space debris is a fundamental requirement for any effort towards debris collision avoidance. As laser tracking is inherently accurate and laser link equations allow scaling of laser tracking system to track small space debris, the laser tracking method became more and more important for orbits determination and catalogue of space debris orbits. Space debris which belongings to non-cooperative targets does not contain corner reflectors, the laser reflection of space debris is in the manner of diffuse reflection, so the echo received of each laser pulse is very weak, almost only have several photos. Meanwhile with the dark noise of detector and background noise, the signal to noise ratio (SNR) of data detected is low, usually in the level of 1/20. The existing detection method of satellite laser ranging (SLR) cannot deal these weak signals of diffuse reflection automatically. This paper proposed a new method for automatic detection of laser echo of space debris based on saliency detection. First, the residuals of laser ranging are assembled along the time measured axis, which formed an image of residuals distribution, and the saliency of valid data is enhanced. Then with the hypothesis of that the valid echo data is distributed in the pattern of piecewise linear, a weighted Hough transform is used to detect all possible echo pixels. Finally the polynomial fitting method is used to obtain all valid echo pixels in the image, and then the real echo signals are detected. Experiment with actual measurement data shows that the method has a high detection efficiency and accuracy, and can automatically handle laser ranging echo data of space debris.