Development and validation of object detection algorithm for robust video based laser safety system

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The majority of ground based systems requires continuous tracking of satellites or objects creating a demand for moderate cost automation systems. However, working with high powered lasers requires independent measures to ensure the safety of any flying objects. Low 61 cost receivers such as ADS-B and FLARM 1 can provide the position of an aircraft allowing for an easy implementation of laser safety measures. However, objects such as helicopters, small aircraft, gliders, balloons or others might not carry such transponders and are therefore at risk of exposure to laser radiation. Hence, a robust video based detection system was developed to provide sensors in addition to ADS-B for an independent and thus redundant mean to establish in-sky safety, allowing for a safe autonomous operation of laser systems in the future. The system features cameras in three different spectral regions: thermal infrared (TIR) [8 - 14µm], near infrared (NIR) [0.4 - 1.7µm], and visible spectral band (VIS) [0.4 – 0.7µm], to exploit strengths of the individual camera systems under different lighting and weather conditions. An image-based object detection algorithm was developed to evaluate the real-time video feed of each camera.

A total of 150,000 images from each camera containing 200 individual objects such as aircraft, helicopters, balloons, etc. was captured during day and night time. Furthermore, the video streams of the GFZ Potsdam SLR station in the TIR and VIS wavelength were used, providing additional data for an independent comparison. The developed algorithms were tested on collected data and cross compared with each other, as well as the ADS-B data to quantify the algorithm performance. Furthermore, a detailed analysis was performed to highlight the limitation associated with individual sensors. The presented approach is promising for current and future satellite/space debris laser ranging and optical communication applications.