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CLOWN: A NEW TOOL FOR CLOUD DETECTION WITH ALL-SKY CAMERA FOR OPTIMIZATION OF SPACE-DEBRIS SURVEYS.

Abstract

Space asset management needs to address the dramatic increase in the number of satellites in orbit. The ever growing competition in space exploration has lead to the accumulation of space debris in orbit, which due to high speeds can cause great damages to active satellites or manned missions. As such, there has been a growing effort in the worldwide monitoring and surveying capacity of these debris in order to protect present and future missions through the use of radar and optical telescopes. The optical telescopes typically acquire thousands of images per night and their operation time has to be optimized for space surveillance and tracking operations. This project aims to create a real-time automatic cloud detector, to optimize the operations of the new large field-of-view double telescope, which is being installed at the PAmpilhosa da Serra Space Observatory (PASO), Portugal, as a future sensor of the national SST program. The telescope platform is designed to conduct automatic space debris surveillance and tracking operations. The project main goal aims to avoid dark images (cloudy) taken while surveying the sky, optimizing the telescope time, reduce unnecessary processing, and increase the telescope's efficiency. The method uses an all-sky camera to obtain images of the sky, analyzes the images to map the presence of clouds and relays that information to assist the automatic operation of the telescope. The `CLOWN` tool was developed in order to work with any type of all-sky camera. `CLOWN` requires minimal information, the camera location and the timestamp of acquired images. The tool app can be used with any camera since it is not model or brand-specific enabling its integration with any already installed sensor equipment. `CLOWN` uses the presence or absence of stars in the image to confirm cloud detection even in difficult detection conditions. The software tool was also developed to have a low computational cost, making it possible to use local resources without major investment. The tool results are very good: it correctly identifies and maps clouds in a variety of sky conditions and improves space debris survey operations. This tool can be implemented at any observatory to increase the efficiency of telescope time, not only for space-debris surveillance but also for astronomical surveys. In the future, `CLOWN` will also be used to assist other robotic equipment at PASO and integrated into a visual assistance tool to aid operations of other observatory sensors.