# OCS: A flexible observatory control system for robotic telescopes with application to detection and characterization of orbital debris.

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## ABSTRACT

OCS is a software package for remote and autonomous telescope control, optical detection and tracking of orbital debris, and data analysis. It supports a wide range of hardware and is highly configurable. It is capable of tracking objects in orbits ranging from LEO to GEO, while simultaneously acquiring images. The software was developed specifically for NASA's MCAT facility on Ascension Island, where it is currently in use, but could have wider application to other observatories.

Observations are conducted automatically, with the telescope observing a list of targets prepared and uploaded by the user. Observing conditions for each target, such as maximum airmass, solar phase angle, illumination, time of observation, tracking rates, exposure parameters, etc. can be specified. OCS observes the targets automatically as they become accessible to the telescope. It can estimate cloud cover by analyzing images from an infrared camera viewing the same field of view as the telescope. This allows it to suspend exposures when clouds enter the field. Observatory systems and weather sensors are monitored and the dome is closed if clouds weather conditions exceed specified limits, or if there is any malfunction of critical systems. OCS is also capable of controlling several telescopes in coordinated observations.

At the end of each night, images are automatically analyzed. Images, data products and log files are archived and can be transferred to a remote computer. The data analysis capabilities of OCS include preprocessing of images, automatic object detection and photometry, astrometric and photometric calibration, identification of moving objects from multiple frames, and estimation of orbital parameters.

Designed for UNIX platforms, the code is implemented in the python language and employs numpy and scipy numerical routines for speed. A library of python modules supports a variety of sensors, actuators, cameras, and several types of telescope and dome controllers. A detailed configuration file enables specification of installed hardware, observing limits and data analysis parameters. Users may also write their own OCS scripts to further customize operations and data analysis.