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HIGH-FIDELITY SIMULATION OF GROUND-BASED OPTICAL NEO SURVEYS

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ABSTRACT

We present a Near-Earth Object (NEO) survey simulator that can estimate the discovery capability of existing or planned ground-based optical surveys. The simulator is composed of several modules, including a model population of solar system objects and an ephemeris generator, a site-specific atmospheric model that allows for seasonal variability, a model telescope and camera that accounts for optical throughput and focal plane fill factor, and simulated source extraction and moving object detection software with tunable detection requirements. A flexible survey cadence-planning tool is used to generate multiple simulated pointing "history" variants for the lifetime of each survey, or actual pointing history can be used for current and past surveys if available. Limiting magnitudes are calculated for each individual pointing, taking into consideration exposure time, filter choice, sky brightness, seeing, stellar crowding, and software extraction limit. Positions and magnitudes for every object in the model solar system population are generated once per night, and re-calculated for the exact time of every nearby telescope pointing. Once an object is determined to be within the field of view of a particular pointing ("discoverable"), a series of filters are applied to determine whether the object is first "detected" (recorded on the detector, above the extraction threshold) and subsequently "discovered" (enough positions within the allowable search space of the moving object detection software). The ratio of discoverable to discovered objects is tracked to provide quantitative measures of the overall survey efficiency as a function of object magnitude and rate. Results to date include the creation of models for a subset of current and past NEO surveys, which mimic the actual performance of these surveys. These model surveys can produce a realistic "known object" subset of the model NEO population to the present day, and can be run forward to estimate the collective survey progress into the future. Models are also created for “next-generation” ground-based surveys utilizing several wide-field

optical designs, up to and including the baseline LSST design. A variety of possible survey cadences are tested, ranging from fully NEO-optimized, to novel yet unverified cadences that sparsely spread the observations required for discovery over several days or weeks.

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