Search for NEOs using a Farm of Small Synthetic Tracking Telescopes

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Abstract

Synthetic tracking (ST) is a technique that uses multiple short exposures that added together with a velocity shift between adjacent images to increase the SNR the coadded images. We have installed a cluster of 4 28cm telescope at a dark site in central california. We search for NEOs by taking ~100 images (5 sec exposure each). Each telescope has a 16Mpix CMOS sensor, at f/2.22. The 4 telescopes together have a total 8 sqdeg FOV. Under ideal conditions, the limiting magnitude is 20.8mag. Unlike NEO searches using CCD cameras, ST does not suffer trailing losses, unless the NEO's motion is > 2 arcsec in a 5 sec exposure. The CMOS sensor has ~1.6e read noise so the system is skybackground limited when the sky is 21mag/arcsec^2. A cluster of GPUs are used to process the data in real time.

The simulation did not include MBAs. With a 500 sec integration, a large fraction of MBAs would be identified as star. Our simulations using the Granvik NEO population model predicts that a 6 telescope cluster could potentially detect ~2000 NEOs/year, roughly equal to all current NEO search facilities in 2017. The cost of 1 28cm telescope and 1 16mpix camera is ~ $5K. And ST allows very faint limiting magnitudes at the cost of integration time. The very low cost of these telescope can offer order(s) of magnitude reduction in the cost of NEO searches.

The 4 telescopes were installed at the beginning of Nov 2018 and we're still in the debugging stage. The Celestron telescopes do not have a stable focus, and the focus mechanism has noticable backlash. As a result our initial data set had a limiting magnitude of 20.0 mag instead of 20.8 mag. Our initial test looked at 150 2sqdeg FOVs. The simulation predicted a discovery rate of 1 NEO per 30 pointing's per telescope at 20.8 mag.

Current discovery statistics (early Nov test)
Sky scanned 150 unique pointings (300sqdeg) (with a repeat 1hr later)
known asteroids detected 6 (all main belt)
new asteroids detected 3 (2 fast moving NEOs, 1 slow moving most likely MBA)
Limiting mag ~20.0. (each new detection was seen twice 1 hr apart)
Expected # NEOs if limiting mag is 20.8 ~5 NEOs.

Syn tracking astrometry

During this period we also made 11 observations of 6 known NEOs. We compared our RA, Dec measurements to the prediction from JPL's Horrizons website that will calculate predicted RA/Dec for a telescope at our site in central california. For the NEOs whos 3 sigma error in Horrizons was < 150mas, our agreement with Horrizons was ~50mas.

We have an improved autofocus software that properly accounts for the backlash in the focus mechanism and have recorded images with FWHM < 2 arcsec. This is the last step to improving our sensitivity to ~20.8 mag when the sky is 21mag/arcsec^2.