FAST IDENTIFICATION OF STREAK-SHAPED NEOs IN ASTRONOMICAL IMAGES THROUGH HETEROGENEOUS COMPUTING

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ABSTRACT

We have developed a fast image processing pipeline to detect and identify "streak-shaped" objects in astronomical images, based on a heterogeneous (multi-CPU, multi-GPU) computing system. Depending on the production rate of images of a particular telescope, the system can achieve real-time performance, meaning that the images are processed faster than they are produced. The fast processing speed can be very useful when there is a massive number of images that need to be processed automatically, or when a fast data handover between follow-up observation sites is required, when observing a particular NEO object.

The processing pipeline consists of three stages: multi-CPU preprocessing, where star removal and binarization are performed; multi-GPU detection, which is a variation of the Stacking Method, previously developed by some of the authors of this work, which successfully can detect very faint "dot-shaped" NEO objects; and multi-CPU postprocessing, where astronomical coordinates and apparent magnitude of each detected streak are obtained.

We have assessed our processing pipeline with observations during five nights using the Tomo-e camera of the 1M Schmidt Telescope at Kiso Observatory in Japan. These tests were focused on the detection of "streak-shaped" objects in LEO Orbit, ranging from 350 to 2000 km, but we plan to extend the observations with different exposure time/field-of-view ratios, which will give us the chance to detect NEOs at higher slant ranges as "streak-shaped" objects. From the results of this tests at Kiso Observatory, during 2 hours observation time after sunset, streaks were detected in approximately 3% of the images, which corresponded to 35 real objects in LEO orbit, where 27 of them were identified in the NORAD catalog from a space-track.org database. The minimum detectable streak had an apparent magnitude of +11.3 in the GAIA G-band.

In this work we show that our heterogeneous computing system can achieve remarkably high processing speed of astronomical images, currently 28.4 MPixels/second, and high detection sensitivity, +11.3 apparent magnitude. We believe this system can help in establishing optical observations as a fast and sensitive technique to successfully detect and track NEOs, when aided by automatic heterogeneous computing.

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