PDC2023
Vienna, Austria

Near-Earth Object (NEO) Discovery

Real-time synthetic tracking for near-Earth asteroids detection

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Keywords: *near-Earth objects, detection, synthetic tracking, parallel processing*

ABSTRACT

The surveys targeting the detection of near-Earth objects (NEOs) are a key component ~~for~~of planetary defence. While the current surveys have discovered most NEOs larger than 1 km, and have made significant progress ~~for~~in detecting asteroids larger than 100 m, smaller objects tend to be discovered only during close flybys. This is due to their very faint apparent magnitude ~~limit~~ for most of the time. Recent examples of minor planets entering the atmosphere are the 1908 Tunguska event, where over 2000 km^2 of forest burnt due to an object whose size is estimated to be less than 100 m. Similarly, the shockwave of the 2013 Chelyabinsk super-bollide has injured over 1200 people.

Conventional methods of detection based on (automated) blink technique require large aperture telescopes for observing the faint apparent magnitudes of these smaller NEOs. Since the cost of telescopes increases steeply with the aperture, the blink method (which is the most common one used to find asteroids) is increasingly prohibitive as the targets decrease in size. However, the detection technique known as Synthetic Tracking (or Digital Tracking) allows the use of smaller telescopes (albeit with longer integration times) where the detections can be significantly under the noise floor of individual images. Thanks to modern computational resources, it is possible to combine the images to increase the signal to noise ratio across all possible trajectories of a faint potential moving object.

Here we present a moving object detection software called Synthetic Tracking on Umbrella (STU), which leverages the power of modern GPUs to perform this new detection method. The software is based on the Umbrella2 library (Stănescu & Văduvescu 2021~~2~~), previously developed to apply the blink method detection and auxiliary functionality for a complete pipeline. Thanks to innovative search strategies, this software can perform ~~near~~ real time detection of fast-moving Near Earth Asteroids, even on large, multi-CCD instruments.

We show the functionality of this new software package using the observations performed with a few telescopes, starting with the small aperture ones up to the 2.54m Isaac Newton Telescope and the 10.4 m Gran Telescopio Canarias. The validation tests included the processing of more th~~e~~an 100 000 images obtained

in various conditions (variable seeing, detectors with different noise level, pixel scales, field of view, objects with different apparent magnitudes, and moving rates).

Acknowledgment. This work was developed in the framework of the EURONEAR collaboration, and it is financed by a grant of the Romanian National Authority for Scientific Research and Innovation CNCS – UEFISCDI, project number PN-III-P2-2.1-PED-2021-3625.

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