

A fast asteroid detection method



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Abstract

- We construct a new automatic asteroid-detection algorithm. This algorithm has the capability of detecting **asteroids on various orbits**. It completes all processes in **only a few minutes**, in case of a few 2kx2k.



Minor planet detection in large area survey

- For orbit determination of the minor planets, we have to start follow-up observations quickly after the discovery.

e.g., Near Earth Asteroid & Comet 1 day

Main-Belt Asteroid a few days

- Mosaic CCD cameras covering field of view beyond 30'x30' provide us large volume of data.

e.g., Typical wide-field surveys 4GB/night

- Thus, fast data processing is very important for asteroid detection.

Previous works and their deficit



- There are some automatic detection algorithms of asteroid (e.g., Yanagisawa et al. 2005, Gural et al. 2005)
- However, they focus on detection of Main-Belt Asteroids on orbits of low eccentricity and low inclination.

 We construct the detection algorithm of Asteroids on various orbits, including Near Earth Asteroids, MBA on orbits of high eccentricity and/or high inclination.



Merrit of our algorithm

- The algorithm is optimized for multi-core PC.

Previous algorithms are constructed before 2005, and then they are optimized for only single core PC.

- Cosmic-ray events are removed more accurately before moving object searches.

Fully-depleted CCDs are more sensitive to cosmic-ray events than previous CCDs. Their removal with good accuracy provides rapid detection of asteroids

- The position accuracy in undersampled CCD images is improved.

It's essential for NEO survey with undersampled CCD.



Flowchart of our algorithm (1)

Bias subtraction and flat correction

Removal of cosmic-ray events
(L.A.Cosmic, Pieter&van Dokkum 2001)

Apply World System Coordinates Parameters with high precision



Flowchart of our algorithm (2)

Detection of objects (sextractor)

Removal of spurious objects
using μ_{MAX} vs. Mag_{AUTO} plane (Robin et al. 2007)

Removal of stars and galaxies in USNO-B1.0 / SDSS



Flowchart of our algorithm (3)

PSF Correction using an effective PSF
(Anderson & King 2000)

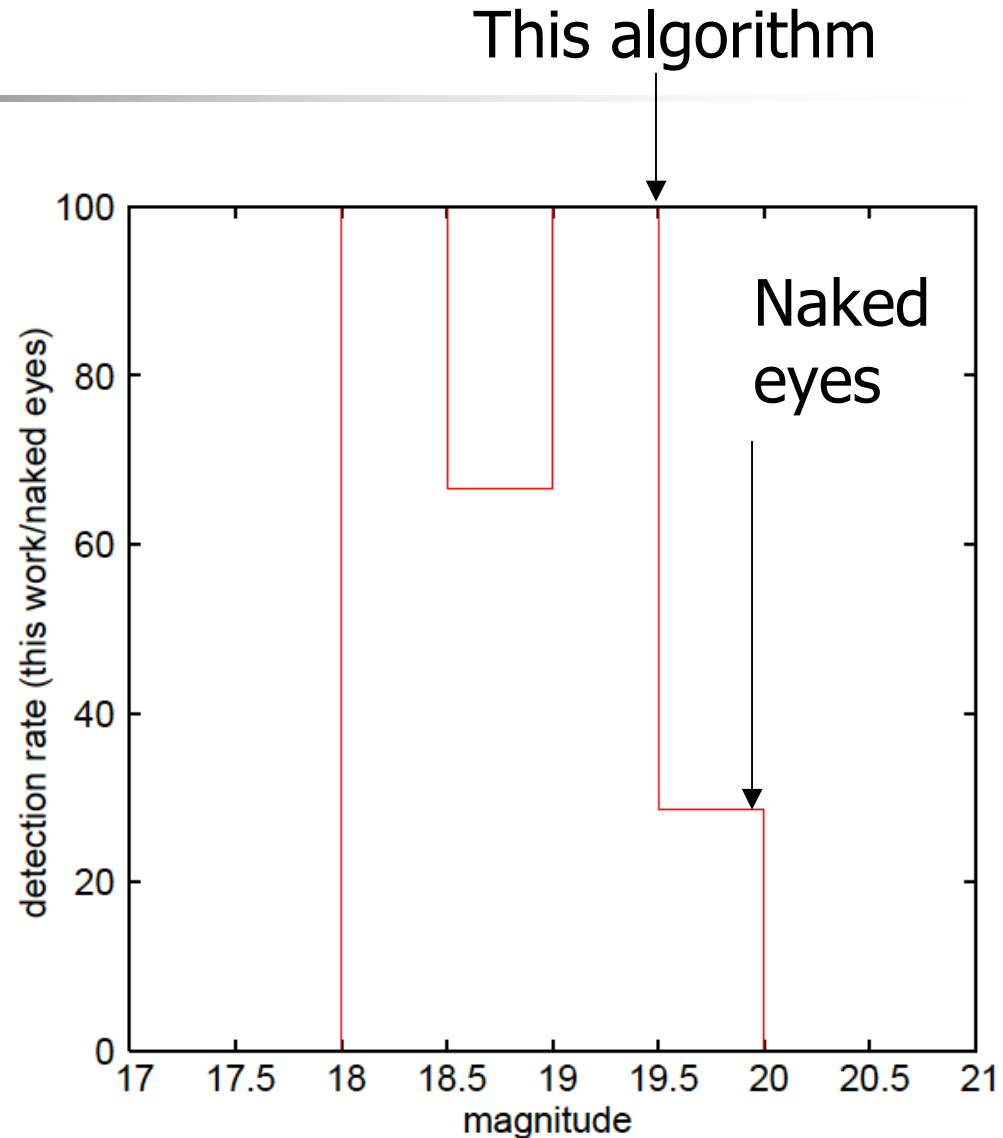
Divide into some fields

Search for moving object (rms < 1.5'')

Result: Detection probability and speed

- Data:
 - Kiso 1m telescope
 - 5 2k x2k (1.5"/pix)
 - Two 3.33GHz Quad Core
 - **~only 4 minutes**
 - Limiting magnitude
- This algorithm 19.5 mag
Naked eyes 20.0 mag

Only -0.5mag





summary

- We construct a new automatic asteroid-detection algorithm.
- The limiting magnitude is only 0.5 mag. brighter than that of naked eyes, in case of typical Main-Belt Asteroid.
- It completes all processes in only a few minutes, in case of a few 2kx2k.



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