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Images analysis in Asteroid and Satellites Astrometry

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Abstract. At Astronomical Observatory of Valencia University (OAUV), CCD observations of asteroids and big planets satellites are obtained since 2001 with a big format camera and several telescopes.

Software has been developed, including accurate ephemerids calculation, stellar maps presentation, automatic measuring and reduction process of film plates and CCD frames.

Software for special conditions is under development, including distorted images from differential tracking and images with spikes. Treatment of regular nets on old plates ('Carte du Ciel') is under development. Software for comparison of single and overlapped CCD fields obtained at different epochs has been developed.

1. Introduction

CCD observations of asteroids and big planets are obtained at Valencia Observatory (OAUV) since 2001 with two telescopes of 30 cm. and 3 meters focal length and a CCD camera CCD AP10 of big size (2048 x 2048 pixels of 14 microns), getting fields of 30' by 30'. A new telescope 60 *cm* wide ($F8$) with altacimutal mounting, is operative since 2003. It will be used to astrophysical observations and to astrometry of solar system faint objects.

Automatic techniques for measurement of plates, developed at OAUV since 1990, have been extended to detection and measuring of objects of CCD frames.

Reference stars are got from several dense catalogues. For each image a 'data file' is obtained, containing field information and catalogue stars in and around field region. Field measurement is make with VisualBasic 5.0 algorithms, with images on BMP format.

2. Observation of asteroids and satellites

Small distance of Uranus and Neptune satellites from planet needs maximum resolution of CCD images (2048×2048 pixels). Results improve with a red filter that dims blue color of planet. Special algorithm for detection and separation of satellite images has been developed.

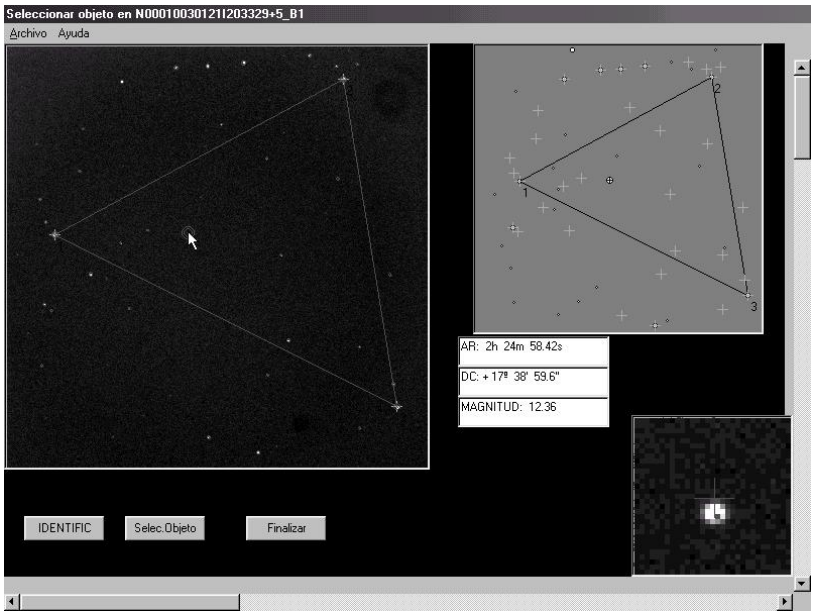

Figure 1. Final step of the asteroid identification

We have developed algorithms for several kinds of observations, including ephemerids calculation, stellar maps presentation, measuring and reduction of CCD fields and residuals calculation for asteroids observations.

In satellites work, ephemerids are obtained with ERA software (Krasinsky & Vasilyev 2001), provided by Applied Astronomy Institute of St.Petersburg (Russia). CCD field size allows this kind of observations every day.

3. Algorithm for asteroids and satellites astrometry

The selected image is charged if 'data file' exists. Measurement can be done in 'automatic' or 'manual' way. Detection process includes algorithms for distorted images. After images measurement in CCD field, catalogue stars are identified and adjusted with images. Asteroid image is selected manually and coordinates α, δ and magnitude are obtained. Process for satellites is similar and all main satellites can be selected for each planet (López et al. 2001).

4. Fields comparison

Algorithms for individual and 'mosaic' fields comparison has been developed, allowing the search and detection of objects with different positions or brightness (new asteroids, nova stars, variable stars).

In first case, each field is analyzed automatically, adding manually stars not identified. For comparison, two similar triangles are found and field images superposed for blinking. If identification is not correct, blinking shows big dif-

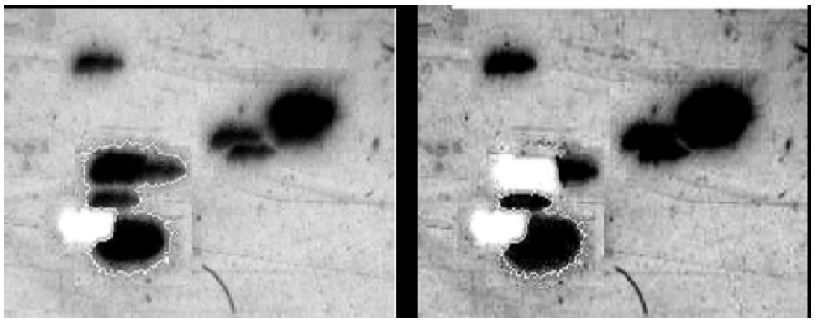

Figure 2. Separation process of close images with differential motion

ferences and triangles must by chosen manually. Comparison field is fitted to the reference one by rotation and translation of image pixels.

5. Fields overlapping and comparison

In this case two 'field mosaics' of 4×4 'reference images' (A) and 'working images' (C) are constructed. To do that, linking of adjacent fields allow to overlap them in order to obtain a single mosaic image for (A) and (C). Comparison of mosaic images is done by hand blinking. If it shows a bad fitting, images of three object in both mosaics are selected and image (C) is fitted to image (A) by rotation and translation..

6. Special algorithms

Algorithms for analysis of peculiar images, as obtained in differential motion, spikes shown by bright images of telescopes and existence of reticula in old plates (Carte du Ciel).

In differential motion of crowded fields plates, distortion of images and partial overlapping increase difficulties of algorithm. After detection of a complex image, contour is obtained and spurious images are eliminated.

For every group a sequential separation process is applied. Gaussian model with two axis is fitted to each object and is substracted from its image before continuing with the next one.

Spikes joined to reflectors images and reticula of 'Carte du Ciel' plates need a previous elimination before applying standard measuring algorithms. In both cases a 'dirt' field image produces many 'ghost' objects. Our algorithm for spikes elimination is rather efficient (López & Moraño 2003).

We are developing algorithms for 'Carte du Ciel' plates full analysis, without using lists of objects detected in previous studies. Bad quality of some plate zones increases complexity of this analysis.

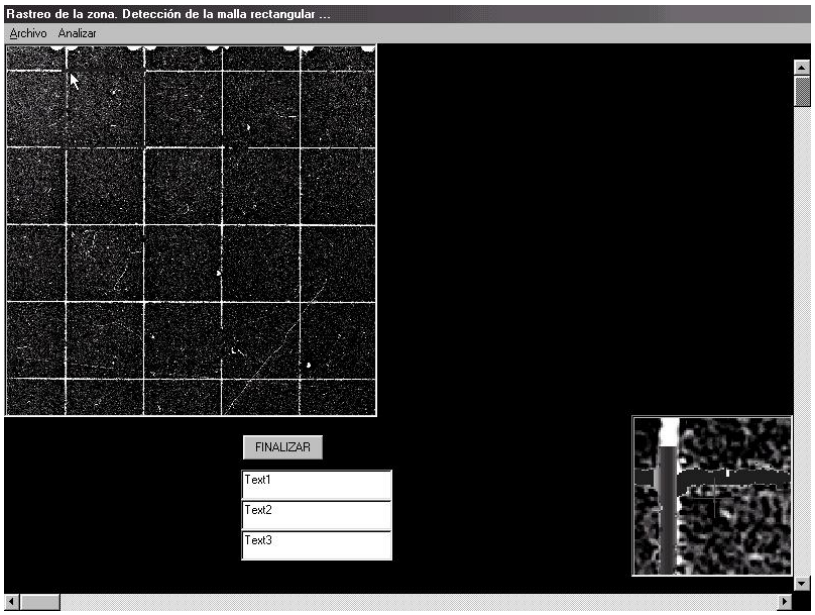

Figure 3. Reticule elimination in Carte du Ciel plates

7. Conclusions

We have developed a program for systematic observations of asteroids and satellites,that is carried on with several telescopes and CCD sensors at OAUV.

Several problems associated to astronomical images analysis (spikes elimination, differential tracking of crowded fields, reticula of 'Carte du Ciel' plates, etc.), have been faced with good results.

Our projects for next year include astrometry and photometry of faint asteroids, using 60 cm. telescope.

References

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