APPLICATION OF BLOCK-ADJUSTMENT ON EXTENDING FOV OF CCD [1]

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1. INSTRUCTION

To minimize the systematic errors caused by plate parameter variance, overlapping-plate technique was first applied to reduce plates in astrometry by Donner & Furuhjelm in 1929. This technique was usually called Block-adjustment (BA) since a block of plates were reduced together at the same time when it used. Eichhorn (1960) was the first to publish a rigorous formalism for BA. BA had been used to reduce the AC data (Eichhorn 1962-1983) and CPC plates (de Vegt, et al., 1967-1981, Zacharias, 1988) since 1960.

There are two causes that had obstructed the wide application of BA before 1990s. One is the systematic error that cannot be represented by polynomial models. The precision of the results of BA was depressed severely by such errors, which usually were caused by the defect of optics of telescopes and sometimes plate curve in Schmidt telescopes. Another is the computer capability. With positions of all stars covered by all plates and all plate parameters as unknowns, the system of normal equations was so big that it is difficult to solve without powerful computers. Except such two reasons, BA would have been used usually to construct the photographic catalogues covering all the sky.

When compared with photographic plates, CCD detectors have three advantages : higher quantum efficiency, higher linearity and greater convenience. But there is an obvious shortcoming for CCD, the field of view (FOV) of a CCD is often much smaller than that of photographic plate, especially for astrometric telescope with long focal length. It is difficult to use CCD in many research fields that need large FOV. On the other hand, small FOV of CCD implies that the influence of the defect of optics of telescope should be small, or even negligible. Along with the much smaller size, CCD doesn't suffer from the systematic error that obstructs the application of BA. At the same time, nowadays the capability of the computer is much more developed than before.

[1]Based on observations of Schmidt telescope in Xinglong Station of National Astronomical Observatories of China.

Since both problems mentioned in the second paragraph have been solved, it is natural to apply BA to reduce overlapped CCD frames together. At the same time, the FOV of the CCD will be extended to what all CCD frames covering with high precision, which will be much useful to all research fields that need large FOV. To validate the effect of BA, we used it to reduce some CCD observations, the preliminary results will be presented in next section.

2. SOME PRELIMINARY RESULTS OF THE APPLICATION OF BA

The observations were obtained from the 60/90cm Schmidt Telescope (F/3, CCD: 2048*2048, Scale: 0.015mm/pixel, FOV: 1*1). The overlapping style of CCD frames is corner-center. The exposure time for all observations was 120s. With Astrometry Calibration Region (ACR, Stone1999) as reference catalogue, all CCD frames were reduced with BA.

Results show that when compared with single CCD solution, BA can weaken the influence of positional errors of reference star, improve the results when reference stars were not distributed uniformly and obtain rather good results even when the reference stars are too insufficient to carry out single solution. The following figures show the differences between positions obtained from CCD reduction and those of ACR catalogue. In each figure, left : distribution of reference stars; center : differences of single solution; right : differences of BA solution, and the unit of (x, y) are pixel of CCD.

3. REFERENCES

Stone R., et al. 1999, AJ, 118, 2488
All references can be found in: Eichhorn H., 1988, IAU Symp.133, 177.

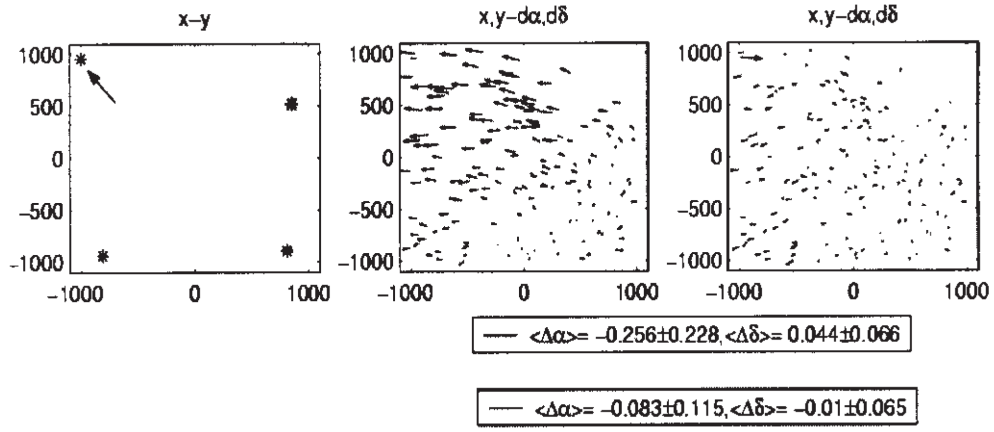

Figure 1: When R.A. of one reference star (arrow) was added 1" artificially

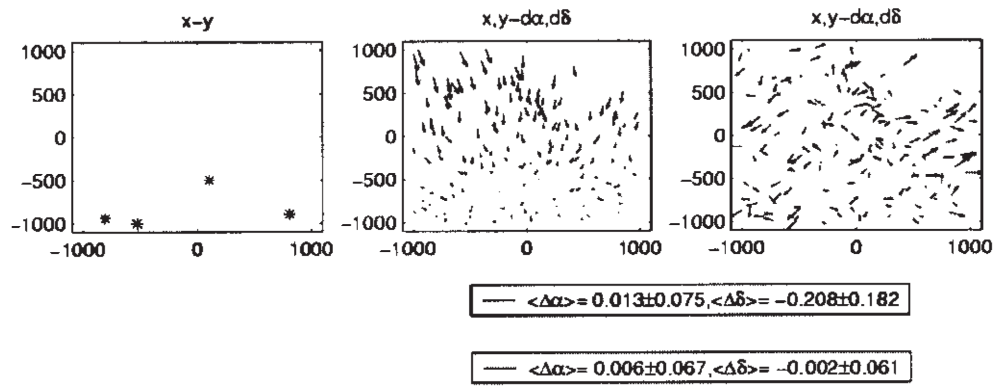

Figure 2: When reference stars were not distributed uniformly

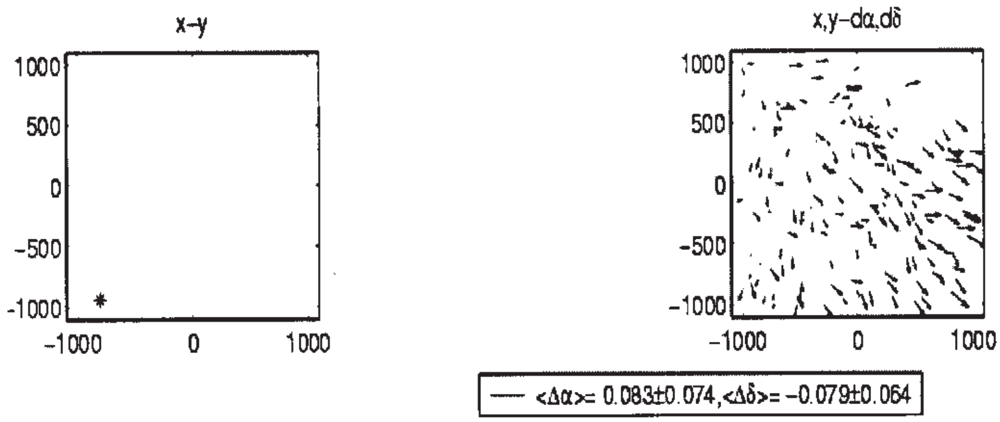

Figure 3: When reference stars are too insufficient to carry out single solution