OPTICAL POSITIONS OF ICRF SOURCES USING UCAC3 REFERENCE STARS

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ABSTRACT. Optical positions for 171 extragalactic radio sources (ERS) were derived using UCAC3 as a reference catalogue. The extragalactic sources are located in the range of declinations from -40 to +80 degrees. The observations of the optical counterparts of the extragalactic radio sources were performed using 1.5m Russian-Turkish Telescope (Turkey) and 1m Telescope YAO (Kunming, China) during 2000-2003 years. The fields around the extragalactic sources have sizes $4' \times 3'$, $6.5' \times 6.5'$ and $8' \times 8'$. We have used UCAC3 catalogue because it is all-sky catalogue contained enough reference stars for the astrometric reduction of the most part of our fields. The standard error of one optical position is about 40 mas for both coordinates. The mean optical positions of the ERS were compared with ICRF radio positions. Additionally, the results obtained with UCAC3 as a reference catalogue were compared with the previous ones obtained with UCAC2 and 2MASS catalogues.

1. STATEMENT OF PROBLEM

To align the radio and optic realization of the ICRS with the highest accuracy, it is desirable to have observations of common objects with uniform sky coverage and accurate optical positions. Therefore till astrometric space missions will not produce scientific results, ground based astrometric observations of ERS are very important. For resolving of this task observations of the optical counterparts of the ICRF radio sources were carried out mostly during 2000-2003 years in frame of the International Project between astronomical observatories from China, Turkey, Russia and Ukraine (Aslan et al., 2005).The previous astrometric reductions of these observations were made using UCAC2 and 2MASS reference catalogues (Aslan et al., 2010). The UCAC3 catalogue (Zacharias et al., 2010) was used as reference catalogue for calculation of the optical positions of ERS in this work because it covers all our zone of declination and has enough stellar density for astrometric reductions in small fields.

2. OBSERVATIONS AND REDUCTIONS

The observations of optical counterparts of the ICRF radio sources were carried out using two telescopes equipped with CCD-cameras. There were Russian-Turkish telescope (1500/11620) and telescope of Yunnan Observatory (1000/13250). The more detailed information about telescopes, detectors and reductions are given in (Aslan et al., 2010). The observations were completed for the declination range of -40 to +80 degrees. We have tried to have uniform distribution in available declination zone on the celestial sphere but there was a gap in zone between 10 and 12 hours in right ascension because part of observational data was unusable for proceeding by reason of small field of view. Figure 1 plots the distribution of the observed optical counterparts of the ERS in celestial sphere. The range of stellar V-magnitudes of observed ERS is from 13 to 20. (V-magnitudes were taken from (Archinal et al., 1997) Two-dimensional elliptical Gaussian model was applied to the image profile fits. And then linear six-parameter mode was used for transformation the measured coordinates to tangential. Unweighted least -squares method was performed for standard reductions with available reference stars if number of stars in the frame was more than 4. Figure 2 shows the average optical minus catalogue ((O-C)) differences and absolute average (O-C) differences in both coordinates against UCAC3 magnitudes for UCAC3 stars. Every point is the average from 30 to 200 UCAC3 reference stars. There are no magnitude equation in range of reference stars and significant systematic errors. The average (O-C) absolute differences show that internal mean error of stars is about 35 mas for the stellar magnitudes range from 10 to 15.5 and deteriorates on faint end.

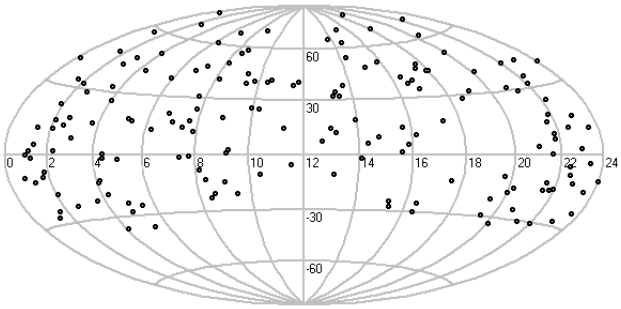

Figure 1: Distribution of observed optical counterpart of ERS over celestial sphere

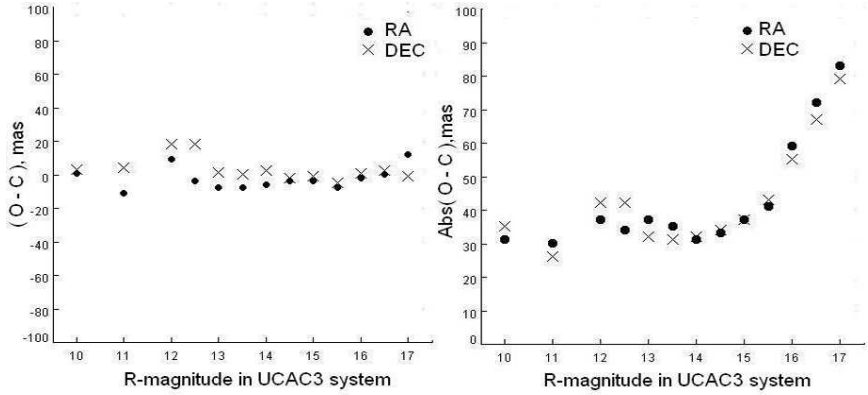

Figure 2: (O - C) (right) and absolute (O - C) (left) differences of the UCAC3 reference stars in both coordinates against UCAC3 magnitudes, filled circles - right ascension, crosses - declination

3. RESULTS

Optical positions of 171 optical counterparts of ERS were obtained using UCAC3 reference stars. The unweighted mean of optical positions and optical minus radio position differences (O - R) are calculated from the scatter of the individual optical positions. The average number of frames per source was about 6. The mean values of optical minus radio positions differences are -6 ± 4 mas and $11 \pm 4 mas$ for right ascension and declination, respectively. From the 171 final optical positions 15 lie beyond 150 mas from radio positions. The final statistics of the comparison this results with previous reductions using 113 common ERS is given in Table 1. The Figure 3 displays the averaged (O - R) position differences with respect to the UCAC3, UCAC2 and 2MASS catalogues as function of right ascension and declination. The figure displays no significant zonal systematic differences between catalogues on their accuracy levels, with the exception perhaps a difference between UCAC3 and 2MASS catalogues in high declination zone. Further study may clarify whether these zonal differences are significant. The parameters of relative orientation between optical and radio frames have been calculated using (O - R) position differences with respect to the UCAC3 and UCAC2 catalogues following the method used by (Arias et al., 1988). Table 2 shows the mean values of rotation angles and their standard errors obtained by least squares procedure.

Table 1: Mean values of (O-R) differences with their errors

Reference Catalogue	$\Delta\alpha cos\delta, mas$	$\Delta\delta, mas$	σ_α, mas	σ_δ, mas	N_{ERS}
UCAC2	-7 ± 4	13 ± 4	39	38	113
UCAC3	-9 ± 5	15 ± 4	57	57	113
2MASS	-8 ± 6	33 ± 7	87	88	113

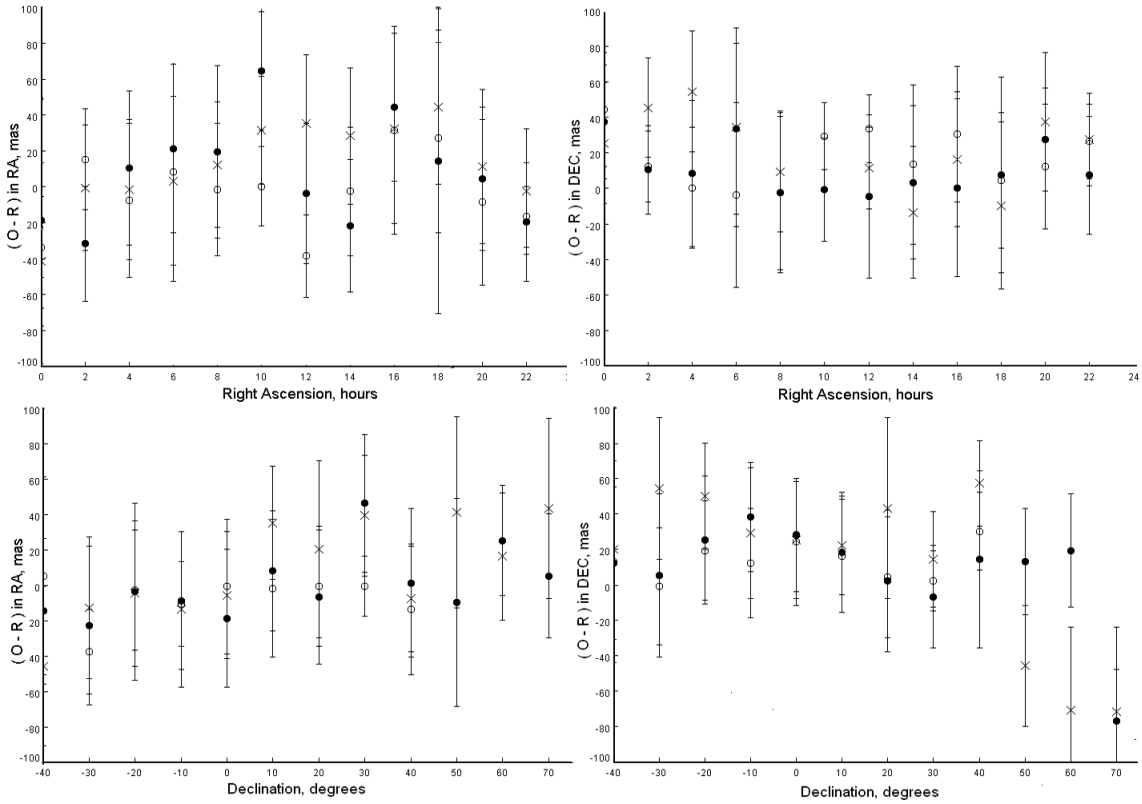

Figure 3: Averaged (O - R) differences as function of right ascension (up) and declination (down) for 171 ERS, filled circles - UCAC3 catalogue, open circles - UCAC2 catalogue, cross - 2MASS catalogue

Table 2: Optical-radio rotational parameters

Reference Catalogue	ϖ_x, mas	ϖ_y, mas	ϖ_z, mas	N	σ, mas
UCAC2	-0.2 ± 5.8	7.2 ± 5.5	7.0 ± 4.5	130	43
UCAC3	-0.1 ± 6.1	6.4 ± 5.8	-1.8 ± 2.4	152	57

4. CONCLUSIONS

Astrometric positions for optical counterparts of 171 ERS from the ICRF list were obtained using reference stars from the UCAC3 catalog in declination zone from −40 to +80 degrees. Though accuracy of the UCAC3 catalogue is a little worse than UCAC2, it is a good all-sky densification of Hipparcos reference frame and can be used as reference catalogue for astrometric reductions in small fields.

5. REFERENCES

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