Measuring Neglected Double Stars with Two Alt-Az Telescopes

Lucian Curelaru[1] and Florin Marc[2]

1 - Braşov, Romania – lucian.curelaru@gmail.com

2 - Târgu Mureş, Romania – florinmarc@rdslink.ro

Abstract: This article presents a set of neglected double star measurements obtained with two alt-az telescopes. Also, the methods used for these measurements are described in detail.

Measuring Setups and Methods

Two different measurement setups and two methods were used in measuring the target objects. Both methods are imaging methods inspired by the method described by Mr. Florent Losse on his website but also adapted a little to the existing equipment of the observers. The observations were reduced using the Reduc Software – V 3.85, written also by Mr. Florent Losse.

The first setup , operated by Lucian Curelaru, is composed of a Celestron Nexstar 6 SE telescope, a DBK 21AF04.AS Imaging Source camera, and a Barlow. The telescope focal length is 1500mm, but it was enlarged by the 2.5x Barlow lens to 3750 mm. The camera has only 640x480 pixels – one pixel is 5.6 microns resulting a resolution of 0.33173 arcsec/pixel

The method used is modified because we had to adapt it to an alt-az telescope. The basic method , using an equatorial setup, consists in measuring in each session a calibration star (used to determine both field orientation and pixel size in arcseconds), then target stars, but without touching the camera - to keep the field orientation unchanged, and at the end measuring another calibration star. With the Nexstar telescope we had two issues using this method. First, and most important, is that being an alt-az mounted telescope the field orientation is not preserved when moving form one object to another. Second is that the Nexstar goto mount is not precise enough to move to the desired star in the tiny field of view in the camera. Also the mount was too weak to keep a parallel telescope on it, so the camera would sometimes be removed between imaging two different objects.

The adapted method is the following. Some calibration objects with different separations was chosen from the Sixth Catalog of Visual Binary Stars and imaged on different nights, by recording an AVI file around 300-500 frames for each. The observed objects are STF2032AB, STF2758AB, STF2863AB, STF2727. From this AVI, we calibrated the sampling of the setup (the size in arcseconds of the pixel) by calculating an average value. Then for each target star, we recorded one AVI having 100-400 frames with tracking started for measuring and, without removing the camera, we recorded a second AVI on same object with the tracking motor stopped, so the star trails across the field. The star was previously moved near the east edge of the field, the motor stopped and recording started. In this way we obtained a drift AVI from which, using Reduc software "Synthetic Drift" function, we could determine the field orientation for each particular star.

Measuring Neglected Double Stars with Two Alt-Az Telescopes

Reduc software was then used to measure the target doubles.

Still there are two issues that must be clarified. Because the instrument is alt-az mounted, there still might be problems because of the field rotation. Even when the drift images were taken immediately after the measurement avi the field rotation is so fast that the rotation in a few minutes could be big enough to change the final results and to make them useless. In general our measurement AVI's last between 5 and 7 minutes, depending on the magnitude of the target doubles, and the drift AVI is about 30 seconds long. There is also a few minutes time span between them, necessary for moving the star to the edge and sometimes adjusting the camera exposure and other parameters. We have to mention that in the drift AVI, we do not need to image the secondary star. So if there is a large magnitude difference, we prefer to reduce the exposure to be just enough to see the primary star crossing the field. This enabled us to increase the frame rate of the camera and the drift AVI can contain many frames, so the field orientation might be determined with a little bit better precision. Finally, we performed corrections calculations for each object taking into account the length of both AVIs, the starting moment of both, the object position and so on and we tried to apply corrections by calculating how much the field rotated between the middle of the measurement movie and the middle of drift movie.

For this calculation we used a spreadsheet from Harry Kambanis webpage to calculate the field rotation for each object at the observing interval (we used an average value of around 50 values spread in the observing interval) and another simple spreadsheet made by us to evaluate and correct the effect of field rotation between the measurement and drift AVI's

Another issue in this method was the fact that using an SCT, the focusing process might change notably the focal length, so my method of estimating the size of the pixel in separate observation (even using exactly same equipment – telescope – Barlow – camera) and use this result as a calibration value might be inaccurate because of refocusing between operations. On the other hand, if focusing is made accurate the focal point should be quite close between different attempts. To make sure the effect does not introduce too much inaccuracy, we imaged one of the calibration objects (STF2863AB) three times on different nights and compared the results. The biggest difference between two separation values of this calibration object was 0.0018 arcseconds which keeps the accuracy in an acceptable range.

The second setup , operated by Florin Marc, is a 250 mm home-made dobsonian on a dual axis motorized equatorial platform. The camera is a Canon 350D unmodified DSLR. The telescope focal length is 1270mm. The camera has 3456 x 2304 pixels – one pixel is 6.4 microns yielding a resolution of 1.04409 arcsec/pixel.

The observing session starts by choosing the target object and establishing the moment when the object crosses the meridian when it is best viewed from our balcony location.

The target identification is made by having a maximum 30 seconds exposure which we compare with a prepared map of that sky area. As an example, an image of BU 625 is shown in Figure 1.

After positively identifying the field, we move the target star to the east side of the field and stop the tracking. Then, we start the camera and expose it around 30 seconds, which is enough for the star to cross the field from east to west and produce a star trail. Then, we move the star back to the field center, start the tracking, and take multiple exposures, between 5 - 30 seconds in length. The exposure time depends on the magnitude of the target. We usually take enough frames to obtain 5 to 10 good quality frames which are useful for measurements. Then, we move the star again in the east part of the field and take a second drift frame.

The raw images obtained with the camera are then converted to FITS format using the IRIS software. First, we compute the field orientation using the two drift frames obtained at start and end of the session. The field orientation is obtained by calculating an average of multiple star paths which appears

Data: 14.08.2010 - 19h25m UT
BU625 AC - theta: 87.64° rho: 25.596"
BU625 AD - theta: 270.45° rho: 129.773"

Figure 1: One of the targeted objects - BU 625 and neighborhood imaged and measured by Florin Marc.

Measuring Neglected Double Stars with Two Alt-Az Telescopes

in the calibration images. Also, the pixel size was previously determined by imaging two calibration stars with the same setup. Once the field orientation is determined, using this value and the sampling determined by calibration, we load the pictures in the software and reduce the position angle and separation manually or using automatic functions of the software. For the final result we remove the values that have too big residual values, which are also marked distinctively by the software.

The Measurements

Using the described instruments and methods we measured 10 neglected double stars. The results are presented in Table 1.

Also we measured 3 other objects which are not neglected, but were in the neighborhood or in the same field with our target objects. The results of these measurements are presented in Table 2. Measuring these objects also confirm that the methods we employed are reliable.

The magnitudes from tables were not measured, but were taken from the WDS.

Problems Encountered

Besides the issues already mentioned, we encountered some other difficulties. From the equipment point of view, we should mention that the lightweight Nexstar mount caused problems when changing accessories. Many times the instrument has moved a little getting the object out of the tiny field of the camera. Also, the mount did not well support adding a parallel guiding instrument, which might help a lot in this case. This cost extra time, making the process more difficult and sometimes generating frustration.

We started this project with an established list of objects, selected by different criteria to satisfy equipment and location limitations. Still, at the start we did not check surveys of the target object before going to the field, expecting that the problem object would be rare. We were surprised when many objects from our list were not in the expected location or that they were considerably different than expected. Initially, we checked the surveys only with problematic objects. But, after we noticed that many objects had problems we began checking any object on surveys before going to the field.

During these checks we were able to suggest some fixes for some objects or to just announce the noticed differences between the catalog values and real objects. In this case was the following objects:

- GIR 5 – was not found at the expected location. At the listed location there was a two component star (STF 1482 AB). But, only few arcminutes in the NE there was another double

Table 1: Neglected double stars measured with the telescopes described in the text.

NAME	RA+DEC	MAGS	PA	SEP	DATE	N	NOTES
GIR 5	10525+0730	9.39, 11.39	195.3	89.75	2010.335	1	2
BU 625AC	16254+1402	4.50, 11.0	87.6	25.60	2010.620	1	2
BU 625AD	16254+1402	4.50, ?	270.5	129.77	2010.620	1	2
WAL 79AC	17161+6043	6.93, 9.78	79.4	137.29	2010.311	1	1
HJ 2836AB	18384+6043	6.70, 9.9	316.3	33.13	2010.319	1	1
HJ 2836AC	18384+6043	6.70, 9.9	252.4	58.00	2010.319	1	1
SLE 235AD	18384+6043	6.70, 8.9	311.5	158.79	2010.431	1	1
BU 665A-BC	20222+4015	2.27, 5.5	197.1	147.08	2010.546	1	1
HJ 5529	22378-0414	5.00, 8.8	256.3	87.07	2010.617	1	1
LV 21AB	19377-0958	7.24, 10.0	285.4	86.46	2010.631	1	1

Notes:

1. Measurements performed with first setup described in this article.
2. Measurements performed with second setup described in this article.

Measuring Neglected Double Stars with Two Alt-Az Telescopes

Table 2: Some other double stars measured in the same observing sessions.

NAME	RA+DEC	MAGS	PA	SEP	DATE	N	NOTES
STF1482AB	10522+0728	8.25, 9.20	306.1	12.00	2010.335	1	2
STF2155AB	17161+6043	6.93, 9.97	112.9	9.80	2010.311	1	1
S 409AD	02181+5731	6.11, 9.62	137.3	125.82	2010.612	1	1

Notes:
1. Measurements performed with first setup described in this article.
2. Measurements performed with second setup described in this article.

star which matched very well the expected object. We announced this issue on binary-stars-uncensored yahoo group and our supposition that the other object was in fact GIR 5AC was confirmed. The object position has been updated in the WDS and the object renamed to GIR5. We also measured this object. The result is included in our list of measurements.

- STF 2083AC – It seems there is no C component in this system. The C seemed to be added because of a typo error in the published data.
- STN 50 – is not in the expected place. No object in the neighborhood was found to match the expected object. So, STN 50 seems to be lost for the moment.
- STU 8AC – There seems to be an error in data reduction of the C component which generated a mistaken rho value.
- ES 871 – is not exactly at the specified precise coordinates. In that place is a single star, but one object with very close parameters (PA, separation and magnitudes) is located around 1.9 arcminutes at NNE. We think there is an error at the precise coordinates.
- PKO 4 - is in the expected place, and the PA and separation are very close to expected values (around 356 - 357 PA and 15.5 - 16 sep) but both components are considerably fainter than declared. We estimate them around 12.3 - 12.4 instead of 10 - 10.5 declared in WDS.
- ES 1890 – is not in the expected place. No object in the neighborhood was found to match the expected object. So, this object seems to be lost as well.

Conclusions

After this interesting project we could say that measuring double stars is clearly accessible to alt-az instruments. The equipment we used is quite simple and not very expensive. It does generate some extra work by taking field orientation for each star, but we think this is quite acceptable. Moreover, all this work was performed from some small balconies too small for an equatorial mount. We measured a smaller number of objects than we expected for a four month time span, but we hope we will be more efficient in the future. This was the first attempt of this kind for both of us, but we also think that the experience we've accumulated will help us a lot in the next measuring sessions.

Regarding the equipment, we want to mention that the Nexstar telescope was quite good for this purpose excepting the problems already described. So, we would prefer a similar scope with a little better mount (like the CPC series) for this kind of job. We're sure that using such an instrument should improve the efficiency generating more measurements in the same period of time.

References

Florent Losse double star webpage:
    http://www.astrosurf.com/hfosaf/

Harry Kambanis webpage:
    http://users.otenet.gr/~harrykam/

Observing and Measuring Visual Double Stars,
    R.Argyle, Springer, London 2004.

SIMBAD Astronomical Database,
    http://simbad.u-strasbg.fr/simbad/

Measuring Neglected Double Stars with Two Alt-Az Telescopes

Sixth Catalog of Visual Binary Stars,
    http://ad.usno.navy.mil/wds/orb6.html

WDS Catalog, The Washington Double Star Catalog,
    Mason, Wycoff, Hartkopf, Astrometry Depart-
    ment, U.S. Naval Observatory

Yahoo Binary Stars-uncensored group., http://
    tech.groups.yahoo.com/group/binary-stars-
    uncensored/

Lucian Curelaru is a senior software engineer in a multinational company living and working in Brasov, Romania. He is also a passionate amateur astronomer and member of Romanian Society for Meteors and Astronomy. He spends most of his free time in different amateur astronomy projects in double star and planetary areas.

Florin Marc is an electrical engineer working and living in Târgu Mureş, Romania. Most of his free time he likes to build different devices including astronomical instruments. He also likes to participate in different amateur astronomy projects.