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Astrometric Speckle Interferometry for the Amateur

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1. CONCEPT

Because of the improvements in CCD detector quality and availability, as well as the increased performance and lower prices of PC compatible computers and digitizer boards, the time is ripe for getting amateur astronomers interested in speckle interferometry. Presented is a low–cost (under $1500 U.S., without computer) prototype astrometric speckle interferometry package suitable for use by amateur astronomers on their own telescopes. Table 1 lists the names and addresses of the manufacturers of the various products required as well as their prices.

TABLE 1. Manufacturers and cost estimate.

Edmund Scientific Company 101 E. Gloucester Pike, Barrington, NJ 08007-1380 Telephone: (609)573-6259	
4X Microscope Objective, Stk. No. A38,345	$ 32.95
535–700nm Filter, Stk. No. A43,386	$ 15.75
Amperex Electronic Company A Division of North American Philips Corporation Imaging Products Business Unit Providence Pike, Slatersville, RI 02876 Telephone: (401)762-3800	
CCD Monochrome Imaging Module, type 56471	$440.00
Catenary Systems 470 Belleview, St. Louis, MO 63119 Telephone: (314)962-7833	
Image Processing Library and Digitizer Card	$490.00
IDEC, Inc. 1195 Doylestown Pike, Quakertown, PA 18951 Telephone: (215)538-2600	
Manufacturer of Digitizer Card available through Catenary Systems	
Total Price for Components	$978.70

2. OBSERVATIONS AND REDUCTIONS

The speckle package was tested using a 0.2-m (8-inch) f/10 Schmidt–Cassegrain telescope on 24 Mar, 1992 at GSU's Hard Labor Creek Observatory (HLCO). The binary systems of Castor (α Gem) and Algieba (γ Leo) were observed, both with a 16X microscope objective and no filter. The package was also tested using the 0.4-m (16-inch) f/16 classical Cassegrain at HLCO on 31 Mar, 1992. The binary systems of Algieba (γ Leo), Castor (α Gem), Mizar (ζ UMa), and π Boo, were all observed without a microscope objective and with a red (610–690 nm) filter. Additionally, Algieba was observed with a green (530–570 nm) filter. The data from both instruments were recorded on 8mm video cassette.

The directed vector autocorrelation (DVA) was done using the CHARA DVA setup (an Imaging Technology PC Vision+ digitizer card in a 386 PC to digitize and store the bright pixel positions and UNIX workstations to perform the DVA, see Bagnuolo *et al.* 1992). To approximate the capability of an anticipated amateur DVA setup (a simple digitizer card in a 386 PC, calculating the DVA real–time) and a 10 minute integration, only the brightest 100 pixels in each of about 1800 frames were used in the DVA.

The secondary positions of the binaries were determined using the CHARA astrometric reduction routines written in Interactive Display Language (IDL). Peaks were found in all DVA's except that of π Boo. The results are summarized in Table 2.

TABLE 2. Selected binaries.

Name	V	Δm	Aperture (m)	Image Scale (pix/arcsec)	Filter (nm)	Fitted X (pixels)	Fitted Y (pixels)
Algieba	1.90	1.25	0.4	1.936	650	-6.85	-5.69
Algieba	1.90	1.25	0.4	1.936	550	-6.54	-5.38
Algieba	1.90	1.25	0.2	5.229	–	5.73	22.82
Castor	1.58	0.86	0.4	1.936	650	4.32	-1.75
Castor	1.58	0.86	0.2	5.229	–	0.16	-6.17
Mizar	2.06	1.68	0.4	1.936	650	-10.97	-25.82
π Boo	4.54	0.92	0.4	1.936	650	–	–

3. CONCLUSION

In speckle interferometry, the brightness of the speckle is independent of the telescope size. However, the speckle size is inversely proportional to the telescope size, scaling as the Airy disk. Increasing the effective focal ratio of a telescope through the use of microscope objectives has the effect of enlarging the seeing disk as well as decreasing the available light per pixel in the CCD camera. Therefore, finding the optimum image scale for calculating the astrometry while still getting enough light per pixel is the greatest challenge. In practice, the Airy disk should certainly be no more than 10 pixels across.

Three of the more popular sizes of amateur telescopes are the 8-in (20.32-cm), the 13.1-in (33.33-cm), and the 17.5-in (44.45-cm). Table 3 lists the diffraction limits in arc-seconds, the number of speckles across the seeing disk for average seeing, the magnitude limits with filters in place, and an approximate number of known binaries that could be measured for each of these telescopes. The magnitude limits for two different image scales are given to highlight the cost of higher magnification.

TABLE 3. Telescope comparisons.

Aperture (cm)	θ_d	No. of r_o (r_o=10 cm)	V limit at 2 pix/arcsec	V limit at 4 pix/arcsec	No. of Objects at 2 pix/arcsec
20.3	0″.77	4	3.7	2.2	9
33.3	0″.47	11	4.8	3.3	29
44.5	0″.38	19	5.4	3.9	53

4. REFERENCES

Bagnuolo, W.G. Jr., Mason, B.D., Barry, D.J., Hartkopf, W.I., & McAlister, H.A. 1992, *AJ*, **103**, 1399