Double Star Measures Using the Video Drift Method - III

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Abstract: This paper gives the position angle and separation for 242 multiple star systems measured using the video drift method. Standard deviations averaged 0.59" for separation, 1.8° for position angle for single drifts. The drift method generates a Cartesian (*x*,*y*) coordinate pair for each star for each video frame during the drift to derive position angle and separation. Many doubles had multiple drifts done over several nights resulting in 4,000 - 10,000 (*x*,*y*) pairs analyzed per system. Doubles with multiple drifts/nights combined gave probable errors of 0.10" in separation and 0.27° in position angle. An image intensifier was used on some doubles to reach fainter systems in which WDS catalog magnitudes were in the +13 to +15 range. The systematic accuracy of this method is discussed with multiple drifts over several nights.

Introduction

In our first and subsequent paper (Nugent and Iverson, 2011, Nugent and Iverson 2012, hereinafter called "Paper I and Paper II") we described a new method that computes both the position angle and separation for a multiple star system using 100's to 1,000's of (*x*,*y*) positions of the components obtained from a short video clip of the multiple star system drifting across the field of view. The freeware program *LiMovie* (Miyashita, 2006), originally intended for analysis of occultation data, is used to automatically convert the raw video into a table of Cartesian (*x*,*y*) positions for the two component stars being measured. *VidPro*, an Excel program written by co-author RLN, reads the (*x*,*y*) coordinate data and computes a unique value for the position angle and the separation and other statistical quantities.

A detailed description of how to set up and use the *LiMovie* and *VidPro* programs plus a free *VidPro* download link can be found in Nugent (2010). The advantage of using this method is that the data collection and subsequent data analysis is automated and requires little human interaction. Unlike other methods, no calibration doubles are needed, no line is drawn to determine the east-west direction, no star catalog is needed since there is no "plate adjustment" performed and no video frames are discarded thus all (*x*,*y*) coordinate pairs are used with equal weight. Each double star drift is self calibrating. *VidPro* computes a unique scale factor for each drift, plus an offset correction from the east-west direction compared to the camera's pixel array. The offset of the pixel array alignment of the camera's chip from the true east-west direction (drift angle) is calculated to an accuracy of better than 0.04°.

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Table 1. Telescopes used in this research. Scale factors vary slightly due to the declination of the doubles.

TELESCOPE	APERTURE	FOCAL LENGTH	SCALE FACTOR
Meade LX-200	14" (35cm)	3550 mm f/10	0.6"/pixel
Questar	3.5" (9cm)	1299 mm f14.4	1.6"/pixel

The whole recording and analysis process can be done in just a matter of minutes per double star system at the telescope with the proper set up. Therefore, this method is ideally suited for survey projects involving hundreds of double stars.

Methodology

Preference was given to multiple star systems that the WDS reports less than 35 measurements since being discovered and those with measurements lacking in the past 10 years. This criterion applies to most, but not all of the multiple star systems measured.

Typically 3 or 4 drifts were recorded for many double stars per night. Some doubles had 10-12 drifts done. Additional drifts were made for selected double star systems when it was thought they might prove useful later in the analysis process. This included stars that had close separations or were near the magnitude limit of the telescope. When weather permitted, an effort was made to record each star system on at least two nights. Additional recordings, on other nights, were made for doubles that seemed to differ significantly from the WDS summary list in either position angle and/or separation. This was done in an effort to confirm the apparent differences.

Several drift measurements reported were made over several nights and consist of multiple drift runs per night. In several cases the same double star system was observed by both authors using different telescope/video camera systems. In any case where multiple drifts exist for a given double star system, they were combined using a weighted average function:

$$\overline{M} = \frac{\frac{1}{\sigma_1^{\,2}} M_1 + \frac{1}{\sigma_2^{\,2}} M_2 + ... \frac{1}{\sigma_n^{\,2}} M_n}{\frac{1}{\sigma_1^{\,2}} + \frac{1}{\sigma_2^{\,2}} + ... \frac{1}{\sigma_n^{\,2}}} \qquad (1)$$

In equation (1) $M_1 \ldots M_n$ is the computed value from a drift run of position angle or separation and $\sigma_1 \ldots \sigma_n$ is the standard deviations of position angle or separation for that same drift run. As stated earlier, each drift run typically has 1,000's of values used for the computation of M_n.

The new standard deviation from combining measurements from different drift runs of the same double star system is computed from:

$$\sigma_{new} = \frac{1}{\sqrt{\frac{1}{\sigma_1^{\,2}} + \frac{1}{\sigma_2^{\,2}} + \frac{1}{\sigma_3^{\,2}} .... \frac{1}{\sigma_n^{\,2}}}} \qquad (2)$$

For several doubles, Nugent used a Collins I[3] image intensifier (Collins 1998) to aid in reaching fainter doubles. This device is attached between the telescope and the video camera and adds approximately three (3) magnitudes to the faint limit of the video system. This three magnitude limit increase comes with a price – the videos are noisy. However with careful use of the *LiMovie* and *VidPro* programs for the reductions, the noise effect can be overcome in the final analysis. A sample video (made June 2012) using the Collins image intensifier and Meade 14-inch LX-200 is available on author RLN's YouTube account of the system WDS 15376-0147, (LDS 533). Its WDS component magnitudes are +12.7 and +15.2. See http://www.youtube.com/watch?v=JMJxVSirGFU .

Compare this to a typical non-image intensifier video drift made by the 9cm (3.5-inch) Questar of WDS 05005+0337 (STF 627AB). See http://www.youtube.com/watch?v=yAokhR1UR_I . Its component magnitudes are +6.59 and +6.95.

The telescope equipment used and scale factors are summarized in Table 1.

The data collection and analysis procedures used follow those described by Nugent (2010) and Paper I.

Consistency of the Method

For 104 multiple drifts the average probable error was 0.10" for separation and 0.27° for PA. The average probable error for PA's with separations less than 25" was larger at 1.4°. For all of the Table 2 doubles (this includes 138 with single drifts) with separations

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Table 2: Results of 242 double stars using the video drift method.

WDS	Discoverer	PA°	σ-PA	Sep"	σ-Sep	Date	No. of (x,y) pairs	mag Pri	mag Sec	No. Drifts
00314+3335	HJ 5451	86	0.2	55.3	0.17	2012.786	2132	6.01	9.34	3
00352+3650	STF 40AB	310	1.0	11.6	0.15	2012.786	2620	6.72	8.48	3
00369+3343	H 5 17AB	174	0.3	37.7	0.17	2012.786	2505	4.36	7.08	3
00464+3057	STFA 1	46	0.2	47.7	0.16	2011.825	2963	7.25	7.43	4
01062+3211	S 393AB	296	0.2	58.5	0.16	2011.825	2821	6.42	10.61	4
01579+2336	H 5 12AB	47	0.3	37.7	0.19	2011.888	2131	4.80	6.65	3
02305+2514	STF 271AB	184	0.5	13.4	0.13	2011.880	5486	5.9	10.4	7
02370+2439	STFA 5	275	0.2	38.0	0.12	2011.880	4249	6.50	7.02	6
02476+2941	BU 307	317	0.9	16.0	0.18	2011.888	2384	7.2	11.6	3
02500+2716	H 5 116AC	233	0.5	28.5	0.27	2011.888	2171	3.63	10.66	3
02500+2716	STT 47AB	292	0.4	34.0	0.19	2011.888	2186	3.63	11.04	3
03040+2831	STF 339AB-C	331	1.0	13.9	0.18	2011.888	3147	8.24	11.19	4
03311+2744	STFA 7	233	0.1	44.4	0.11	2011.880	5078	7.41	7.81	7
03313+2734	STF 401	271	0.1	11.4	0.09	2011.880	5452	6.58	6.93	7
03431+2541	STF 435	3	0.5	13.5	0.10	2011.880	5505	7.20	8.87	7
06045+4416	LEP 22	290	0.0	192.4	0.07	2012.111	6071	6.74	9.11	12
06045+5134	STT 128A-BC	14	0.2	40.3	0.09	2012.140	7864	6.41	9.26	7
06055+1435	AG 321	188	0.1	36.2	0.09	2012.040	8721	7.78	8.84	12
06090+0230	STF 855AB	115	0.2	29.3	0.09	2012.040	8590	5.68	6.68	13
06090+0230	STF 855AC	107	0.1	117.8	0.12	2012.040	6642	5.68	9.68	13
06090+0230	STF 855BC	104	0.1	89.1	0.12	2012.040	6135	6.68	9.68	12
06120+1947	H 6 72AB	203	0.1	93.1	0.11	2012.111	8014	5.74	9.36	12
06141+2359	STTA 70	178	0.0	117.0	0.10	2012.111	9233	7.55	7.95	12
06145+1148	STTA 71	312	0.1	91.3	0.09	2012.040	7082	7.21	7.62	12
06194+1326	STTA 73AB	43	0.1	73.0	0.15	2012.142	2564	6.94	7.74	5
06308+5810	STT 562	107	0.1	169.2	0.17	2012.137	2954	5.96	9.50	4
06308-0939	HJ 731	33	2.3	11.4	0.54	2012.293	659	8.90	10.01	1
06310+5351	STF 908	357	1.7	8.5	0.34	2012.293	1162	10.71	10.70	1
06343+3805	STT 147A,CD	120	0.2	46.4	0.09	2012.040	6415	6.77	9.85	8
06343+3805	STT 147AB	75	0.2	43.2	0.09	2012.040	6408	6.77	8.69	8
06460+0059	BAL1333AB	321	4.1	15.5	1.17	2012.293	654	8.90	11.7	1
06461+3323	WFC 43	20	4.6	4.5	0.40	2012.293	838	9.82	10.13	1
06462+5927	STF 948AC	304	2.5	9.3	0.25	2012.293	1360	5.44	7.05	1
06530+3852	STF 974AB	223	0.3	22.6	0.10	2012.039	11542	6.14	10.20	13
06541+0641	STTA 79	90	0.0	115.7	0.13	2012.040	4370	7.20	7.52	8
06555+3755	STF 978AB	82	1.4	20.0	0.43	2012.293	850	6.85	10.00	1
06555+3755	WAL 48AC	349	0.5	81.5	0.50	2012.293	833	6.85	11.08	1
06581+1414	STTA 80AB	53	0.1	124.9	0.15	2012.041	2216	7.25	7.37	5
06581+1414	STTA 80AC	112	0.1	81.6	0.14	2012.041	2318	7.25	8.37	5
06581+1414	STTA 80BC	193	0.1	108.9	0.16	2012.041	2225	7.37	8.37	5

Table 2 continues on next page.

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Table 2 (continued): Results of 242 double stars using the video drift method.

WDS	Discoverer	PA°	σ-PA	Sep"	σ-Sep	Date	No. of (x,y) pairs	mag Pri	mag Sec	No. Drifts
07376-1507	XMI 66	31	1.8	19.7	0.69	2012.293	703	10.71	11.33	1
08086-0259	STF1190AB	106	1.0	33.0	0.61	2012.293	633	4.46	10.2	1
08086-0259	STF1190AC	246	0.6	65.4	0.67	2012.293	577	4.46	9.68	1
08380-0226	HJ 98	100	4.9	9.6	1.04	2012.304	741	11.5	11.5	1
08414-0213	HJ 102AB	327	1.5	33.8	0.86	2012.293	674	12.3	13.7	1
09203-0822	AG 339	28	2.9	6.1	0.37	2012.293	713	9.21	9.78	1
09204-0821	J 1545	19	3.4	9.9	1.15	2012.293	783	11.07	11.9	1
09541+0457	S 605	287	0.2	53.5	0.16	2012.236	2500	6.89	8.40	4
09545-1255	HJ 4262AB	103	1.5	7.8	0.27	2012.236	1468	8.69	11.31	4
10141+2314	POU3075	24	1.3	16.9	0.39	2012.307	843	10.45	11.3	1
10145+2434	GRV 814	205	1.2	22.3	0.46	2012.307	846	11.31	11.97	1
10237+0237	LAM 7AB	24	0.4	131.6	1.03	2012.301	1895	7.94	8.60	2
10476-1516	STF1474AB	28	0.4	67.8	0.47	2012.354	1672	6.67	7.05	1
10476-1516	STF1474AC	28	0.6	73.3	0.69	2012.301	1105	6.67	7.59	1
10476-1516	STF1474BC	18	3.6	6.3	0.46	2012.458	674	7.8	7.5	1
10477+6528	STF1469AB	324	0.8	10.6	0.08	2012.236	6355	7.74	10.42	4
11012+2105	WEI 26	174	0.6	14.5	0.13	2012.299	4640	9.50	9.96	6
11045-1940	HDS1580	285	1.8	17.4	0.63	2012.304	718	9.76	11.07	1
11046+1240	HJ 174AB	357	1.1	59.3	0.98	2012.304	690	6.88	12.50	1
11047-0413	STF1506A-BC	224	2.2	11.9	0.40	2012.304	692	7.68	10.75	1
11061+0702	STF1507	166	2.2	8.4	0.32	2012.304	700	8.80	10.23	1
11063+1910	GRV 828	158	1.8	28.3	0.79	2012.304	716	11.4	12.1	1
11065-1325	STF1509	16	0.7	33.2	0.39	2012.304	706	7.43	9.36	1
11072+1055	STF1511	287	2.3	7.6	0.33	2012.304	716	9.27	9.50	1
11075+2203	HDS1586	203	1.7	14.0	0.43	2012.458	399	8.30	11.43	1
11093+0356	STE 9	354	0.8	39.9	0.56	2012.307	778	12.0	13.1	1
11093+1902	VVO 8	275	1.3	27.4	0.62	2012.307	772	11.0	13.3	1
11095+1138	LDS4066	101	0.4	147.1	0.93	2012.307	501	13.0	13.6	1
11107+1542	GRV 830	185	0.9	33.3	0.44	2012.307	784	10.7	12.5	1
11109-1858	ARA 415AB	152	3.9	9.3	0.68	2012.307	596	12.04	12.11	1
11109-1858	WNO 33AC	120	0.5	79.8	0.82	2012.307	653	12.04	11.00	1
11140+0804	KUI 56	256	1.8	23.6	0.73	2012.458	663	5.79	11.83	1
11157+4551	STTA109	256	0.1	83.7	0.11	2012.299	4812	7.95	8.69	6
11165+0736	HJ 2565	9	3.8	15.0	1.16	2012.301	251	10.20	11.4	1
11167-0339	SHJ 121	290	0.4	87.1	0.62	2012.301	524	4.48	9.75	1
11520+0850	STF1575	210	0.8	30.6	0.49	2012.301	683	7.43	7.89	1
11520-0824	HJ 843AB-C	263	4.0	10.2	0.73	2012.301	688	11.14	11.6	1
11524+0733	STF3075	182	1.1	18.8	0.44	2012.301	715	9.70	9.88	1
11551+4629	STF1579AB-D	114	0.2	63.1	0.22	2012.301	1679	6.68	6.97	1
11551+4629	STF1579AB-C	42	3.8	3.7	0.17	2012.458	856	6.68	8.32	1

Table 2 continues on next page.

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Table 2 (continued): Results of 242 double stars using the video drift method.

WDS	Discoverer	PA°	σ-PA	Sep"	σ-Sep	Date	No. of (x,y) pairs	mag Pri	mag Sec	No. Drifts
11555+0333	ABH 75AD	131	0.4	87.9	0.75	2012.304	579	9.34	11.95	1
11555+0333	STF1580AB	262	2.3	8.8	0.40	2012.304	689	9.34	10.01	1
11558+1616	SLE 893	63	1.7	15.8	0.43	2012.304	709	10.59	10.77	1
11559-2344	ARA2174	313	3.3	14.9	0.80	2012.304	742	10.79	12.2	1
11560+2159	STF1582	75	0.6	12.1	0.11	2012.299	5257	8.09	9.53	7
11574-1939	J 1583	71	4.6	8.2	0.65	2012.304	724	10.37	12.0	1
11596+4636	ES 2639	53	3.1	9.4	0.35	2012.458	993	9.36	12.5	1
12030-2139	ARA1478	82	4.8	12.4	1.21	2012.299	816	13.3	13.3	1
12035-0227	STF1593AC	3	0.6	50.0	0.63	2012.299	729	8.70	12.2	1
12043+0724	STF1595	329	0.9	27.7	0.46	2012.299	755	9.22	10.01	1
12084+1403	KU 42	272	1.3	12.1	0.43	2012.299	778	10.93	11.36	1
12093-2403	ARA2177	157	3.4	12.9	0.78	2012.299	819	12.0	12.4	1
12094+0219	BAL1883	259	2.3	17.4	0.66	2012.299	748	11.23	12.8	1
12095-2324	WHC 10	23	3.1	12.3	0.73	2012.299	832	11.2	11.8	1
12123+4618	HJ 2602	227	2.5	20.8	0.64	2012.301	969	11.43	11.82	1
12270-0332	HJ 210AB,D	147	1.4	24.8	0.69	2012.301	669	8.51	10.20	1
12357-1650	HJ 1218AB	259	2.2	11.9	0.42	2012.304	717	6.6	11.0	1
12363-0818	HJ 848	309	2.4	11.7	0.54	2012.304	704	11.01	11.4	1
12506-2117	STN 25	177	1.8	13.2	0.47	2012.307	815	10.61	11.1	1
12506-2330	ARA1796	165	3.4	14.2	0.71	2012.307	823	12.29	12.7	1
12508-2944	HJ 4553	346	2.7	11.5	0.51	2012.307	876	10.59	11.4	1
12509-0428	LDS6270	266	3.2	6.2	0.95	2012.307	747	11.97	14.35	1
12511+0152	BAL1887	51	2.4	9.1	0.29	2012.307	742	9.5	11.5	1
12514-1020	STF1682AB	297	0.8	29.3	0.48	2012.307	723	6.59	9.69	1
12514-1020	STF1682AC	212	0.2	142.1	0.56	2012.307	624	6.59	11.0	1
12514-1020	STF1682BC	201	0.2	143.1	0.50	2012.307	611	9.69	11.0	1
12515-1920	J 1584	273	1.9	11.0	0.50	2012.307	796	11.7	11.7	1
12517-0608	STF1683	198	1.6	15.3	0.44	2012.307	732	8.45	10.69	1
12519+1910	STF1685AB	202	1.2	16.1	0.36	2012.307	824	7.31	7.78	1
12519+1910	SHJ 153AC	328	0.1	243.1	0.55	2012.307	559	7.31	8.22	1
12519+1910	SHJ 153BC	331	0.1	252.5	0.55	2012.307	571	7.78	8.22	1
12525+0712	HJ 2621AB	87	0.6	32.9	0.36	2012.307	720	9.64	9.51	1
12525+0712	HJ 2621AC	129	0.6	38.5	0.45	2012.307	724	9.64	11.42	1
12525+0712	HJ 2621BC	187	0.9	26.2	0.41	2012.307	785	9.51	11.42	1
13008+0252	HLD 14AC	100	1.0	48.5	0.90	2012.301	595	9.77	12.05	1
13021+0717	STF1708	295	1.9	11.6	0.43	2012.304	691	9.23	10.36	1
13027-0159	HJ 1225	111	2.5	14.9	0.64	2012.458	684	10.6	10.8	1
13045+0839	WS 9001AC	235	0.4	75.3	0.57	2012.307	635	8.32	12.	1
13045+0839	WS 9001AD	20	2.6	54.8	1.42	2012.307	685	8.32	12.	1
13050+1430	UC 181	206	1.0	47.7	0.69	2012.307	747	11.39	12.84	1

Table 2 continues on next page.

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Table 2 (continued): Results of 242 double stars using the video drift method.

WDS	Discoverer	PA°	σ-PA	Sep"	σ-Sep	Date	No. of (x,y) pairs	mag Pri	mag Sec	No. Drifts
13054-2103	VVO 11	53	0.3	160.3	0.78	2012.307	539	10.3	10.4	1
13069-0619	AOT 51	177	2.5	9.2	0.69	2012.299	740	11.4	12.5	1
13072+0435	GRV 863	203	3.1	8.5	0.42	2012.299	775	10.0	11.3	1
13076+1216	HJ 2640	6	0.5	52.9	0.43	2012.299	780	9.25	10.86	1
13077+2401	STT 259	21	0.3	39.7	0.16	2012.403	2266	8.24	8.60	3
13085+0107	STF1721	2	2.5	6.3	0.50	2012.304	696	10.18	10.27	1
13085-0241	S 647	213	0.6	42.3	0.46	2012.299	733	7.91	10.36	1
13092+0848	A 1786	96	1.7	13.9	0.43	2012.304	696	10.10	11.6	1
13109+2114	COU 96AB	309	2.4	11.0	0.43	2012.458	750	6.82	10.8	1
13114+0938	LDS5771	169	0.3	82.1	0.53	2012.307	767	8.74	12.33	1
13115-3508	HJ 4571	266	1.2	23.5	0.48	2012.307	888	6.79	9.13	1
13117-3216	HJ 4572	304	1.2	26.0	0.58	2012.307	864	9.86	10.59	1
13121+1113	HJ 221	187	0.8	49.5	0.62	2012.307	761	8.6	11.1	1
13242-0159	GLP 9	243	0.2	61.9	0.23	2012.402	1798	9.98	10.07	3
13242-0206	STF1741	262	0.5	25.0	0.21	2012.402	2007	8.36	9.78	3
13572-1233	HJ 4637	142	1.6	13.4	0.44	2012.304	705	10.63	11.3	1
13577-1717	HJ 2692AC	226	1.6	29.8	0.66	2012.304	699	10.49	11.60	1
14001+0356	UC 188	138	1.5	21.6	0.57	2012.304	669	10.92	11.87	1
14014-1409	HJ 2696	106	3.4	17.4	1.08	2012.304	682	10.14	13.1	1
14178+4845	HJ 2710AC	321	0.3	24.2	0.09	2012.299	6397	9.47	9.77	6
14189+1812	LDS 956	217	2.2	14.6	0.50	2012.458	736	13.15	14.31	1
14189+3220	HJ 2709	84	1.7	28.8	0.81	2012.458	785	11.46	14.5	1
14190-2549	BU 1246AC	117	0.1	85.9	0.06	2012.458	579	5.93	11.0	1
14245-1608	FOX 183	221	1.2	26.2	0.56	2012.307	777	10.32	12.13	1
14250-0301	BAL 234	5	2.0	16.7	0.60	2012.307	760	10.87	12.8	1
14324+3138	STF1855AB	248	0.7	15.7	0.17	2012.301	2473	9.24	9.94	3
14343+2424	STTA129	67	0.1	77.5	0.17	2012.403	1899	8.43	8.53	3
14427-0558	STF1869	132	0.4	26.3	0.20	2012.403	2072	8.43	9.52	3
14505-0527	HJ 4708	165	2.2	23.8	0.94	2012.463	632	11.46	11.95	1
14589-1109	STF1894AB	39	0.6	19.9	0.23	2012.403	2117	5.87	9.9	3
15006+1606	KU 107	359	0.4	53.6	0.41	2012.458	738	9.82	11.00	1
15010-0831	J 1586CD	346	4.0	9.8	0.66	2012.458	720	11.3	13.7	1
15011-3651	FAL 48	5	1.3	14.0	0.30	2012.458	839	9.00	12.15	1
15016-0310	STF1899	68	0.7	27.9	0.38	2012.460	653	6.69	10.15	1
15017-0707	GIC 123	111	1.4	40.9	1.03	2012.458	636	14.9	17.1	1
15018-3656	HJ 4724	228	2.1	15.0	0.55	2012.460	876	7.97	10.27	1
15019+1547	STF1902	191	0.3	26.6	0.16	2012.301	2944	8.99	9.61	4
15019+2141	GRV 896	240	0.6	46.6	0.48	2012.460	700	10.7	11.9	1
15114-3615	HJ 4745AB	22	1.4	27.2	0.59	2012.463	907	9.40	10.78	1
15114-3615	HJ 4745BC	93	2.0	15.3	0.72	2012.463	898	10.78	11.27	1

Table 2 continues on next page.

Double Star Measures Using the Video Drift Method - III

Table 2 (continued): Results of 242 double stars using the video drift method.

WDS	Discoverer	PA°	σ-PA	Sep"	σ-Sep	Date	No. of (x,y) pairs	mag Pri	mag Sec	No. Drifts
15116-3208	HJ 2765	351	1.1	27.6	0.53	2012.463	894	9.53	10.12	1
15117+1623	BPM 625	64	1.2	72.1	1.28	2012.463	679	14.30	14.32	1
15119-3250	HJ 4743	196	2.4	11.0	0.43	2012.463	933	8.80	9.12	1
15128+2756	H 5 125	228	0.3	32.4	0.14	2012.301	3012	8.43	9.46	4
15287+4215	HJ 1274	310	3.9	6.9	0.33	2012.458	949	10.61	10.8	1
15294+4743	BU 944AB	130	2.8	10.7	0.36	2012.458	1019	6.87	12.8	1
15294+4743	BU 944AC	70	0.9	56.5	0.64	2012.458	863	6.87	12.8	1
15329+0531	STF1953	252	3.2	6.7	0.39	2012.458	707	9.65	10.58	1
15346+4454	HJ 2788	302	0.5	47.1	0.32	2012.458	891	8.50	8.58	1
15375+2325	POU3196	176	2.9	12.5	0.67	2012.463	791	13.4	13.6	1
15376-0147	LDS 533	34	3.0	20.2	0.89	2012.463	767	12.7	15.2	1
15383+2431	ARY 11	327	0.1	151.0	0.16	2012.402	2440	7.03	8.83	4
15509+1441	STF1978	237	1.2	15.1	0.36	2012.463	658	9.19	10.13	1
15517-1109	STF3098	336	1.6	23.0	0.65	2012.463	631	9.47	11.3	1
16087+0210	BAL1913	354	3.2	7.9	0.51	2012.463	783	11.45	12.09	1
16089+1738	BPM 651	215	1.0	33.9	0.56	2012.463	795	11.26	12.58	1
16089+2456	HO 550	297	1.4	17.4	0.45	2012.463	837	8.6	12.8	1
16091+0720	HJ 1286AB	156	1.5	18.8	0.57	2012.463	766	10.51	12.1	1
16091+0720	HJ 1286AC	218	1.3	36.4	0.84	2012.463	745	10.51	12.9	1
16093-0140	BAL 563	142	1.6	22.6	0.78	2012.463	765	10.48	13.1	1
16095+1513	BPM 652	135	0.6	97.1	1.00	2012.463	662	12.53	13.98	1
16308-2820	HJ 4859	265	2.8	11.0	0.69	2012.463	729	10.29	10.30	1
17224-1839	ARA 442	307	4.7	6.2	0.57	2012.463	675	8.69	11.8	1
17229-0223	RAG 9	146	0.8	46.3	0.61	2012.463	604	6.3	12.2	1
17245+3657	STT 329AB	12	0.4	33.5	0.17	2012.482	2512	6.35	9.88	3
17249+1320	STF2159	326	0.4	27.0	0.18	2012.510	2119	8.53	9.44	3
17279+1123	STF2166	282	0.3	27.1	0.14	2012.498	4058	7.15	8.58	6
17346+0935	STFA 34AB	190	0.3	42.2	0.19	2012.485	2072	5.80	7.50	3
17360+2100	STF2190AB	23	0.6	10.4	0.09	2012.555	6739	6.13	9.48	9
17411+2431	STF2194AB	8	0.4	16.3	0.12	2012.530	4660	6.51	9.28	6
17465+2743	STF2220A,BC	247	0.2	35.2	0.10	2012.555	6509	3.49	9.78	9
17503+2517	STF2232	139	0.9	6.7	0.11	2012.530	5404	6.71	8.85	7
17526+2443	POU3318	238	5.0	8.3	0.69	2012.463	715	12.9	13.3	1
17526+2536	LBU 1AB,C	253	0.9	34.6	0.55	2012.463	817	9.17	10.89	1
17526-2108	J 1616	155	1.9	5.7	0.22	2012.463	801	10.6	10.9	1
17527+1459[1]	BPM 705	232	0.7	25.9	0.25	2012.463	762	11.87	14.58	1
17531+1401	HJ 1306	5	0.3	30.8	0.13	2012.563	4324	9.80	10.18	6
17590+3003	STF2259	277	0.4	19.5	0.11	2012.528	4681	7.27	8.44	6
18015+2136	STF2264	256	1.1	6.4	0.12	2012.530	4550	4.85	5.20	6
18057+1200	STF2276AB	256	1.3	7.0	0.16	2012.471	2891	7.09	7.44	4

Table 2 concludes on next page.

Double Star Measures Using the Video Drift Method - III

Table 2 (conclusion): Results of 242 double stars using the video drift method.

WDS	Discoverer	PA°	σ-PA	Sep"	σ-Sep	Date	No. of (x,y) pairs	mag Pri	mag Sec	No. Drifts
18067+1359	FOX 219AD	319	0.1	86.8	0.17	2012.558	4320	10.44	9.08	7
18078+2606	STF2280AB	183	0.7	14.6	0.15	2012.471	2386	5.81	5.84	3
18332+4010	STT 356AB	303	0.4	28.9	0.16	2012.482	2540	7.30	9.23	3
18332+4010	STT 356AC	9	0.2	49.4	0.16	2012.482	2563	7.30	10.90	3
18362+4117	STF2351	161	2.1	4.8	0.17	2012.482	2811	7.60	7.64	3
18373+0732	STF2346	299	0.3	30.2	0.18	2012.510	1994	7.93	10.00	3
18433+3918	BLL 35	191	0.1	62.7	0.12	2012.549	5221	6.64	10.35	6
18448+3736	STFA 38AD	151	0.2	44.3	0.12	2012.533	5067	4.34	5.62	6
18501+3322	BU 293AE	318	0.1	66.3	0.13	2012.597	4298	3.63	10.14	6
18501+3322	BU 293AF	19	0.1	86.9	0.13	2012.597	4546	3.63	10.62	6
18501+3322	STFA 39AB	149	0.1	47.6	0.09	2012.565	9944	3.63	6.69	13
18549+3358	SHJ 282AC	350	0.1	46.2	0.08	2012.565	10774	6.14	7.60	13
18560+3347	STF2421	56	0.3	24.7	0.10	2012.587	5672	8.13	9.34	7
18588+4041	STF2431	233	0.7	19.2	0.15	2012.482	2678	6.17	9.61	3
19020+1907	HJ 2851AC	291	0.2	48.7	0.20	2012.485	1960	7.06	11.35	3
19020+1907	WAL 102AD	137	0.5	47.5	0.37	2012.485	1999	7.06	12.	3
19046+2320	SLE1030AD	118	0.2	56.2	0.20	2012.485	1934	7.25	11.19	3
19046+2320	STF2445AB	262	0.6	12.3	0.11	2012.545	4347	7.25	8.57	6
19046+2320	STF2445AC	109	0.1	143.8	0.14	2012.545	2838	7.25	8.46	6
19046+2320	STF2445BC	107	0.1	154.8	0.19	2012.485	1327	8.57	8.46	3
19069+2210	STF2455AB	27	0.8	9.5	0.12	2012.545	4547	7.42	9.44	6
19069+2210	STF2455AC	20	0.1	101.4	0.18	2012.485	2043	7.42	12.3	3
19071+2235	STF2457	200	0.7	10.4	0.12	2012.545	4546	7.46	9.52	6
19138+3909	STF2487AB	81	0.4	28.7	0.15	2012.584	2603	4.38	8.58	3
19164+3808	SHJ 292AB	70	0.1	100.1	0.10	2012.587	4664	4.48	10.14	7
19210+1909	STF2504AB	282	1.1	8.6	0.17	2012.485	2180	7.00	9.03	3
19210+1909	WAL 111AC	102	0.1	91.8	0.25	2012.485	1616	7.00	12.17	3
19255+1948	HJ 2871AB	90	0.4	14.5	0.15	2012.551	4217	5.16	10.0	6
19255+1948	HJ 2871AC	209	0.2	52.2	0.17	2012.551	3915	5.16	11.7	6
19265+1953	STF2521AB	32	0.4	29.1	0.18	2012.485	2124	5.82	10.5	3
19265+1953	STF2521AC	327	0.1	75.4	0.14	2012.545	3916	5.82	10.54	6
19265+1953	STF2521AD	62	0.1	152.6	0.19	2012.485	1374	5.82	10.57	3
20197+4108	STTA205	321	0.2	46.6	0.12	2012.598	5236	7.19	8.91	6
20230+3913	STTA206AB	255	0.2	43.7	0.11	2012.598	4878	6.72	8.63	6
20474+3629	S 765AC	106	0.1	84.0	0.13	2012.614	4039	4.76	9.65	6
22213+2820	HO 615AB	129	0.1	72.3	0.11	2012.684	6610	4.83	10.73	10
22237+2051	STF2900AC	307	0.1	92.2	0.12	2012.718	4750	6.28	8.54	8
22407+2959	STF3134	76	1.2	6.4	0.11	2012.614	4879	9.59	10.09	6
22415+3003	STF2932AB	283	0.3	22.0	0.11	2012.614	5445	9.32	9.44	7
22430+3013	BU 1144A,BC	339	0.1	94.4	0.11	2012.351	7302	3.02	9.87	10
23304+3050	STF3018AB-C	202	0.4	19.2	0.12	2012.218	4832	7.43	9.75	6
23469+2825	STF3039AB	29	0.2	35.8	0.10	2012.252	7578	7.41	9.39	10

Table 2 Notes

All magnitudes taken from the WDS catalog. All position angle / separation measurements are based on the Equator and Equinox of date.

A PA standard deviation of "0.0 deg represents a standard deviation of less than 0.05 deg.

Column titled "**No. of (*x*,*y*) pairs**" is the total combined no. of (*x*,*y*) pairs (video frames) from all drift runs. All video frames were used, none were discarded.

The last column "**N**" is the number of drift runs made for that double.

[1]17527+1459 – WDS magnitude for primary is listed as +11.87. It is" likely closer to +8.5.

(Continued from page 114)

greater than 25" the average probable error was lower at 0.34°. This is an expected mathematical result explained from Figure 1 of Paper II. Thus the video drift method maintains highly consistent results over multiple drifts and over several nights.

Acknowledgements

This research makes use of the Washington Double Star Catalog maintained at the US Naval Observatory.

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