THE USE OF A CAMCORDER IN THE SUPPORT OF SPRINTERS COACHING

Matilde Espinosa-Sanchez

Unidad de Investigación en Cómputo Aplicado, UNAM, México City, México

The intention of this study was to verify if the used methodology and procedures are useful for coaching sprinters. Regardless the possibility to get automated equipment to analyze sprinters, it is possible to register the movement of the athletes in a simple form and to calculate the kinematic parameters to feedback the coach and for research purposes. These study results correspond to the preparation period within the annual macrocycle of a group of sprinters. In order to know the evolution and if there has been an improvement in the athletes performance it would be useful to be able to compare the results obtained in subsequent training sessions.

KEYWORDS: coaching sprinters, camcorder, kinematics

INTRODUCTION: It is possible to record the athletes during the training sessions without interfering or interrupting their performance. One of the intentions of this study is to call the attention about the utility of the kinematics results obtained by the recording of running cycles using one standard camcorder. On the other hand, we know the importance for the coach in getting easily his or her athletes performance information when it has not been necessary to interrupt the normal activities during the training sessions (Müller 2003).
The calculated kinematic parameters (Hay 1985; Mann et al. 1984) consider the critical positions during sprinting: (1) foot touchdown, (2) flat foot, (3) foot takeoff, and (4) body flight. The stride length and stride frequency were calculated in order to know the speed at which the athlete runs. The indicators of, among others, symmetry of movements, arms balance, coordination and connection, are shown by means of the measure of the following angles between body segments: (1) the angle between the trunk and the thigh (hip), (2) the flexion - extension between the thigh and calf (knee), (3) the angle between the trunk and the arm (shoulder), (4) the flexion - extension angle of arm – forearm (elbow), and (5) the trunk inclination.

METHOD: A group of sprinters (17 female and 14 male) (Table 1) was recorded with a non-professional camcorder, during two short distances (30m and 50m) time checking training sessions. The SONY DCR-HC48 was fixed in a tripod and a well-known distance reference was registered. The sprinters wore as few clothes as possible, tops or t-shirts without sleeves or Lycra clothing. In addition, they were asked to run by the central tracks.
The input data were provided by the sagital projection of the running cycles when running in a straight-line section. Both fields (odd and even) of each video frame were used as the images where the capture was made. The anatomic points' coordinates (u,v) were located for a 14 straight-line segments human body representation. No marks were used for locating the anatomical points. With the intention of having additional information, and in order to know the body postures at instants that were not recorded, a Cubic Beta-Spline Interpolation method is used to interpolate the original 60 taped fields per second to obtain about 280 calculated fields per second. The resulting information were cleaned with a Low Pass Filter program in order to clean the data of the noise originated in the capture process. The methodology contemplates the use of several software that allow, to transfer the video to a personal computer as files (*.avi), and to separate the frames in fields (even and odd). Additionally, programs were developed in C++ and Matlab for the capture and the calculations.
The sagital projected angular displacement of the main unions was calculated: shoulders, elbows, hips and knees both right and left, and the trunk inclination. The running cycle is considered divided in the following four sequential body positions as for right side as for the left side: (1) the first posture is at the instant when the athlete touchdown the floor with the foot and initiates the support, (2) the second posture is when the flat foot on the floor

supports the body weight, (3) the third posture is adopted when the foot takeoff the floor with an impulse and initiates the flight of the body, finally, (4) the fourth posture is when the body is suspended in the air and both feet are at the same height. Considering the positions previously described, the cycle is subdivided in four temporal phases, and the time difference between the postures give the duration of the phases: (1) initial support: from the instant when the foot touchdown on the floor to the instant of flat foot, (2) final support: from the instant next to flat foot to the instant before the foot take off the floor, (3) impulse: from the instant of the foot takeoff the floor to the instant when the body is flying with both feet at the same height, (4) landing: from the instant next to the body flight with both feet at the same height to the instant before the touchdown with the foot on the floor. The identification of the postures has been done at the personal computer watching the interpolated frame sequence. The identification of the foot touchdown and the foot takeoff instants are important in defining step characteristics: step length and step frequency (Bezodis et al. 2007).

Table 1 The athlete's characteristics, mean values.

Sex	N	Age [years]	Height [cm]	Weight [kg]	30 m, time [s]	50 m, time [s]
F	17	21.14 ± 3.88	166.12 ± 7.32	55.06 ± 5.36	3.51 ± 0.23	5.82 ± 0.44
M	14	19.89 ± 2.97	174.21 ± 7.66	66.50 ± 7.44	3.18 ± 0.31	5.33 ± 0.56

RESULTS: The coach got the information that was calculated for each athlete: the angular displacement of eleven angles, the duration of the cycle phases, the step length and the step frequency. The Table 2 summarizes the angle values at the critical body postures. For the female athletes, the body posture in which the angles between segments have more variation is at the foot touchdown. The body postures of less variation are at the right flat foot and the right body flight, the other postures have a similar variation. The male athletes have more variation in the body postures; those of greater variation are at the foot touchdown and at the floor takeoff, both with the right foot. The body postures with less variation are the right and left flat foot. Including all the sprinters, the angles between segments with more variation are those of arm-forearm and the amplitude between right and left arms. This variability could indicate that the athlete's swing of arms depends on the personal style. An important factor is that for most of the athletes the touchdown body posture has the greater variation, and considering that this body position is one of the main critical position, it could indicate that there are technical deficiencies.
The mean values of the times of the running cycle phases (Table 3) show that for both, female and male athletes, the behavior could be considered symmetrical. In addition, there is no important variation of duration in the phase's percentage between female and male athletes.
Table 4 shows that the mean values of the distances run in a cycle and the step frequency and velocity, are greater for the male athletes.

DISCUSSION: The capture of the anatomical points coordinates (u,v) in the images is the main procedure and also the most exhausting one. The anatomical points represent the joint unions axes of rotation projected in the sagital plane of the runner, and on the correct location of the points mainly depends the results accuracy. The procedure accuracy depends on: (1) the location of the anatomical points: the person doing the capture must be familiarized with the muscle-skeletal system, (2) the size of the pixel in the computer: the standard NTSC video frame is limited to about 486 horizontal lines of visible pixels and the transferred digital image file has also a limited resolution (640x480 for this study), (3) the time instant length: this is, thirty frames per second that can be deinterlazed to 60 fields per second and later interpolated to about 280 calculated fields per second, (4) the location of anatomical points that are not seen: these are estimated and then calculated using a mathematical procedure of interpolation, and (5) the results are limited to 2D, this means that the corporal segments inclination due to the abduction in unions cannot be known.

The reported mean values in this study show, of course, the global behavior of the analyzed group of runners. The individual differences are not reported and therefore the individual deficiencies or technical efficiencies are not reflected in the tables of calculated values.

Table 2 Angular mean values for the four critical postures, right and left.

		Right Postures [°]				Left Postures [°]			
Sex	Angle	Touch down	FlatFoot	Take off	Bodyflight	Touchdown	Flatfoot	Takeoff	Bodyflight
	R sh	24.6± 12.4	16.8± 7.3	23.6± 10.2	29.1± 12.2	15.7± 10.2	10.3±5.9	38.8± 8.2	52.4± 7.8
F	**L sh**	12.4± 9.9	9.8± 6.7	43.2± 8.0	53.6± 7.1	39.7± 9.3	20.3±8.8	33.0± 9.5	38.1± 10.9
E	**R hip**	129.8± 3.0	134.8± 2.8	170.0± 2.6	166.7± 4.7	173.1± 3.5	165.0±6.9	109.8±11.2	101.8± 8.4
M	**L hip**	170.0± 5.8	163.7± 7.5	112.2± 5.5	102.6± 4.9	120.4± 4.8	132.4±5.1	169.7±2.6	167.0± 4.6
A	**R elbow**	104.1± 17.6	105.7±15.1	75.3± 12.6	64.8± 12.4	104.8± 15.7	129.0±14.7	124.8±13.7	116.2± 12.4
L	**L elbow**	133.8± 12.1	138.5±10.6	125.4± 14.6	117.7± 13.4	104.8± 13.9	104.0±15.3	79.6±11.5	71.6± 11.8
E	**R knee**	151.2± 5.8	149.0± 4.5	150.8± 5.9	157.0± 4.6	82.3± 10.0	54.4±8.1	53.7±8.1	72.7± 7.9
	L knee	63.9± 12.9	52.9± 8.3	51.1± 6.3	69.6± 7.4	145.8± 8.6	147.8±3.9	149.2±4.6	154.8± 4.3
	trunk	284.6± 3.1	284.8± 3.0	284.7± 2.9	284.2± 2.7	285.3± 3.1	285.3±3.0	284.8±3.1	283.3± 3.0
	thighs	44.9± 10.9	31.2± 8.9	65.8± 8.3	89.5± 7.8	62.1± 8.5	34.8±9.9	67.2±10.9	90.3± 7.4
	arms	36.4± 14.9	22.7± 8.6	66.8± 1.8	82.7± 13.1	54.6± 16.1	26.6±11.5	71.7±12.6	90.5± 12.3
	R sh	15.2±12.3	11.5± 6.5	25.9± 12.4	29.3± 12.8	10.2± 7.1	7.6± 4.4	44.9±10.2	57.5± 8.5
	L sh	9.9± 8.6	10.0± 7.1	50.9± 10.2	60.0± 8.7	38.6± 10.1	20.1± 10.6	34.9±9.1	37.9± 11.3
M	**R hip**	126.8± 7.1	130.7± 6.9	168.5± 2.9	168.7± 5.3	169.3± 6.4	156.6± 10.8	103.9±10.9	99.5± 8.7
A	**L hip**	165.1± 7.4	157.8± 10.4	104.1± 11.5	99.8± 8.4	119.1± 4.3	130.4± 6.7	168.2±3.8	165.9± 6.3
L	**R elbow**	114.7± 14.0	117.5± 14.9	80.2± 13.7	70.1± 11.1	111.8± 17.4	136.8± 14.1	132.5±10.5	123.9± 10.6
E	**L elbow**	131.2± 12.9	137.2± 10.0	126.2± 11.9	120.0± 11.3	108.4± 11.3	105.7± 14.6	78.1±12.2	67.7± 12.5
	R knee	149.6± 8.0	147.5± 6.8	149.2± 5.9	151.7± 5.3	79.7± 9.4	55.4± 8.1	57.7±8.3	77.2± 11.2
	L knee	59.8± 5.3	52.0± 5.0	55.1± 9.7	72.5± 10.3	145.0± 7.2	146.9± 7.2	147.3±6.2	151.2± 6.0
	trunk	285.0± 3.9	285.4± 4.0	284.8± 4.1	283.8± 4.0	284.8± 4.1	285.2± 4.4	283.1±5.3	281.8± 5.0
	thighs	38.8± 11.7	27.9± 10.4	73.2± 14.6	88.8± 9.7	56.8± 11.1	29.9± 14.2	75.0±13.6	93.8± 9.4
	arms	20.7± 20.7	18.0± 12.0	76.9± 18.6	89.3± 17.5	46.8± 14.4	25.1± 11.1	79.7±14.3	95.4± 15.1

ANGLES: sh=shoulder, thighs=right and left thigh, arms=right arm and left arm, R=right, L=left.

Table 3 Times in cycle phases, mean values.

	Right Phases [s]				[s]	Left Phases [s]				[s]	Running
Sex	Initial support	Final support	Impulse	Landing	Right step	Initial support	Final support	Impulse	Landing	Left step	Cycle [s]
Female	0.0342	0.0854	0.0260	0.0916	0.2372	0.0344	0.0856	0.0245	0.0887	0.2331	0.4703
	7 %	18 %	6 %	19 %	50 %	7 %	18 %	5 %	19 %	50 %	100 %
Male	0.0306	0.0849	0.0212	0.0891	0.2258	0.0299	0.0839	0.0243	0.0834	0.2216	0.4474
	7 %	19 %	5 %	20 %	50 %	7 %	19 %	5 %	19 %	50 %	100 %

Table 4 Step length and step frequencies mean values.

Sex	Cycle	time [s]	Cycle	distance [m]	Steps	/ s	Velocity	m / s
Female	0.4703	± 0.02	3.75	± 0.28	4.26	± 0.22	7.97	± 0.53
Male	0.4474	± 0.03	3.95	± 0.21	4.49	± 0.27	8.86	± 0.75

As it were said in the results, in this group the male athletes present more variability in the critical body positions of the running cycle. There are no significant differences between the movements of the right side and the movements of the left side, neither in times nor in percentage in the running cycle phases for both, male and female athletes. The Table 1 shows that the mean age of male athletes are younger and this probably indicates that they are less experienced. Nevertheless, as it was expected, the male athletes are faster than the female athletes, since the important differences of the kinematic values between male and female are basically the step length and the step frequency and velocity.

CONCLUSION: Some of the values of the calculated kinematic parameters in this study are within the well-known ranks. Other values have surely not been calculated according to standardized methods. In both cases, the values of the parameters are a reference.
An important advantage is that this procedure is repeatable and therefore reliable. The disadvantage is that values of the kinematics parameters lack accuracy, and therefore they are just an approximate indicative.
The angular velocities and the center of mass displacement of each athlete have to be calculated to complement the performance information of the sprinters.
When the coach repeats the procedure during the training sessions in which he or she wants to verify the performance of its athletes, the accuracy level would be similar if the camera is settled perpendicularly to about the same distance of the sprinters route and using, if possible, the same camcorder.

REFERENCES:
Bezodis,I., Thomson, A., Gittoes, M. and Kerwin, D. (2007) Identification of instants of touchdown and take-off in sprint running using an automatic motion analysis system. XXV ISBS Symposium 2007, Ouro Preto – Brazil
Hay, J. (1985) The Biomechanics of Sports Techniques. Prentice-Hall, Inc. Third Edition.
Mann, R., Kotmel, J., Herman, J., Johnson, B., Schultz, C. (1984) Kinematic Trends in Elite Sprinters. 2nd International Symposium on Biomechanics in Sports Proceedings, Colorado Springs, USA, Terauds, Barthels, Kreighbaum, Mann, Crakes (Editors)
Müller, E. (2003) Biomechanics in Elite Sports Performance.VIIth IOC Olympic Word Congress on Sport Sciences, Book of Abstracts. p. 4E.

Acknowledgment
The author would like to thank Professor Raúl Barreda, his group of coaches and athletes, for his valuable interest and cooperation.