Technique Print for Motion Performance

[1]Dr/ Mostafa Mostafa Ali Atwaa
[2]Dr/ Marwa Abd ElKadr Mohamad Sakr

Abstract

The prints of the blood, eye, finger, and ear are essential method to identify the persons, where it is impossible to find two identical prints even of twins. Therefore, the print refers to the individuality which is the basic of training, diagnose, or educating athletes. The body segments are treated as a community of society, the output parameters of this community by the motion analysis are treated statistically for more understand how the body segment effect each other and the body center of gravity. Three good athletes in gymnastics were asked to perform the Round-off (gymnastics). Motion Track program was used to get the angular velocity for 14 segments plus the center of body mass. The skewness and kurtosis of the segments angular velocity were calculated. The segments were classified into categories according to a matrix between the skewness and kurtosis values. The results emphasis the differences in the technical prints between the three performances in the number of the cooperative, non-participant, and special segments. There is differences in the easiness and difficulty degree of performance.

Keywords: biomechanical statistic, skewness, kurtosis, performance level, print.

Introduction

The Print is a common word that refers to the individuality. Finger print, Voice print, and Eye print are the unique and pure individual way to track down a person or to be used as unbeatable password.

In Sport performance, the principal of individuality is not far from the previous concept. Otherwise the individuality has being used for optimizing training output. The current study adopted another concept of individuality which is related to the performance itself. The author named it (Technique Print), this new

[1] Professor of biomechanics of athletics- Physical Education Faculty- Sadat City University
[2] Lecturer- Physical Education Faculty- Sadat City University

terminology describes each athlete's style including weakness and strength points during the technical phases compared with himself.

The athlete's technique print would be driven from the statistical analysis of motion analysis output, which would add another terminology to the current study which is " biomechanical statistical analysis". The author dealt with the human body segments as elements of community [3][4], which participate with each other to perform harmonically a motion. As a community, the parts should be presented under the normal distribution curve (±3), the way that enables us to study each segment during the technique phases and the whole segments together as one community [2][3]. As a result, it would be subjective to classify and evaluate the athlete generally adding to describing the weakness points in his style according to the contribution percentages of each segment in each phase.

Purposes:

1- How is the athlete's technique print looks like?

2- Identify the performance level (easy- normal- difficult) for each body segment of each athlete.

3- Identify each athlete's style through the contribution percentage of each body segment.

4- Classify the athletes by evaluating the general performance as a degree.

New adopted terminologies:

Technique print: "The individual style an athlete's performance according his body segments mechanical characteristic, where the contribution percentages of body segments are represented statistically by the normal distribution curve."

Biomechanical statistics: Using statistics to treat the mechanical output of motion analysis, where the body segments represent the community or the participants in technique phases [3].

Horizontal analysis: the *Skewness of each body segment during the technical* phases to identify the weakness points and which part is the most effective.

Vertical analysis: *the* Kurtosis of whole body segment during the technical phases to identify the weakness points and which part is the most effective.

Performing easily (segment): the segment performance level where the distribution curve peak for any segment or whole segments is to the right side (+٣).

Performing normally (segment): the segment performance level within the distribution curve (-3<x<+3).

Performing hardly (segment): the segment performance level where the distribution curve peak for any segment is to the left side (-٣).

Special segments: the body segments that the athlete depends on it/them specifically to form his technique style. Statistically, each segment which its kurtosis value is greater than (+٣).

Cooperative segments: the body segments that participate effectively and the athlete depends on it or them. Statistically, each segment that its Skewness has kurtosis value (1<x<3).

Nonparticipant segments: the body segments that participate effectively but the athlete does not depend on it/them. Statistically, each segment that its kurtosis is in between 0 and +1 **(0<x< +1).**

The athlete's level: a degree that represents the athlete level.

Method

In order to study the validity of the new study, we applied on the Roundoff performance. Three gymnastic Second-Level Athletes were chosen, their training age (5-7 years). A number of trials the Roundoff (cartwheel) were captured (30 F/s). The best trial of each athlete were analyzed by (Motion Track program). Angular velocity was chosen to be treated statistically, as it is a significant variable of the any rotational movements [1]. The Skewness, Kurtosis and contribution percentage were calculated for each body segment's velocity, and for the body center of mass. The radar chart was chosen to imitate the finger print , as well as for easy engagement between the Skewness, Kurtosis and the contribution percentages to the body center of mass output. The output results were transformed into matrix to evaluate the performance. Finally, calculating the athlete's level as a degree.

Performance print calculation phases

In general, there are two phases that are the motion analysis of the specific variable and the

statistical treatment of the analysis output.

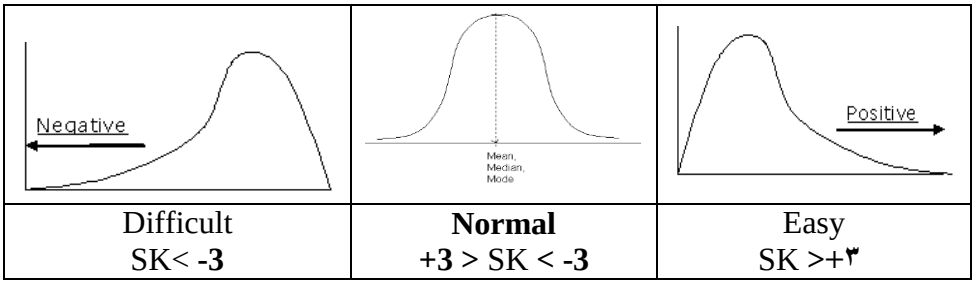
1. Motion analysis of a specific variable: each sport skill has a specific physical ability to depend on beside other sub abilities for support. Therefore, the focus would be on it and would be driven from the motion analysis direct or by calculations. For example, the main variable for Roundoff is the angular velocity. This mechanical variable would be calculated for each body segment of, these segments were considered as a society.

2. Statistical analysis: as the segments represent a society, the resulted output of the variable would be treated statistically by calculating the Skewness and Kurtosis each. In addition, the contribution percentages of each segment would be calculated.

Skewness: represents the performance normality of the segments along performance (horizontal direction) which is between (±3).

$$\text{Skweness} = 3\frac{\text{mean} - \text{mode}}{\text{standerd deviation}}$$

The result from (eq.1) would a case of three; a positive value that greater than (+3) refers to the easy performance level, a value in between (±3) refers to the normal performance level, or a negative value that less than (-3) refers to the difficult performance level (Fig.1).



Difficult	**Normal**	Easy
SK< **-3**	**+3** > SK < **-3**	SK >+٣

Fig. 1 Skewness curve significance

By the Skewness, the strength and the weakness sides for each body segment could be detected. As well as the general level of performance (eq.1)

$$\text{General performance level} = \frac{3 - \text{skewnwss mean}}{3} \quad \text{eq.1}$$

a) Kurtosis: it represents the number of the segments that cooperating in the performance (vertical direction). The value of the Kurtosis should be a case of three; greater than (3) then refers to the special segments which specify the athlete's style, the value is less than (3) then refers to the cooperative segments mainly in the skill, or the value equal (3) then refers to the nonparticipant segments in the skill.

Table (1)
Kurtosis meaning according to the segments participation in the skill

	Non participant	Cooperative	Special
Kurtosis(KU)	KU<1	1<Ku<3	KU >3

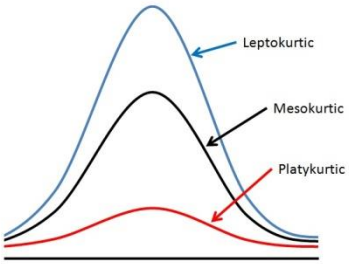


Fig. 2 Kurtosis curves significance, Special (Leptokurtic), Cooperative (mesokurtic), and Non participant (platykurtic)

How to read the technique print matrix:

Each resulted value of body segments Skewness and kurtosis occupies a cell in the matrix (Table2).

- The segment that occupies the 1st cell is classified as a special and easily performing.
- The segment that occupies the 2nd cell is classified as special and performing normally.
- The segment that occupies the 3rd cell is classified as special but performing hardly.
- The segment that occupies the 4th cell is classified as cooperative and performing easily.
- The segment that occupies the 5th cell is classified as cooperative and performing normally.

- The segment that occupies the 6th cell is classified as cooperative and performing hardly.
- The segment that occupies the 7th cell is classified as nonparticipant and performing easily.
- The segment that occupies the 8th cell is classified as nonparticipant and performing normally.
- The segment that occupies the 9th cell is classified as nonparticipant and performing hardly.
- The shaded cells in the matrix (table2) are considered logic performance, unlike the other cells which point to the problems in the performance.

Table (2)

Technique print matrix according to Skewness and urtosis values

values		Skewness (SK)			
		Easy SK>+٣	**Normal +3 > SK < -3**	**Hardly SK< -3**	**Contribution percentage (%)**
Kurtosis	Special KU>٣	1st cell	2nd cell	3rd cell	
	cooperative 1<Ku<3	4th cell	5th cell	6th cell	
	Nonparticipant Ku<١	7th cell	8th cell	9th cell	

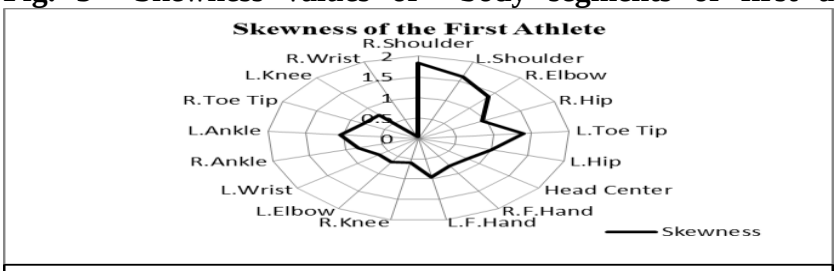
Results and discussion

1. The technique print for the first athlete

All body segments were performing the skill normally as a result of having the Skewness values in between (± 3) (table 3). The values of kurtosis indicate that only the R.shoulder was a special segment, then each of the L.shoulder, R.elbow,R.hip, L.hip, and L.toe tip was cooperative, the other segments were nonparticipant.

Fig (5) is combining both of fig (3) and fig (4) to form the technique print.

Fig. 3 Skewness values of body segments of first athlete



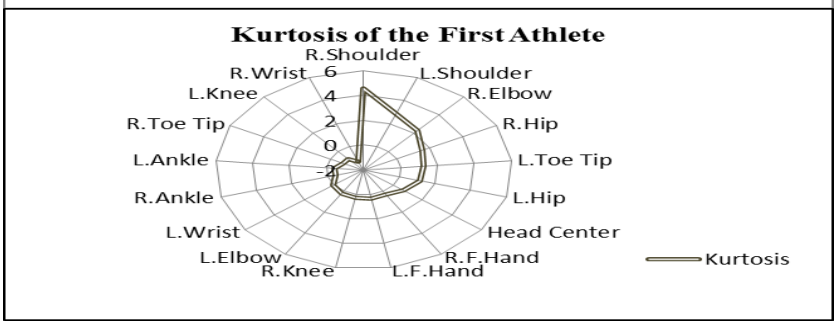


Fig. 4 Kurtosis values of body segments of the first athlete

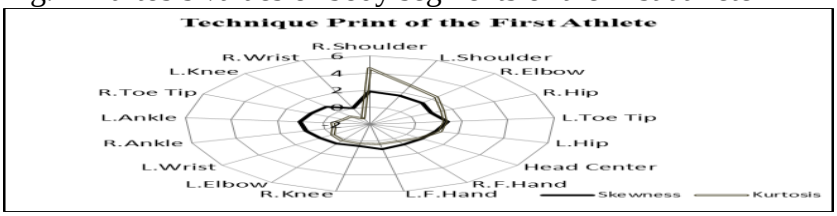


Fig. 5 Technique print of the first Athlete

The athlete's performance level using eq.(1) for the first athlete is (٠.٦٨) , that refers to the easiness of the general performing level. Therefore, the rest of one degree is (0.32) is the degree of difficulty.

The special segments contributed with 6% of the performance, the cooperative segments contributed with 36% of the performance and the nonparticipant segments contributed with 59% (table 4)

Table (3)
performing state of the segments according to Skewness and kurtosis values for the first athlete n=20

Body segments	Skewness	Kurtosis	State

R.Shoulder	١.٨٤	٤.٥٧	Special & Normal
L.Shoulder	١.٦١	٢.٨٥	Cooperative &Normal
R.Elbow	١.٣٧	٢.٣١	Cooperative &Normal
R.Hip	٠.٩٥	١.٥٣	Cooperative &Normal
L.Toe Tip	١.٣٩	١.٢٧	Cooperative &Normal
L.Hip	١.٠٠	١.١٤	Cooperative &Normal
Head Center	٠.٨٢	٠.٧١	Non-participant & Normal
R.F.Hand	٠.٧٨	٠.٣٥	Non- participant & Normal
L.F.Hand	٠.٩٥	٠.٣٤	Non- participant & Normal
R.Knee	٠.٦٠	٠.٢٩	Non- participant & Normal
L.Elbow	٠.٦٧	٠.٢٥	Non- participant & Normal
L.Wrist	٠.٦٦	٠.٠٢	Non- participant & Normal
R.Ankle	٠.٨٢	٠.٤٣-	Non- participant & Normal
L.Ankle	١.٠٤	٠.٤٣-	Non- participant & Normal
R.Toe Tip	٠.٨١	٠.٧٧-	Non- participant & Normal
L.Knee	٠.٧٧	٠.٧٨-	Non- participant & Normal
R.Wrist	٠.٠٤	١.٢٥-	Cooperative &Normal

Table (4)
First athlete technique print

		Skewness (Performing)			Contribution percentage (%)
		easily	Normally	hardly	
Kurtosis	**Special**		R.Shoulder		6 %
	cooperative		R.Wrist, R.Elbow, L.Shoulder R.Hip, L.Hip, L. Toe Tip		35 %
	Non participant		Head Center , R.F.Hand L.Elbow, L.Wrist, L.F.Hand R.ToeTip, R.Ankle, R.Knee L.Knee, L.Ankle		59%

2. The second athlete technique print:

All body segments were performing the skill normally as a result of having the Skewness values in between (± 3) (table 5). The values of kurtosis indicate that

only the L.Knee and L.Ankle were special segments, then each of the L.F.Hand and L.toe tip was cooperative, the other segments were nonparticipant.

The second athlete performed easily. Through applying (eq.1) second athlete's performance level was (0.29)

Table (5)
performing case of the segments according to Skewness and kurtosis values for the second athlete n=21

Body segments	Skewness	Kurtosis	State
L.Knee	٢.٠٤	٤.٤٣	Special & Normal
L.Ankle	١.٨٣	٣.٠٧	Special & Normal
L.F.Hand	٠.٩٦	١.٢٩	Cooperative &Normal
L.Toe Tip	١.٥٢	١.٠٩	Cooperative &Normal
R.F.Hand	١.١٥	٠.٨٧	Non-participant & Normal
L.Wrist	٠.٧٣	٠.٧٦	Non-participant & Normal
R.Knee	١.١٢	٠.٧٤	Non-participant & Normal
R.Hip	٠.٤١	٠.٤٢	Non-participant & Normal
R.Toe Tip	١.٢٢	٠.٣٧	Non-participant & Normal
R.Ankle	١.١١	٠.١٥	Non-participant & Normal
R.Wrist	٠.٧٧	٠.١١-	Non-participant & Normal
L.Elbow	٠.٥٧	٠.٤٢-	Non-participant & Normal
R.Elbow	٠.٣٣	٠.٧٩-	Non-participant & Normal
Head Center	٠.٤٦	١.١٧-	Cooperative &Normal
L.Hip	٠.١٧	١.٢٥-	Cooperative &Normal
L.Shoulder	٠.٣٣	١.٣-	Cooperative &Normal
R.Shoulder	٠.١٢	١.٤٤-	Cooperative &Normal

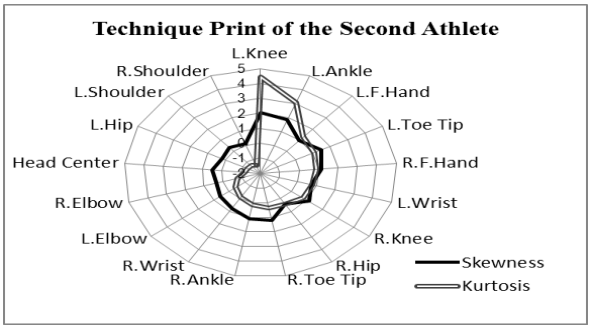


Fig. 6 The technique print of the second athlete

The special segments contributed with 12% of the performance, the cooperative segments contributed with 35% of the performance and the nonparticipant segments contributed with 53% (table 6).

Table (6)
second athlete technique print matrix

		Skewness (Performing)			Contribution percentage (%)
		easily	**normally**	**hardly**	
Kurtosis	**special**		L.Knee ,L.Ankle		%١٢
	cooperative		Head Center, R.Shoulder, L.Shoulder L.F.Hand, L.Hip, L.Toe Tip		%٣٥
	Non participant		R.F.Hand, R.Wrist, R.Elbow, L.Elbow, L.Wrist R.Toe Tip, R.Ankle, R.Knee, R.Hip		%٥٣

3. The third athlete technique print:

Most of the body segments were performing the skill normally as a result of having the Skewness values in between (± 3), except (R.F.Hand, L.F.Hand, and R.ToeTip) which were performing the skill easily as a result of having the Skewness values greater than (+3) (table 7).

The values of kurtosis indicate that only the R.F.Hand, L.F.Hand and R.Toe Tip were special segments, then each of the R.Wrist, L.Wrist, R.Elbow, and L.Elbow was cooperative, the other segments were nonparticipant (table 7).

Table (7)
performing case of the segments according to Skewness and kurtosis values for the third athlete n=19

Body segments	Skewness	Kurtosis	State
R.Toe Tip	٢.١	٦.١	Special & Normal
L.F.Hand	١.٧٤	٤.٥٧	Special & Normal
R.F.Hand	١.٧٧	٣.٢٧	Special & Normal
L.Wrist	١.٢٣	١.٧	Cooperative &Normal
R.Wrist	١.٤٤	١.٣٤	Cooperative &Normal
R.Elbow	١.٣١	١.٣٢	Cooperative &Normal
L.Elbow	١.٣٢	١.١٧	Cooperative &Normal
R.Knee	١.٢٣	٠.٥	Non-participant & Normal
R.Shoulder	٠.٩١	٠.٤٤	Non-participant & Normal
L.Knee	٠.٣١	٠.٤٢	Non-participant & Normal
R.Hip	٠.٩٤	٠.٣٩	Non-participant & Normal
Head Center	٠.٩٣	٠.٢٤	Non-participant & Normal
L.Shoulder	٠.٥٨	٠.٢٢	Non-participant & Normal
L.Ankle	٠.٩٢	٠.١٧-	Non-participant & Normal
R.Ankle	٠.٨٩	٠.٦١-	Non-participant & Normal
L.Toe Tip	٠.٩٢	٠.٦٣-	Non-participant & Normal
L.Hip	٠.٣٢-	٠.٨٩-	Non-participant & Normal

The contribution percentage of the special segments was 18 %, the cooperative segments was

29%, while the non-participant segments was 53% (table 8). By applying (eq.1) the third athlete's performance level was (٠.٦٤)

Table (8)
third athlete technique print matrix

		Skewness (Performing)			Contribution percentage (%)
		easily	**normally**	**hardly**	
Kurtosis	**special**		R.F.Hand , L.F.Hand, R.Toe Tip		١8%
	cooperative		R.Wrist, R.Elbow, L.Wrist L.Elbow, R.Knee		29%
	Non participant		Head Center, R.Shoulder, L.Shoulder, R.Ankle, R.Hip, L.Hip, L.Knee, L.Ankle, L.Toe Tip		%٥٣

4. A comparison among the three prints of the technique

The first athlete has style, the second athlete has style, and the third athlete has no style. The three athletes perform just with half of their maximum ability, although their performance level was (0.68, 0.71, and 0.64) respectively (table 9), but the non-participant segments percentage in performance were (59%, 53%, and 53%) respectively. In addition, the cooperative segments percentages were (35%, 35%, and 47%), which represent the third, for the first and the second athlete, and quite the half, for the third athlete. Finally, regarding to the special segments, for the second athlete 12%, twice as the first athlete, but the has no special segments in third athlete's case (table 10).

Table (9)
The performance level of the three technique prints

Athlete	First	second	Third
Performance level	٠.٦٨	٠.٧١	٠.٦٤

Table 1 the Contribution type and percentages of the three athletes' segments

		Contribution percentage %		
		First athlete	Second athlete	Third athlete
Contribution	The special	%٦	%١٢	%٠
	The Cooperative	%٣٥	%٣٥	%٤٧
	Non participant	%٥٩	%٥٣	%٥٣

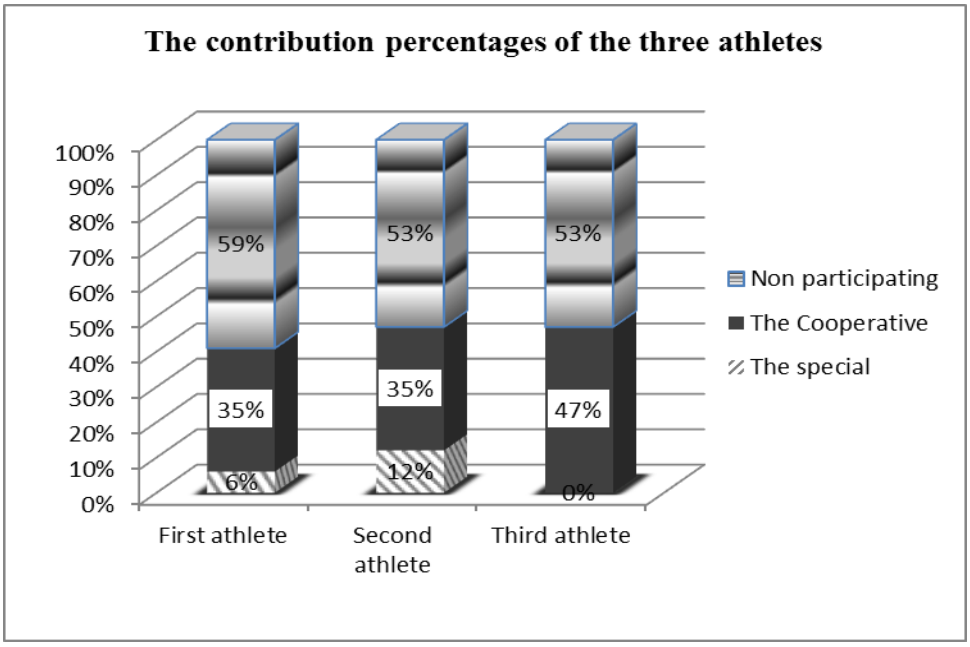


Fig.7 the contribution percentages of the segmets of the three athletes

The Conclusion:

1- he biomechanical statistics enables us to evaluate each athlete individually without comparing to a group or a model. Where his technique consideres his print.

2- he skewness and kurtosis are objective treatment to identify the technique print of the athlete.

3- It was possible to compare among athletes but even individually according to the way the segments participate in the athlete style .

4- he segment is considered a person in a community whereas it contributes in the technique relative to the body centre of mass as the community.

5- It was easy to classify the segments into specific, cooperative, or nonparticipant in the technique, therefore, easy to see the weakness and strength points, that what is remarkable of the technique print.

6- It would be helpful to take the person's technique print in order to identify his performance level.

References:

1- Aydın Tözeren (2000): Human Body Dynamics Classical Mechanics and Human Movement,Springer-verlag New York, Inc,pp.259, 283.

2- Liu Ren (2006): Statistical Analysis of Natural Human Motion for Animation, Carnegie Mellon University,Phd thesis, USA, pp.6, 41.

3- Mostafa A.Atwa, Mohamad.M. Payomi (2010): Biomechanical Statistical Analysis Entrance to Diagnose the Deficiencies in Low Start from Block Start, World Journal of Sport Sciences 3 (3):pp 174-179:

4- Roger Bartlett (2007): Introduction to Sports Biomechanics Analysing Human Movement Patterns, 2nd Ed, Taylor & Francis e-Library, pp.54:55, 93.