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Analysis of Performance Parameter and Variables of Long Jump

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Abstract: *Long Jump is a board jump sport event in world competitions. It is played on the track The common aim of the long jump is to attain maximal horizontal distance fromthe front of the lift-off board. This is achieved by converting some horizontal velocity developed in the approach run into vertical velocity at take-off. The main aim of the study was to determine the kinematic analysis for the long jump and define the kinematicand dynamic parameters of an elite long jump Athlete's technique. To perform this purpose, An analysis will be made on who won the gold, silver, and bronze medallion in Men's long jump at the 2016 Olympics in Rio. The best and lowest long jump performances, approach run speed, length of the stride, limited parameters, and variables will also be measured. The collected data were analyzed with Dartfish Live-S video analysis software. The analysis data will conclude that the performance of the athletes depends upon all criterion variables.*

Key Word: *Kinematic and Dynamic Parameters, Skills Analysis, Dartfish Live S*

I. INTRODUCTION

This event is a track and field sports event in which the athlete needs to attain the topmost distance from the take-off board to the sandpit. For the Olympics final, three players are selected to be the finalist among the 15 players. In the finals, they have six attempts each. From the six attempts, those who achieved the topmost distance won first place. The long-jump track consists of the runway to run for the approach is that are approximately 40-45 meters in length. After the runway, the lift-off board is presented on a white rectangular board and its dimensions are 1.22mm long and 0.20mm wide. After the take-off board, the sandpit is presented and the sandpit dimensions are approximately 10meter length. The event contains three different stages, they are **Approach, Lift-off, and Flight Stage.**

1.1 Approach Stage

In the approach phase, the athlete can take maximum strides count and try to gain maximum speed before the lift-off phase to attain maximum distance. The last two strides make a huge difference for the lift-off Phase. The second to last step before the jump is known as the penultimate step. If the last step dimension is low, then the penultimate step dimension is high.

Figure 1: Approach Phase

1.2 Lift-off Stage

The second stage of the event is the Lift-off phase. The lift-off stage consists of the inclination angle, take-off angle, and the full extension of the leg. During the lift-off stage, the kinematics parameters[1] are analyzed that's known as touch down for the leg angle.

Figure 2: Take-off Phase

1.3 Flight Stage

The flight phase is the third phase of the long jump event; it consists of the action in the air, maximum distance in the sandpit, knee angle, Arm swings, and leg swings to attain maximum distance from the take-off board.

***Figure 3**: Flight Phase*

There are three types of jump styles, they are hitch kick, hang-style, and stride jump

1.4 Rio 2016 Olympics Long Jump

There are a total of 12 players who have participated. From the 12 they finalized three for the final. Their achieved distance details are listed below,

Rank	Team	Participant	Results
G	USA	Jeff Henderson	8.38
S	RSA	Luvo Manyonga	8.37
B	GBR	Greg Rutherford	8.29

***Figure 4**: Rio 2016 Men's Long Jump FinalsSix attempts are done by each of the athletes.*

Rank	Team	Participant	Trail 1	Trail 2	Trail 3	Trail 4	Trail 5	Trail 6
Gold	USA	Jeff Henderson	8.20	7.94	8.10	7.96	8.22	**8.38**
Silver	RSA	Luvo Manyonga	8.16	-	-	8.28	-	**8.37**
Bonze	GBR	Greg Rutherford	8.18	8.11	8.22	-	8.09	**8.29**

Table1:*Trails Men's Long Jump Finals 2016 Rio Olympics*

The video from youtube is downloaded, and the duration of the video is 14 minutes 07 seconds long, showing the athlete's trial performance to achieve who gets the maximum distance in the long jump event.

1.5 Dartfish Analysis

Dartfish is a video analysis software that is used to analyze the motion, performance, and team sports performance analysis. nowadays in sports, the video analyst using dartfish is more efficient to get the results accurately. and to develop the modern coaching style changes using dartfish video analyst. For work-related we use the dartfish software to find the parameters for the long jump events, like take-off angle, knee angle, and action in the air. The study is to analyze the athlete's performance using dartfish. The dartfish software is not open source for all. The work uses the facilities of dartfish depending on the nature of thevideo taken during the event.

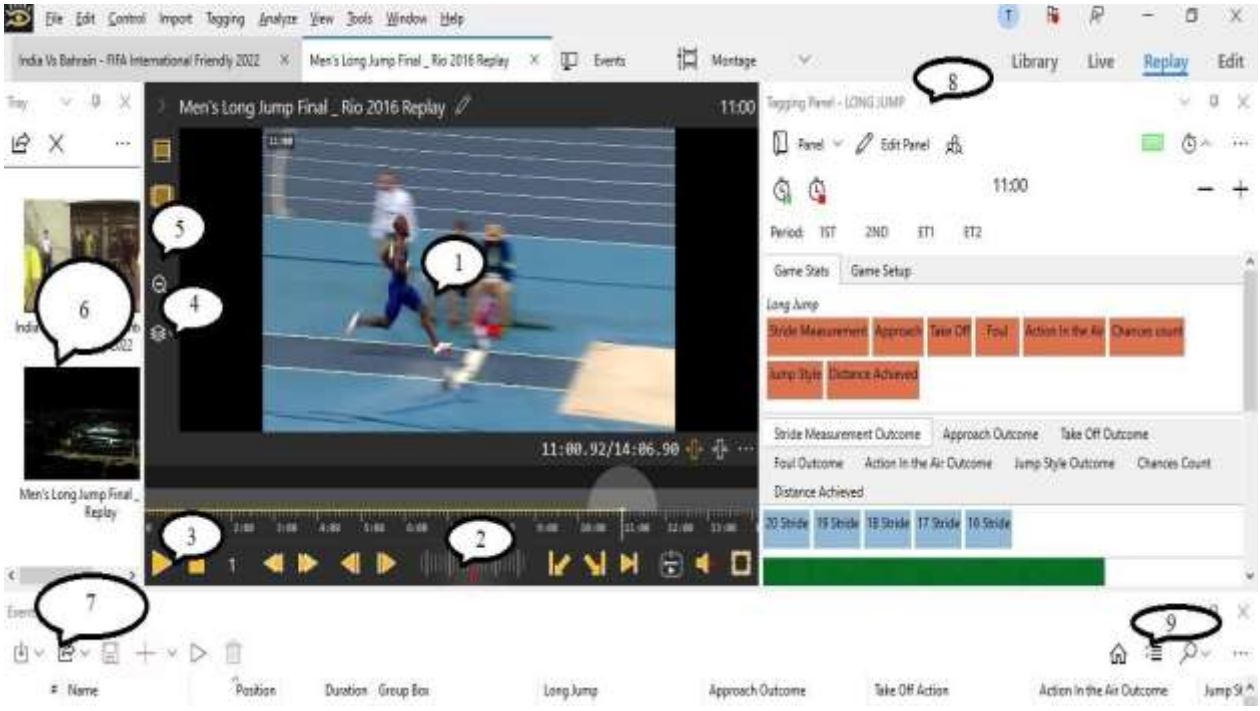

Figure 5: *Dartfish Analysis workspace*

1.6 Problem Statement

Long jump athletes face lots of drawbacks that cannot be visualized by the naked eye. Athletes mostly face technical problems in all sorts of procedures in long jump like approach run-up, take-off, action in the air, and landing. the drawbacks faced by the athlete in performance parameters[2] like knee angle, board contact, take off, average speed and stride length, etc. By using dartfish video analysis, we can analyze the pre-event video of the athlete performed and the data will be used to improve and help the athlete's performance.

II. VIDEO ANALYSIS

The Rio Olympics 2016 long jump final videos were downloaded from youtube. The camera is not correctly positioned to take all the side-to-side measurements so we cannot take the values concerning the study. so we take angle measurements only on the body concerning the ground level and duration measurements. This section elaborates on how the analysis was performed

2.1 Data Studied

The event is separated into phases using dartfish analysis software. Then the phases of the video are exported and saved into the file. After that, the phases of the videos are imported to the dartfish into the editing part, and then the parameters were measured by using drawing tools.

2.2 Parameters to Analyze

Video footage is analyzed on dartfish software. For example, Angle Measurements, Height, Etc. The Parameters of the long jump that needed to be taken are as follows. Average Speed, Stride Counts, Body inclination Angle, Take-off Angle, Knee Angle, Maximum Height during flight phase, Effective Distance, Landing Distance.
These are the parameters that should be measured by the dartfish analysis software[9]. The analysis of the parameters and comparison of the athletes are followed below.

2.3 Parameters Analyzing

The Kinematic parameters are analyzing listed are given below[9]

Average Speed

The Average speed[7] is taken from the distance and the time by using Timer and Visual.

Last Three Strides

During the Approach Phase from the last three strides[8], they attain maximum speed. If the last stride is a low distance then the penultimate stride is higher than the last stride. The last three strides are important to achieve the Take-off correctly.

Take Off Angle

The athletes use the kinetic energy of run-up to take off with a large launching velocity. The process of takeoff converts the horizontal momentum in the run-up into the momentum in the launching direction. This conversion determines the launching angle[6]. Take-off Angle is Calculated by Dartfish at the Take-off Phase of Long Jump.

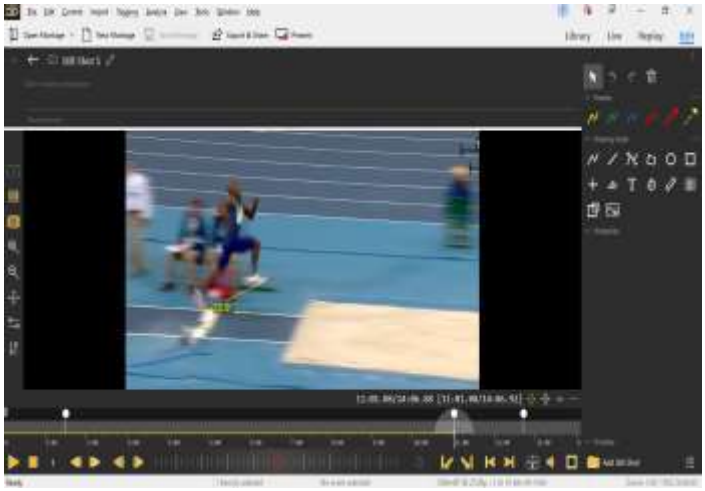

***Figure 6**: Take-off Angle*

Location Of Maximum Height

From the Flight Phase in Long Jump, the Athlete's maximum height(Hip to Sand) from the sandpit is measured using Dartfish. The reference values are taken first and then the height is measured. During the flight phase, the Athletes make hand swings, and leg swings.

Figure 6: *Flight Phase Maximum Height*

Knee Angle

From the Take-off Board to the jump, the maximum angle of the knee bend was measured by using Dartfish. The maximum Knee flexion means the more distance they swing their leg.

Figure 7*: Knee Angle Parameter*

Effective Loss

The Loss between the Foot tip on the Take-off Board to the Foul Line on the Take-off Board is Known as an Effective loss in Long Jump. It will be taken from the Video.

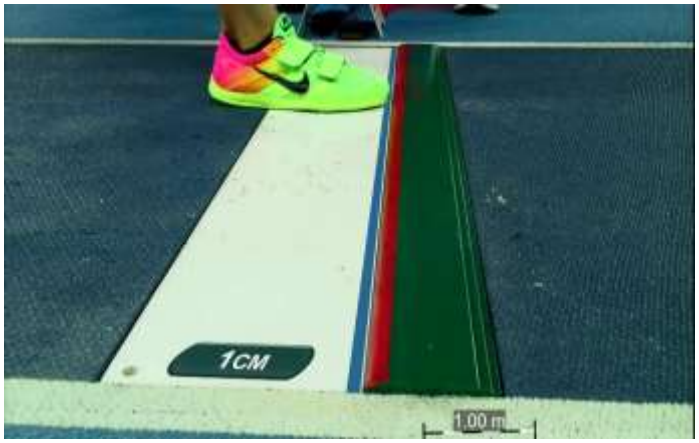

Figure 8*: Effective Loss Parameter*

Body Inclination Angle

In the Take-off Phase when the body contacts the Take-off Board the Angle of the Leg to the hip is Measured by using Dartfish. The Body Shape is managed with an angle of a range of up to 22 to 45 degrees.

***Figure 9**: Body Inclination Parameter*

Landing Distance

The landing Distance is to be Measured by the Take-off Board to land in the sandpit. It will be Taken from the Video.

***Figure 10**: Landing Distance The parameters for analyzing the sample report using dartfish are shown in figure 11.*

long jump.csv — Open with

	A	B	C	D	E	F	G	H	I	J	K	L
1	Name	Position	Duration	Approach Outcome	Field Position	Group Box	Long Jump	Players Group Box	Take Off Action	Action In the Air Out	Chances Count	Distance Achieved
2	Approach (1)	84560	5000	Made	Runway	Rio	Approach	Greg Rutherford(GBR)				
3	Take Off (1)	88980	5000		Take off Board	Rio	Take Off	Greg Rutherford(GBF	Contact Board In			
4	Action In the Air (1)	89200	5000		Landing Pit	Rio	Action In the Air	Greg Rutherford(GBR)		Leg Swing Made		
5	Chances count (1)	94200	5000		Landing Pit	Rio		Greg Rutherford(GBR)			Chance 1	
6	Distance Achieved (	98080	5000		Landing Pit	Rio	Distance Achieved	Greg Rutherford(GBR)				8.18 Metres
7	Chances count (2)	139120	5000		Runway	Rio	Chances count	Luvo Manyonga (RSA)			Chance 1	
8	Approach (2)	144640	5000	Made	Runway	Rio	Approach	Luvo Manyonga (RSA)				
9	Take Off (2)	148920	5000		Take off Board	Rio	Take Off	Luvo Manyonga (RS	Contact Board In			
10	Action In the Air (2)	149280	5000		Landing Pit	Rio	Action In the Air	Luvo Manyonga (RSA)		Leg Swing Made		
11	Distance Achieved (	161520	5000		Landing Pit	Rio	Distance Achieved	Luvo Manyonga (RSA)				8.16 Metres
12	Chances count (3)	207640	5000		Runway	Rio	Chances count	Jeff Henderson (USA)			Chance 1	
13	Approach (3)	222680	5000	Made	Runway	Rio	Approach	Jeff Henderson (USA)				
14	Take Off (3)	224960	5000		Take off Board	Rio	Take Off	Jeff Henderson (USA	Contact Board In			
15	Action In the Air (3)	225240	5000		Landing Pit	Rio	Action In the Air	Jeff Henderson (USA)		Leg Swing Made		
16	Distance Achieved (	232080	5000		Landing Pit	Rio	Distance Achieved	Jeff Henderson (USA)				8.20 Metres
17	Chances count (4)	287320	5000		Runway	Rio	Chances count	Greg Rutherford(GBR)			Chance 2	
18	Approach (4)	289760	5000	Made	Runway	Rio	Approach	Greg Rutherford(GBR)				
19	Take Off (4)	293480	5000		Take off Board	Rio	Take Off	Greg Rutherford(GBF	Contact Board In			
20	Action In the Air (4)	293800	5000		Landing Pit	Rio	Action In the Air	Greg Rutherford(GBR)		Leg Swing Made		
21	Distance Achieved (	303320	5000		Landing Pit	Rio	Distance Achieved	Greg Rutherford(GBR)				8.11 Metres
22	Chances count (5)	341640	5000		Runway	Rio	Chances count	Jeff Henderson (USA)			Chance 2	
23	Approach (5)	356040	5000	Made	Runway	Rio	Approach	Jeff Henderson (USA)				

***Figure 11**: Long Jump Analysis*

2.4 Analyzing Outcome

The long Jump parameters are taken and all the parameters are measured by dartfish and the statistical report is taken by the values. There are some small differences between gold, silver, and bronze. They are discussed in the following.

PARAMETERS	Greg Rutherford(GB)				Luvo Manyonga		Jeff Henderson			
	Trail 1	Trail 2	Trail 3	Trail 6	Trail 1	Trail 6	Trail 1	Trail 2	Trail 4	Trail 6
Average Speed(m/s)	8.09	8.04	8.12	8.19	8.07	8.26	8.1	8	8.01	8.3
Stride Counts	20	20	20	20	16	16	20	20	20	20
Take off Angle(°)	25.4	26.8	23.5	21.4	23.6	22.7	20.2	23.5	23.8	22.8
Body Inclination Angle(°)	28.4	27.3	27.4	29.8	29.6	25.2	27.2	25	28.2	27.3
Location Of Maximum Height(m)	1.57m	1.5	1.51	1.61	1.63	1.46	2.14	1.44	1.84	2.12
Knee Angle(°)	80.5	104.2	81.4	113.4	108.1	119	94.8	94.2	85.5	86.2
Thigh Angle of Swing Leg(°)	92.3	87	68.5	69	111.4	105.3	69.4	85.7	70.1	74.5
Landing Distance(m)	8.18	8.11	8.22	8.29	8.16	8.37	8.2	7.94	7.96	8.38
Effective Distance(cm)	1	3	9	1	11	4	2	21	28	3
Last Stride(m)	1.71	1.83	1.72	1.88	1.87	1.75	1.76	1.96	1.97	1.83
Last second stride(m)	2.52	2.45	2.34	2.5	2.42	2.2	2.36	2.37	2.35	2.37
Last Third Stride(m)	1.71	1.83	2	1.88	2	1.93	1.67	1.96	1.96	1.83

Table 2:*Parameters of long jump*

Comparing the above details from the table there are many differences in Approach, Takeoff, and Flight Phase. For the highest jump, the total distance is 8.38meter. He came with the maximum speed and attained the maximum velocity speed before the last two strides and the take-off was also good, comparing the other two players. and the major one is in the flight phase he gains the maximum height of 2.12meters from the sandpit comparing the other two players. That's the reason he won the gold medal. Luvo Manyonga is also just a cm behind Jeff Henderson. He is always tall and that's the advantage he has. but at the effective loss, he lost 4cm in the take-off phase. Very short runup and gaining maximum speed at a short distance is a big advantage for him. but the swing of the leg and the maximum height were low compared to Jeff Henderson. And then the last Greg Rutherford, he didn't get the correct angle at the take-off board and he is using a hitch kick style. He did not swing his leg in the air and lost his shape in the flight phase. Not a major difference between all the three winners. The only major difference is in the flight phase. If it will be corrected they attain Maximum Distance. The Take-off angle also varied for the athletes. They are someone losing the take-off due to the approach so they are losing the effective distance. The highest effective distance loss comparing these three is Jeff Henderson. He lost a maximum distance of 28 cm. For this jump, he only jumped 7.94 meters. These are also the major problems for the long jumpers in the long jump. The following Figure shows the comparison between three Players.

The above report shows the comparison of all the parameters of the Long Jumpers. And it has been explained above. By using the dartfish we can make all measurements like line, angle, slow motion, time calculation, etc.
The Values of Parameters Measured by using dartfish images are the following as well,

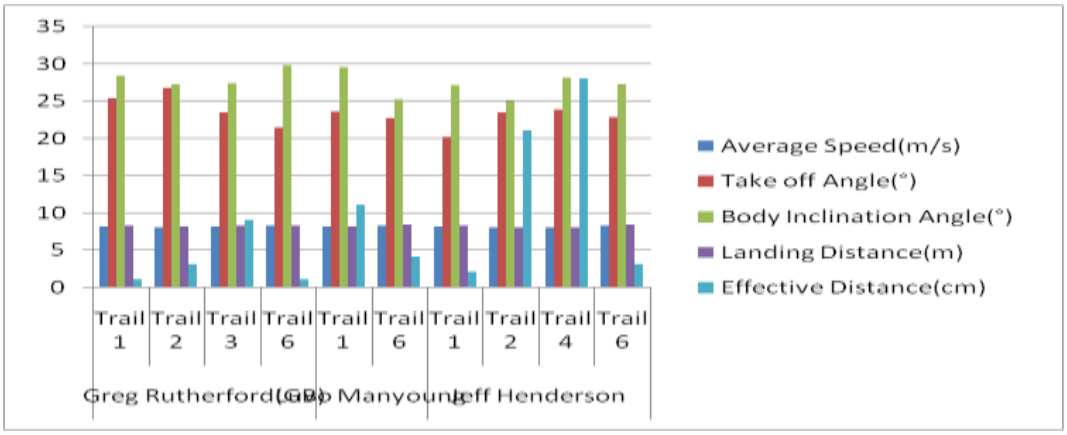

Figure 12: *Comparison Of Long Jump AthletesThe above figure shows the comparison of the trail of the athletes and parameters.*

III. CONCLUSIONS

In this paper, we performed the analysis for the finalists in the long jump held in 2016 at the Rio Olympics. The analysis is made in three phases of a long jump to earn the winners in Olympics. and measurements, like parameters for the long jump, are analyzed. This analysis will be used by the coaches to improve athletes' performance based on the variables and parameters analyzed using Dartfish. Also in the future, we can analyze world record jumps using high-performance parameters, which will help create an athlete who is having a similar physique with the help of proper diet and training can be done by the coaches which will help athletes to adopt a similar type of parameters to achieve maximum distance.

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