Transilvania University of Brasov
FACULTY OF MECHANICAL ENGINEERING

COMAT 2020 & eMECH 2020

Brasov, ROMANIA, 29-31 October 2020

THE HORIZONTAL VELOCITY ANALYSIS IN THE MOMENT OF TAKE-OFF FOR LONG JUMP TRIAL

Maria Violeta GUIMAN[1]
[1]Transilvania University of Brașov, Brasov, ROMANIA, violeta.guiman@unitbv.ro

Abstract: *In the present paper it is presented a method used to find out one of the influence parameter that determinate the jump distance during the long jump trial. The performances obtained the athletes depends on some parameters as: the length of the run-up, the take off force and time, the mass center angle vs. horizontal direction, the mass centre balancing position during the flight through the air, and the correct landing position. The used data were obtained using a video record based on image processing. Using special markers attached on athletes it was obtained the trajectory of the jumpers and some important parameters as horizontal and vertical velocities in the moment of the take-off. The founded parameter was the horizontal velocity of the global mass centre of the athlete in the moment of take-off.*
Keywords: *biomechanics, long jump, jump trajectory, motion analysis, imagine processing*

1. INTRODUCTION

The long jump is one of the most important athletic trials known since the first Olympic games. The subject of the present paper is based on the interest in the human ability to set new records in the athletic tests. Biomechanics exercise sets mechanical efficiency of the human body forces and indicate practical methods to increase the yield, depending on the purpose of the training.
The technique used by athletes consists of four phases: run-up, take-off, aerial and landing. Thus the performance of a long jumper directly depends on: his/her qualities as sprinter in the first phase, the developed force in legs in the take-off moment, flight and landing.
As it is known, for a great jump distance the athlete must have to the end of the run-up a high horizontal velocity with the take-off placed as close as is possible on the take-off board. After the moment of the take-off the athlete must generate a large vertical velocity combined with a loss minimizing of the horizontal velocity. Another important aspect of the athlete technique is represented by the flight phase when it is necessary to be developed a self-control of the forward rotation produced at the take-off moment. Description of all these phases can be found in different specific papers [1, 2, 3, 4, 5, 6, 7].
In the run-up phase, at the end of the track, the athlete has to obtain a maximum horizontal velocity that is used in the take-off moment. The main target of the take-off is to maximize the flight distance of the athlete body (i.e. the centre of mass) based on both optimum take-off angle and optimum take-off velocity.
In the air, the centre of the mass has a resultant velocity given by two components: a vertical one and a horizontal one. The values of these velocities have to be as large as possible in different moment. Referring to the mass centre, the vertical one is needed to be maximized to stay as much in the air before landing.
The vertical velocity generates a propulsive impulse. A short contact time of the leg in the moment of the take-off and a high force developed in the moment of take-off to produce the push-off, are some of other factors that influence the quality of the long jump.
Considering a segmentation of this phase in terms of moments that succeed follows: the moment of beating leg placing on the threshold; the moment of shock taking up; the moment of active take-off.
A short contact time of the leg in the moment of the take-off and a high force developed in the moment of take-off to produce the push-off, are some of other factors that influence the quality of the long jump.

2. TECHNICAL REQUIREMENTS

The aim of the study was to record four jumpers, and analyse their jumps, to determine some mathematical correlations. The four considered subjects were jumpers with high-level competition performances. Two of them were females and the other two were males. All the four athletes were members of the Romania National Athletic Team and having different jump techniques.
The motion was recorded by a high-speed camera (AOS X - PRI) done with a resolution of 800x600 pixels at 500 frames/s. On each jumper body there were attached colored markers, the points of attachments were

established considering the main points of a mechanical equivalent model of the body and using the suggestions given by the trainers. The markers were placed on the bodies on the same side with the video camera.
The video camera was installed in the lateral direction, on a perpendicular direction on the jumpers at a distance of 5.20 meters from the jump path and was mainly focusing on the take-off point. In the same time the considered position offered the possibility to obtain images in the sagittal plane of the athlete during performing of the long jump (Fig.1).
Video camera was attached to a Laptop and it was used a specialized soft for recording.

Figure 1: Camera AOS X –PRI and recording data system

Four long jump athletes with high level competition performances were considered for the present study: two females and two males (different jump techniques) and they were members of the Romania National Athletic Team. The tests were done during the training in the summer camp conducted by Athletics Squad in the Romanian National Sports Complex (Poiana Brasov) for a period of two weeks. In Fig.2 it is presented the trajectory of the jumper highlight by a selected marker.

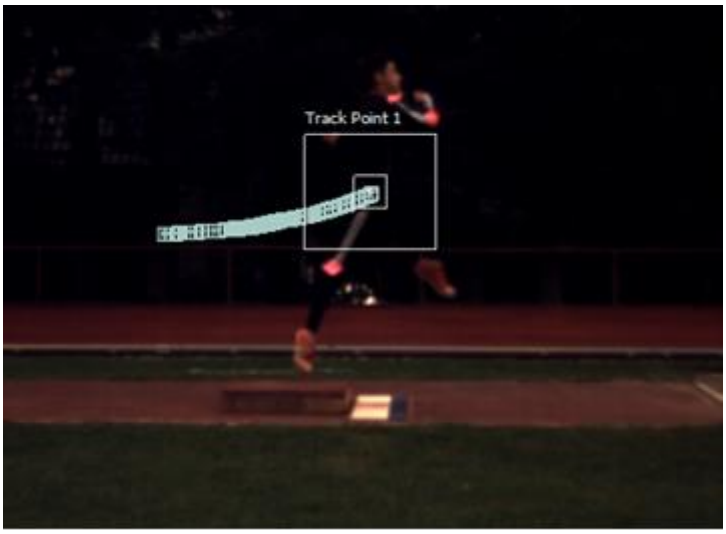

Figure 2: The trajectory of jumper mass

3. THE TAKE-OFF VELOCITIES ANALYSIS

One of the most important targets of a trainer work is to obtain the best performances from an athlete. In case of long jump each phase is an important one and a useful help for trainers is to find a mathematical relation that can describe the correlation between different parameters of each jumper. As was mentioned above one of the most important moments is the end of the run-up where it is needed to be obtained.
The performances are directed tied with the horizontal Vx, developed by the jumper in the take-off moment.
Based on the recorded velocities measured for all four athletes there were established some correlation functions between the length of jump and the horizontal velocity component. According with the measurements there were found data presented in Table 1 for one of the jumper.

Table 1: Horizontal velocity vs. measured jumped length

No. Jump	Horizontal velocity Vx[m/s]	Jumped length L [m]
1	9.90	5.27
2	9.62	5.36
3	9.49	5.39
4	9.40	6.59
5	9.28	6.43

The considered jumper is member of the Junior Romania Athletic team. The athlete is 1.78 m tall and has a weight about 67 kg. The main values of the long jump are around 7.25 m. There were considered the first five best jumps.

Considering the presented data there were found interpolation curve velocity vs. jump length. The interpolation function were found using MATLAB code.

The relation refers to the jump length L approximation as function of the horizontal velocity Vx: (Fig. 3):

$$L(v_x) = 0.5504v_x^2 - 90.22v_x + 53.14 \quad (1)$$

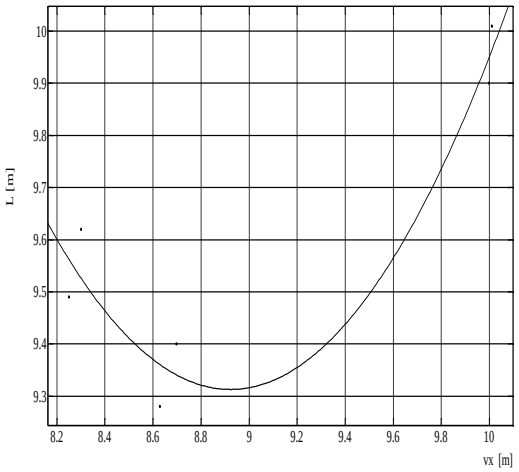

Figure 3: The curve interpolation for horizontal velocity Vx vs. jump length

The realised simulations lead to a polynomial approximation.

3. CONCLUSION

The long jump consists of four phases that have their role in a good performance. One of these phases is the take-off. As was presented above there are done a lot of studies about this moment being analysed important parameter: horizontal velocity of the mass centre. The main parameter that can increase the athlete performance are the horizontal velocity.

REFERENCES

[1] J. G. Hay, J. A. Miller, R. W. Canterna: The techniques of elite male long jumpers, Journal of Biomechanics, Vol. 19, (1986), pp. 855–66.

[2] J. G. Hay, H. Nohara: Techniques used by elite long jumpers in preparation for takeoff, Journal of Biomechanics, Vol. 23 (1990), pp. 229–39.

[3] J. G. Hay, T. J. Koh: Evaluating the approach in the horizontal jumps, International Journal of Sport Biomechanics, Vol. 4 (1988), pp. 372–92.

[4] A. Lees., N. Fowler, D. Derby: A biomechanical analysis of the last stride, touch-down and take-off characteristics of the women's long jump, Journal of Sports Sciences, Vol. 11 (1993), pp. 303–14.

[5] A. Lees, P. Graham-Smith, N. Fowler: A biomechanical analysis of the last stride, touchdown, and takeoff characteristics of the men's long jump, Journal of Applied Biomechanics, Vol. 10 (1994), pp. 61–78.
[6] A. Seyfarth, R. Blickhan, J. L. Van Leeuwen: Optimum take-off techniques and muscle design for long jump, The Journal of Experimental Biology, Vol. 203 (2000), pp. 741-750.
[7] Guiman, M.V., Burcă, I. et al.: Theoretical and experimental aspects regarding long jump dynamics. In: Palestrica of the third millennium – Civilization and Sport 16(2) (2015), p. 154–157.