Motion Analysis for Different Type of Jumping

Mohd Yusof Baharuddin[1], Adilah Hashim[1], Mohd Sayuti Mohd Salim[1],
[1] Biomedical Electronics Engineering Program,
Schools of Mechatronics, University Malaysia Perlis, Malaysia

***Abstract* — Jumping is another type of motion analysis. We have long jump, triple jump, static jump and leap frog jump. The long jump which athletes combine speed, strength and agility in an attempt to land as far from the take-off point as possible. The triple jump occurred when the athlete runs down a runway until he reaches a designated mark, from which the jump is measured. The leap frog jump means jumping by both foots by maintains subjects kneels or bends over for the next jump. The static jump means jumping with both foots at one place. In this study, we will acquire the force, moment and center of pressure. This experiment will consist of subjects standing on two feet, wearing and not wearing shoes. The comparison will be made between long jump vs triple jump and static jump vs leap frog jump. The experiment was held at Biomechanic and Motion Analysis Laboratory, UniMAP. Qualisys Track Manager (QTM) software been used for this purpose where this software aid us in analyzing motion of the subject as shown in Figure 1. Two Bertec force plate and five high frequency cameras were used to capture the motion of the subjects while doing the experiment. The result shown force exerted at toe will be highest in leap frog jump compare to others.**

***Keywords*— Biomechanics, jump, force plate**

I. INTRODUCTION

Biomechanics is the application of the laws and knowledge of mechanics to the anatomical (structural) and physiological (functional) aspects of a living system. Biomechanics also can define as the application of the principle of mechanics to study the biological systems. Application of the principles from mechanics and engineering in the field of sports is known as sports biomechanics.

This is about biomechanics of different type jumps. The biomechanics of long jump, triple jump, static jump and leap frog jump have been differed in the following paragraph. In the approach run, a jumper must use a very high approach speed and then be able to control maintain that speed through three fast and powerful takeoff actions [1-4].

Long jump event comprises of four phases, like approach run, takeoff, flight and landing. Triple jump, consists of approach run, a hop (subject takes off and lands on the same foot), a step (the subject takes off and lands on different feet) and a jump (subject takes off on one foot and lands on both feet in the sand pit). The leap frog jump means jumping by both foots by maintains subjects kneels or bends over for the next jump. The static jump means jumping with both foots at one place.

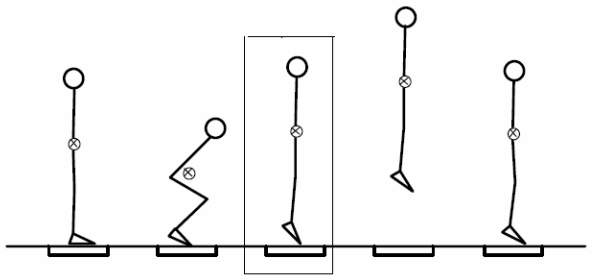


Figure 1: The value of ground reaction force had been taken at step three which had mark.

The take off phase consists of ground reaction force that is pushing up against the jumper. The ground reaction force is an example of Isaac Newton's third law (every action has an equal and opposite reaction).

According to Newton's 3rd Law of Motion (Law of Reaction) for every action, there is an equal and opposite reaction. Due to the gravity, we constantly maintain contact with the ground, and in this process, there occur interactions between the body and the ground. The reaction force supplied by the ground is specifically called the ground reaction force (GRF), which is basically the reaction to the force the body exerts on the ground. The GRF, along with the weight, is an important external force. The GRF is normally measured by a force-plate.

II. MATERIAL AND METHODS

Two healthy university students with different gender were selected for the purpose of this study as shown in Table 1. The subject's data of this study was collected during lab session by the second year biomedical student of University Malaysia Perlis. Each subject was asked to jump from the force plate.

Table 1

SUBJECT	WEIGHT (kg)	HEIGHT (cm)
Female 1	55.1	163.5
Male 1	56.9	164

The experiment was carried out in the Biomechanics and Motion Analysis Laboratory. A brief explanation of the experiment and its significance was provided by the teaching engineer and lecturer as well as the prior to the initiation and caution of the procedure.

The subjects were asked to measure their weight and height and record the file name that to be analyze by QTM software as *M ww hh* or *F ww hh* where M is Male; F is Female; ww:weight ; hh:height. Markers were placed bilaterally on hip, knee, ankle and toe of each subject. For this study, the subjects will be asked to perform four types of jumping which are leap frog jump, long jump, static jump and triple jump. The subjects were asked to jump with shoe and barefooted.

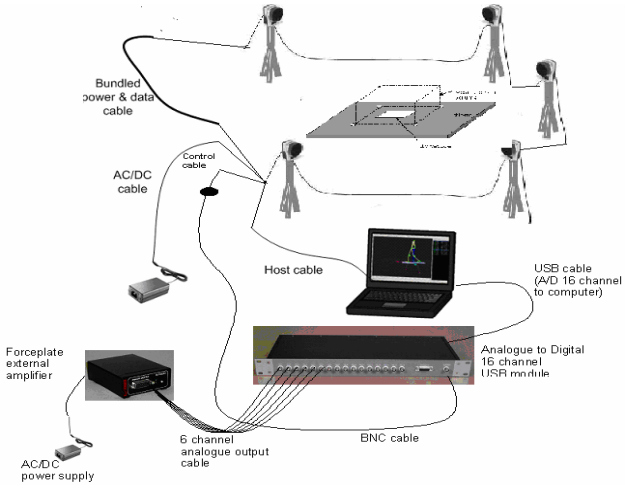


Figure 1 Qualisys Track Manager

The Biomechanics and Motion Analysis Laboratory has an instrumented, horizontal walkway. The walkway is an 8m long plywood floor build with 2 set of force plate leveled on the center of the platform. A five-camera motion capture system (ProReflex infrared, Qualisys) was applied to capture the range of motion of hip, knee, ankle and toe joints in sagittal plane during walking. Eight reflecting markers were placed at different joint positions for defining joint motion. The marker protocol was based on the Helen Hayes model. The commercial software, Qualisys Track Manager (QTM), an interface that allows the user to perform 2D and 3D motion capture was used to acquire kinetic and kinematic data during experiment.

III. RESULTS AND DISCUSSIONS

In this study, we had performed 4 types of jumping which consist of leap frog jump, long jump, static jump and triple jump. The subjects were asked to jump few times before collecting the data. This study will only focused on the first jump done by the subjects.

Table 2 Male 1 Jumping with shoe

SUBJECT WITH SHOE: Male 56.9kg 164cm		Leap Frog	Long	Static	Triple
Kinetics:					
Force [N]	X	3.815	159.457	-95.979	60.273
	Y	-48.676	-350.195	-1756.313	-198.520
	Z	1033.036	4039.063	1756.313	2264.134
Moment [Nm]	X	-148.592	291.417	281.346	117.464
	Y	21.912	-271.305	-88.808	-101.503
	Z	-14.969	20.829	16.709	-17.258
C.O.P	X	-21.211	67.170	50.565	44.831
	Y	-143.840	72.150	160.191	51.880
	Z	0	0	0	0

Table 3 Male 1 Jumping Barfooted

SUBJECT WITH BARE FOOT: Male 56.9kg 164 cm		Leap Frog	Long	Static	Triple
Kinetics:					
Force [N]	X	-24.262	117.647	-39.216	78.584
	Y	-97.505	-124.666	-109.102	-19.074
	Z	1681.849	3423.819	2126.192	2409.400
Moment [Nm]	X	-99.153	374.914	268.162	-38.544
	Y	-27.039	-49.378	133.364	-110.903
	Z	-3.616	-15.518	17.533	-29.068
C.O.P	X	15.500	14.422	-32.724	46.029
	Y	-61.274	109.502	126.123	-15.997
	Z	0	0	0	0

Table 2 and 3 demonstrate Male 1 while jumping with shoe and barefooted. For this study, only kinetics parameters has been study which is the force, moment and center of pressure (COP).

Table 4 Female 1 Jumping with Shoe

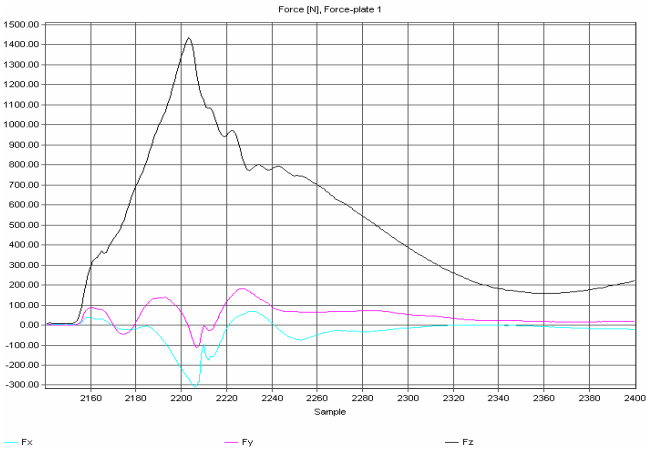
SUBJECT WITH SHOE: Female 55.1kg 163.5cm		Leap Frog	Long	Static	Triple
Kinetics:					
Force [N]	X	68.818	40.131	-72.786	-1.068
	Y	-0.458	-95.064	-126.802	2.289
	Z	2243.382	1236.896	1820.401	600.900
Moment [Nm]	X	0.092	-37.995	288.853	-40.009
	Y	-27.527	-59.144	104.189	-26.673
	Z	-3.159	-14.420	23.850	-13.321
C.O.P	X	12.270	47.816	-57.234	44.388
	Y	0.041	-30.718	158.676	-66.582
	Z	0	0	0	0

Table 5 Female 1 Jumping Barefooted

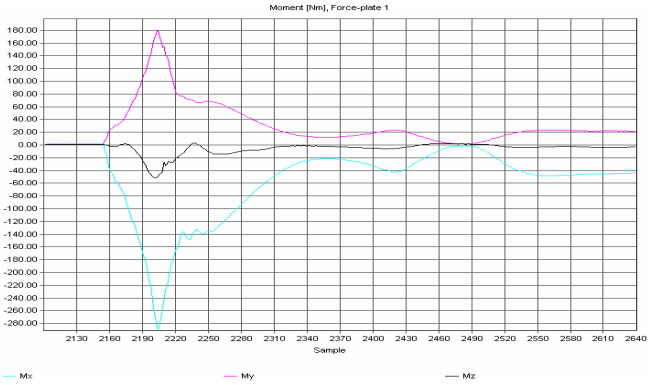
SUBJECT WITH BARE FOOT: Female 55.1kg 163.5cm		Leap Frog	Long	Static	Triple
Kinetics:					
Force [N]	X	-9.308	43.183	-99.947	-14.191
	Y	23.346	-7.782	-102.693	-37.690
	Z	2107.881	1593.957	1589.685	786.450
Moment [Nm]	X	-85.054	-27.008	180.087	-88.716
	Y	53.651	97.108	-62.196	-57.679
	Z	-9.567	-1.144	3.525	-25.589
C.O.P	X	-25.452	-60.923	39.125	73.341
	Y	-40.350	-16.944	113.285	-112.806
	Z	0	0	0	0

Table 4 and 5 shows Female 1 while standing with flat foot and tip toe. Similar to Male 1, only kinetics parameters has been study which is the force, moment and center of pressure (COP).

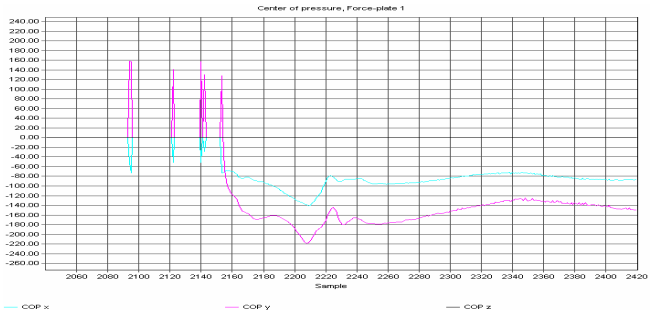
From the table, we can see the variations of GRF accumulated for both Male 1 and Female 1. There is no consistency and pattern for both subjects. Female 1 shows that triple jump given less force and the highest given to leap frog. On the other hand, Male 1 showing highest value in long jump and less in leap frog. The contrary between Male 1 and Female 1 especially during leap frog which gives highest and lowest force value giving us another reason on the methodology during experiment is essential. This can be looked upon the direction given during experiment being held and data collection.



(A)



(B)



(C)

Figure 2 Kinetic graph for Female 1

Figure 2 shows the kinetic graph for Female 1 which are force (A), moment (B) and COP (C). Here we can see only one peak for force in (A) and COP leads to 0 in z direction.

IV. CONCLUSIONS

Jumping has become vital in biomechanics especially in sports during departure and landing to prevent injuries and improve performance. In this study, four types of jumping has been done and there lot rooms of improvements can be done especially in methodology and data analysis .

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