BIOMECHANICS ANALYSIS OF KICKING MOTION

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I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

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IN THE NAME OF ALLAH,
THE MOST BENEFICENT, THE MOST MERCIFUL

A special dedication of This Grateful Feeling to My
Beloved parents, En.Nordin Bin Mat Zin and Pn.Norharisah Bt. Abdul Rani for giving me full of moral and financial support. It is very meaningful to me in order to finish up my degree's study. Not forgetting also to all my loving brothers and sisters. Last but not least to all my colleagues and my lovely friends.

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ABSTRACT

High quality kicking technique is the most important aspect of the football player. The good technique will increase quality of the game. This study will focus on the biomechanics analysis on the ten male Majlis Sukan Negeri Terengganu (MSNT) football players as well as to clarify the difference between three types of step run using kinematic variables and electromyography analysis. Electromyography data management and analysis are using Origin Pro 8.5.1 software and the statistical analysis carried out by using the ANOVA analysis. In order to observe the kicking motion experiment, the subjects will perform the instep kicking on the plane of activity in the laboratory. The image of the instep kicking was shot using high speed camera (250Hz). The subject tried to kick a ball at their full strength for each kick, namely the one step kick, two step kick and three step kick. The results indicate that there was no great difference in performance between the muscle of Quadriceps and Hamstring to the pairing of the three types of step run, though muscle discharge of the Calves and Tibialis Anterior show greater values in the group of pairing the three type of step. Image of the instep kicking was captured during the study and is useful to get the data of the kicking action for the kinematic variables. In this context, kinematics variable can be determine such as leg velocity, ball velocity, ball deformation, coefficient of restitution (COR) and force by leg. Based on the investigation with same leg velocity after impact which is 16 m/s, the highest force for leg is 5378.95N and the highest ball velocity is 23.07 m/s. The maximum ball deformation and coefficient of restitution noted as 0.018m and 0.86. These finding led to the conclusion that in a comparison between the kicking, three steps run demonstrates higher kinematics variables value compared to the one step and two step of kick.

ABSTRAK

Teknik menendang yang adalah aspek yang paling penting pada pemain bola sepak. Teknik yang baik akan meningkatkan kualiti permainan. Kajian ini akan memberi tumpuan kepada analisis biomekanik pada sepuluh pemain bola sepak daripada Majlis Sukan Negeri Terengganu (MSNT) dalam mengkaji perbezaan di antara tiga jenis langkah sepakan menggunakan analisis data kinematik dan data Electromyography. Perkiraan data dan analisis data Electromyography menggunakan Origin Pro 8.5.1 perisian dan analisis statistik dengan menggunakan teknik analisis ANOVA. Untuk menjalankan kajian pergerakan sepakan, subjek akan menggunakan sepakan kekura kaki di atas pelantar aktiviti di dalam makmal. Gambar pergerakan sepakan kekura kaki diambil dengan kamera berkelajuan tinggi (250Hz). Subjek akan menendang bola pada kekuatan maksimum mereka untuk setiap sepakan, iaitu satu langkah sepakan, dua langkah sepakan dan tiga langkah sepakan. Hasil kajian menunjukkan bahawa tidak ada perbezaan yang dalam aktiviti pergerakan antara otot Quadriceps dan Hamstring pada dalam ketiga-tiga jenis langkah sepakan, namun terdapat perbezaan besar dalam aktiviti pergerakan otot di antara otot Calves dan Tibialis Anterior dalam tiga langkah sepakan. Gambar pergerakan spekan kekura kaki yang diambil semasa kajian boleh diguna dalam menentukan data-data kenematik. Dalam konteks ini, pelbagai data kinematik dapat ditentukan seperti halaju kaki sebelum dan selepas sepakan, kelajuan bola selepas sepakan, perubahan bentuk bola dan pekali restitusi (COR). Berdasarkan kajian dengan menetapkan halaju sebelum sepakan yang sama iaitu 16 m/s, daya sepakan yang paling tinggi oleh kaki yang dihasilkan adalah 5378.95 N dan halaju paling tinggi bola selepas sepakan adalah 23.07 m/s. Sementara itu, perubahan bentuk bola tertinggi dan pekali restitusi tertinggi yang dihasilkan adalah 0.018m dan 0.86. Hasil kajian dapat disimpulkan bahawa sepakan dengan tiga langkah akan menghasilkan nilai data kinematik yang lebih tinggi berbanding dengan satu langkah dan dua langkah.

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LIST OF SYMBOLS

m	Mass (kg)
N	Newton
A	Area (m^2)
F	Concentrated force (N)
e	Coefficient of Restitution
r	Radius

LIST OF ABBREVIATIONS

LVBI	Leg Velocity before Impact
LVAI	Leg Velocity after Impact
BVAI	Ball Velocity after Impact
BD	Ball Deformation
COR	Coefficient of Restitution
B	Between groups variance
W	Within group variance
*	Indicates significant ($p < 0.05$)
**	Indicates significant ($p < 0.01$)
n.s	No significant
S	Steps
Def	Deformation

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The football game is one of the favourite sports to millions of people in this people. The games give huge enjoyment to those who are watching or playing the game of football. The World Cup or in big league in Europe, the football games will increase the human emotions and feeling in any situation. The football game required a skilful play in control, which are normally trained at different levels of training programs but skill are very difficult to learn. Football are includes many skills such as control play, counter attack, running, dribbling, passing and kicking which are commonly done by the football players during the hole game. When investigating the complex system of muscle actions during the game of football, the kicking motion apparently situated in a place of important matter. A football player tries to show different stage of speed and direction of the ball with high level of accuracy in the implementation of this skill. According to football, the football kicking motion is likely more to finding the biomechanics and kinematics variable. Many researchers dedicated their time to study the complex kicking motion of football by examining the relevant biomechanical variables. This kinematic revisions about the position of non kicking leg position and joint angles (Burdan, 1955 and Togari, 1972) and also the positioning and angular movements of the foot at ball contact and kicking leg (Aitchison and Lees, A. 1983) or previously ball contact (Roberts and Metcalfe, 1968 Copper , 1982) for successful kicking. The studies also show that there is connection between the swipe velocity of the kicking limb, striking mass at impact and the ball velocity (Plagenhoef, 1971). Kicking is run by the muscle action of single player (Rodano and Tavana, 1993) and dissimilar levels of players have a different swipe motion kinematics (Togari, 1972). A few study on the effect of different approach angle on ball velocity confirmed that different angled approach will creates greater ball velocity compared to a straight to the ball approach (Plagenhoef, 1971, Asai 1980).

1.2 STATEMENT OF THE PROBLEM

The main purpose of this study was to investigate the kinematics variables of kicking motion in football and to determine the effect of different type of step by perform instep kick. The investigation project also observed the relationship amongst the different type of step with the anthropometry data and electromyography data.

1.3 PROJECT OBJECTIVE

Basically, this thesis would be done to fulfil the following objective:

i. To investigate the leg muscle activation with different step run using the Electromyography (EMG).
ii. To investigate the kinematics variable such as leg velocity and ball velocity during the kicking motion.
iii. To determine the effect of different step run with the anthropometry data.

1.4 SCOPE OF PROJECT

i. The ability of this study is only to execute football kicking motion.
ii. The subject's kicking motion was recorded by using the high speed camera in the laboratory.
iii. The experiment in a laboratory setting.
iv. Ten male football players of Majlis Sukan Negeri Terengganu (MSNT) between the ages 15 - 17 years.
v. Type of step run is one step run, two step run, and three step run.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The previous literature review exhibit many texts and articles that described the human performance involving all aspects of human activities such as walking, running and kicking. Generally investigations conducted in this area focussed on kinematic, kinetic and electromyography analysis of different skills levels of sports and non-sports persons. The region of research in sports biomechanics deals with kinematic analysis of relevant sports technique. The review of related literature is arranged under the following headings, (a) Kinematics of kicking (b) Kinematics of instep kick, (b) Electromyography and Videography and (c) Summary of all literatures.

2.2 KINEMATICS OF WALKING AND RUNNING

The systematic investigation of human walking is known as gait analysis and without any doubt this gait has been observed ever since man evolved. Though early studies were mainly confined to general observation, it was Borelli in 1682 who became the first person to study the human gait in a truly scientific manner (Whittle, 1993). Since then numerous papers have been published on this particular area. Human gait consists of two modes: walking and running (Winter, 1991 Enoka, 1994). One complete gait cycle (foot contact to foot contact of the same foot) is called a stride and one half cycles is known as a step. During support phase of gait cycle, the foot is in contact with the ground while in the swing phase, the foot is off the ground (Whittle, 1993; Enoka, 1994). Hay (1993) described that in running events the primary objective of an athlete is to cover a set distance in the least possible time.

Running speed depends on stride length and stride rate/ frequency (Vaughan, 1984; Hay, 1993). The running speed increases when stride length remains constant and stride rate increases. Similarly, if stride rate remains constant then stride length increases resulting increase in speed (Enoka, 1994). The stride length is again related with the range of motion about a joint (quantity) and the pattern of displacement (quality). As the runner goes from a walk to a run the angular displacement about the knee joint increases. Stance phase of gait includes both flexion and extension during walking and running but only extension in sprint. Likewise, the range of motion about both shoulder and elbow joints also increases as a person goes from walk to a sprint (Vaughan, 1984).

2.3 KINEMATICS OF KICKING

Kicking is necessary to be one of the fundamental movement skills which human being utilises in various games and sports including football. Good kicking technique is an important aspect for a football player. Therefore, understanding the biomechanics of football kicking is particularly important for guiding and monitoring the training process (Kellisand, E. and Katis, A. 2007). The kicking motion can be considered as a slight change of walking and running motion. It disagrees from walking and running in that the swinging of the kicking leg rather than the supporting leg generates the primary force of the kick. Kicking is the defining action of football, so it is appropriate to review the scientific work that provides a basis of our understanding of this skill (Lees, A.; Asai, T.; Andersen, T.B.; Nunome, H. and Sterzing, T. 2010). Since the beginning of the scientific research on football game kicking has been regarded without doubt the most widely studied skill. Football experts, coaches and physical education teachers have been extensively investigating better ways and means for teaching successful kick in football (Barfield, 1995; Lees, A. 1996). In order to execute technically and mechanically correct kick, some of the important factors should be given an emphasis.

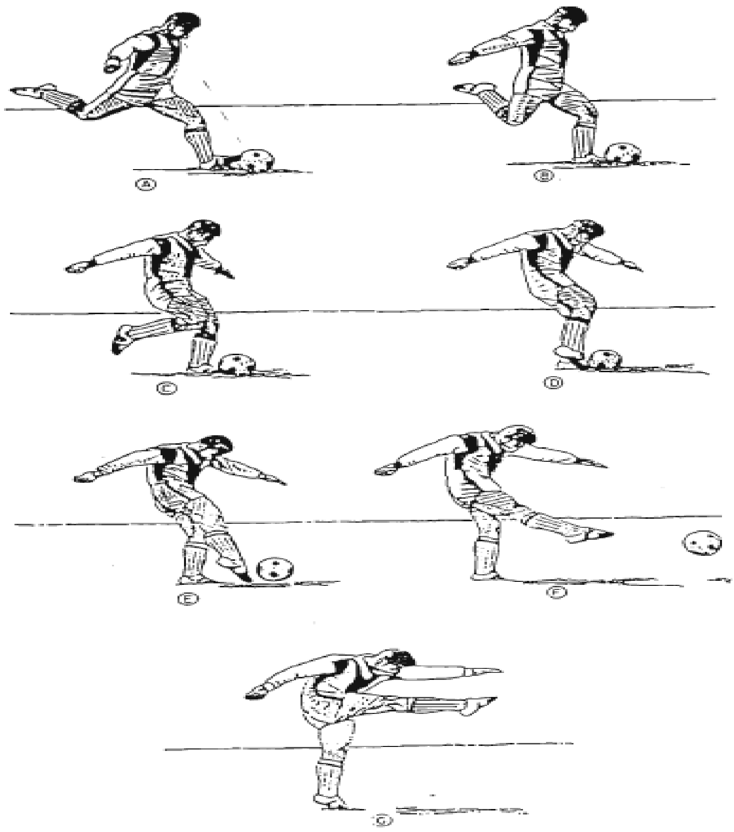

Figure 2.1: Instep Kick in football (Plagenhoef, 1971)

(A) The trunk and kicking leg revolve about the left hip and obtain a fuller back position of the right thigh, (B) The trunk and thigh rotate as one segment, until the full knee bend is reached, (C) Pointing of the thigh at the ball during the fast swing of the kicking leg, (D) Position of the non-kicking foot in relation to the ball and firm foot at impact, (E-G) The high follow-through

As described in the Edinburgh Napier University (Lees, A.; Asai, T.; Andersen, T.B.; Nunome, H. and Sterzing, T. 2010), a kicking technique can commit into (a) the approach, (b) the support leg and pelvis, (c) the kicking leg, (d) the upper body. The biomechanics of kicking in the football sport is particularly important for guiding and monitoring the training process. Studies in the biomechanics of kicking have been focusing on numerous variables in different populations; all seek for the establishment of the optimal variables or variables that might be most predictive of success in instep kicking, with success being most typically defined by resultant to the ball velocity. Biomechanical techniques can be used for any sports and football in particularly, useful to define the characteristics of skills, to gain the ground of the mechanical effectiveness of their execution and to identify the factors under laying their successful performance. This knowledge and understanding can assist to enhance the learning and performance of those skills.

Ismail, A.R.; Ali, M.F.M.; Deros B.M. and Johar, M.S.N.M. (2010) has described that in order to perform the kicking technique, kick a ball with the maximum velocity, the linear velocity of the kicking foot upon impact must be at the maximum. The dynamical mechanism of the kicking motion must be clarified to better understand the mechanism to produce the maximum velocity of the kicking foot. In the execution of the kick the striking leg is first taken backwards and leg flexes at the knee. The forward motion is initiated by rotating around the hip of the non-kicking leg and by bringing the upper leg forwards. The leg is still flexing at this stage. Once this initial action has taken place the upper leg begins to decelerate until it is essentially motionless at ball contact. The leg remains straight through ball contact and begins to flex and foot often reaches above the level of the hip during the long follow-through. Some researcher (Kellisand, E. and Katis, A. 2007) agreed that for successful football kick depends on various factors including the distance of the kick from the goal, the type of kick used, the air resistance and the technique of the main kick which is best described using biomechanical analysis.

A study by (Hideyuki et al, 2009) examined the factors affecting the ball velocity and rotation for side-foot soccer kick using a numerical investigation. The theoretical equations of the ball velocity and rotation were deriving based on impact dynamic theory. Using the theoretical equations, the relationships of the ball velocity and rotation to the attack angle and impact point were obtained. The validity of the theoretical equations was verified by comparing the theoretical relationships with measurement values. The ball deformation and impact force were calculated three-dimensionally using Ishii and Maruyama's (2007) methods. In Fig. 2, the ball deformation β in the normal direction to the contact surface was calculated by subtracting the distance between the centre of the ball and contact point from the radius of the ball. The absolute magnitude of the impact force |Fb| is expressed in the following equation by applying the Hertz contact theory (Greszczuk, 1982;

Timoshenko and Goodier, 1970). The force produce by the leg was calculated using equation (1) below

$$F = m\ (foot)\left(\frac{V(\ foot\ initial\ ) - V(\ foot\ \ final\ )}{Contact\ time}\right) \quad (1)$$

A group of studies, Sakamoto, K.; Hong, S.; Tabei, Y. and Asai, T. (2012) observed from their investigation that the population of female players is increasing worldwide, and it is necessary to determine the technical characteristics of female players and the training methods suitable for them. It is important to instruct them how to impact the ball near the foot's centre of gravity under a variety of conditions. Moreover, the female players exhibited lower inclination of hip and thigh immediately before the impact compared to the male players. Because differences gender may affect kicking performance, the competitiveness of female players may be enhanced by providing training and coaching that is adapted to their characteristics. Accordingly, the study was designed to compare the ball impact and swing motion kinematics between female and male football players to deepen the knowledge of the mechanical and technical characteristics of female players.

From the studies on curve ball kicking (Ozaki, H. and Auki, K. 2007) there are two types of curve kicks are seen in football. One is a kick in which the player attempts to rub the ball with the toe trying to keep in contact with the ball as long as possible also called the usual curve kicks. This is frequently described in common tutorial manuals. The second is a kick in which the ball is spun by the angle of attack which is made by the swing direction of the kicking foot and the direction of the impact surface also called the angle curve kick. No studies have determined the difference of these two types of kicking. In a football sport, curve kick purposely spins a ball so that its rotation can be changed. It is one of kicking technique that usually applied in set play. The technique of a curve kick which is usually used in set play has going to be a focus of research interest for the above study.

The development of velocity in kicking leg at impact has been found to be the important in football kicking. The contributing factors to the swing velocity of the kicking limb at the time of instep kick are linear velocity of hip rotation as the kick begins, forceful hip flexion followed by extension of knee (Grunda, T. and and Senner, V. 2010). The studies by Ismail, A.R.; Ali, M.F.M.; Deros B.M. and Johar, M.S.N.M. (2010) also agreed that the powerful kicks are achieved through a high foot velocity and coefficient of restitution. The hip action makes an important contribution in the early force producing phase of the kick. As the thigh is swung forward by hip flexion, leg begins to rotate and carries the leg and foot with it. The knee extension starts the moment thigh past the perpendicular and become primary contributor in the final force-producing phase of the kick.

The velocity of kicking leg is determined by the knee extension and hip flexion, although the latter action does not occur on impact pelvic rotation may be acting at the time of contact. However there is little or no hip action in the final phase. The ankle action of the kicking foot is used to position the foot for impact. The investigation conducted by Ozaki, H.; Ohta, K. and Jinji, T. (2012) reported that in full instep kick as the kicking foot took off the groin pelvis started rotating backward and tilted left ward. To kick a ball with the maximum velocity, the linear velocity of the kicking foot upon impact must be at the maximum. The investigation conducted by Ismail, A.R.; Ali, M.F.M.; Deros B.M. and Johar, M.S.N.M. (2010) reported that the variables was identified to be significant to the force model besides succeeded to obtain the force equation model. Through readings gathered from the Taguchi's method the researcher managed to get the optimum kicking value. Based on the findings, the velocity and distance was identified to be significant with the force model. The highest average force of kicking is 5879.60N, while the highest average ball velocity is 8.2m/s with distance covered by the ball until 47.85m. From Taguchi's method, the optimum distance and velocity namely respectively as much as 0.163m and 8.035m/s can give the highest optimal force to the reading of 5602.12N. These studies found that the highest optimum force achieved from the three steps run. In three step run, the optimum distance and velocity respectively to give the optimal force. Success of an instep footballer kick rely on various factors including the distance of the kick from the goal, the type of kick used, the air resistance and the technique of the main kick which is best described using biomechanical analysis. The distance, velocity and angle levy kicking are the important parameters involved in the kicking activities where it can contribute to the high impact of kicking effectiveness.

Ability to kick with increased velocity is, dependent on the length of the lever arm of kicking limb (Grunda, T. and Senner, V. 2010) and development, summation and application of force (Carstensen, J.C.; Krupop. S. and Gerndt, R. 2011). The lower leg and the part of the foot between the ankle and the point of impact form the lever utilised in kicking. During the kicking ball, the length of the arm and the length of the lever are increased through extension of the lower leg prior to impact with the ball. The moment arm is that line which is perpendicular to the axis and to the direction of desired application of force. The length of the moment arm is approximately the distance from the knee to the point of impact. Moment arm length will differ on the length of the individual's body segment and the position of the body segments at the time of impact. Considering all other factors equal, the potential linear velocity at the end of the lever is increased when the length of the moment arm is increased. Since the length of the moment arm is partially dependent on the length of the lever, increasing the length of the lever increases the potential linear velocity at the end of the lever. Although the above studies showed high relationship between the muscle strength and performance, however there are also other factors, which contribute to successful kicks. These factors are appreciated from a consideration of the relationship between foot and ball velocity before and after impact with the ball (Lees, 1996). By considering the mechanics of collision between the foot and ball, the velocity of the ball can be stated

as:

$$V_{(ball)} = V_{(foot}\left(\frac{(Mleg).(1+e)}{(Mleg+mball)}\right) \quad (2)$$

Where V = velocity of ball and foot respectively, M_{leg} = mass of the leg, m_{ball} = mass of the ball and e = coefficient of restitution.

which is

$$e = \left(\frac{\mathrm{v2 - v1}}{\mathrm{u1 - u2}}\right) \quad (3)$$

Where v_1 is the final velocity of the first object after impact, v_2 is the final velocity of the second object after impact, u_1 is the initial velocity of the first object before impact, and u_2 is the initial velocity of the second object before impact.

A different equation to describe the velocity of the ball after foot impact was developed by Bull-Andersen et al. (Bull-Andersen et al., 1999)

$$V_{(ball)} = \frac{I.u1(1+e)}{I + mball.r2} \quad (4)$$

Where V_{ball} = velocity of the ball, I = the moment of inertia of the shank-foot segment about the knee joint, u_1 = velocity of the foot before impact, e = the coefficient of restitution, m_{ball} = the mass of the ball and r_2 = the distance between the knee joint and the centre of the ball as well as the distance between the knee joint and the point of contact on the foot (the length r is the same between these points).

A group of researcher, (Tanaka, Y.; Shiokawa, M.; Yamashita, H. and Tsuji, T. (2006)) conducted a research about an analysis tool of kicking motion in football. They reported that they developed tool can calculate kinematics, dynamics, and manipulability of trainee's movements with considerations of human physical characteristics from the trainee's postures measured by a motion capture system, and can visually provide the quantitative analysis to users in the main window of the tool. The effectiveness of the proposed approach is verified through basic experiments with skilled and unskilled subjects in football. The tool starts to compute joint angles in a human model of the whole body expressed by the combination of multi joint links from the measured data by the motion capture system. The analysis results are then presented with the animation of measured human motion on the feedback viewer so that users can instinctively understand time-variant properties of kicking motion. Analysis of kicking motion was conducted along the proposed approach with two skilled subjects in football (Subject A: aged 21, height 170cm, weight 68.0kg; Subject B: aged 22, height 173cm, weight 65.0kg) and two unskilled subjects (Subject C: aged 23, height 175cm, weight 72.0kg; Subject D: aged 22, height

179cm, weight 60.0kg). The experimental apparatus for measuring the kicking motion, in which Vicon (Oxford Metrics; sampling frequency: 120Hz) was employed to capture rapid movements of subjects. The subjects were asked to kick a ball forward by their instep within two strides from the initial position because of the measuring range of the motion capture, in which the approach angle φ was fixed at about 30°. In the experiment, 28 markers were attached on the whole body of the subject so that all joint angles can be calculated from the 3D positional information of the markers.

The present paper developed the analysis tool of kicking motion in football just by using captured postures that can provide the effective and efficient training information with trainees as well as coaches. The experiments were conducted to investigate the kicking motion in football with regard to the skilled and unskilled players and showed the following major points as both the lower and upper torsos are equally important in football kicking, Manipulability increases to maximize the end-point velocity at impact and the force manipulability of the lower extremities increases around the transmitting period of rotational energies of the body.

In the study conducted by Ghochania, A.; Ghomshe, F.T.; Nejad, S.K.A.R. and Rahimnejadd, M. (2010) reported the analysis of torques and forces applied on limbs and joints of lower extremities in free kick in football**.** The aim of this study is to analyse forces and torques applied on joints and limbs of lower extremities in free kick in football and to understand the relationship between these forces and moment and injuries in lower extremities in free kick and therefore to help in preventing injuries while having good performance in efficient kicks. In this research, lower extremity one-side 2-Dimentional kinematical analysis. Video recording was in digital plane by use of infrared camera with frequency of 250 Hz was used. As was considered in graphs, maximum velocity and acceleration of toe and ankle are at the instant of contact of foot with ball. Maximum rotational velocity of shank is at this time, too. Thigh and ankle reach the maximum rotational velocity before shank as, toe reaches its maximum rotational velocity just before stroking. Maximum acceleration of toe centre of gravity (COG) in x direction is at the moment of contact between toe and ball.

A few studies have investigated the effect of approach angles on ball velocities in football. Moudgil (1967) compared two styles of instep kicking, the straight and the pivot approach, through the use of electrogoniometry. He found a significant difference between the two angles. The pivot instep kick generated a higher average ball velocity of 21.93 m/s than the straight instep kick, which generated a ball velocity of 18.94 m/s.

2.4 KINEMATICS OF INSTEP KICK

Success of an instep football kick is an important aspect of a football player. Therefore, understanding the biomechanics of football kicking is particularly important for guiding and monitoring the training process. The game of football is one of the most popular team sports worldwide. Football kick is the main offensive action during the game and the team with more kicks on target has better chances to score and win a game. For this reason, improvement of football instep kick technique is one of the most important aims of training programs in young players. Success of an instep football kick depends on various factors including the distance of the kick from the goal, the type of kick used, the air resistance and the technique of the main kick which is best described using biomechanical analysis. The previous literature review shows that most of the research focused their studies only on the biomechanical characteristics of instep football kick.

The effective striking mass is the mass equivalent of the striking object and in this case the leg which relates to the rigidity of the limb (Plagenhoef, 1971). To achieve optimal performance in kicking striking the ball as near to the ankle as possible rather than behind is also very important (Barfield, 1996). The term $M_{leg}/(M_{leg}+m_{ball})$ in equation (2) indicates the rigidity of impact and relates to the muscle involved in the kick and strength at impact. The term (1+e) relates to the firmness of the foot at impact. Because the ball is on the ground, the foot contacts the ball on the dorsal aspect of the phalanges and lower metatarsals.

Plagenhoef (1971) conducted a research with a single subject in order to measure the quantity of striking mass. He reported that the instep kick taken from a side or pivot recorded highest in striking mass value for all the kicks tested with an average of 3.9 kg. The striking mass of the straight instep kick averaged 3.2 kg. In computing striking masses, Plagenhoef measured foot as well as ball velocities. Bensira (1980) elicited that striking mass equated the product of the ball's mass before and after impact (see equation 5 below). Striking mass may also be considered as a function of the ball's velocity before contact divided by loss in the velocity during impact (Sawhill, 1978).

as: $$m_2 = m_1 \left(\frac{v3}{v2 - v4} \right)$$

(5)

m_2 - striking mass
m_1 - mass of ball
v_3 - ball velocity after impact
v_2 - velocity of striking mass before impact
v_4 - velocity of striking mass after impact

Rexroad (1968) conducted a study on pivot instep kick and found the linear velocity of the kicking foot as it approached the ball varied between 18.07 m/s and 21.48 m/s. Also the resulting ball velocities ranging from 23.70 m/s to 25.30 m/s. Plagenhoef (1971) and Asai (1980) investigated the effect of straight and diagonal approaches on ball velocity and leg swing velocity. These studies concluded that the diagonal approach caused greater ball and leg swing velocities than the straight approach. Gibson (1985) also concluded that angled approach produces more powerful kick than straight approach. But how angular changes in approach would affect the ball velocity or the kick has not been explored in these studies. With twenty high school right footed football players Levy (1995) conducted a study in order to examine the effect of target locations and kicking techniques on approach angle. The research concluded that players tend to approach the ball differently depending on the target locations.

Ismail, A.R.; Ali, M.F.M.; Deros B.M. and Johar, M.S.N.M. (2010) conducted a study of biomechanics analysis and optimization of instep kicking with the subjects selected from professional football player with average heights of the Asian people, to investigate the biomechanical analysis has been used to identify the variable such as velocity, acceleration, distance and the angle of the knee whether it would influence the players kicking force. The three step kick produced greater linear and angular velocities in the leg. However, the one and two step kick generated higher acceleration suggesting greater muscular efforts were being applied. The highest average force received in right leg analysis also, as well as the highest average force noted to be 5879.60 N and highest average velocity is 8.2 m/s with the kicking distance achieved up until 47.85 m.

2.5 ELECTROMYOGRAPHY AND VIDEOGRAPHY

There is a little information about the way footballer use their muscles to perform highly trained and during the movements in the electromyography. Studies of kicking motion activity have focused only on the biomechanical characteristics and technique sustained by the footballer. Biomechanical errors in technique that contributes to single impact and error overuse football injuries have been described.

Through this investigation (Ozaki, H. and Auki, K. 2007) using kinematics and electromyography (EMG) is to clarify the kicking movements observed in a kick applying the angle of attack and in a kick as explained in general tutorials material. The subject was 6 healthy male college student football players with a mean of 21.2(±0.4) cm. Their mean heights, weight, and experience of football were respectively 172.3(±5.2) cm, 63.3 (±3.7) kg and 13.2 (±2.6) years old. Kicking movements were shot with a high speed camera 250Hz. Table 2.1 below indicates the percentages of muscle discharge in each muscle of each subject in Usual Curve and Angle Curve Kick compared to Inside Kick. The muscle that this study investigates is Rectus femoris, Vastus medialis and Adductor longus. Each kick was t-tested, revealing a significant difference in the Rectus femoris muscle ($p<0.05$). As the result of the within group of femoral extensor muscles including the Rectus femoris and Vastus Medialis muscles, subject A’s Vastus Medialis show a great difference. However, the other subjects beside subject A show similar result to each other with no statistical difference. Table 2.1 shows the Ratios of EMG of kicking leg in Usual Kick and Angle Kick compared with Inside Kick.

Table 2.1: Ratios of EMG of kicking leg in Usial Kick and Angle Kick compared with Inside Kick (%)

	Rectus femoris		**Vastus medialis**		**Adductor longus**	
SUBJECT	**I vs U**	**I vs A**	**I vs U**	**I vs A**	**I vs U**	**I vs A**
A	128.02	128.54	104.55	67.55	166.61	147.53
B	92.50	109.14	146.32	154.49	176.76	136.77
C	150.33	157.99	113.38	149.99	82.66	56.81
D	101.70	74.96	86.68	82.15	92.26	91.30
E	117.55	103.48	139.69	162.97	96.47	83.98
F	84.47	83.37	98.48	80.85	37.80	27.75
Mean	112.43	109.58	114.85	116.33	108.76	90.69
SD	24.50	30.42	23.57	43.75	53.12	45.85

The study in electromyography analysis of Chu Yih Bing, S.Parasuraman and M.K.A.Ahmed Khan (2012) is focused on the development of EMG techniques of the human lower extremity and kinematic and kinetic analysis of the Knee and Ankle during football kicking motion. The musculoskeletal model is developed by means of Surface marker techniques and the related kinetics and kinematics analysis are performed. The EMG Techniques are used to estimate the muscle strength responsible for the Knee and Ankle movement during kicking action. Five soccer players (aged 23 to 25, BMI: 25-29) are involved in the experimental studies. EMG sensors are also placed only on major muscles of lower limb, which include Quadriceps, Hamstrings, Tibialis Anterior and Calves. These are the muscles responsible for flexion and extension of knee and ankle, essential motions during soccer ball kicking.A mathematical model was proposed to convert the EMG signal of muscles into muscle strength through correlation with various models and players.

The peak performance of the Knee and Ankle are evaluated in terms of the estimated torque and compared against the measured data.

Electromyography (EMG) has been used to examine muscle activation patterns to explain the role and level of muscle activation during the kick (Bollens et al., 1987; De Proft et al., 1988; Dorge et al., 1999; Kellis et al., 2004; McCrudden and Reilly, 1993; McDonald, 2002; Orchard et al., 2002). To allow comparisons between different findings, all EMG values are frequently expressed as percentage of the EMG recorded during a maximum isometric effort (MVC). Examination of EMG activity levels reported in the literature (Table 2.2) indicates large variations in EMG magnitude and temporal patterns, which prevents extraction of safe conclusions regarding the role of various muscles during the kick.

Table 2.2: Characteristic EMG activity values during back swing and forward swing phases as reported in the literature

Iliopsoas	60-80% [2]	65.1 – 100.9% [2]	
Rectus femoris	25-60% [2]	32.5 – 68.7% [2]	59.1 – 63.8% [3]
	47.8 – 51% [3]	78.6 – 85.5% [3]	
Vastus lateralis	0 – 40% [2]	~64 – 102% [2]	~80% [1]
	70% [1]	~80% [1]	
Vastus medialis	90% [1]	~80% [1]	~80% [1]
	33.1 – 40.8% [3]	66.9 – 70.4% [3]	55.4 – 70.8% [3]
Biceps femoris	15-25% [2]	5.2 - 30% [2]	~40% [1]
	70% [1]	<30% [1]	53.6 – 54.1% [3]
	38.9 – 50% [3]	39.8 – 40.1% [3]	
Gluteus maximus	5-15% [2]	2.1 – 32.1% 2	~80% [1]
	65-70% [1]	<30% [1]	
Semitendinosus	70% [1]	30% [1]	~40% [1]
Tibialis Anterior	40% [1]	30% [1]	~80% [1]

[1] De Proft et al. 1988, [2] Dorge et al, 1999, [3] Manolopoulos et al. 2006.

Bergemann (1974) attempted to eliminate the restrictions on camera placement. The accuracy of this technique was highly dependent on how accurate all the coordinates could be determined. The coordinates of the vectors were first found with respect to reference planes aligned parallel to the film plane of each camera. These coordinates were then transformed and expressed with respect to the object reference frame. The multipliers used by Bergemann were determined by using a circle with its centre at the origin of the object reference frame. The circle was drawn on a flat surface and contained within the field of view of each camera. The circle appeared as an ellipse in the photographic image. The image length of the major axis of the ellipse was the image length of the true diameter of the circle. This was then used as a multiplier for each of the views.

2.6 SUMMARY OF LITERATURE REVIEW

The extensive literature review reveals that most of the investigators focused their studies only on the mechanics of instep kick in relation to the ball velocity. A few research (Moudgil, 1967; Rexroad, 1968; Plagehoef, 1971; and Asai 1980) studied the influence of approach angle on ball and leg velocities. These studies have 37 demonstrated the influence of approach angles on ball and leg velocities. It is not known, however, how angular changes in approach will affect other kinematic variables. Investigation carried out by Isokawa and Lees (1988) did elicit the importance of approach angle in instep kick in order to generate the maximum ball velocity. They omitted the important fundamental skills that govern the success of football game distance covered by the ball and accuracy of the instep kick. It should also be noted that these investigations are limited to two-dimensional kinematic analyses (which ignores rotational effect) and also with small sample size which might have affected their results.

Several researchers (Doolittle, 1971; Noss, 1967; and Plgenhoef, 1968) examined the perspective error problem occurred in two-dimensional studies. It appears that the only complete solution to this perspective problem is three-dimensional studies (Tant, 1991).A single camera in planner film analysis cannot provide information about twisting or diagonal actions in different planes of a movement (Miller and Petak, 1973). Two or more cameras, utilised in a three-dimensional measurement technique could provide a better understanding of complex movement (Allard et al., 1995).

The football instep kick involves complex movement of the whole body specially the lower extremity, thus a three dimensional measurement technique is required for a thorough analysis of this activity. To date no study has been reported on the three dimensional biomechanical aspects of the instep kick activity and the relative influence of approach angles on distance covered by ball and accuracy of the kick. The current study should add knowledge in the area of biomechanics of football kick.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The aim of this study is to analyze the leg muscle action during the different step and approach angles of kicking using the Electromyography (EMG). Explanation of the research equipment and procedures that are used are listed contained in this chapter. This chapter is arranged under the following sections: (i) overview procedure, (ii) description of instrument, (iii) data and analysis, and (iv) kinematic analysis

3.2 OVERVIEW PROCEDURE

The procedures that were followed during this investigation are presented in this section. The section is divided into three subsections: (a) selection of subjects, (b) beginning investigation, (c) recording procedure, and (d) selection of trials for analysis.

3.2.1 Selection of subjects

Total of 10 subjects have been selected from Majlis Sukan Negara Terengganu (MSNT) football player with a mean age (SD) of 15.8 (±0.63). Their mean height (SD) and weight (SD) were of 169.49 (±26.64) kg and 57.16 (±4.83) kg respectively. Most important thing is the subject must in good health during the experiment conducted. In order to keep homogeneity result, only right footed football player were selected for this experiment.

3.2.2 Beginning investigation

In the experiment, a camera positions and focus setting are obtain during the subject performing the kicking from different step which is one step run, two step run and three step run that is recorded by the high speed cameras. The laboratory setting of experiment included of (a) locations for high speed cameras, and (b) electromyography (EMG) setup,

As a result of the beginning investigation, the investigator became familiar with the equipment used for the study research. The beginning investigation helped to reduce many problems that could have occurred during the actual data collection session. The correct experimental setup is helping in the recording process.

3.2.3 Recording procedure

The video recording was conducted in the laboratory setting. The recording sessions were required in two different days to get absolute result. The subjects were instructed to wear entire sport outfit in order to do successful instep kick. They will be briefed about the test equipment and method which is included a demonstration before the actual recording experiment. The players will take practice kick trials earlier before the actual recording session. The subject will perform three instep kicks, one step run, two step run and three step run. The order of the kicks was randomly assigned for each kicker. The subject will be asked to kick it at maximum attempt along the direction of the ball. An Adidas FIFA standard football ball size 5, ball weights 0.45 kg and has diameter of 0.22 m was use for the experiment.

3.2.4 Selection of trials for analysis

For selection of trials for analysis, the distance of the different step is measured by the subject himself which is one step, two steps and three steps distance. Then, the players will take practice kick trials earlier before the actual recording session. From the plane of activity, the subject will perform the kicking using three instep kick which is one step run, two steps run, and three step run. The subject will be asked to kick it at maximum attempt along the direction of the ball.

3.3 EXPLANATION AND SELECTION OF INSTRUMENTS

The explanation and selection of instrument are use during this investigation involved four subsections. The following subsections are: (i): videographic location and equipment, (ii) electromyography

3.3.1 Videographic location and equipment

The camera that used in this experiment is XCAP SV643C high speed camera type. The interactive program for the PIXCI® imaging boards allowing capture, analysis, measurements, loading, and saving of imagery. It includes a script language for customization and automating tasks. The XCAP software is available for Windows and Linux. The video cameras resolution were 640 × 480 Global Shutter in order to reduce the influence of blurring while video recording.

The shutter speed for high speed camera is 1/2000 frame per second to capture the kicking motion. The foot kicking velocity and the ball velocity were recorded using the high speed camera. The high speed cameras are used to record the subject during the kicking motion in the laboratory. The high speed cameras were setup on a rigid stand and focused to the hit point horizontally as shown in the figure 3.1. The high speed cameras were conducted by one assistant and were started recording after getting a signal from the investigator. After a signal was given, the subjects begin to perform the kicking motion. A high speed camera was installed and facing the origin point in the direction of x-axis. Besides that, two LED spotlight will used for lighting during the high speed camera recording. The origin point for kicking was placed in the center of the synthetic grass. A circular target with a diameter 0.15 m diameter was hanging to the 3 m X 2 m net goal and place 2 m in front of the origin point and 1m above the floor. The direction of a straight line connecting the origin point and the center of target was regarded as the y-axis.

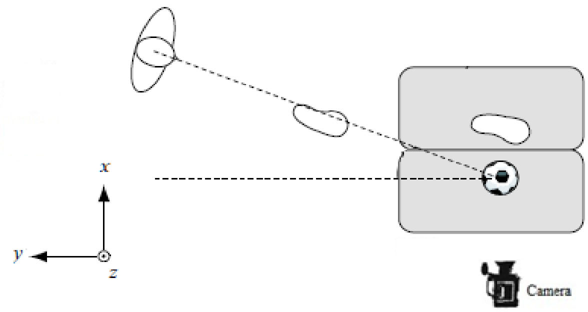

Figure 3.1: Top view of camera location for the experiment

3.3.2 Electromyography

The purpose of using electromyography (EMG) is to observe the leg muscle action in kicking motion by applying the instep kick. The types of leg muscle that were investigate in this research that act respectively during extension and flexion during kicking are quadriceps, Hamstring, Tibialis Anterior, And Calves Muscles These are the muscles responsible for flexion and extension during the kicking motion (Chu Y.B. et. al. 2012).

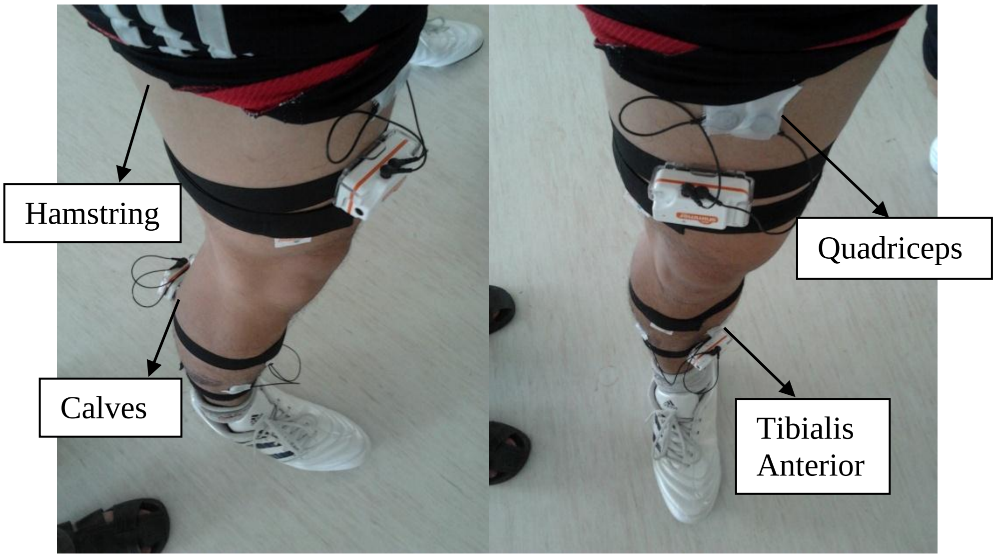

Figure 3.2: Leg muscle to be investigated

In a kicking motion as explained in previous study, it principally concentrates on the area of the impact surface because a subject can only kick a ball while the kicking foot hits the ball. Moreover, it was measured that ball actions is decided by the relationship between the ball and the kicking foot, the kicking foot and velocity the moving direction.

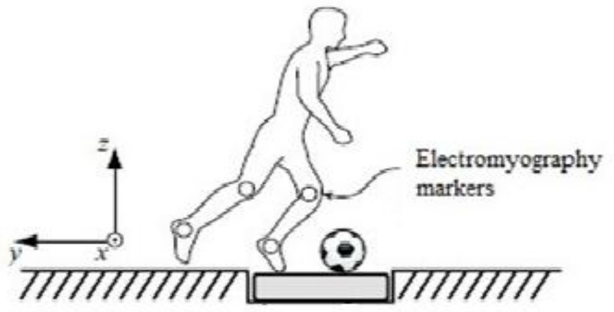

Figure 3.3: Side view of electromyography setup for the experiment

3.3.3 Statistical analysis method

The analysis of kinematic variables for velocities of the kicking leg velocity before impact and after impact, ball velocity after impact, ball deformation, and coefficient of restitution are using ANOVA analysis. One-way ANOVA are used to determine the significant difference between the kinematics variable compared to the three factor (one step run, two step run and three step run). Then the Two-way (ANOVA) statistical analyses were used to determine the significant difference between the subject and the type of kicking step for each kinematics variable factor each other.

In order to analyze the EMG data, the software that use is Origin Pro 8.5.1. First of all, copy the EMG data from Microsoft Excel to Origin Pro 8.5.1 software. Then, choose Envelope menu in Signal Processing analysis toolbar to smooth the EMG data. After that, choose the Normalize Columns menu in Mathematics analysis toolbar to normalize the EMG data using divide by mean method. Finally, choose Windowed RMS in EMG toolbar to normalize all the data with 100 window size and plot line the data into graph to find the α and R^2. Then the value will be calculated in t-test analysis.

3.4 METHODOLOGY FLOW CHART

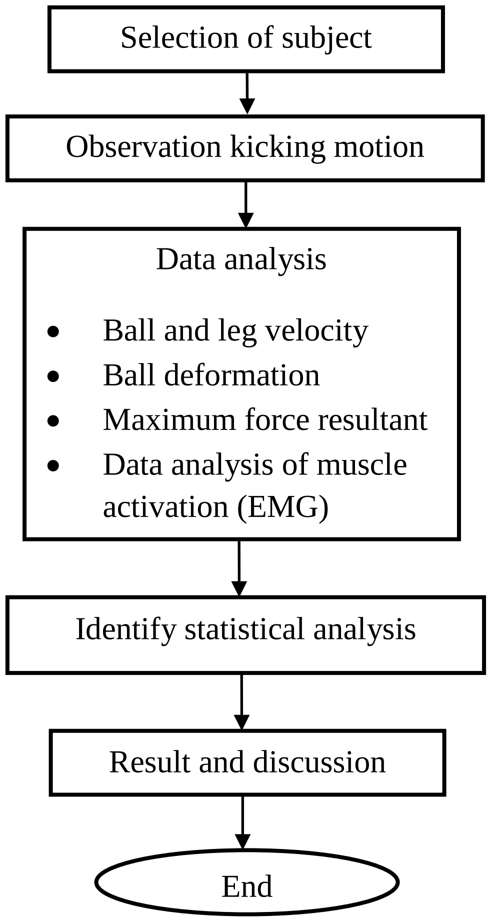

Figure 3.4: Flow chart of the methodology

CHAPTER 4

RESULT AND ANALYSIS

4.1 INTRODUCTION

The purpose of this investigation was to analyze the leg muscle activation with different step run using the Electromyography (EMG), investigate the kinematics variable and also to determine the effect of different step run with the anthropometry data. The results of the present investigation are organized under the following headings:

(a) Description of the subject
(b) Kinematic variable of instep kicking motion
(d) Statistic analysis of kinematic variables
(i) Analysis of Anthropometry data on kinematic variables
(j) Analysis of Electromyography data

4.2 DESCRIPTION OF THE SUBJECT

Ten male football players of the Majlis Sukan Negara Terengganu (MSNT) acted as subjects for the study. Table 4.2.1 presents the demographic data of all the subjects participated in the investigation.

Table 4.1: Demographic Profile of the Subjects

Characteristics	N	Range (Min-Max)	Mean	SD
Age (years)	10	2 (15.00-17.0)	15.80	0.63
Weight (kg)	10	14.4 (47.60-62.00)	57.16	4.83
Stature (cm)	10	87 (165.60-169.40)	169.49	26.64

Table 4.2.1 demonstrates that a relatively homogeneous group participated in the study, as evidenced by the small standard deviations. The difference between the subject's ages, which is about 2 year, indicates that they have started playing football fairly at same age. Basic anthropometric measurements of the subjects presented in Table 4.2.2 also show that the subjects were relatively homogeneous with low standard deviation for these variables.

Table 4.2: Anthropometric Data of the Subject

Characteristics	Range (Min-Max)	Mean (mm)	SD (mm)
Lower leg length	72.00 (394.00-466.00)	424.90	20.40
Ankle circumference (R)	30.00 (209.00-239.00)	225.90	10.18
Heel ankle circumference (R)	29.00 (318.00-347.00)	330.80	9.52
Ball of foot circumference (R)	24.00 (236.00-260.00)	248.80	8.05
Instep circumference (R)	22.00 (236.00-258.00)	249.00	7.12
Lateral malleolus height (R)	20.00 (56.00-76.00)	68.50	6.90
Medial malleolus height (R)	9.00 (82.00-91.00)	86.20	2.78
Foot length (R)	17.50 (240.90-258.40)	251.65	5.82
Ball of foot length (R)	18.30 (157.70-17600)	168.35	5.41
Foot breadth (R)	12.40 (91.70-104.10)	98.94	4.45
Bimalleolaar width (R)	11.80 (63.70-75.50)	69.36	2.97
Heel breadth (R)	15.70 (46.00-61.70)	53.54	5.00

4.3 KINEMATIC VARIABLE OF INSTEP KICK MOTION

In order to describe the kinematics of instep kick motion, the data of a typical subject was abstracted. The whole motion of the instep kick was described on the basis of the leg of the subject. Particularly for coefficient of restitution, the leg velocity before impact, after impact and ball velocity after impact data of the subject were considered.

These data were presented during the following main phases/ events: (a) Leg velocity before impact; (b) Leg velocity after impact; (c) Ball velocity after impact; (d) Ball deformation and (e) Coefficient of restitution (COR). The kinematics data and graph are presented in the Figures 4.1 - 4.5 of all 10 subjects, such as leg velocity after impact velocity, ball velocity after impact, ball deformation and COR using one step, two step and three step run. The data revealed no major differences in the different of the type of step kick.

Table 4.3: Leg velocity before impact data

Subject	One step (m/s)	Two step (m/s)	Three step (m/s)
1	15.11	19.91	20.37
2	16.45	17.92	19.46
3	11.23	12.15	14.19
4	16.05	15.99	16.04
5	14.29	14.56	15.05
6	16.64	17.34	18.50
7	14.23	16.73	17.19
8	15.48	16.69	20.98
9	10.95	10.98	14.19
10	12.16	14.55	14.55

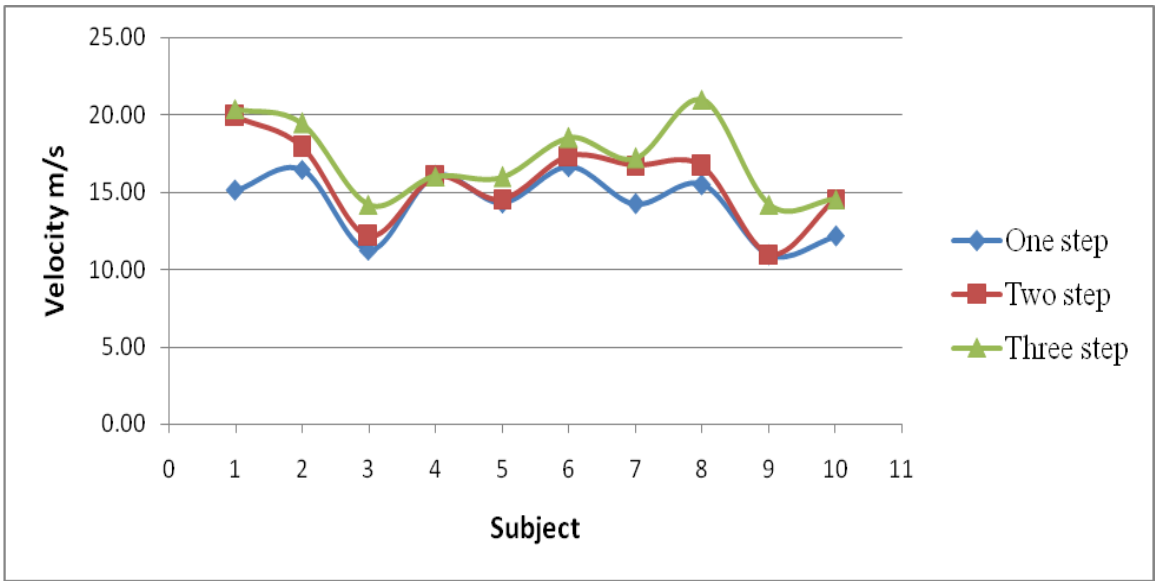

Figure 4.1: Leg velocity before impact graph

From Figure 4.1, the graphs show that most subjects produce maximum leg velocity before impact on three step run while the lowest is on one step runs. Subjects 8 produce the highest velocity of 20.98 m/s and the lowest velocity is perform by subject 9 which is only 10.95 m/s on one step run.

Table 4.4: Leg velocity after impact data

Subject	One step (m/s)	Two step (m/s)	Three step (m/s)
1	8.47	11.56	10.53
2	8.06	9.90	10.98
3	7.23	8.99	8.98
4	8.68	7.88	7.26
5	6.11	6.81	7.26
6	9.01	9.68	11.07
7	7.44	8.56	9.15
8	7.44	10.37	10.22
9	5.50	6.08	7.41
10	6.72	7.87	7.87

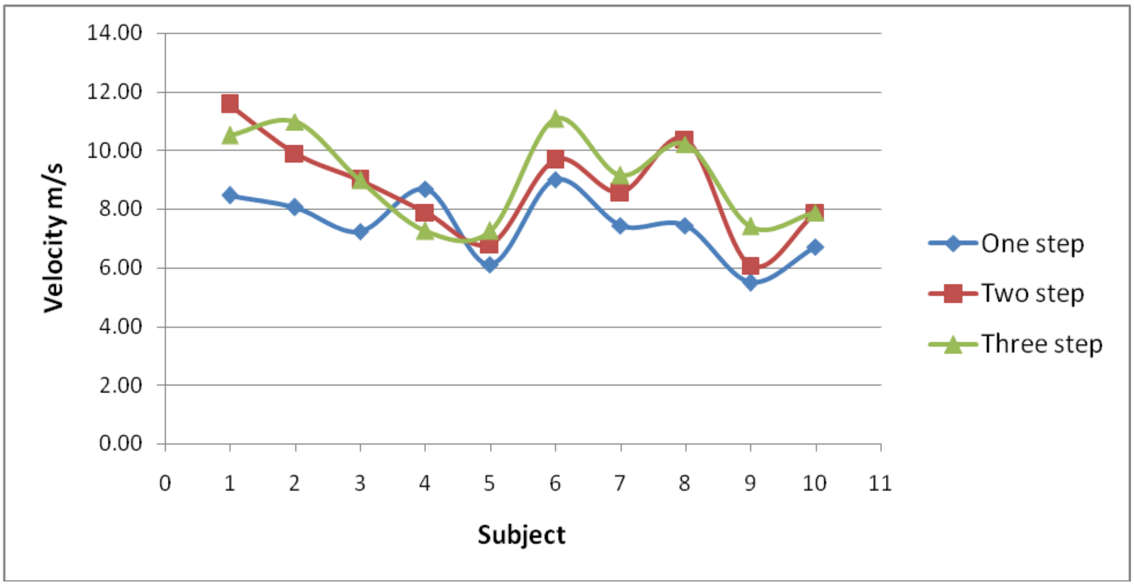

Figure 4.2: Leg velocity after impact graph

From Figure 4.2 show the graphs that most of the subjects produce maximum leg velocity after impact on three step run while the lowest is on one step runs. But the subjects 1 produce the highest leg velocity after impact, 11.56 m/s on two step run and the lowest velocity is perform by subject 9, 5.50 m/s on one step run.

Table 4.5: Ball velocity after impact data

Subject	One step (m/s)	Two step (m/s)	Three step (m/s)
1	17.03	23.83	26.71
2	17.13	21.03	24.88
3	11.77	15.26	17.61
4	17.17	19.33	23.07
5	16.10	17.01	19.83
6	19.62	22.05	25.79
7	16.72	20.74	23.03
8	17.08	21.78	28.25
9	12.28	13.09	17.92
10	12.50	15.58	15.58

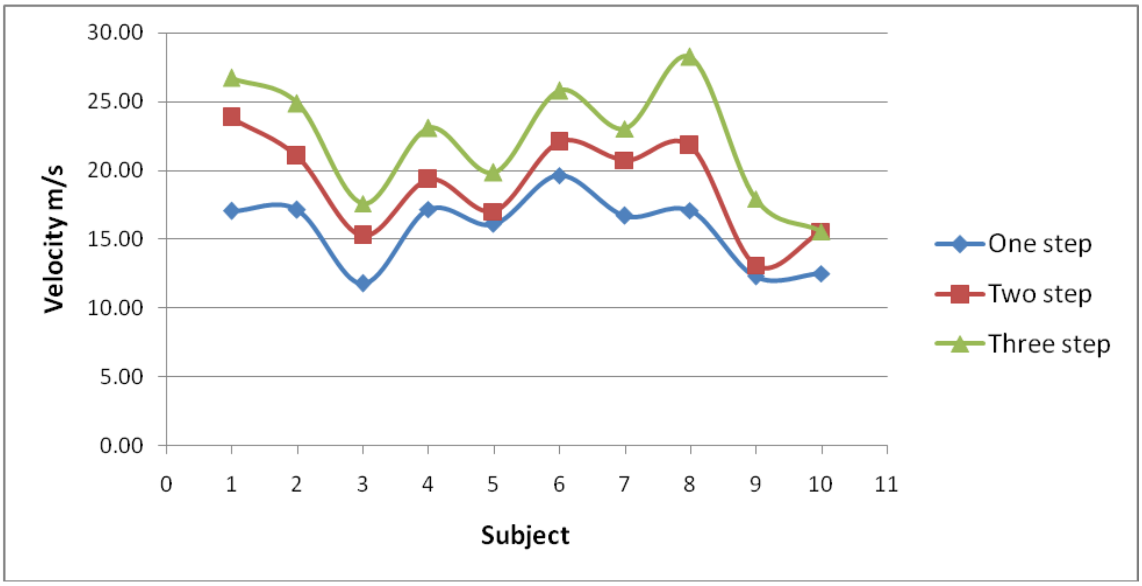

Figure 4.3: Ball velocity after impact graph

From the graphs of the ball velocity after impact of Figure 4.3, the graph also shows that most of the subjects produce maximum ball velocity after impact on three step run which is again by subject 8, 28.25 m/s while the lowest is on one step runs, 11.7 m/s by subject 3.

Table 4.6: Ball deformation data

Subject	One step (m)	Two step (m)	Three step (m)
1	0.0122	0.0153	0.0217
2	0.0093	0.0124	0.0153
3	0.0153	0.0183	0.0248
4	0.0093	0.0153	0.0186
5	0.0155	0.0155	0.0244
6	0.0093	0.0124	0.0155
7	0.0062	0.0122	0.0153
8	0.0124	0.0155	0.0217
9	0.0092	0.0122	0.0124
10	0.0061	0.0092	0.0092

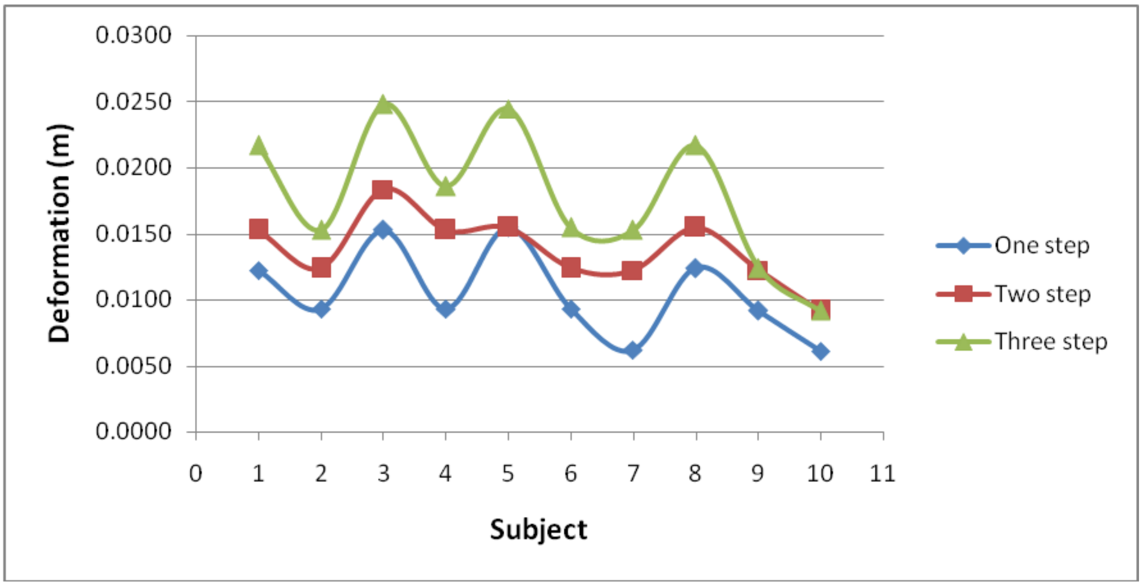

Figure 4.4: Ball deformation graph

Graph from Figure 4.3 show the subjects produce maximum ball deformation from subject 2 which is 0.0248 m. While the lowest ball deformation is on one step runs, 0.0061 m. The three step are produce higher ball deformation than other two type of step run.

Table 4.7: Coefficient of restitution data

Subject	One step	Two step	Three step
1	0.57	0.62	0.79
2	0.55	0.62	0.71
3	0.40	0.52	0.61
4	0.61	0.72	0.86
5	0.52	0.70	0.79
6	0.64	0.71	0.80
7	0.65	0.73	0.81
8	0.62	0.68	0.86
9	0.62	0.64	0.74
10	0.48	0.53	0.53

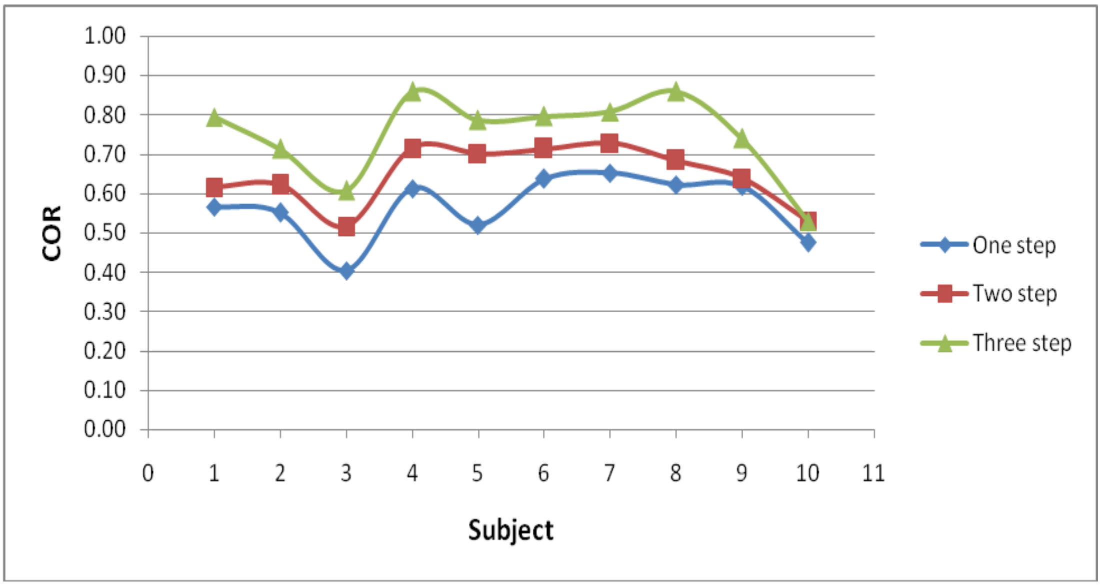

Figure 4.5: Coefficient of restitution graph

The coefficient of restitution of the ball shows the maximum coefficient of restitution is 0.86 perform by subject 8 on three step run kick. Meanwhile, the lowest coefficient of restitution are shown from subject 3 which is only 0.40.

4.4 STATISTICAL ANALYSIS OF KINEMATIC VARIABLES

The focus of the study in the kinematic variables obtained by the high speed camera analysis software were examined the linear velocities of the kicking leg velocity before impact and after impact, ball velocity after impact, ball deformation, and coefficient of restitution. These kinematic variables were calculated at the exactly during the leg contact the ball contact. The velocity of the ball was analyzed at the event of the ball take off from the leg. To get the valid value for the coefficient of restitution, the angle of the foot and the ball were calculated to get the resultant velocity on x-axis. For the leg velocity before impact and after impact, ball velocity after impact, ball deformation, and coefficient of restitution, a one-way ANOVA analysis with three factor (one step run, two step run and three step run) was applied to six respective value obtained for each kick, (18 value in total from the three types of kick) to determine the significant difference between the kinematics variable compared to the factor each other. Then the two-way (ANOVA) statistical analyses were used to determine the significant difference between the subject and the type of kicking step for each kinematics variable. For clarity and better understanding of the results found in this area it has been subdivided into the following headings:

(a) Linear velocity of the leg velocity before impact
(b) Linear velocity of the leg velocity after impact
(c) Linear velocity of the ball velocity after impact
(d) Correlation of the ball deformation
(e) Correlation of the coefficient of restitution
(f) Effect of same leg velocity before impact on kinematic variables
(g) Effect of leg velocity before impact on ball velocity after impact

4.4.1 One-way ANOVA of linear velocity of the leg velocity before impact (LVBI)

4.4.2

Table 4.8: Mean value of the leg velocity before impact

Subject	One step	Two step	Three step
1	15.11	19.91	20.37
2	16.45	17.92	19.46
3	11.23	12.15	14.19
4	16.05	15.99	16.04
5	14.29	14.56	15.05
6	16.64	17.34	18.50
7	14.23	16.73	17.19
8	15.48	16.69	20.98
9	10.95	10.98	14.19
10	12.16	14.55	14.55
Mean	14.26	15.68	17.05
SD	2.12	2.69	2.62

n.s. (One step vs. Two step) n.s. (Two step vs. Three step)

* (One step vs. Three step)

*: $p \leq 0.05$, **: $p \leq 0.01$, n.s.: no significant

Result from Table 4.8 shows the result of the leg velocity before impact for each subject. The result of the one-way ANOVA reveal a significant difference in effect between kicks (F (2, 18) = 18.39, $p \leq 0.05$). As a result of multiple comparisons, no significant difference between the one step kick and three steps kick both ($p \geq 0.05$) to the two step kick. Meanwhile, the three step kick ($p \leq 0.05$) was significantly higher than the one step kick.

4.4.3 One-way ANOVA linear velocity of the leg velocity after impact (LVAI)

Table 4.9: Mean value of the leg velocity after impact

Subject	One step	Two step	Three step
1	8.47	11.56	10.53
2	8.06	9.90	10.98
3	7.23	8.99	8.98
4	8.68	7.88	7.26
5	6.11	6.81	7.26
6	9.01	9.68	11.07
7	7.44	8.56	9.15
8	7.44	10.37	10.22
9	5.50	6.08	7.41
10	6.72	7.87	7.87
Mean	7.47	8.77	9.07
SD	1.13	1.67	1.56

n.s. n.s.

*

*: $p \leq 0.05$, **: $p \leq 0.01$, n.s.: no significant

Result from Table 4.9 shows the result of the leg velocity after impact for each subject. The result of the one-way ANOVA reveal a significant difference in effect between kicks (F (2, 18) = 12.56, $p \leq 0.05$). As a result of multiple comparisons, no significant difference between the one step kick and three steps kick both ($p \geq 0.05$) to the two step kick. Meanwhile, the three step kick ($p \leq 0.05$) was significantly higher than the one step kick.

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4.4.4 One-way ANOVA linear velocity of the ball velocity after impact (BVAI)

Table 4.10: Mean value of the ball velocity after impact

Subject	One step	Two step	Three step
1	17.03	23.83	26.71
2	17.13	21.03	24.88
3	11.77	15.26	17.61
4	17.17	19.33	23.07
5	16.10	17.01	19.83
6	19.62	22.05	25.79
7	16.72	20.74	23.03
8	17.08	21.78	28.25
9	12.28	13.09	17.92
10	12.50	15.58	15.58
Mean	15.74	18.91	22.67
SD	2.62	3.53	4.31

One step vs. Two step: *; Two step vs. Three step: n.s.; One step vs. Three step: *

*: $p \leq 0.05$, **: $p \leq 0.01$, n.s.: no significant

Result from Table 4.10 shows the result of the ball velocity after impact for each subject. The result of the one-way ANOVA reveal a significant difference in effect between kicks (F (2, 27) = 52.31, $p \leq 0.05$). As a result of multiple comparisons, the two step kick and three steps kick both ($p \leq 0.05$) were significantly higher than the one step kick to the two step kick. No significant difference was recognized between the two step kick and three steps kick.

4.4.5 One-way ANOVA correlation of the ball deformation (BD)

Table 4.11: Mean value of the ball deformation

Subject	One step	Two step	Three step
1	0.0122	0.0153	0.0217
2	0.0093	0.0124	0.0153
3	0.0153	0.0183	0.0248
4	0.0093	0.0153	0.0186
5	0.0155	0.0155	0.0244
6	0.0093	0.0124	0.0155
7	0.0062	0.0122	0.0153
8	0.0124	0.0155	0.0217
9	0.0092	0.0122	0.0124
10	0.0061	0.0092	0.0092
Mean	0.0104	0.0138	0.0178
SD	0.0033	0.0026	0.0052

* *

*

*: $p \leq 0.05$, **: $p \leq 0.01$, n.s.: no significant

Result from Table 4.11 shows the result of the ball deformation for each subject. The result of the one-way ANOVA for ball deformation, the result reveal a significant difference in effect between kicks (F (2, 18) = 45.86, $p \leq 0.05$). As a result of multiple comparisons, all the type of kick show the significant different between each other kick. The one step kick, two step kick, and three steps kick all show the p value below significant level, ($p \leq 0.05$). Means that, there a significant difference was recognized between the all the type of kick one step kick, two step kick and three steps kick.

4.4.6 One-way ANOVA correlation of the coefficient of restitution (COR)

Table 4.12: Mean value of the coefficient of restitution

Subject	One step	Two step	Three step
1	0.57	0.62	0.79
2	0.55	0.62	0.71
3	0.40	0.52	0.61
4	0.61	0.72	0.86
5	0.52	0.70	0.79
6	0.64	0.71	0.80
7	0.65	0.73	0.81
8	0.62	0.68	0.86
9	0.62	0.64	0.74
10	0.48	0.53	0.53
Mean	0.08	0.08	0.11
SD	0.56	0.65	0.74

* (One step vs Two step), * (Two step vs Three step), * (One step vs Three step)

*: $p \leq 0.05$, **: $p \leq 0.01$, n.s.: no significant

Result from Table 4.12 shows the result of the coefficient of restitution for each subject. The result of the one-way ANOVA for ball deformation, the result reveal a significant difference in effect between kicks (F (2, 18) = 56.20, $p \leq 0.05$). As a result of multiple comparisons, the ball deformation also show the significant different between each other kick. The one step kick, two step kick, and three steps kick all show the p value below significant level, ($p \leq 0.05$). A significant difference was recognized between the all the type of kick one step kick, two step kick and three steps kick.

4.4.7 Two-way ANOVA analysis of kinematic variables

Table 4.13: Test for Differences between Groups from Two-way Analysis of Variance

Variable	Source	df	Sum of Squares	Mean Square	F	p
LVBI	B	2	41.62	20.81	18.39	0.0001**
	W	18	20.37	1.13		
LVAI	B	2	14.59	7.29	12.56	0.0003*
	W	18	10.45	0.58		
BVAI	B	2	212.94	106.47	52.31	0.0001**
	W	18	36.63	2.04		
BD	B	2	0.0003	0.00014	45.86	0.0001**
	W	18	0.0001	2.99E-06		
COR	B	2	0.1690	0.0845	56.20	0.0001**
	W	18	0.0271	0.0015		
LVBI and	B	1	163.03	163.03	17.41	0.0001**
LVAI	W	54	505.63	9.36		

*: $p \leq 0.05$, **: $p \leq 0.01$, n.s.: no significant

The two-way (ANOVA) were analyzed to determine either the significant difference or not between the kinematic variables (linear velocities of the kicking leg velocity before impact and after impact, ball velocity after impact, ball deformation, and coefficient of restitution) compared to the all three type of step kick for each subject. From the analysis, all the result shows ($p \leq 0.05$), so there is the statically significant difference between all the kinematics variables compared to the all type of step kick. Result analysis of effect of leg velocity before impact on ball velocity after impact (LVBI and BVAI) will be described in more detail in the next sub topic.

4.4.8 Effect of Leg Velocity before Impact on Ball Velocity after Impact

In order to use to produce high ball velocity, the leg velocity before impact and velocity ball velocity after impact data will be synchronized and examine with the Two-way ANOVA analysis. Table 4.14 summarized the descriptive statistical values of leg velocity before impact and ball velocity after impact data. Figure 4.5 shows the regression statistics of leg velocity before impact and ball velocity after impact. From the figure it is evident that the fit was quite good with a R^2 value of 0.88. The regression line shows that the data of LVBI on BVAI it is positive linear correlation with the equation of $y = 0.573x + 4.803$. It means the ball velocity will increase with 0.573 m/s for each 1 unit of leg velocity before impact. Part of the two way ANOVA table presented in previous Table 4.13 revealed that there was a significant effect of LVBI on BVAI ($F (1, 54) = 17.41$, $p \leq 0.0001$). One step run, two steps run and three step run by itself affect the leg velocity and ball velocity. In other words, there is a significant difference when only considering the type of velocity (LVBI and BVAI) ($p = 0.0001$). There is also a significant difference when only considering between the type of step (1, 2, and 3) by itself ($p = 0.0001$). However, there is no significant difference when considering the different type of step (1, 2 and 3) and its relationship to the type of velocity (LVBI and BVAI) ($p = 0.1801$).

Table 4.14: Leg Velocity before Impact and Ball Velocity after Impact Data

Run type	**Leg Velocity Before Impact (LVBI), (m/s)**	**Ball Velocity After Impact (BVAI), (m/s)**
One Step	15.1	17.0
	16.5	17.1
	11.2	11.8
	16.1	17.2
	14.3	16.1
	16.6	19.6
	14.2	16.7
	15.5	17.1
	11.0	12.3
	12.2	12.5
Two Step	19.9	23.8
	17.9	21.0
	12.1	15.3
	16.0	19.3
	14.6	17.0
	17.3	22.1
	16.7	20.7
	16.7	21.8
	11.0	13.1
	14.6	15.6
Three Step	20.4	26.7
	19.5	24.9
	14.2	17.6
	16.0	23.1
	16.0	19.8
	18.5	25.8
	17.2	23.0
	21.0	28.2
	14.2	17.9
	14.6	15.6
Mean	15.70	18.99
SD	2.67	4.37

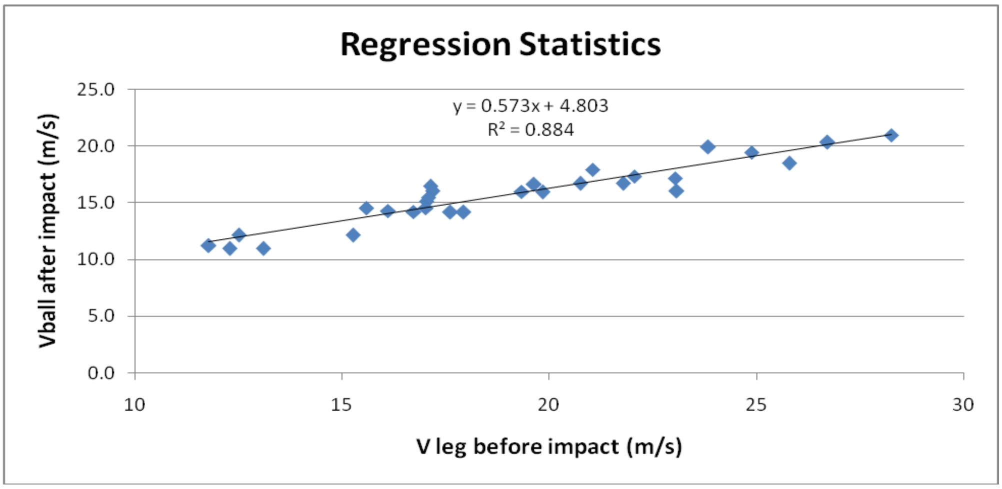

Figure 4.6: Regression Statistics of Leg Velocity before Impact and Ball Velocity after Impact

4.4.9 Effect of Kinematic Variable on same Leg Velocity before Impact

Table 4.15: Result comparison on same leg velocity

Characteristics	One step	Two step	Three step
Leg velocity before (m/s)	16	16	16
Max ball velocity (m/s)	17.18	19.33	23.07
Max ball deformation (m)	0.009	0.015	0.018
Force (N)	3809.89	4522.52	5378.95
COR	0.61	0.72	0.86

Result analysis from Table 4.15 presents the maximum ball velocity, ball deformation, force, and coefficient of restitution for each run type with same leg velocity before impact. One selected kicking velocity which is 16 m/s from the subject 4 were fix for each run type to make sure the kinematics variable value is homogeneous for each run type.. It was clear from the table, the maximum ball velocity, maximum ball deformation, force, and coefficient of restitution is found in three step run. The foot velocity before ball kicked is directly proportional with force imposed against the ball. In this analysis, the force resultant before ball kicked will be increased. The highest force for leg is 5378.95 N and the highest ball velocity is 23.07 m/s. Three steps run demonstrate higher ball speed values if compared to the one step and two step of kick. The maximum ball deformation and coefficient of restitution noted as 0.018 m and 0.86.

4.5 ANALYSIS OF ANTHROPOMETRY DATA

Table 4.16: Multiple regression analysis for influence of anthropometric data on coefficient of restitution (COR)

Anthropometry data	Mean (mm)	SD (mm)	p-value
Weight	56.69	5.35	0.5852
Stature	1698.00	29.00	0.9304
Lower leg length	424.90	20.40	0.5688
Ankle circumference (R)	225.90	10.18	0.4459
Heel ankle circumference (R)	330.80	9.52	0.3413
Ball of foot circumference (R)	248.80	8.05	0.3063
Instep circumference (R)	249.00	7.12	0.3958
Lateral malleolus height (R)	68.50	6.90	0.8697
Medial malleolus height (R)	86.20	2.78	0.9063
Foot length (R)	251.65	5.82	0.2902
Ball of foot length (R)	168.35	5.41	0.2126
Foot breadth (R)	98.94	4.45	0.1731
Bimalleolaar width (R)	69.36	2.97	0.9851
Heel breadth (R)	53.54	5.00	0.5562

According to Table 4.16, the multiple regression analysis showed the anthropometric data significantly contribute to coefficient of restitution (refer Table 4.7). Based on these results, all the p value of anthropometric data compared to the coefficient of restitution show the significant level, ($p \geq 0.05$). It shows that there is no significant between the anthropometric data and coefficient of restitution. However, right foot breadth shows the lowest value of p-value compare to other anthropometric characteristic.

4.6 ANALYSIS OF ELECTROMYOGRAPHY DATA

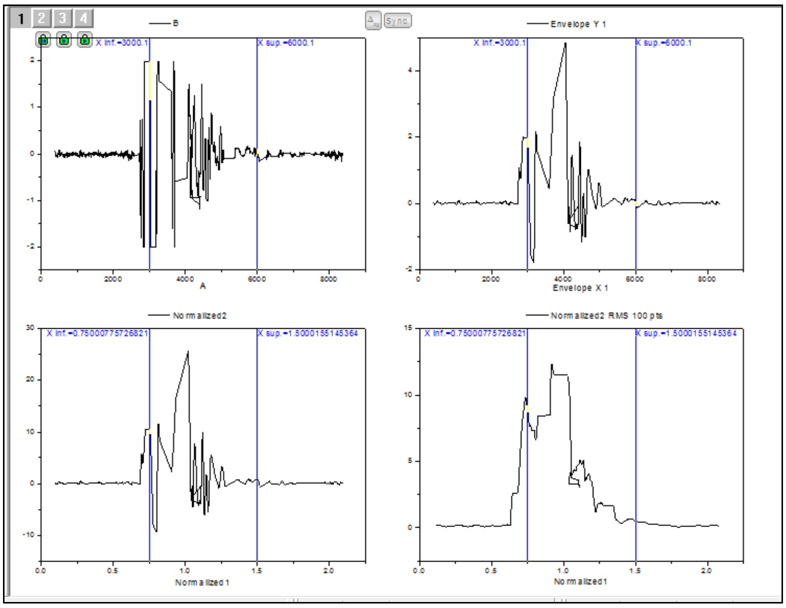

Figure 4.7: Filtering the Calves EMG raw data for subject 1

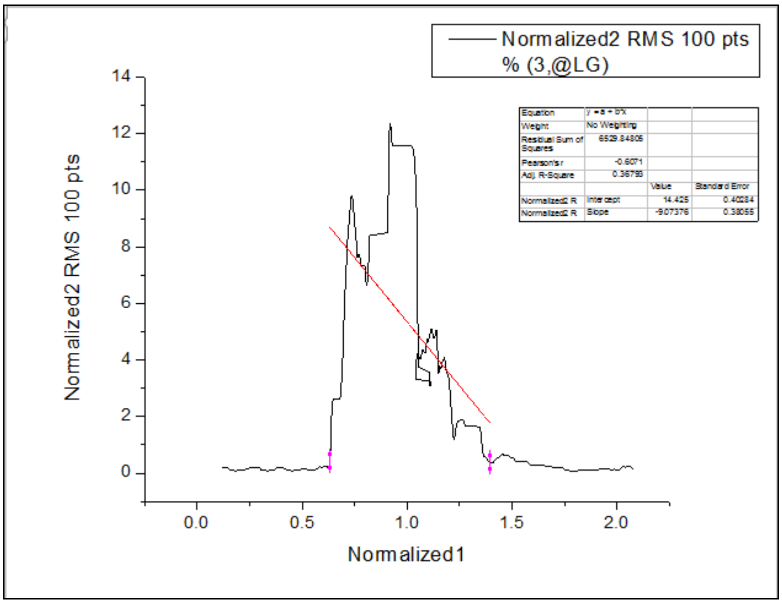

Figure 4.8: Regression line for Calves EMG data subject 1

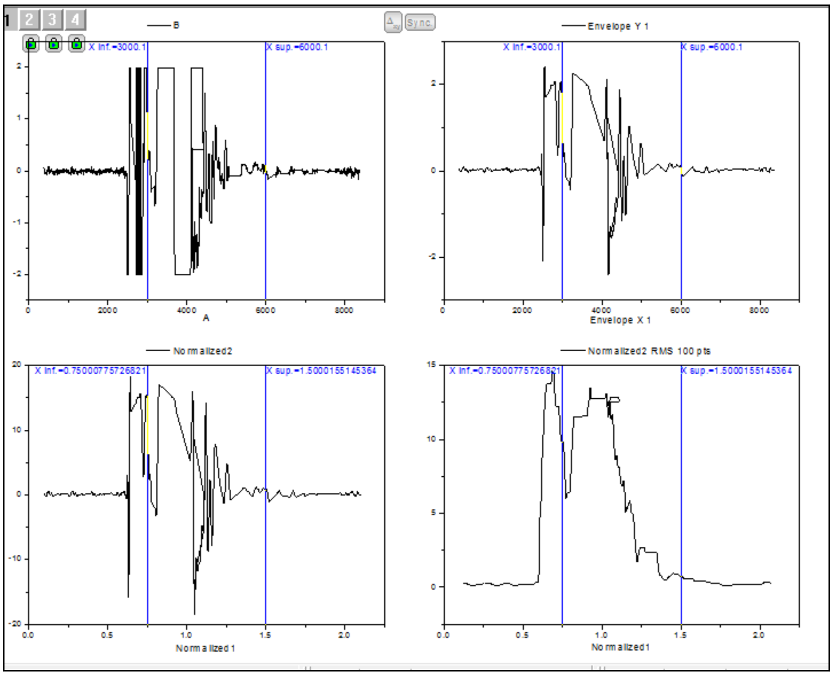

Figure 4.9: Filtering the Tibialis Anterior EMG raw data subject 1

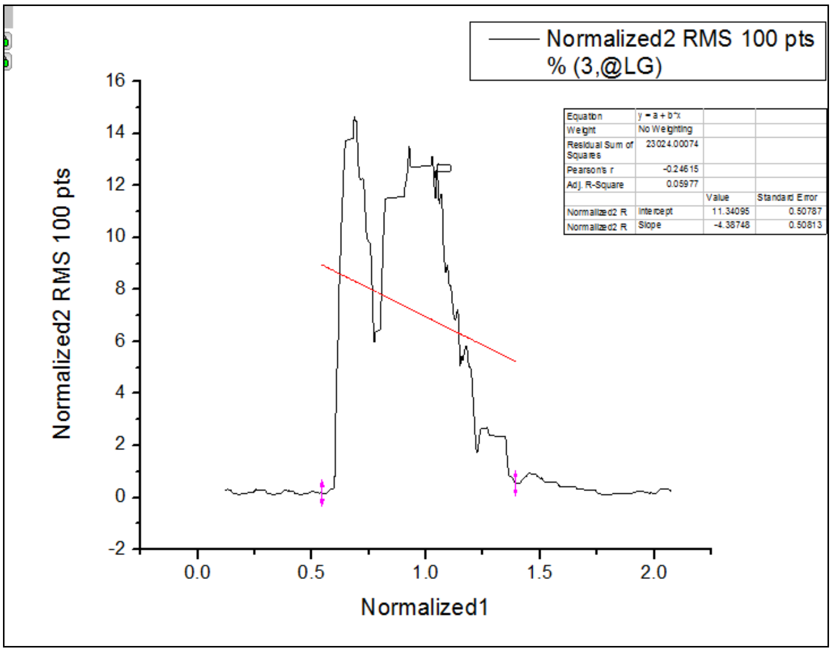

Figure 4.10: Regression line for Tibialis Anterior EMG data subject 1

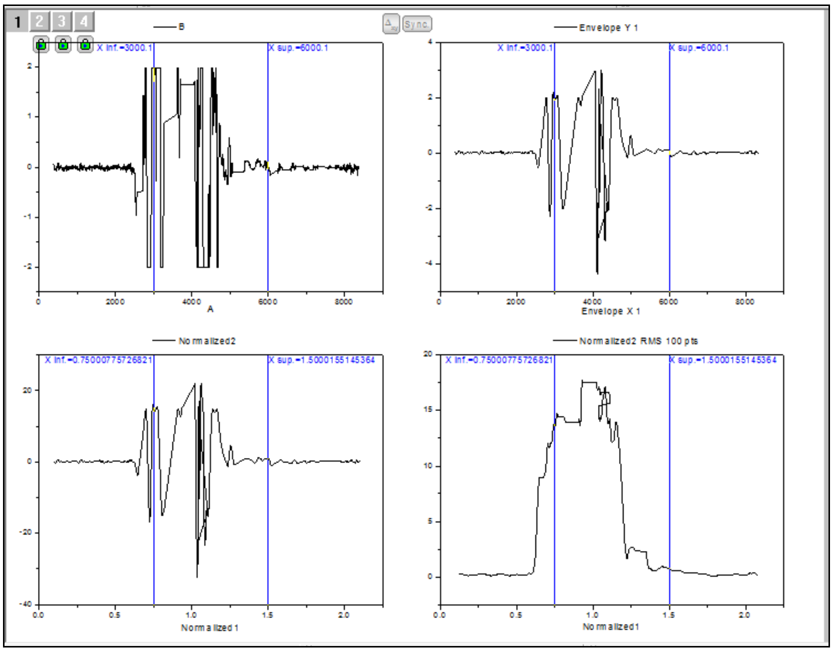

Figure 4.11: Filtering the Quadriceps EMG raw data subject 1

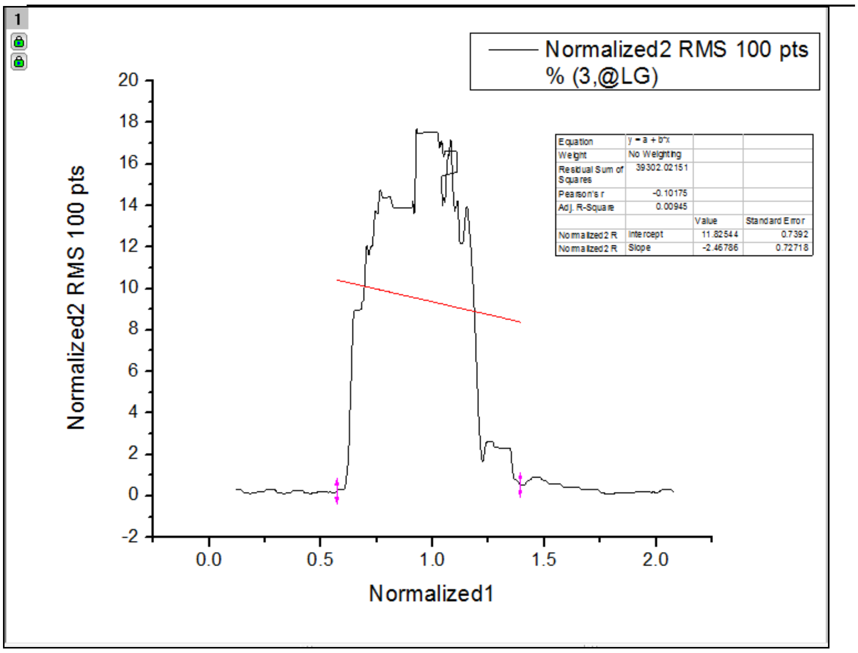

Figure 4.12: Regression line for Quadriceps EMG data subject 1

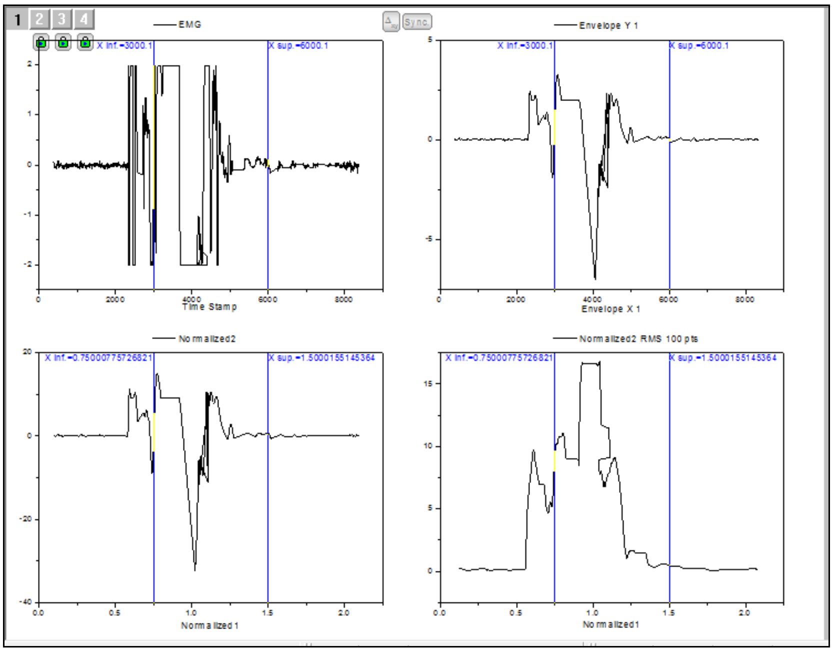

Figure 4.13: Filtering the Hamstring EMG raw data subject 1

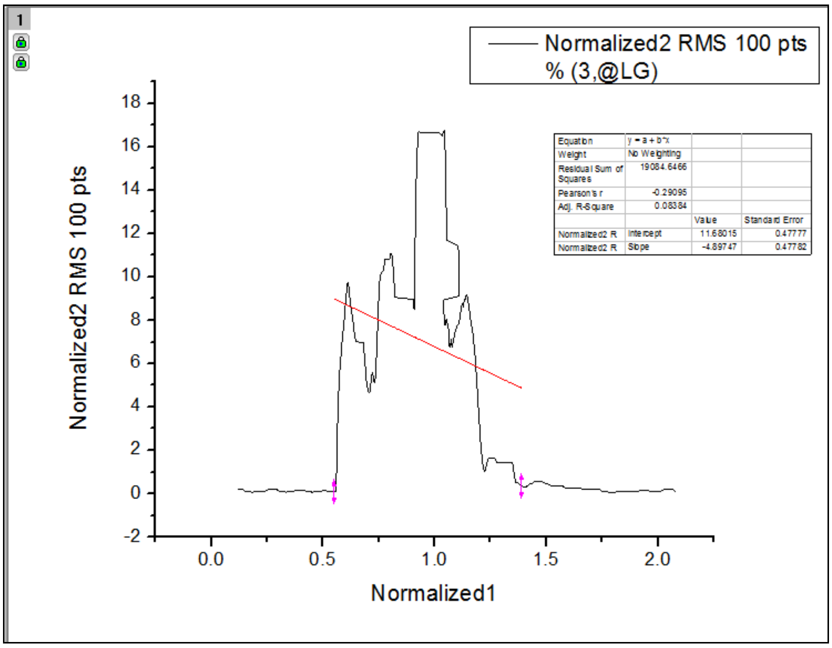

Figure 4.14: Regression line for Hamstring EMG data subject 1

Table 4.17: α coefficient and R^2 values for multiple subjects for one step run

	Calves		**Tibialis Anterior**		**Quadriceps**		**Hamstring**	
SUBJECT	**α**	**R^2**	**α**	**R^2**	**α**	**R^2**	**α**	**R^2**
1	-9.0738	0.3686	-4.3875	0.0606	-2.4679	0.0104	-4.8975	0.0847
2	-0.4196	0.0015	5.6805	0.0337	-0.3839	0.0030	-1.4760	0.0635
3	-1.0692	0.0004	-1.5071	0.0093	3.6092	0.0228	0.5307	0.0089
4	1.2839	0.2530	-5.7439	0.0724	29.4437	0.1370	-3.2980	0.0246
5	-6.2544	0.2937	-6.4793	0.0914	-3.5422	0.2010	-3.8229	0.0651
6	-11.0134	0.1630	-16.7436	0.0922	-2.7833	0.0345	1.0962	0.0387
7	-1.5968	0.0094	-4.3363	0.0580	1.6913	0.0161	1.0573	0.0196
8	-0.1781	0.0004	0.3808	0.0021	-1.1271	0.0181	1.1912	0.0020
9	-5.2391	0.0336	3.0964	0.0227	2.1991	0.0034	-10.6459	0.5182
10	0.0794	0.0001	-4.2518	0.1106	-5.7082	0.2276	82.5379	0.1001
Mean	-3.3481	0.1124	-3.4292	0.0553	2.0931	0.0674	6.2273	0.0925
SD	4.2642	0.1444	6.1295	0.0373	10.0235	0.0869	27.0672	0.1531

Table 4.18: α coefficient and R^2 values for multiple subjects two step run

	Calves		**Tibialis Anterior**		**Quadriceps**		**Hamstring**	
SUBJECT	**α**	**R^2**	**α**	**R^2**	**α**	**R^2**	**α**	**R^2**
1	-4.7333	0.0970	0.1046	0.1596	-0.0858	0.1155	-3.1510	0.1363
2	1.0991	0.0366	3.5992	0.3477	-0.7323	0.0116	-1.0015	0.1136
3	7.5225	0.2766	1.2710	0.0039	-5.5637	0.2806	0.8836	0.0087
4	0.3118	0.0046	3.8551	0.1801	-0.0510	0.0001	18.154	0.1575
5	-1.3397	0.0753	-0.3468	0.0029	1.1706	0.0055	-0.8558	0.0172
6	4.3983	0.1535	-4.3368	0.1683	1.9422	0.0334	0.8825	0.0261
7	3.9453	0.2337	2.6510	0.0056	0.5088	0.0141	-1.2766	0.0623
8	-1.1138	0.0414	1.5943	0.0502	-0.2012	0.0053	0.9125	0.0096
9	-7.3975	0.2570	-3.4214	0.0692	-1.4499	0.0234	-2.0545	0.0472
10	7.8059	0.2906	5.9176	0.0286	-1.3053	0.0393	2.3243	0.1208
Mean	1.0499	0.1466	1.0888	0.1016	-0.5768	0.0529	1.4817	0.0699
SD	4.9763	0.1097	3.2113	0.1116	2.0391	0.0867	6.0819	0.0570

Table 4.19: α coefficient and R^2 values for multiple subjects three step run

	Calves		Tibialis Anterior		Quadriceps		Hamstring	
SUBJECT	**α**	**R^2**	**α**	**R^2**	**α**	**R^2**	**α**	**R^2**
1	-1.1353	0.0012	-1.3197	0.0442	-0.6555	0.0194	0.5580	0.0034
2	1.6398	0.0286	3.2843	0.0427	-0.6063	0.0101	-2.0032	0.2033
3	4.7257	0.2245	1.2261	0.0067	0.7360	0.0076	0.0018	0.9661
4	0.9725	0.0070	-4.1419	0.0370	-6.2136	0.1050	-0.6183	0.0008
5	-4.3525	0.2710	3.5461	0.0394	-0.8886	0.0269	-0.8819	0.0319
6	4.3111	0.2463	1.5193	0.0316	-1.2009	0.0206	-1.7490	0.1348
7	11.5810	0.3198	4.9705	0.1928	0.0102	0.022E5	-1.7251	0.0485
8	0.6787	0.0277	-1.4142	0.0046	-9.5190	0.1345	-8.0372	0.2192
9	-17.5715	0.3999	-1.4150	0.0098	-3.2707	0.1003	-3.9642	0.0541
10	-2.6041	0.0501	-0.1914	0.0002	-7.0094	0.1430	-8.9060	0.2934
Mean	-0.1755	0.1576	0.6064	0.0409	-2.8618	0.0567	-2.7325	0.1956
SD	7.5616	0.1500	2.8114	0.0561	3.5075	0.0569	3.2742	0.2889

4.6.1 Result of Paired t-Test Between Different Type of Run

All the EMG data of the ten subjects were analyse using Origin Pro 8.5.1 to get the R^2 and α value. The raw data were filtering for four times to get the accurate data using the EMG toolbar as shown in Figure 4.8 – 4.15 for subject 1. Table 4.17, Table 4.18 and Table 4.19 shows the α coefficient for the one step, two step and three step run for the different subjects for the Calves, Tibialis Anterior, Quadriceps, and Hamstring. For α values obtained it can be seen that 41.67% of the values display positive linear correlations, while the other 58.3% reveal negative linear correlations. The R^2 values indicate how well the data represent in a straight line. While the α values is the slope of the graph present in the data. These results verify that the alpha values obtained were not a coincidence but a representation of those subjects performs the kick. To test the hypothesis that different type of step run did not significantly the kicking performance (null hypothesis), a two-tailed paired t-test was used to test the probability that the two from three sets of data came from the same source (Table 4.20 - 4.23).

Table 4.20: A two-tailed paired t-test for Calves

Pair	Mean Difference	t Statistic	Prob > |t|
1S & 2S	-3.17265	-1.25802	0.24004
2S & 3S	-1.22533	-0.68384	0.5113
1S &3S	4.39798	2.58701	0.02936*

* = Indicates significant ($p \leq 0.05$)

. The result of two-tailed paired t-test for Calves muscle from Table 4.20 shows there a significant difference (p = 0.02936) between one step run and three step run. However, there is no significant difference was recognized between pairing the one step run and two steps run also for pairing two steps run and three step run.

Table 4.21: A two-tailed paired t-test for Tibialis Anterior

Pair	Mean Difference	t Statistic	Prob > |t|
1S & 2S	-4.03558	-1.86136	0.09561
2S & 3S	-0.48237	-0.35203	0.73292
1S &3S	4.51795	2.44232	0.03722*

* = Indicates significant ($p \leq 0.05$)

The result of two-tailed paired t-test for Tibialis Anterior muscle from Table 4.21 shows there also a significant difference (p = 0.03722) between one step run and three step run. However, there is no significant difference was recognized between pairing the one step run and two steps run also for pairing two steps run and three step run.

Table 4.22: A two-tailed paired t-test for Quadriceps

Pair	Mean Difference	t Statistic	Prob > |t|
1S & 2S	4.95487	1.38497	0.19943
2S & 3S	-2.28503	-1.69879	0.12358
1S &3S	-2.66984	-0.81405	0.43663

The result of two-tailed paired t-test from Table 4.22 shows there no significant difference between one step run and two step run, two steps run and three step, and one step run and three step for Quadriceps muscle.

Table 4.23: A two-tailed paired t-test for Hamstring

Pair	Mean Difference	t Statistic	Prob > |t|
1S & 2S	8.95981	0.96548	0.35953
2S & 3S	-4.21422	-1.98095	0.07894
1S &3S	-4.7456	-0.54754	0.59732

The result of two-tailed paired t-test from Table 4.23 shows there also no significant difference between one step run and two step run, two steps run and three step, and one step run and three step for Quadriceps muscle. The two muscles of Calves and Tibialis Anterior are placed on the lower leg, while the Quadriceps and Hamstring are on the upper leg.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Considering the objective and the scope of this study the following conclusions were drawn from the investigation:

As a conclusion, step run of kicking has an important role to play while instep kick is being taken to make a maximum ball velocity. The three steps run were found to produce maximum ball velocity while, the minimum ball velocity to perform. In order to maintain maximum leg velocity after impact, football player should execute the kick using the three steps run. Highest leg velocity after impact was found for the three steps run. Three steps run produce maximum ball deformation and highest coefficient of restitution.

Different step run has significant effect on linear velocities of the kicking leg velocity before impact and after impact, ball velocity after impact, ball deformation, and coefficient of restitution. Most of the ANOVA analyses to the kinematics variable are indicates a significant difference that contributor to the cause of difference of step run. Based on the comparing anthropometric data to the coefficient of restitution, the result shows that there is no significant between the anthropometric data and coefficient of restitution.

The results from the two-tailed paired t-test shows no significant differences between the different types of step run of Quadriceps and Hamstring. However, significant difference was recognized between the one step run and three steps run for Calves and Tibialis Anterior. The two muscles of Calves and Tibialis Anterior are placed on the lower leg, while the Quadriceps and Hamstring are on the upper leg. Base on the findings, in order to produce a higher ball velocity, football athletes can use the results of this study to focusing on the strength of the two muscles of the lower legs which is Calves and Tibialis Anterior from the muscle in the upper leg, Quadriceps and Hamstring.

5.2 RECOMMENDATION FOR FUTURE RESEARCH

Based on the findings of the present investigation, the following recommendations are made for further research:

Examine the influence of the different step run on type of kicking (e.g. Toe Kick, Inside Kick, and Outside Kick) as well as dominant kicking leg. The experiment also can examine the relationship kinetic parameters such as distance covered by the ball and accuracy of the kick. Use of force platform in combination with kinematic data to aid in better understanding of the patterns of the movement and force resultant in a kicking motion and how different step run affect these results. The further study can repeat the present study with different population groups to examine gender and age effect at different skill levels (skilled and unskilled). This would provide invariant parameters for a kicking motion. A similar study may be conducted to investigate upper body kinematics due to different step run variations.

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APPENDICES

SURVEY FORM
RAW DATA OF KINEMATIC VARIABLES
ANTHROPOMETRY DATA
FLOW CHART
GANTT CHART

62 kg

Subject: (1)

Name: AZIZAN IKHWAN BIN ABD AZIZ

Syrvey on Soccer Shoes

1. Which one shoes that you can prefer when played in the game??

   a) Nike b) Adidas c) Puma

   Please describe why?

   Sebab dapat menjamal dan sesuai dengan kaki saya.

2. What position you played in the game?

   Defend

Survey on Kicking Step

1. Did the different kicking step effect to your kicking movement?

   a) YES b) NO

2. Did the different kicking step effect to your kicking force?

   a) YES b) NO

3. Which one the step you use are suitable?

   a) ONE b) TWO c) THREE

   Please explain.

   Kerana dapat membuat ~~tendater~~ ~~jarak~~ tendangan yang selesa dengan jarak itu.

49.8 kg

Subject: (2)

Name: WAN FAKHRUL FIRDAUS B WAN RUSLI

Syrvey on Soccer Shoes

1. Which one shoes that you can prefer when played in the game??

   a) Nike b) Adidas c) Puma

   Please describe why?

   Sebab ia lebih sesuai dengan kaki saya dan ~~saya~~ ia dapat mengawal bola dengan mudah.

2. What position you played in the game?

   Defender

Survey on Kicking Step

1. Did the different kicking step effect to your kicking movement?

   a) YES b)NO

2. Did the different kicking step effect to your kicking force?

   a) YES b) NO

3. Which one the step you use are suitable?

   a) ONE b) TWO c) THREE

   Please explain.

   Dapat membantu jarak yang sesuai untuk tendangan ~~tepat~~ yang tepat

61·2kg

Subject: 3

Name: AzRuL Amri bin ishak

Syrvey on Soccer Shoes

1. Which one shoes that you can prefer when played in the game??

   a) Nike b) Adidas c) Puma

   Please describe why?

   sebab dapat mengawal bola dan sesuai dengan kakisaya

2. What position you played in the game?

   Defender

Survey on Kicking Step

1. Did the different kicking step effect to your kicking movement?

   a) YES b)NO

2. Did the different kicking step effect to your kicking force?

   a) YES b) NO

3. Which one the step you use are suitable?

   a) ONE b) TWO c) THREE

   Please explain.

   kerana dapat memberikan jarak yang sesuai ~~bagi tendangan tepat~~

Subject: 4 59·5kg

Name: mustakim hakimi bin che halim

Syrvey on Soccer Shoes

1. Which one shoes that you can prefer when played in the game??

   a) Nike b) Adidas c) Puma

   Please describe why?

   kerana selesa dengan saya
   ....

2. What position you played in the game?

   striker
   ....

Survey on Kicking Step

1. Did the different kicking step effect to your kicking movement?

   a) YES b)NO

2. Did the different kicking step effect to your kicking force?

   a) YES b) NO

3. Which one the step you use are suitable?

   a) ONE b) TWO c) THREE

   Please explain.

   ....

Subject: (5) 57.3 kg

Name: MOHAMAD ZULFIKAR ILHAM B. ABDULLAH

Syrvey on Soccer Shoes

1. Which one shoes that you can prefer when played in the game??

   a) Nike b) Adidas c) Puma

   Please describe why?

   kerana sesuai dengan bentuk kaki

2. What position you played in the game?

   GK

Survey on Kicking Step

1. Did the different kicking step effect to your kicking movement?

   a) YES b) NO

2. Did the different kicking step effect to your kicking force?

   a) YES b) NO

3. Which one the step you use are suitable?

   a) ONE b) TWO c) THREE

   Please explain.

   ....

Subject: 6 (6-3/09)

Name: AIZAT B. HANAPI

Syrvey on Soccer Shoes

1. Which one shoes that you can prefer when played in the game??

   a) Nike b) Adidas c) Puma

   Please describe why?

   kerana kelas dengan saya

2. What position you played in the game?

   def

Survey on Kicking Step

1. Did the different kicking step effect to your kicking movement?

   a) YES b)NO

2. Did the different kicking step effect to your kicking force?

   a) YES b) NO

3. Which one the step you use are suitable?

   a) ONE b) TWO c) THREE

   Please explain.

   Tendangan lebih kuat

47·6 kg

Subject: 7

Name: Engku Muhammad Nur Shakir B. Engku Yacob.

Syrvey on Soccer Shoes

1. Which one shoes that you can prefer when played in the game??

   (a) Nike) b) Adidas c) Puma

   Please describe why?

   ......Sesuai dgn kaki Saya......

2. What position you played in the game?

   ......Med-fielder......

Survey on Kicking Step

1. Did the different kicking step effect to your kicking movement?

   (a) YES b)NO

2. Did the different kicking step effect to your kicking force?

   (a) YES b) NO

3. Which one the step you use are suitable?

   a) ONE b) TWO (c) THREE

   Please explain.

   ......tendangan lebih kuat

Subject: 8 55-8kg

Name: solahudin bin mahmud.

Syrvey on Soccer Shoes

1. Which one shoes that you can prefer when played in the game??

   a) Nike b) Adidas c) Puma

   Please describe why?

   kerana selesa dengan kaki saya.

2. What position you played in the game?

   Striker

Survey on Kicking Step

1. Did the different kicking step effect to your kicking movement?

   a) YES b)NO

2. Did the different kicking step effect to your kicking force?

   a) YES b) NO

3. Which one the step you use are suitable?

   a) ONE b) TWO c) THREE

   Please explain.

   Tendangan lebih padu dan kuat.

58.6 kg

Subject: 9

Name: muhammad ~~m~~ Fekry Azram B. Sharif

Syrvey on Soccer Shoes

1. Which one shoes that you can prefer when played in the game??

   a) Nike   b) Adidas   c) Puma

   Please describe why?

   kerana selesa dengan kaki saya

2. What position you played in the game?

   mid - field

Survey on Kicking Step

1. Did the different kicking step effect to your kicking movement?

   a) YES   b)NO

2. Did the different kicking step effect to your kicking force?

   a) YES   b) NO

3. Which one the step you use are suitable?

   a) ONE   b) TWO   c) THREE

   Please explain.

   Tendangan lebih kuat

Subject: 10

59.5kg

Name: Mohamad Firdaus bin Che Awang

Syrvey on Soccer Shoes

Kasut mana yang anda suka ketika bermain?

1. Which one shoes that you can prefer when played in the game??

   a) Nike ✓ b) Adidas c) Puma

   Please describe why? Nyatakan sebab-sebabnya

   Kerana ia selesa ketika saya pakai semasa bermain

Nyatakan posisi anda

2. What position you played in the game?

   def

Survey on Kicking Step

Adakah jenis-jenis sepak memberi kesan kepada pergerakan anda?

1. Did the different kicking step effect to your kicking movement?

   a) YES ✓ b)NO

Adakah jenis-jenis sepak mempengaruhi kekuatan sepak anda?

2. Did the different kicking step effect to your kicking force?

   a) YES ✓ b) NO

Pergerakan mana yang anda selesa

3. Which one the step you use are suitable?

   a) ONE b) TWO c) THREE ✓

   Please explain. Nyatakan sebab

   Tendangan lebih kuat

APPENDIX B

Raw data of kinematic variables for one step run

Subject	Def (m)	LVBI (m/s)	LVAI (m/s)	BVAI (m/s)	COR	Contact Time
1	0.0122	15.1121	8.4696	17.03	0.5664	0.0127
2	0.0093	16.4527	8.0563	17.13	0.5515	0.0192
3	0.0153	11.2290	7.2336	11.77	0.4041	0.0133
4	0.0093	16.0506	6.1129	17.17	0.6130	0.0192
5	0.0155	14.2949	8.6761	16.10	0.5197	0.0159
6	0.0093	16.6435	9.0145	19.62	0.6372	0.0190
7	0.0062	14.2287	7.4366	16.72	0.6525	0.0219
8	0.0124	15.4806	7.4366	17.08	0.6231	0.0131
9	0.0092	10.9505	5.5000	12.28	0.6189	0.0180
10	0.0061	12.1616	6.72	12.51	0.4755	0.0163
Mean	0.0105	14.2604	7.4658	15.7415	0.5662	0.0169

APPENDIX B (continued)

Raw data of kinematic variables for two step run

Subject	Def (m)	V Leg 1(m/s)	V Leg 2(m/s)	V Ball (m/s)	COR	Contact Time
1	0.0153	19.9056	11.5588	23.83	0.6163	0.0120
2	0.0124	17.9223	9.8961	21.03	0.6215	0.0162
3	0.0183	12.1475	8.9887	15.26	0.5162	0.0126
4	0.0153	15.9942	7.8830	19.33	0.7156	0.0178
5	0.0155	14.5605	6.8051	17.01	0.7012	0.0151
6	0.0124	17.3410	9.6793	22.05	0.7134	0.0178
7	0.0122	16.7316	8.5556	20.74	0.7285	0.0211
8	0.0155	16.6926	10.3748	21.78	0.6832	0.0123
9	0.0122	10.9831	6.0808	13.09	0.6385	0.0174
10	0.0092	14.5533	7.8748	15.58	0.5293	0.0155
Mean	0.0138	15.6832	8.7697	18.9706	0.6463	0.0158

APPENDIX B (continued)

Raw data of kinematic variables for three step run

Subject	Def (m)	V Leg 1(m/s)	V Leg 2(m/s)	V Ball (m/s)	COR	Contact Time
1	0.0217	20.3669	10.5253	26.71	0.7949	0.0127
2	0.0153	19.4645	10.9831	24.88	0.7139	0.0117
3	0.0248	14.1893	8.9820	17.61	0.6080	0.0117
4	0.0186	16.0401	9.2842	23.07	0.8597	0.0162
5	0.0244	15.9772	7.2596	19.83	0.7867	0.0159
6	0.0155	18.4993	11.0723	25.79	0.7955	0.0190
7	0.0153	17.1928	9.1464	23.03	0.8077	0.0219
8	0.0217	20.9783	10.2205	28.25	0.8592	0.0131
9	0.0124	14.19395	7.4110	17.92	0.7405	0.0180
10	0.0092	14.55325	7.8748	15.58	0.5293	0.0163
Mean	0.0179	17.1456	9.2759	22.2674	0.7496	0.0157

APPENDIX C

Anthropometry data

Subject	**1**	**2**	**3**	**4**	**5**
Weight (kg)	62	49.8	61.2	59.5	57.3
Stature (mm)	1701	1726	1717	1743	1678
Eye height (mm)	1580	1583	1580	1610	1567
Shoulder height (mm)	1406	1383	1394	1414	1363
Elbow height (mm)	1071	1011	1040	1066	1026
Knee height, midpatella (mm)	501	465	502	499	471
Calf height (mm)	356	338	338	455	330
Shoulder (biacromial) breadth (mm)	340	389	387	415	380
Chest breadth (mm)	266	285	320	295	282
Shoulder to elbow length (mm)	329	337	476	341	325
Forearm-fingertip length (mm)	476	460	368	464	458
Head length (mm)	170	175	179	175	175
Head circumference (mm)	530	567	567	555	555
Chest circumference (mm)	745	850	880	810	845
Thigh circumference (mm)	490	553	550	505	510
Calf circumference (mm)	333	375	363	344	365
Sitting height (mm)	809	827	784	844	859
Knee height (sitting) (mm)	517	513	543	527	508
Lower leg length (mm)	445	423	466	436	423
Ankle circumference (L) (mm)	218	240	237	223	225
Ankle circumference (R) (mm)	209	235	235	239	220
Heel ankle circumference (L) (mm)	321	338	352	326	316
Heel ankle circumference (R) (mm)	320	332	347	336	318
Ball of foot circumference (L) (mm)	235	252	257	255	246
Ball of foot circumference (R) (mm)	237	247	260	256	253
Instep circumference (L) (mm)	237	250	250	254	259
Instep circumference (R) (mm)	236	243	252	256	258
Lateral malleolus height (L) (mm)	76	76	72	76	72
Lateral malleolus height (R) (mm)	66	74	76	73	74
Medial malleolus height (L) (mm)	88	90	83	92	89
Medial malleolus height (R) (mm)	86	89	84	88	91
Foot length (L) (mm)	249.5	257.1	254.65	245.7	251.7
Foot length (R) (mm)	243.6	258.4	257.9	253	252
Ball of foot length (L) (mm)	153.6	177.5	175	163.8	168.3
Ball of foot length (R) (mm)	172.2	176	172.2	164	163.1
Foot breadth (L) (mm)	95.3	102.8	103.3	101.6	98.6
Foot breadth (R) (mm)	94	103	104.1	100.3	101.3
Bimalleolaar width (L) (mm)	67.2	72.4	72.8	72.5	68.1
Bimalleolaar width (R) (mm)	63.7	70	71	75.5	70.5
Heel breadth (L) (mm)	48.1	53.3	49.2	59	50.7
Heel breadth (R) (mm)	46	55.3	57.2	61.7	55.8

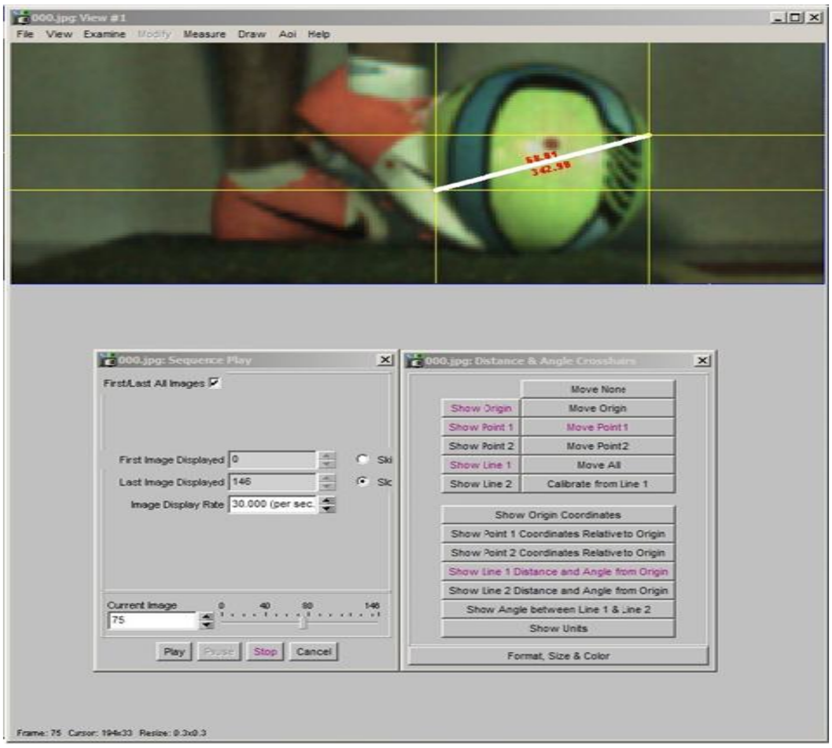
APPENDIX C (continued)

Anthropometry data

Subject	**6**	**7**	**8**	**9**	**10**
Weight (kg)	60.3	47.6	55.8	58.6	59.5
Stature (mm)	1681	1656	1682	1690	1675
Eye height (mm)	1545	1526	1556	1557	1542
Shoulder height (mm)	1357	1344	1351	1384	1356
Elbow height (mm)	1036	1008	1017	1056	1003
Knee height, midpatella (mm)	468	471	451	454	460
Calf height (mm)	323	335	311	313	293
Shoulder (biacromial) breadth (mm)	393	337	365	340	374
Chest breadth (mm)	305	243	280	280	305
Shoulder to elbow length (mm)	316	330	331	338	348
Forearm-fingertip length (mm)	456	433	470	458	460
Head length (mm)	183	173	173	182	175
Head circumference (mm)	555	542	515	562	555
Chest circumference (mm)	850	710	840	810	870
Thigh circumference (mm)	535	460	538	540	520
Calf circumference (mm)	390	335	350	375	359
Sitting height (mm)	825	805	968	879	872
Knee height (sitting) (mm)	494	503	466	492	475
Lower leg length (mm)	413	428	394	411	410
Ankle circumference (L) (mm)	242	241	212	225	233
Ankle circumference (R) (mm)	236	218	216	223	228
Heel ankle circumference (L) (mm)	342	331	325	334	334
Heel ankle circumference (R) (mm)	342	334	323	324	332
Ball of foot circumference (L) (mm)	245	246	236	254	256
Ball of foot circumference (R) (mm)	249	255	236	243	252
Instep circumference (L) (mm)	243	242	237	247	259
Instep circumference (R) (mm)	247	251	243	247	257
Lateral malleolus height (L) (mm)	70	72	69	70	64
Lateral malleolus height (R) (mm)	72	71	56	64	59
Medial malleolus height (L) (mm)	86	79	81	84	85
Medial malleolus height (R) (mm)	82	83	85	87	87
Foot length (L) (mm)	248.3	250	246.6	242.7	254
Foot length (R) (mm)	254.7	253.6	247.7	240.9	254.7
Ball of foot length (L) (mm)	176.9	166	172.2	160.7	167.2
Ball of foot length (R) (mm)	170.5	157.7	169.8	167	171
Foot breadth (L) (mm)	97.4	102.2	93.5	96.6	101
Foot breadth (R) (mm)	96.6	103	91.7	94.1	101.3
Bimalleolaar width (L) (mm)	68.4	64.6	67.9	70	67.3
Bimalleolaar width (R) (mm)	68.6	68.5	68.6	67.5	69.7
Heel breadth (L) (mm)	67.7	53.6	55.6	53.1	50.3
Heel breadth (R) (mm)	58.5	53	49.7	49.9	48.3

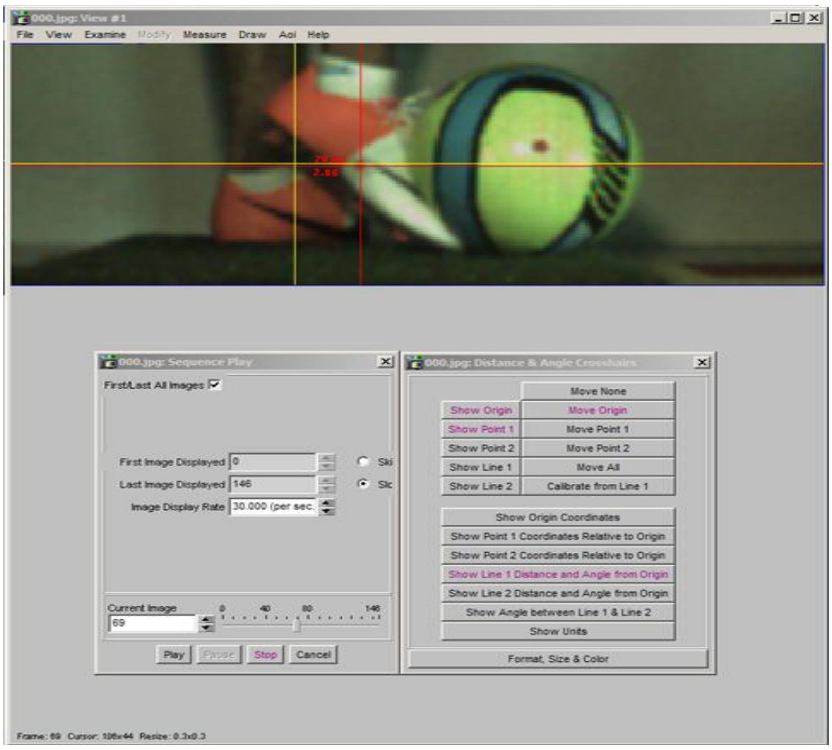
APPENDIX D

BALL DEFORMATION CALCULATION USING HIGH SPEED CAMERA SOFTWARE



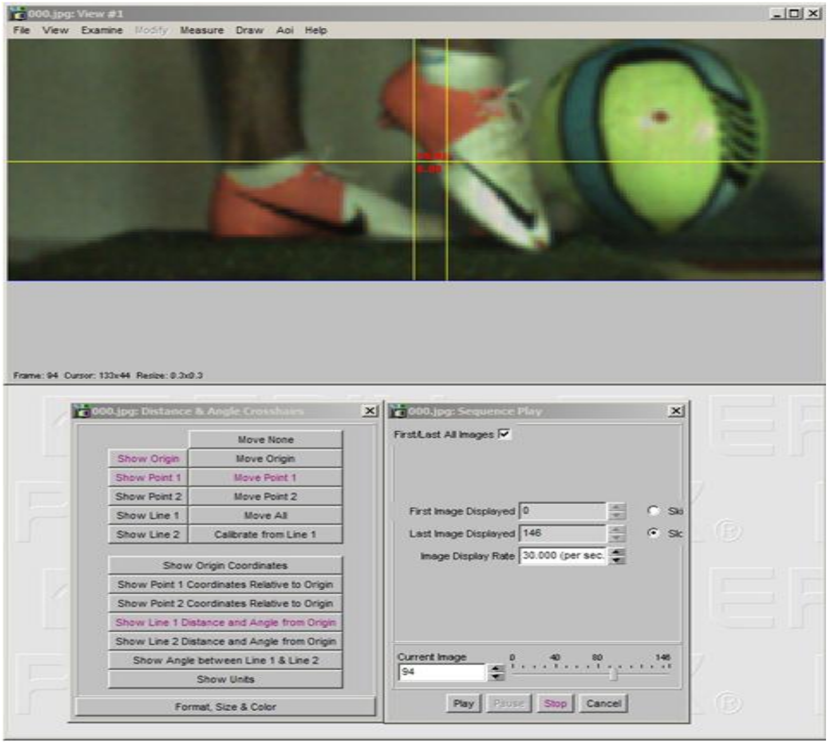
APPENDIX D (continued)

LVBI CALCULATION USING HIGH SPEED CAMERA SOFTWARE



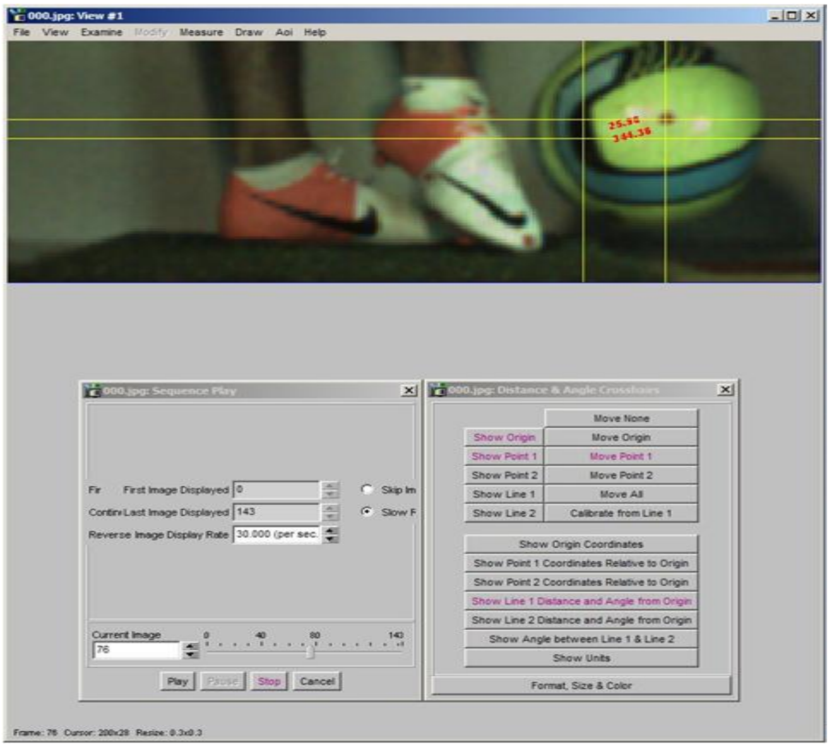
APPENDIX D (continued)

LVAI CALCULATION USING HIGH SPEED CAMERA SOFTWARE



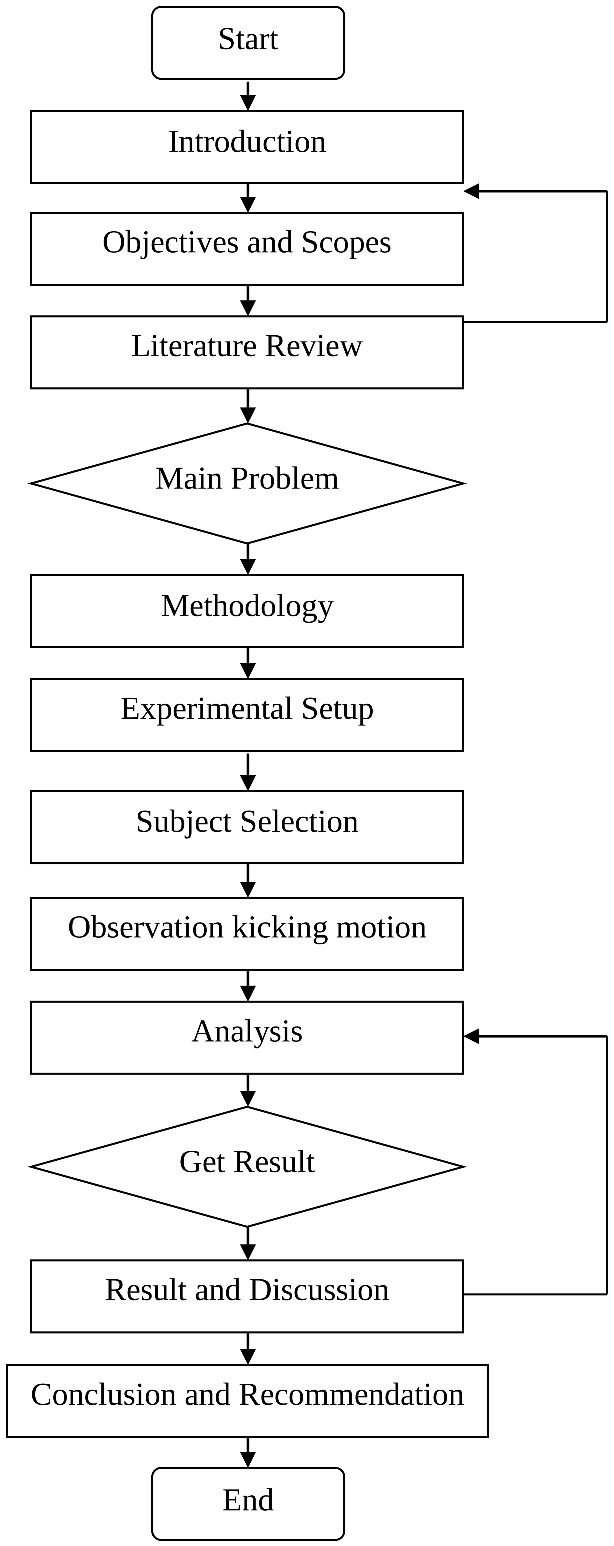
APPENDIX D (continued)

BVAI CALCULATION USING HIGH SPEED CAMERA SOFTWARE



APPENDIX D

FLOW CHART



APPENDIX E

GANTT CHART FYP 1

Bil.	Task		Week													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Choose Supervisor discuss topic	Plan														
		Actual														
2	Register Title and Prepare Journal	Plan														
		Actual														
3	Literature Review (overall flow chart)	Plan														
		Actual														
4	Literature Review (research past experiment)	Plan														
		Actual														
5	Prepare for project proposal	Plan														
		Actual														
6	Submit proposal and Slide presentation	Plan														
		Actual														
7	Prepare for Progress Presentation PSM 1	Plan														
		Actual														
8	Progress Presentation PSM 1	Plan														
		Actual														
9	Methodology (design experiment setup)	Plan														
		Actual														
10	Methodology (design experiment setup)	Plan														
		Actual														
11	Methodology (Testing)	Plan														
		Actual														
12	Methodology (expected outcomes)	Plan														
		Actual														
13	Report for PSM 1 and log book	Plan														
		Actual														

APPENDIX E

GANTT CHART FYP 2

Bil.	Task		Week													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Meet supervisor to discuss about PSM 2	Plan														
		Actual														
2	Literature Review (finalize study)	Plan														
		Actual														
3	Progress Presentation	Plan														
		Actual														
4	Methodology (Testing)	Plan														
		Actual														
5	Prepare for project proposal	Plan														
		Actual														
6	Methodology (design experiment setup)	Plan														
		Actual														
7	Methodology (Experiment with MSNT atlet)	Plan														
		Actual														
8	Result and Discussions	Plan														
		Actual														
9	Prepare for Progress Presentation 2	Plan														
		Actual														
10	Progress Presentation 2	Plan														
		Actual														
11	Prepare for Final Presentation PSM 2	Plan														
		Actual														
12	Final Presentation PSM 2	Plan														
		Actual														
13	Report for PSM 2 and log book	Plan														
		Actual														