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The Effect of Foot Angle in Soccer Ball Kick Due to Ball Trajectory

Gatut Rubiono[1]✉, Ikhwanul Qiram[2]

Mechanical Engineering, Universitas PGRI Banyuwangi, Indonesia[12]

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Abstract

This study is aims to get the influence of the foot angle in soccer kick on the motion of the ball. The research was carried out by making a leg swing device such as an impact test on material testing. The independent variables include foot angle: 0o (straight to the ball), 25o, and 35o (inner and outer legs) and the angle of swing arm: 45o, 60o, and 75o. The dependent variable is the ball path observed and recorded with the camera. Experimental data was carried out on a cement floor with a length of 5 meters. Five times repetition data collection are done to get the average value. Analysis is carried out to obtain the trajectory characteristics in the form of angles of spherical trajectories. The distance of the trajectory and the time indicated on the recording data is used to calculate the ball velocity. Swing angle data is used to calculate the amount of kick force with the equation of impact energy. The results show that the angle of the foot in the kick of football affects the trajectory of the ball motion. The angle of the foot affects the angle of the ball deviation, the velocity of motion and the energy absorbed by the ball.

How to Cite

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✉ Correspondence Author:
E-mail: g.rubiono@fdi.or.id

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INTRODUCTION

Football is the most popular sport in the world so it is often referred to as the world game. This sports branch has 208 football-affiliated organizations (Alcock AM, 2010). It is estimated that there are 200 million active players who play football (Castellanos OL, et al, 2014). Football is a sport that uses the main strategy of attacking in a match and a team with lots of targeted kick so that it has the opportunity to score and win matches (Bal BS, et al, 2011).

The basic motion of football is bait and kick the ball using the foot. During the 90 minutes of the match, an average player makes contact with the ball 51 times, 26 times using the foot (Castellanos OL, et al, 2014). Kick is a movement that is widely developed. Standard kick techniques include accuracy, distance and velocity (Kadirgama K, et al, 2013). The kick technique is needed according to the match situation where it is divided into silent ball kicks and moving balls (Sterzing T, 2010).

Kick is undoubtedly the subject of many players' ability to do football. Kicks are the most fundamental and most commonly used part of the ability. Furthermore, a soccer player or athlete uses a kick that involves complex interactions between the angular approach to the ball, the foot contact (SFC) support stage and the ground accompanied by the displacement of the momentum of the limb swinging to kick (Bal BS, et al, 2011).

A kick in football is an individual's ability to show the efficiency of an attack and the outcome of a match. The velocity of the kick is not only important in terms of attack but also in passing the ball over longer distances. This can be an opportunity for a midfielder to determine the situation on the field. Kick becomes the most interesting object in scientific studies (Maly T, et al, 2015).

Football kick research has been carried out and is still an interesting research topic and is still developing in innovative research (Sterzing T, 2010). The study was conducted for curvilinear kicks (Carre MJ, et al, 2002 and Asai T, et al, 2002), penalty kick kinematic analysis (Goktepe A, et al, 2008), the effect of the initial angle on penalty kick accuracy and kinematics (Scurr J, Hall B, 2009), hull / volleyball kick (Linthorne NP, Patel DS, 2011), biomechanics of long distance kick (Bal BS, et al, 2011), kinematics and ball impact dynamics (Nunome H, et al, 2012), performance kicks (Maly T, et al, 2015) and kinematics for predicting the direction of penalty kicks (Li Y, et al, 2015).

One type of kick that is mostly done is kicking with the inner leg. This research was conducted for the accuracy of kinematics (Bubanj S, et al, 2010), kinematics comparison (Gheidi N, Sadeghi H, 2010), biomechanical analysis (Barfield WR, et al, 2002 and Ismail AR, et al, 2010), the effect of velocity static foot stretching (Workman CD, 2010), the effect of knee motion (Kadirgama K, et al, 2013), kick comparison (Bjelica D, et al, 2013), kinematics analysis (Kapidzic A, 2014) and motion and biomechanics analysis (Castellanos OL, et al, 2014).

Analysis of the trajectory of ball motion is also very important to do in football. A player who does a free kick or corner kick will give a force that can make the ball move (spin). But the ball may only rotate slightly and tend to bend (Goff JE, Carré MJ, 2009). Ball motion studies can be used to improve ball kicking techniques called curve kicks (Asai T, et al, 2002).

Based on the description of the background above, it is necessary to research which studies the kick of the ball. This study aims to get the influence of the foot angle in soccer kick on the motion of the ball. The study was conducted by experimentally influencing the angle of the foot as a form of kick technique using the inner legs and outer legs. Experiments were carried out using a foot model. Ball trajectory is observed as a form of curvilinear motion that occurs due to foot force.

METHOD

Previous research shows that soccer kicks have been examined in terms of players and balls. This study was arranged based on the concept that soccer kick can be considered as an impact force (shock) concerning an object. Impact tests in the science of physical properties using a pendulum swing that breaks the test object with impact force. Football kicks can be investigated using the impact test principle where the ball is considered a workpiece material and the foot is considered a swing arm with a pendulum load. The independent variables include the angle of the foot: 0^o (straight to the ball), 25^o, and 35^o. The swing arm of the tool includes 45^o, 60^o, and 75^o. The dependent variable is the ball track observed and recorded with the camera. The track uses a cement floor.

Analysis is carried out to obtain the trajectory characteristics in the form of angles of ball trajectory. Repetition of data collection is done to get the average value. With this analysis there will be a relationship between the angle of the foot and the angle of the track. While the swing angle data is used to calculate the magnitude of the kick force with the equation of shock or impact, where the energy absorbed in Joule units is (Handoyo Y, 2013):

E = m. g. □ (cos □ - cos □) (1)

With m is the weight of pendulum (kg), in this case the foot and soccer shoes, g is gravity constant (9.81 m/s^2), □ is the length of the swing arm (m), cos □ is initial angle position of the pendulum, in this case the foot model and cos □ is end position of the pendulum angle, in this case the foot model.

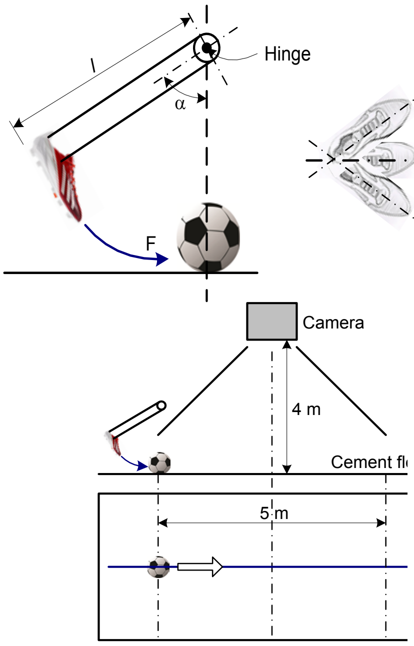

Figure 1. Experimental setup

RESULT AND DISCUSSION

Ball motion recording data is processed to get the photos of the ball position at 1 meter interval on the trajectory. **Figure 2** shows an example of ball track photos for foot angle of 35°, initial arm angle of 45°. The figure shows ball positions at 0, 1, 2, 3, 4 and 5 meter distance.

Table 1. Ball deviation for instep kick with foot angle of 35°, initial arm angle of 45°

X	Y
0	0
1	0,10
2	0,25
3	0,35
4	0,51
5	0,62

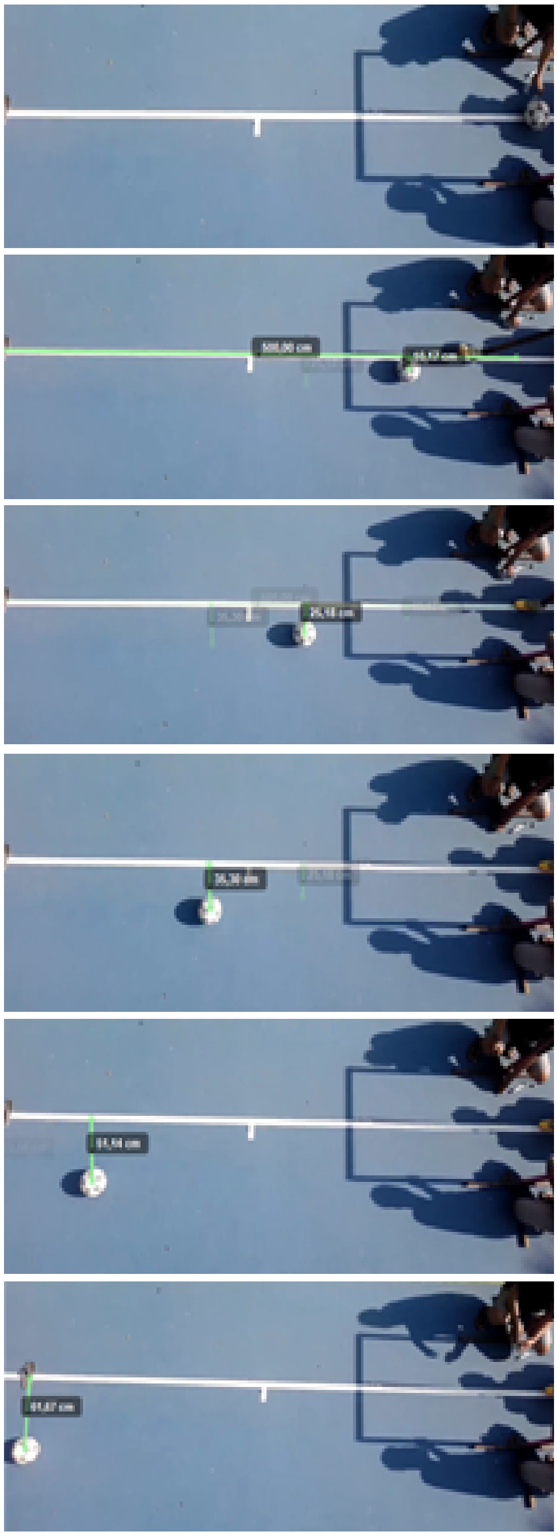

Figure 2. Photograph of ball position with foot angle of 35°, initial arm angle of 45°

The photos above are processed with Kinovea 0.8.15 to get the junction distance. Data processing results are shown in **Table 1** below.

The data in **Table 1** is then plotted into a graph with Microsoft Excel. The regression line is added to get the graph line equation. This equation is the trajectory of the motion of the ball. This path can be seen in **Figure 3.**

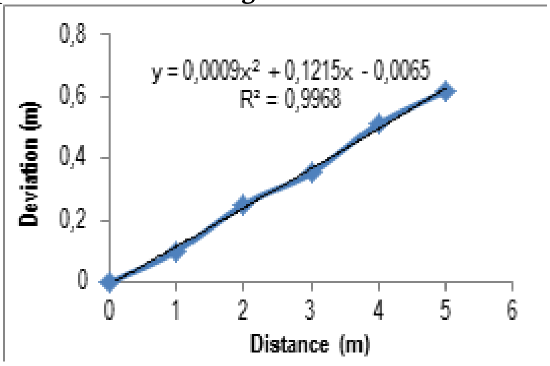

Figure 3. Ball trajectory and its regression

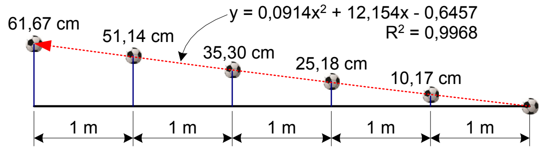

Figure 4. Example of ball trajectory line

The ball deviation data at a distance of 5 meters total distance is then used to calculate the magnitude of the angular angle using the tangential angle formula. The calculation results are shown in **Table 3**. The time data is used to calculate the velocity of the ball where velocity is the result of the distance divided by time. The calculation results are shown in **Table 4**. The initial

Table 2. Experimental data

Iniatial arm angle (0°)	Arm & angle (0°)	Kicking type	Foot angle (0°)	Ball deviation (cm)	Time (s)
45	42,27	Straight	0	3,32	2,23
45	40,64	Instep	25	35,63	4,23
45	38,96	Instep	35	63,43	4,15
45	42,73	Out step	25	71,38	5,24
45	41,26	Out step	35	79,20	5,38
60	57,20	Straight	0	4,05	2,08
60	56,27	Instep	25	39,42	3,92
60	54,98	Instep	35	86,65	4,27
60	57,92	Out step	25	81,78	4,97
60	56,19	Out step	35	111,63	5,04
75	72,21	Straight	0	1,26	2,01
75	71,28	Instep	25	49,80	3,31
75	70,59	Instep	35	101,42	3,16
75	73,04	Out step	25	84,29	4,64
75	71,65	Out step	35	129,01	4,70

Table 3. Angle of ball deviation (degree)

Arm angle (0°)	Straight kick	Instep Kick 25°	Out step Kick 25°	Instep Kick 35°	Out step Kick 25°
45	0,38	4,09	8,24	9,15	9,15
60	0,46	4,53	9,46	10,03	13,01
75	0,14	5,73	9,75	11,78	15,12

Table 4. Ball velocity (m/s)

Arm angle (0°)	Straight kick	Instep Kick 25°	Out step Kick 25°	Instep Kick 35°	Out step Kick 25°
45	2,24	1,18	0,95	1,20	0,93
60	2,40	1,28	1,01	1,17	0,99
75	2,49	1,51	1,08	1,58	1,06

Table 5. Energy absorb by the ball (Joule)

Arm angle (0°)	Straight kick	Instep Kick 25°	Out step Kick 25°	Instep Kick 35°	Out step Kick 25°
45	0,69	1,08	0,58	1,48	0,94
60	0,87	1,16	0,65	1,55	1,18
75	0,98	1,30	0,69	1,54	1,17

and final swing angle data are used to calculate the energy absorbed by the ball using equation (1). The calculation results are shown in **Table 5**.

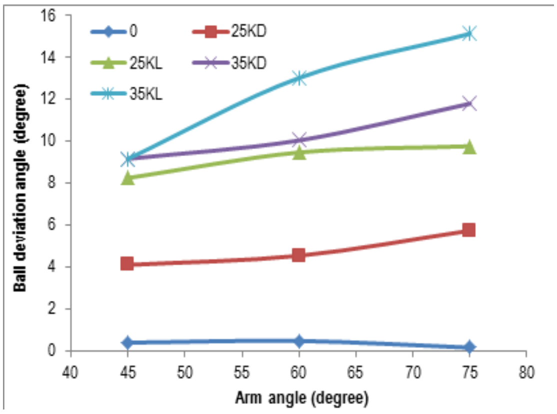

Figure 5. Angle of ball deviation

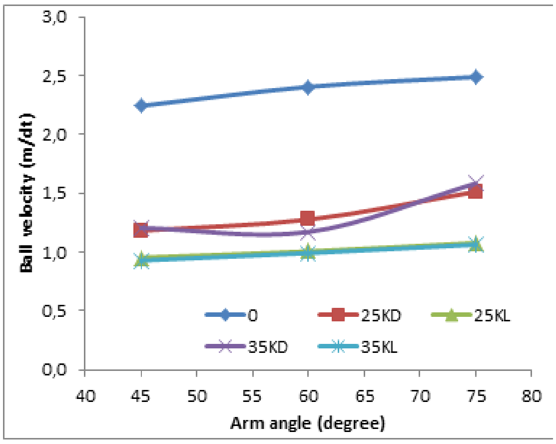

Figure 6. Ball velocity

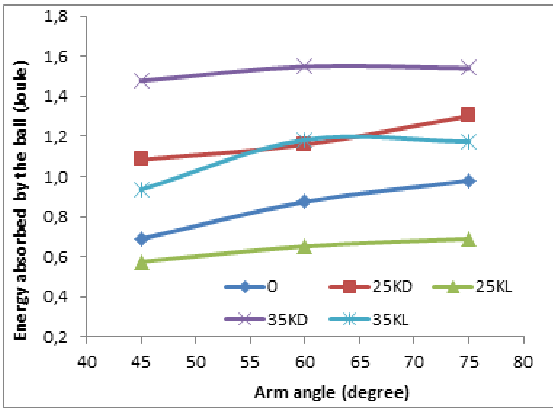

Figure 7. Energy absorbed by the ball

The graph in **Figure 5** shows that the angle of the ball deviation tends to increase with the increasing of a swing angle. This is because the increasing of the swing angle provides greater impact force on the ball. The graph also shows that the variation of the outside leg kick tends to produce a greater angle of deviation compared to the variation of the inner leg and straight leg.

The graph in **Figure 6** shows that the greater the swing angle, the greater the ball velocity. This phenomenon is similar to changes in the angle of deviation. Larger swing angles also provide greater external force so that the ball moves faster. Variations in straight leg kicks tend to have greater velocity than variations of the outer legs and deep legs.

The graph in **Figure 7** shows that the greater the swing angle, the energy absorbed by the ball tends to increase. This is consistent with the phenomenon of angular angle and spherical velocity. A larger swing angle causes the outer force in the form of impact that works on the ball to be larger. This greater force becomes the form of energy absorbed by the ball. This absorbed energy is then converted into kinetic energy in the form of velocity of motion that affects the trajectory of the motion of the ball.

CONCLUSION

Based on data processing and analysis, it can be concluded that the angle of the foot in the soccer kick affects the trajectory of the motion of the ball. In this case, the angle of the foot affects the angle of the ball deviation. The outer leg kick tends to produce a greater angle of deviation compared to the variation of the inner leg and straight leg. In addition, the angle of the foot also affects the speed of motion and energy absorbed by the ball.

Similar research or further research can be developed to get the optimum angle in soccer kicks.

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