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Study about Backhand Short Serve in Badminton Based on the Euler Angle

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Abstract-Service plays an important role to start a game of badminton. One of the service type is backhand short service. In this research, study about how the arm movement for backhand short service was done. Four motionnode sensors were attached to human arm each on the dorsal area of hand (sensor 1), wrist (sensor 2), elbow (sensor 3) and shoulder (sensor 4). The Euler angle was processed by gradient method. Two certified coaches and 3 professional players participated in this research. They were asked to serve the shuttlecock five times. The pattern of arm movement determined from the coaches stroke and the The result showed that there were two types of arm movement while backhand short serving. Players could serve the ball with only the movement in the dorsal area of the hand. The player could also move the sensor 1, 2 and 3 to this serve skill. There was about 85% similarity of the player's skill compared to the coaches' or 15% arm movement of young players were unrecognized as short serve. The model could be used by players to evaluate their skills.

Keyword: badminton, backhand short service, local Euler angle, pattern

I. INTRODUCTION

Many researchers used computer vision to analyze badminton game. A sequence of 2-D images was investigated to determine the shuttlecock trajectories of movement during the game. Then the stroke type was defined based on the shuttlecock trajectories [1]. Another automatic stroke recognition was also developed using video. The badminton stroke was recognized to be either smash, forehand, backhand or other based on the dense trajectories of body movement using SVM classifier [2].

Arm and trunk actions in overhead forehand strokes were studied among students with four skill levels [3]. The participants were recorded while striking the shuttlecock with overhead forehand skill. The results showed that the patterns of the steps for the arm and trunk were only mapped the skill levels among the beginner players.

Smash is one of the techniques that should be handled by a badminton player. The sensory system was developed using a 2-axes piezoelectric accelerometer and an acoustic sensor on the head of racket to investigate the smash by [4]. The result showed that using fuzzy inference system and ANFIS sensor the performance of smash was successfully analyzed.

Study about EMG on the extremity of badminton player while performing smash was studied by [5]. Four professional young players were the subject of this research. Two high speed cameras were used to record 3D movement of the subject. The results showed that the average speed of the racket was 42.37 m/s and the subject touched the shuttlecock 2.64 m above the floor. Rectur Femoris and Vastus Medialis had an important role while performing the smash because they had the greatest EMG value.

Service in badminton is very important, but the study for skill is still less than smash. Badminton game is started by a service. It is an advantage if a player has a turn to serve the ball. This player can set the game based on his strategy. But, taking serve should be very careful. The opponent is easy to get points when the player has low skill of serving.

This research aims to study the movement of arm for a short service in badminton. The arm was segmented by four gyro sensors. The gradient of Euler angle was used to determine the pattern of arm movement.

II. METODHOLOGY

A.Motionnode Sensor

Motionnode is an inertial measurement unit. It has 3-axes gyroscope and accelerometer. There are 8 outputs from this sensor, as follows:

- Global quaternion
- Local quartenion
- Local Euler angle rotation
- Global linear acceleration
- Accelerometer measurement
- Magnetometer measurement
- Gyroscope measurement
- Temperature

In this research, the Local Euler angle was used to determine the pattern of arm movement. The data were streamed into a computer and saved for analyzing. The data was possibly saved into following formats:

- Autodesk FBX (*.fbx)
- COLLADA Digital Asset Exchange Schema (*.dae)
- Biovision Hierarchy (*.bvh)
- Comma Separated Values (*.csv)

Four motionnodes were attached to human arm each on the dorsal area of hand (sensor 1), wrist (sensor 2), elbow (sensor 3) and shoulder (sensor 4), as shown by Fig. 1.

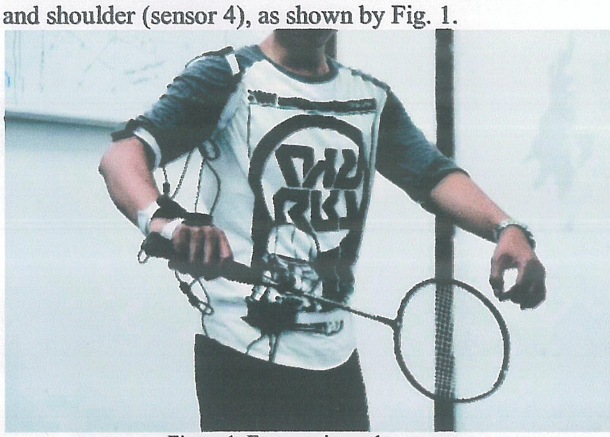

Figure 1. Four motionnodes on arm.

The motionnode software showed the coordinate of four sensors, as shown by Fig. 2. On the motion node viewer, the calibration of accelerometer, gyro and magnetometer is given.The calibration of the sensor position was adjusted using this user interface. The initial position of the sensor was very important to standardize the pattern among the participants. Table I gives the information of the sensor position relative to the earth's gravitational attraction.

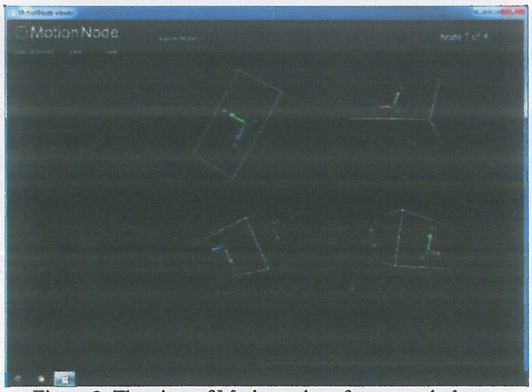

Figure 2. The view of Motionnode software on desktop.

TABLE I
THE INITIAL OF POSITION OF SENSOR

Sensor	α	β	γ
1	150°	20°	85°
2	110°	25°	120°
3	-150°	30°	110°
4	120°	25°	90°

B. Gradient of Euler Angle

In this research, the pattern of arm movement was determined by the sign of the local Euler angle [6]. This technique has the same basic idea with the polarity sign in [7]. The sign of the local Euler angle was decided based on (1) and (2). Fig. 3 illustrates the local Euler angle and its sign. In this example, there are four reference points to decide the sign, A, B, C, and D. The graph between A and B had a positive sign of the local Euler angle.The graph between B and C had a negative sign. The line between C and D had positive sign again. And the rest was labeled as 0 to indicate that the movement stopped. In this research, the threshold value was used to ignore small movement. The threshold value is 7.5% of the maximum/minimum value of Euler angle. The pattern of the local Euler angle for the Fig. 3. is +-+.

$$Sign = +(positive), if \frac{d\theta}{dt} > 0 \quad (1)$$

$$Sign = -(negative), if \frac{d\theta}{dt} < 0 \quad (2)$$

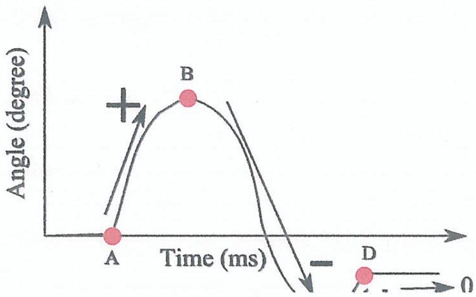

Figure 3. The sign of local Euler angle.

The pattern of the gradient local euler angle was determined independently of the arm movement velocity. Fig. 4. shows three levels of arm movement velocity, fast, average and slow. The pattern of three graphs are same, +-. The difference is just only the duration of the movement. The faster arm movement, the shorter time is needed.

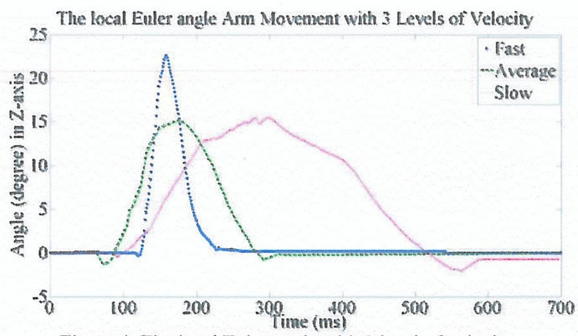

Figure 4. The local Euler angle with 3 level of velocity.

TABLE II
THE SIGN OF LOCAL EULER ANGLE FOR SHORT BACKHAND SERVE

Participant	Serve	Sensor 1			Sensor 2			Sensor 3			Sensor 4		
		x	y	z	x	y	z	x	y	z	x	y	z
Coach 1	1	- + 0	+ - 0	+ - 0	- + 0	0	0	0	0	0	0	0	0
	2	- + 0	+ - 0	0	- 0	0	0	0	0	0	0	0	0
	3	- + 0	0	0	- + 0	0	0	0	0	0	0	0	0
	4	- + - 0	0	0	- 0	0	0	0	0	0	0	0	0
	5	- + 0	0	0	- + 0	0	0	0	0	0	0	0	0
Coach 2	1	- + - 0	- 0	0	0	- + 0	0	0	0	0	0	0	0
	2	- + 0	+ - 0	0	0	- + 0	0	0	0	0	0	0	0
	3	- + 0	+ - 0	0	0	0	0	0	0	0	0	0	0
	4	- + - 0	+ -0	0	0	0	0	0	0	0	0	0	0
	5	-+0	0	0	0	0	0	0	0	0	0	0	0
Player 1	1	- + 0	+ - 0	0	0	- + 0	0	0	+ - 0	0	0	0	0
	2	- 0	0	0	0	0	0	0	0	0	0	0	0
	3	- + 0	0	0	0	- + 0	0	0	+ -0	0	0	0	0
	4	- + 0	0	0	0	- + 0	0	0	0	0	0	0	0
	5	- + 0	+ - 0	0	0	- + 0	0	0	0	0	0	0	0
Player 2	1	+ - + 0	+ - 0	0	0	0	- + 0	0	0	0	0	0	0
	2	- + 0	+ - 0	0	0	0	0	0	0	0	0	0	0
	3	- + 0	+ - 0	0	- + 0	+ - 0	- + 0	0	0	0	0	0	0
	4	- + 0	+ - 0	0	- + 0	+ - 0	- + 0	- 0	0	- + 0	0	0	0
	5	- + 0	+ - 0	0	- + 0	+ - 0	- + 0	0	0	0	0	0	0
Player 3	1	- + 0	+ - 0	+ 0	- + 0	+ - 0	- + 0	0	0	0	0	0	0
	2	- + 0	+ - + 0	+ - 0	- + 0	- 0	- + -0	0	0	0	0	0	0
	3	- + 0	+ - 0	+ - 0	- 0	+ - 0	0	0	0	0	0	0	0
	4	- 0	+ - 0	+ 0	- 0	+ - 0	- + 0	0	0	0	0	0	0
	5	+ - 0	+ - 0	0	0	+ - 0	0	0	0	0	0	0	0

TABLE III
THE PATTERN OF THE SIGN OF LOCAL EULER ANGLE FOR SHORT BACKHAND SERVE

Pattern	Sensor 1			Sensor 2			Sensor 3			Sensor 4		
	x	y	z	x	y	z	x	y	z	x	y	z
1	- + 0 (70%)	+ - 0 (50%)	0 (90%)	0 (50%)	0 (80%)	0 (100%)	0 (100%)	0 (100%)	0 (100%)	0 (100%)	0 (100%)	0 (100%)
2	- +- 0 (30%)	0 (40%)	+-0 (10%)	- +0 (30%)	- +0 (20%)							
3		-0 (10%)		-0 (20%)								

TABLE IV
THE SIMILARITY OF THE PLAYERS SKILL WITH THE COACHES'

Pattern	Sensor 1			Sensor 2			Sensor 3			Sensor 4		
	x	y	z	x	y	z	x	y	z	x	y	z
1	73%	73%	73%	53%	20%	53%	93%	86%	93%	100%	100%	100%
2	0%	20%	13%	33%	27%							
3		0%		13%								
uknown	27%	7%	14%	0%	53%	47%	7%	14%	7%	0%	0%	0%

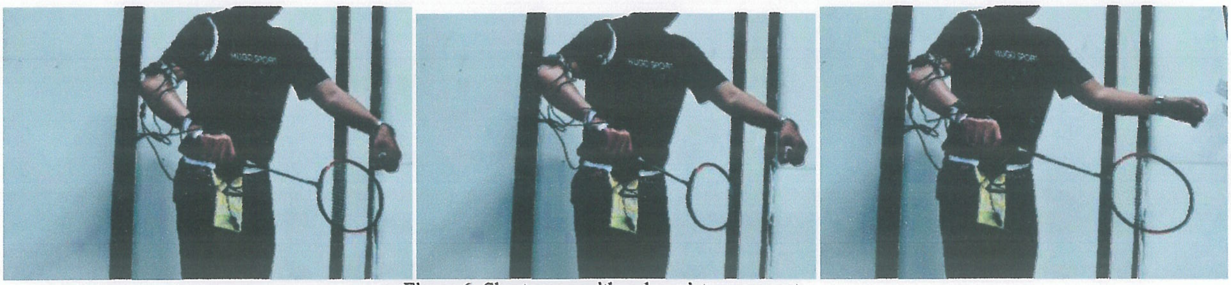

Figure 6. Short serve with only wrist movement.

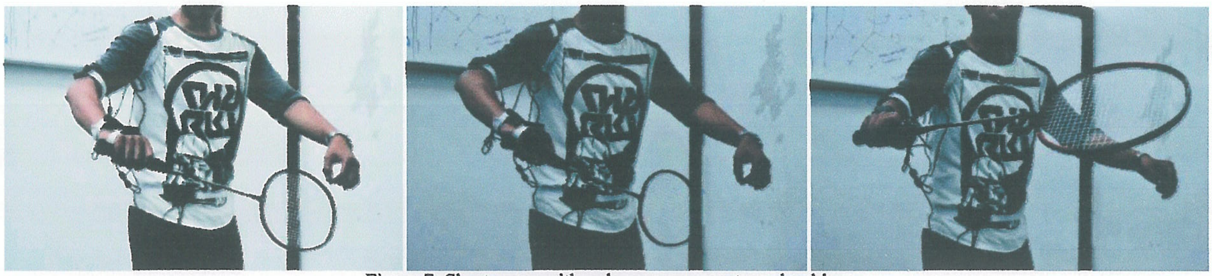

Figure 7. Short serve with only no movement on shoulder

C. Short Serve

There are at least two types of serve in badminton, long serve and short serve. Short serve could be both forehand short serve and backhand short serve. This research only studied about the pattern of arm movement for the short serve. Fig. 4 illustrates the trajectory of shuttlecock for the short serve. The blue area is the possible location for the shuttlecock destination.

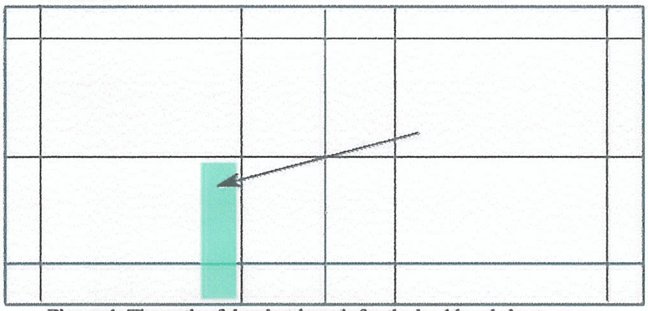

Figure 4. The path of the shuttlecock for the backhand short serve.

Short serve needs a good shuttlecock placement. It should pass the net with short distance. If it is too high, the opponent would take the advantage to end the play. Fig. 5. Illustrates how close the shuttlecock to the net.

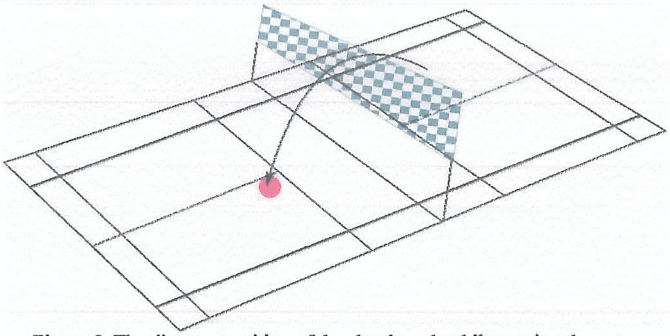

Figure 5. The distance position of the shuttlecock while passing the net.

III. RESULT AND DISCUSSION

Two certified coaches and three young professional players (18 years old) were participated. They performed backhand short serve five times each. Table II shows all the pattern resulted by the two coaches and three players. Based on the result, there was a clear situation on the sensor 4 which had no sign. It meant that the shoulder had no or very small movement while serving the shuttlecock with a short serve technique.

Table III concludes the possibility of the sign of the local Euler angle gradient based on the coaches pattern. Sensor 1 indicated that the dorsal area of the hand must be moved, because there is no option for the dorsal area without the sign of the local Euler angle. It is different with sensor 2 and sensor 3, which were possible to move or not. Fig. 6. illustrates the backhand short serve with only wrist movement. Fig. 7. shows the arm movement with stationary shoulder.

Table IV indicates the similarity between skill of three young professional players and the skill of two certified coaches. The result shows that the three young players has about 85% similarity with the coaches. Sometimes the players had no associated skill to the coaches. This condition was called unknown technique. The average of unknown technique was about 15%.

IV. CONCLUSION

This study investigated the pattern of arm movement using the sign of the local Euler angles gradient. The result showed that there were two types of backhand short serve among the coaches and players. First was the short serve with only wrist movement and second was the short serve with movement on dorsal area and wrist only. Both of the types were same in the dorsal area by hand. This area had dominant movement compared to other points. The shoulder was static for both types. Using the determined pattern, The skill of three young professional players was studied. Their patterns were compared to the coaches pattern. The result shows that the professional players had a big similarity in backhand short service with their coaches.

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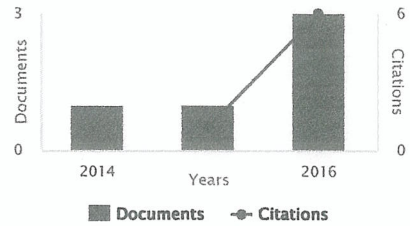

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