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Automatic Line Calling Badminton System

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Abstract. A system and relevant method are described to detect whether a projectile impact occurs on one side of a boundary line or the other. The system employs the use of force sensing resistor-based sensors that may be designed in segments or assemblies and linked to a mechanism with a display. An impact classification system is provided for distinguishing between various events, including a footstep, ball impact and tennis racquet contact. A sensor monitoring system is provided for determining the condition of sensors and providing an error indication if sensor problems exist. A service detection system is provided when the system is used for tennis that permits activation of selected groups of sensors and deactivation of others.

1. Introduction

Badminton is one of the favorites sports and pastimes for most Malaysian. Ever since the Sidek's children and Lee Chong Wei played for internationals and made Malaysia renowned worldwide [1] Malaysians are interested to play in the evenings with their friends and family. Unfortunately, there are cheats and scandals occur in badminton by the players and the umpire .Nowadays, to judge a game fairly is challenging as human eyes has its limitation. Without proper equipment's or items, a game is biased especially the underhanded method between the players and the judge especially in line call. Such incident could spark anger to both supporters and players. Therefore, various methods had been set to create a fairly judged game without any human interference. This project is aimed to create an Automated Line Calling which is an automatic shuttlecock detector that can detect the shuttlecock when it falls on the line. This system is installed on the line of the court and each are embedded with force sensor which could differentiate between the feature given off by the player and the shuttlecock. When the shuttlecock hits on the line, the system will show an "IN" and "OUT" on the LCD display. Each corner of the court has a box shaped mechanism to detect the sensors which acts as receiver for the force detected by the sensor. The system has software which connects both hardware and software. Hence, when a product is created, the system is plugged in and automatically detect any pressure which is programmed in the software. Therefore, when it detect the force emitted by the shuttlecock, it will automatically display the "in "or "out". The result are verified by simulation and hardware result to prove the effectiveness of the propose product. Cyclops was created by an aeronautics engineer, Bill Carlton. This automatic line judge was the first to commercially introduce in the 1980s emphasise the usage of the beam system. There are transmitter and receiver boxes on the either sides of the net which transmit 5-6 infrared beams above 1cm from the ground. [2]The system was built so that one beam is on the “in” side while the other 4 beams are at the “out” side. If the ball hit the “in” beam line , the system automatically turned off the other 4 beams whereas when the ball hit either one of the 4 “out” beams ,the system produced a distinct beep. The systems had to be turned on before a serve and turned off after the serve which usually handled by the service line umpire. Figure 1 below shows the Cyclops system [2,3].

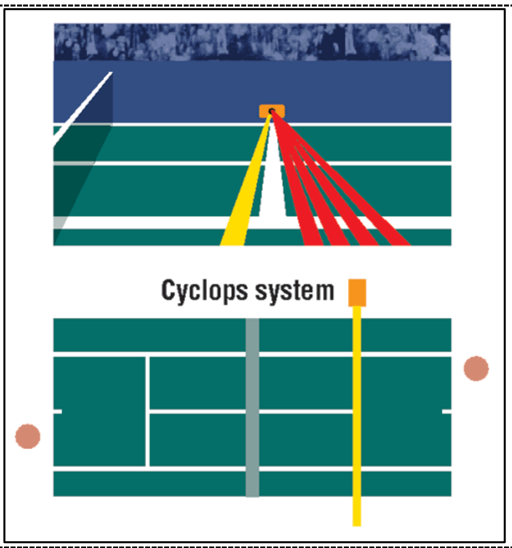

Figure 1: A system called the Cyclops uses infrared beams to determine whether a serve is in or otherwise

2. Methodology

This project is done on the flat area, whereas the velostat is used. The theory behind the function the velostat is, it is type of sensors that apply the principle of the increase of force cause the resistance to decrease over time. When the shuttle hit the velostat, the value of the velostat decreases. Technically, the parameter of a shuttlecock weighs around 4.75 to 5.50 grams (0.168 to 0.194 oz). The top 20 of the fastest smash in badminton recorded and the players’ names, which was recorded with the speed guns in the tournament as tabulated in Table 1.

Table 1: Smashes speed of various players

No	Speed of smash, kph	Name of players
1	390	TAN WEE KIONG
2	393	GOH V SHEM
3	393	MADS KOLDING
4	395	IHSAN MAULANA MUSTOFA
5	395	GOH V SHEM
6	395	LEE CHONG WEI
7	396	FU HAIFFENG
8	397	CHAI BIAO
9	397	GOH V SHEM
10	397	LEE CHONG WEI
11	398	LEE CHONG WEI

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12	399	ANTHONY GINTING
13	399	GOH V SHEM
14	399	LIN DAN
15	399	GOH V SHEM
16	400	HONG WEI
17	401	VLADIMIR IKANOV
18	402	GOH V SHEM
19	402	TANONGSAK SAENSOMBOONSUK
20	426	MADS KALDING

These smashes are recorded if they are more than 390 kph. The speed ranged from 390 to 426 kph as the 426 is the highest speed ever recorded in the tournament. From the table above it can be concluded that the mode for the speed of smash is 399 as it has been recorded for 4 times in the tournament. The median for the speed of the smash is

(390+393+393+395+395+395+396+397+397+397+398+399+399+399+399+400+401+402+402+42) /20 =398.5

Thus, the median force for the strongest smash detected based on the formula F=ma is 2.192 N.

3. Results and discussion

Since the output of the arduino operate by the voltage, it is important to understand the relation of force and voltage. The difference in voltage measured when moving from point A to point B is equal to the work which would have to be done, per unit charge, against the electric field to move the charge from A to B. When a voltage is generated, it is sometimes called an "electromotive force" or emf as shown equation 1 and 2.

$$emf = \frac{FL}{q} = \frac{qvBL}{q} \tag{1}$$

$$emf = vBL \tag{2}$$

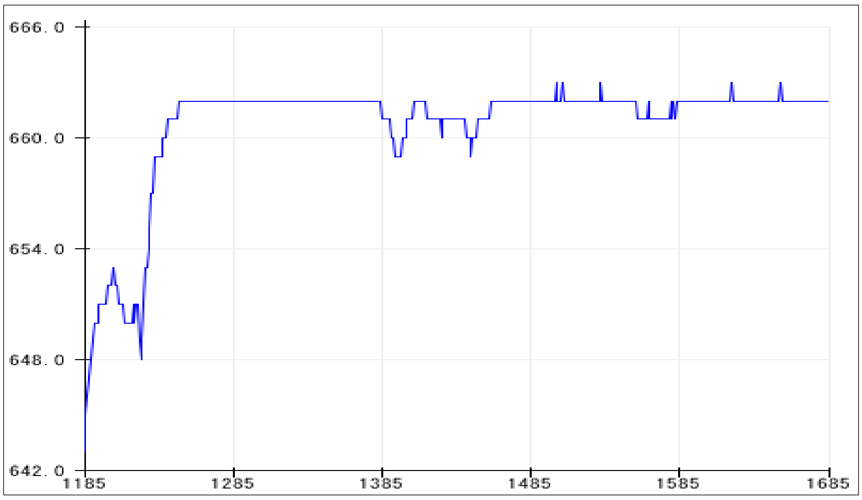

Figure 2: The startup of the sensor in terms of voltage over time

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Figure 2 show the startup of the sensor in terms of voltage over time. The sensor is highly sensitive and detects small changes that may occur. Any vibrations or pressure applied will change the condition of the graph. To avoid the condition a fixed pressure offset is exerted on the sensor with a weight that has been placed at least half an hours before starting the test, this ensures that the material has reached the stability.

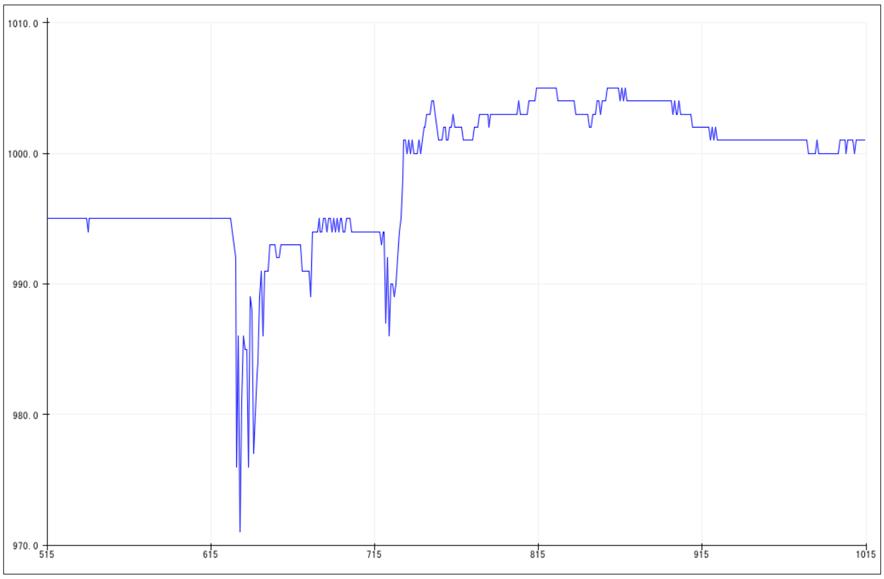

Figure 3: The impact on the velostat caused by the shuttle

Since the analog pin is code as the PULLUP pin whereas the voltage is continuosly apply across it, it will provide a different effect such as when the resistance is decrease when the force is applied. Figure 3 shows the impact on velostat casused by the shutte. The sharp drop of the above graph shows the impact on the velostat caused by the shuttle decrease the resistance across it. When the resistance drops, as stated in the ohm’s law , the voltage decreases and the output is shown as above. Any sudden drops in the resistance of the graph above are caused by reducing the resistance . However,the result over time shows after certain repeatability, the voltage peak suddenly from its usual margin before the graph it maintain its linearlity.With these results it can be state that on average the sensor behavior is monotonic but the repeatability of results is low since for the same pressure up to a factor two of difference is observed between the lowest and the highest output value. It has to be remarked that these results have been obtained using the average of ten test cycles; therefore this processing technique is suitable for periodic signals only; moreover the output has a delay equal, in this case, to five times the cycle duration. Moreover error is calculated using the same test set used to calculate system coefficients; then it is an underestimation. From the test that had been done on this custom-made sensor it can show that the repeatability is one of the major issues. To try solving this applied a technique we called Period Averaging which helps to get more reliable results, but this has some limitations; for example, it can be applied only on signals which are known to have some form of periodicity. The low accuracy of single point sensors, the cost and complexity of sensor matrices, and issues related to measure pressure are certainly some key factors for the relatively low diffusion of this technology for commercial devices. The result or the score of the game may be able to achieve, but the time taken for the velostat to reach its stability is time consuming as it takes certain time to reach its stability. A certain calculation technique such as called Period Averaging is proposed to limit uncertainty issue but it is not resolutive. Considering that the time needed to review the ball falling on the line may take some time and may be considered as fault.

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4. Conclusion

As a conclusion, in this state that measure absolute pressure with this sensing technology could be very challenging, but for other applications where spatial information is the key, they can be used exploiting their low cost and simplicity.

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