Line Detection and Monitoring System on Woodball Sport

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Abstract. In most sports today, the decisions taken by referees are supported by the use of electronic technology. The detection and monitoring system of the woodball lines serves the same function, helping the referee to take decisions and modernise woodball sports. The modern sport of wood balls depends entirely on out decisions. The line detection technology helps inform the judge whether the ball is OB (out of Bounds), while the monitoring system notifies players, judges, and the crowd whether or not the gating is effective. But the referee's manual assistance is always necessary to start the game after a good gating, since the player cannot touch the wood ball the whole time. Finally, the percentage of precision and error was achieved.

1. Introduction

The recent progress in sports technology helps modernise and compute the game and completely changed the whole game [1,2]. These advances in sports technology give a direction this paper proposes an automated line detection system for a woodball pitch [3]. The woodball line detection and monitoring system can minimise the work of a referee, as a wood ball OB (Out of Bound) can be detected and a gating monitoring [4]. First, since the normal length of a wood ball pitch is from 30 to 130m, a referee could not have a clear view on the gating. This long pitch would make it difficult for the referee to see clearly whether or not the gating is effective. In addition, the player may not be specific about the gating, and the unfair judgement of the referee may lead to a biased judgement of the opponent [5]. The monitoring system therefore uses an LED to show a successful gating. If the wood ball crosses the door, it turns on the green LED, but if the wood ball does not move through the LCD, it does not show a player's score. For the monitoring of the data, an additional LCD panel used. Next, the position of the player during the game may obstruct the view of the audience from watching the game and does not know whether the gating is successful or not [6]. For example, the player must position himself in a way that best suits him to perform the gating. This may block the view of the audience to watch the game and know the result. The player possibly could not pay attention to the audience as he must be fully concentrated on gating the wood ball. The users of the monitoring system
will help the audience to get to know the result and stay in the game. Finally, the decision of the referee if the wood ball goes OB (Out of Bounds) may not be accurate at all times. According to the rules of wood ball, the wood ball considered OB only when it is completely out of the boundary line. Hence, the line detection system will help to notify the referee if the ball is OB. It detects of the motion of the wood ball once it crosses the boundary line. Moreover, the presence of the referee at the sideline may block the view of the audience. The use of the line detection does not require a referee to be on the sidelines at all times [7].

2. Methodology

2.1 Base Design & Gate Design

The actual woodball is played on a 50 m to 130 m grass pitch. This paper uses a basic design which measures (80 cm x 60 cm x 1.5 cm). To design the foundation, the AutoCAD software is used. The size of the base is 80 cm long, 60 cm wide and 1.5 cm high. The foundation designed for the paper is shown in Figure 1. The gate is designed to count players’ score after a good match when they play woodball. The gate design is also carried out through the software AutoCAD. The dimensions of the gate are almost the same as the actual size of the game. The AutoCAD gate architecture is shown in Figure 2 below.
2.2 Material Selection for Gate

The gate is built by using two 1.5 litre plastic bottles with their top part cut off. The two bottles are spray painted brown in colour to resemble the actual woodball gate. The bottom third of the bottles are screwed and filled with cement from the inside and bolted from the bottom to the base to ensure that they do not move when gating is performed. They will serve like two pillars that hold the gate in place. The centre part (gate cup) is also built using a small plastic bottle also sprayed brown. The gate cup is left empty and is connected to the bottles at the side using a PVC pipe.

The gate cup is designed so as to rotate if the woodball reaches a certain speed. In addition, all three of these components have a PVC pipe which crosses the top third of its cup and the two hollow bottles. The materials used finally are almost like the real gate used in the real game. It has its advantages, because wood has a stronger mass and does not overflow when hit. It is also more sturdy. So, instead of using actual wood for a stronger support, the use of cement and screw are incorporated as an alternative. Figure 3 below shows the finished gate design.

![Figure 3: Actual Gate Design](image)

A total of 2 layers are used in the base. A solid, robust splintered layer forms the base for the prototype. The bottom layer is used. A layer of synthetic artificial grass for a certain degree may be used to mimic the pitch in the woodball. The height of the base is roughly 1.4 ± 0.5 cm since the lower layer of artificial grass is 0.5 cm tall and the height of the grass is up to it and the plywood 0.9 cm tall. Beneath the plywood 6 PVC is fixed and serves as the legs for the prototype. The reason for using PVC instead of other material is that because it is cheaper and much more flexible and waterproof.

2.3 Hardware Selection for Prototype

The six PVC pipe is cut at the same length of 5.5 cm to serve as the legs for the prototype. The legs are placed at the four corners and the two middle parts of the base. The plywood serves as the main layer and on top of that a layer of artificial grass is placed so that it simulates a pitch area. The height of the prototype from the bottom of the legs to the second layer is measured at approximately 6.5 cm ± 0.2 cm taking into consideration the height of the grass to the tip. The gate is done using 3 hollowed plastic bottles at the top third with the top part cut off. The two side gates measure 27.5 cm, whereas the gate cup is 22.5 cm is height. The bottom of the two bottles on the sides is hollowed and a screw is inserted each of the two gates.

Then, a bit of cement is added inside to add weight to the gate so that it stays rigid when gating is done. After the cement dried, the two gates are screwed to the base and bolted from the bottom of the plywood. The use of stoned was initially used, but the stability of the gate was not up to par. Next, all three bottles were fixed using a PVC pipe measuring 32.6 cm approximately and it holds
all the three parts together forming the gate. The gate cup in the middle is left as it is so that it rotates when the woodball passes through. The Figure 4 below shows the finished prototype of the paper.

Figure 4: Paper Prototype

2.4 Hardware Selection for Line Detection

The line detection is done using both IR Sensor and Ultrasonic Sensor. The infrared sensor is fixed behind the left gate directly across the part where the woodball passes through. The two Ultrasonic Sensors are placed at the corner of the pitch beside the two gates. The IR Sensor will be used for line detection for the woodball scoring whereas the Ultrasonic Sensor will be used to detect OB woodball. The connections are all wired into the PVC pipe mounted at the side in the junction box. Figure 5 shows both the IR and Ultrasonic Sensors on the paper. Two black coloured blocks are placed across the two Ultrasonic Sensors at the corner end of the pitch. This is to limit the sensors detection limit so that it can bounce back once the sound wave detects an obstacle.

Figure 5: Ultrasonic Sensor and Infrared Sensor

2.5 Hardware Selection for Monitoring System

The monitoring system to display the score is done using an LCD display. The LCD display is fixed at a junction box mounted to a PVC pipe at the side of the gate. The junction box holds the Arduino UNO microcontroller and also the LED for score and OB indication. Figure 6 shows the monitoring system in the paper.
3. Results and Discussion

The initial results were obtained by using simulation results from Proteus software. The results from circuit simulation were successful. Figure 7 shows the circuit simulation for the paper.

Two Ultrasonic Sensors and only one Infrared Sensor will be used to simulation the circuit. After the woodball reaches the sensors on the side, the red LED lights up to show that the woodball is OB (Out of Bounds). In addition, the Red LED does not light up because it does not say that the ball is still in play.

The IR sensor on the gate detects the ball movement through the gate. If the ball passes through the gate is recognised, the sensor sends a signal to the LCD and displays the player score and the Green LED. On the other side, if the ball does not pass through the gate the sensor does not sense the motion of the ball, it does not display the score and it does not activate the Green LED indicating failed gating. Finally, if the player scores, the LCD monitor also present the data of the gating. The test results are shown in Table 1 below.
### 3.1 Prototype Workflow

**Table 1: Testing Results**

| Steps | Results | Descriptions |
|-------|---------|--------------|
| 1     | ![Image](image1) | Once the supply is connected, the LCD display ‘Wood Ball Score Board’ for 3 seconds and then displays ‘System Ready’ for another 2 seconds. |
| 2     | ![Image](image2) | Then the LCD displays the current score of the player. This indicates that the system is ready for gating process and the player can perform the gating. |
| 3     | ![Image](image3) | The gating score can be counted consecutively. Once the gating is successful, the Green LED lights up 0.5 seconds and the score is added to the previous score. |
| 4     | ![Image](image4) | During the gating process, if a strike of the woodball goes OB the LCD display will show ‘OUT BALL’ and the Red LED will light up. The display will show back the current score before the failed gating. |
| 5     | ![Image](image5) | The LCD displays the score after the failed gating. If the next gating should be successful, the score will add. |

The Table 2 shows the results obtained on the LED and LCD through performing the gating of the woodball. A total of 10 attempts at gating were performed and the results are recorded and presented. Through the analysis of the results obtained, the accuracy and the error percentage of the prototype is measured and the calculation is shown below.
Table 2: LED and LCD indications based on gating results

| Gating Attempt | Gating Result | Player Score | LCD Display | Red LED | Green LED |
|----------------|---------------|--------------|-------------|---------|-----------|
| 1<sup>st</sup>  | Successful    | Score 1      | Current Score: 1 | OFF     | ON        |
| 2<sup>nd</sup>  | Successful    | Score 2      | Current Score: 2 | OFF     | ON        |
| 3<sup>rd</sup>  | Failed        | Score 2      | OUT BALL    | ON      | OFF       |
| 4<sup>th</sup>  | Successful    | Score 3      | Current Score: 3 | OFF     | ON        |
| 5<sup>th</sup>  | Failed        | Score 3      | Current Score: 3 | OFF     | OFF       |
| 6<sup>th</sup>  | Failed        | Score 3      | OUT BALL    | ON      | OFF       |
| 7<sup>th</sup>  | Successful    | Score 4      | Current Score: 4 | OFF     | ON        |
| 8<sup>th</sup>  | Successful    | Score 5      | Current Score: 5 | OFF     | ON        |
| 9<sup>th</sup>  | Successful    | Score 6      | Current Score: 6 | OFF     | ON        |
| 10<sup>th</sup> | Successful    | Score 7      | Current Score: 7 | OFF     | ON        |

4. Conclusions

Concisely, the woodball line detection and monitoring system focuses primarily on its two important paper requirements as described in the title: OB (Out of Bounds) woodball line and the gate result monitoring system, as well as the player scores. The prototype was finished after several simulations and tests. The results from gating after completion of the prototype are displayed. Finally, the outcomes of the simulation and the real results are identical and all three goals achieved. The paper’s advice for the future is to do this on a much larger scale so that players can experience the line detection and monitoring system first hand in the real-time game. First, a line detection performed using Ultrasound Sensors to track the ball movement if it goes out of boundaries. Finally, if the player effectively tackles woodball, he can use a much bigger LCD display to display the score.

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