Project Proposal: In and Out Line Monitoring System for Volleyball

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Introduction

Volleyball is a fast paced, competitive game and line calls are an issue that continuously comes up in any level of play. Any line judge trained or not, can make an error due to lack of focus and inaccuracy of the eye. The overall main goal for this project is to create a line monitoring system to aid the line judges and referees in their decision making and reduce the frequent misjudged line calls. The In and Out Line Monitoring System for Volleyball will benefit both the teams and the referees.

Lack of focus, the speed or the ball, and the inaccuracy of the eye have caused many incorrectly judged calls in the game of volleyball. These calls can be just a minimal point in a game, or the deciding factor between the continuation of a season or termination of a season. Judy Katalina, a chair member of the New England Volleyball Association (NERVA) and president of the New England Professional Volleyball League (PVL) says that "at certain levels, the ball is traveling too fast for the line referees to call the lines alone. A bad line call at a critical time can change the momentum or even the outcome of the game". There needs to be an aid for the line judges to help call the balls that are too close to tell.

Proposed Project

An in and out line monitoring system will relieve the stress of line judges as well as ensure good calls and a fair game for players and coaches. My line monitoring system will be able to stick down on top of the already painted lines. When a ball has contacted the line, the head referee will see a light signal flash on the microprossessor. Due to time constraints for this project, my prototype will be 6 feet long (one fifth of the end line) and consist of force sensitive resistors that are rectangular strips. The design will be able to tell the difference between a ball and a person touching the line based on the length of time of the contact. Figure 1a is the diagram of a whole volleyball court and its dimensions (1). Figure 1b is the expanded section I intend to design for this project.

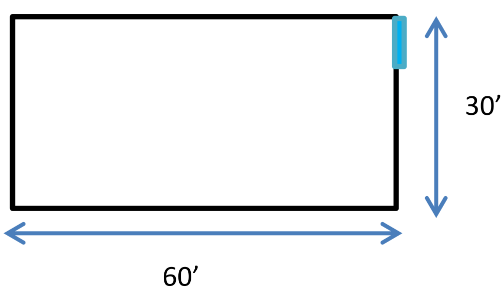

Figure 1a: Volleyball Court Dimensions. Highlighted is the 6' section that I have chosen to be my prototype. (2)

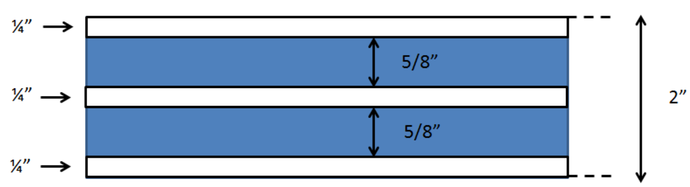

Figure 1b: An expanded section view of the chosen prototype. The white lines are the chosen layout of the pressure sensors.

Design Requirements

I would like the Volleyball In and Out Line Monitoring System to be flat and to fit in the standard 2" wide line as to not interfere with the game, accurate, easy to install, low cost, easy to use and be able to run a full day of games on a 9 V battery.

A flat line monitoring system in necessary for this project. This is because it would be a safety hazard for players if it was not flat. A volleyball lines width is 2” and all components in my line monitoring system will fit in that width. The goal is that the force sensors and wires within the line will create a negligible thickness for the players

The installation of the line monitoring system will be extremely easy. A 2” wide adhesive strip will be placed on top of the existing volleyball lines on the court.

The line monitoring system must be accurate. In order for this system to be used in games, the schematic must be tested and cleared for all plays in volleyball. The line monitoring system will need to be able to tell the difference between a person contacting the line and a ball contacting the line. Ideally the line monitoring system will be more accurate than the human eye.

Lastly, I would like for the line monitoring system to be easy to use and last a full day on a 9V battery. If a ball touches the line, I would like a light to go on on the microprocessor at the head referee stand for 10 seconds. If something else touches the line (i.e person, ball cart) I do not want any light to flash at all. This input and output system should be able to last through a full day of a volleyball tournament (about 10 hours). Therefore, the device can be recharged over night for the following day.

Design Approach

The goal of this project is to make a working prototype that will be 6 feet of the 30 foot end line (2). Using the force plate in Butterfield, I have concluded that the best way to differentiate between a ball contact from any other contact is the length of time of the pressure made. The time a volleyball contacts the line is about half of the time a person could contact the line. Further testing will be held in Professor Bumas lab as well as with the force plate so ensure accuracy. All in all, there will be an input of pressure that the microprocessor will read and output a decision of whether or not it was a ball. Figure 2 is the block diagram of my overall system.

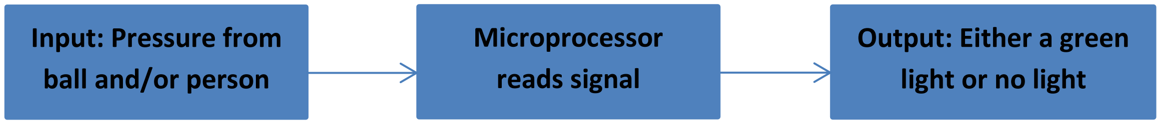

Figure2: Block Diagram of the overall line monitoring system

Another part of the design is the sensors. There are many different sizes and shapes of force sensitive resistors (FSR’s). Each FSR was carefully thought out on how it could be placed on the line. By looking at cost and the amount of area a sensor takes up, the 24” long ¼” wide strip came out to be the most effective (1). If a ball touches any part of the line the ball is in. Therefore, I know I need to have sensors covering the horizontal edges of the line (figure 1b). A ball contacting the ground makes a minimum diameter of 1.5”. Therefore with the two strips on the horizontal edges, I still need one more strip sensor in the middle of the line to ensure accuracy. See figure 1b for the final layout of the sensors.

Another part of the design approach is the thickness of the line. The goal is to have a negligible thickness as to not interfere with play. The thickness of the FSR is 0.2mm and the thickness of the flex wires are 0.36 mm. Both of this components fitting in the 2” wide wire should create a negligible thickness.

Once all of these parts have been validated, I will start with an adhesive strip and one of the sensors to test different signals and confirm that it responds to various force inputs. From there I will continue adding sensors and repeat the previous process until I can confirm that all the sensors work in one circuit. Each sensor should have its’ own connection to an analog input with signal conditioning electronics.

The next step will be to design the circuit so that the microprocessor can read the input. The microprocessor will need to be able to read multiple inputs at the same time. This is because a person can touch the line the same time the ball touches the line. The microprocessor will have to read two different signals and determine that one input signal was a ball. This brings me to the next part of the design. Coding the microprocessor to determine the output based on the input will be the most time consuming of the design steps. I will use established, open sourced code for algorithms to help me fulfill my project.

Once the code has been configured, the algorithm needs to be tested. With the help of the Union College Volleyball team, the different players will produce a variety of force inputs to ensure if my algorithm works. If any errors occur, I will modify the code and repeat the tests until the accuracy has been achieved.

Anticipated Outcomes

I believe I can satisfy all design requirements in this project time period. I want my project to be flat as to not interfere with the game, accurate, easy to install, low cost, easy to use and be able to run a full day of games on a 9 V battery. I am aware a real validation of my system will require more time allotted than the project allows. In order ensure that all of the requirements have been met, I will be working with the Union College Volleyball team. The volleyball team has willingly accepted to help me throughout this project. Once I declare my system as fully functional, then I would like to go to the next steps of providing the line monitoring system to the whole court.

References

(1) "Force Sensitive Resistor - Long." Sparkfun. N.p., n.d. Web. 24 Sept. 2015.

<https://www.sparkfun.com/products/9674>.

(2) "Your Source for Court & Sport Field Measurements." Volleyball Court Dimensions &

Measurements. N.p., n.d. Web. 24 Sept. 2015.

<http://www.courtdimensions.net/volleyball-court/index.php>

Reasons Funding is Necessary

Funding will be necessary for this project in order to purchase parts for the circuit, including the long pressure sensor strips, as well as the microprocessor.

Budget Breakdowns

By request of the committee, Table 1 shows the costs of each component needed for this project. The project will need 9 extra-long force sensitive resistors. The layout of the resistors has been thought out while considering accuracy and cost and is shown in figure 1b. The Microprocessor was carefully picked out regarding appropriate memory and sampling rate. Specific for this project, I need to order soft flex wire. The regular wires in lab are too thick where this soft flex wire, at a width of .014”, is thin enough for the line monitoring system. The total amount of funding requested from the Student Research Grant Program is $204.75 plus the cost of shipping the components, making the total $235.00. The entire project funding is requested from the Student Research Grant Program. Any additional funding needed as the project develops will be supplied by the Electrical and Computer Engineering Department.

Table 1:

Stage:	**Part:**	**Purpose:**	**Price**
Force Sensitive Resistors	(9) FSR 408	Needed to send signal to microprocessor	$161.55
Microprocessor	Arduino Mega 2560 Rev3	Converts input to output	$39.38
Op amps	LF356	Part of circuit	*
Resistors	10K ohm	Part of circuit	*
Resistors	10M ohm	Part of circuit	*
Battery	9V Alkaline, snap terminal	Power for circuit	$3.81
Wires	Soft flex wire	Thin, durable wire to connect components	$11.69
			TOTAL: $204.75

The * indicates the component will be covered by the ECE department.