Cornhole/Bags Electronic Scoring System

Project Proposal

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February 8, 2012

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i. Introduction

Cornhole, or bags, was originally adopted from the Blackhawk Native American tribe who "filled pigs' bladders with dried beans and competitively tossed them for entertainment" [3]. They would throw these pigs' bladders at various objects and mentally remember which player was able to hit the furthest target [3]. As the game progressed into its current form, its primitive method of scoring did not change. We propose to update this traditional game into modern times by being able to electronically keep track of both teams' scores. The ability to free the user from having to mentally track their score will significantly increase the enjoyment and competition brought to this game.

i. Objectives

The main goal we are trying to address with the completion of this project is for two teams, consisting of two players each, to be able to successfully play the game of bags without having to keep their own scores. As a player from each team faces off, the game board will continuously check for a team's bag, either on the board (1 point) or through the hole (3 points). If it is able to detect one of these two cases the microcontroller will output the updated score for each team during the end of a round.
In our version of this game we are adopting the method of a "money bag." Each team will have a single "money bag" worth double points. Our computing system will be able to detect this special bag and display the correct score based on where the bag ends up landing.

Benefits:

- Teams don't have to remember their scores from each round
- Aesthetically pleasing score display
- Compact design does not alter traditional rules of play
- Game board weight should not significantly change with added electronic components, allowing for ease of mobility between site to site

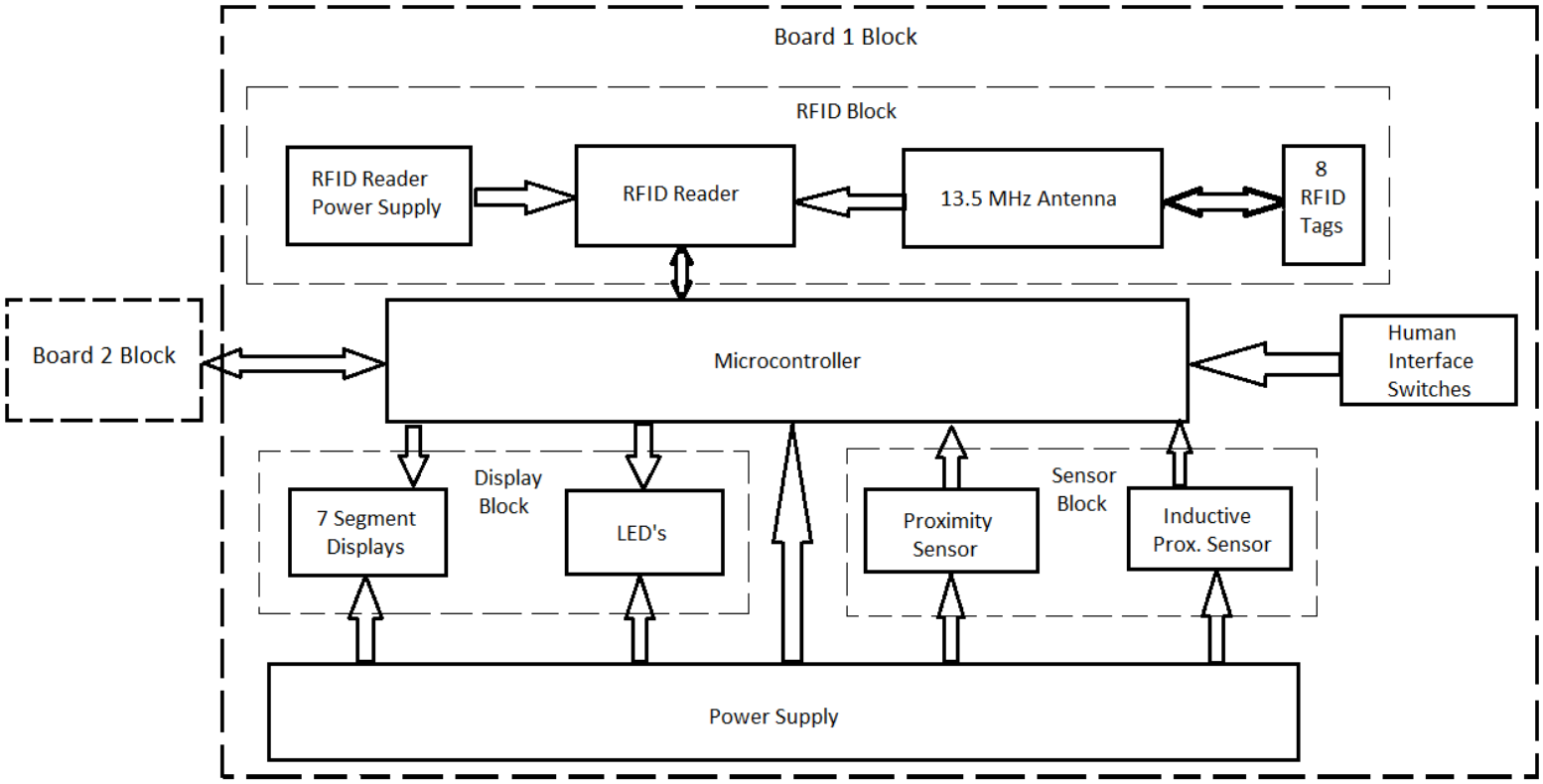
Features:

- Electronic scoring
- Bag differentiation between two teams
- LED's light up indicating bag going through main hole
- Scores update after each side has thrown their respective set of bags
- "Money Ball" detection for extra points
- Communication between both boards to output correct score
- Wireless detection to differentiate bags between the two teams
- Switch for users to store previous round score and start the next round

ii. Design

i. Block Diagram

The design of this project includes two block diagrams that are replicas of each other. Since the game consists of two playing boards, each board will have the same block diagram and the two microcontrollers will be connected together. This will allow the two boards to communicate with each other in order to calculate the correct total score before it is displayed.



ii. Block Descriptions

RFID Tags - One of the eight RFID tags will be placed in each bag. This will give each bag a unique RFID code that will be transmitted at 13.5 MHz to the antenna and RFID reader. The RFID tags are passive and will receive their power from the signal sent from the RFID reader through the 13.5 MHz antenna.

13.5 MHz Antenna – This is a high frequency antenna that will be connected to the RFID reader. This antenna will send a signal at 13.5 MHz to the passive RFID tags and will receive the unique codes from each bag that is sitting on top of the game board.

RFID Reader - The RFID reader will acquire the signal from the antenna indicating a tag has been detected. The reader will then decipher the tags unique identification number and relay this information to the microcontroller.

RFID Reader Power Supply - The RFID reader power supply is a standalone battery power supply that is dedicated to powering up the RFID reader, antenna, and passive RFID tags.

Microcontroller - The microcontroller will receive input signals from the RFID reader, proximity sensor, inductive proximity sensor, and the human interface switches. It will then use these signals to compute the proper score at the end of a round. The completion of a round will allow a new user to trigger the human interface in order to start the next round. The microcontroller will then send signals to the 7 segment displays when the score is to be updated. This update will occur at the end of every round until completion of a game. The microcontroller will also light the LED's indicating a bag has been detected going through the center hole on the game board.

Human Interface Switches - The human interface switches are physical switches that the user will hit when they reach the end of a round or the end of the game. When the user hits the end of a round game a signal will be sent to the microcontroller to tell it to calculate the score and update the displays. When the game reset switch is hit, a signal will be sent to the microcontroller telling it to rest the scores to zero.

7 Segment Displays - The 7 segment displays will receive the scoring signal from the microcontroller and will display the current scores for each team to view.

LED's - The LED's will receive a signal from the microcontroller when a bag passes through the center hole and triggers the proximity sensors. When they receive this signal they will light up signaling a 3 point shot.

Proximity Sensor - The proximity sensor will be placed at the center hole and will sense when either team's bag passes through the hole. When it senses a make, it will send a signal to the microcontroller in order to update the score calculation.

Inductive Proximity Sensor - The inductive proximity sensor will sense the metallic object placed in one team's set of bags. This sensor will be placed at the center hole and will be used to distinguish between which team's bag has passed through the hole. Its signal or the absence of its signal will be interpreted by the microcontroller in order to distinguish which team shall receive the points for the make.

Power Supply The power supply will provide the power for all elements outside of the RFID block. This power supply will consist of a battery pack.

Board 2 Block The board 2 block is identical to the board 1 block and is designated for the second game board. The two block diagrams will be connected together through the two microcontrollers. This connection will allow the two microcontrollers to communicate with each other so that the total score can be calculated. Once the total scores are calculated, the scores will be displayed on the 7 segment displays located on each board.

iii. Performance Requirements

This project will require that the electronic scoring system is able to score all possible scenarios. In order for this to happen, all RFID tags must be able to be read while spaced throughout the face of the board. At the same time we have to make sure not to account for those RFID tags displaced away from the game board. In order to meet these two goals, an antenna with a range of 1.6 feet will be used and a proper shielding mechanism will be implemented. Shielding will be enforced on the walls of the board and under the antenna to insure only bags on top of the board can be scored. Secondly to ensure proper scoring, the proximity sensors will be sized to the area of the center hole and will have a field of view of approximately 7 inches in the lateral direction and 5 inches wide. To stay within the proper parameters of the original game, weight will be removed from the bags that have components added to them. This will be done in order to retain the original weight of 8 oz. for each bag.

iii. Verification

i. Testing Procedures

RFID TESTING - In order to test the RFID portion of the project, unique RFID tags will be designated to each bag. Each bag will be tested on the board with the antenna in its proper location. Bags will also be placed around the outside perimeter of the board in order to test that the antenna is properly shielded from unsuccessful throws. Once each bag has been tested outside of the board, each bag will be placed inside the board under the shielding to simulate a bag passing through the hole. With the respective bags under the shielding, testing will be completed to ensure that the bags are not picked up by the RFID system. The weight of each bag will also be recorded to ensure original standards. The table below will be populated after testing.

Bean Bag	RFID Tag Code	Bag Weight	Detected on Board in All Locations?	Ignored When Off of Board Face?	Ignored When Under Board Face?
Team 1 Bag 1					
Team 1 Bag 2					
Team 1 Bag 3					
Team 1 Bag 4					
Team 2 Bag 1					
Team 2 Bag 2					
Team 2 Bag 3					
Team 2 Bag 4					

Proximity Sensor Testing In order to test the proximity sensors, all bags will be thrown through the center hole to simulate real game play. Both sensor outputs will be recorded and placed in the table below. Only bags from the team with the metallic bag inserts should be detected by the inductive proximity sensor, and both sets of bag should be detected by the other proximity sensor.

Bean Bag	Metallic Insert	Detected by Proximity Sensor?	Detected by Inductive Proximity Sensor?
Team 1 Bag 1	Yes		
Team 1 Bag 2	Yes		
Team 1 Bag 3	Yes		
Team 1 Bag 4	Yes		
Team 2 Bag 1	No		
Team 2 Bag 2	No		
Team 2 Bag 3	No		
Team 2 Bag 4	No		

Once testing is complete on both the RFID system and the proximity sensor systems, both systems will be connected to the microcontroller. At this point multiple scoring scenarios will be tested along with the LED lights. To finish both user interface switches will be tested to ensure next round functions and game reset functions.

ii. Tolerance Analysis

One of the most important subsystems of this project is the RFID system. This system needs to be able to accurately distinguish between a bag that is on the board face and one that isn't. With the possibility of having up to eight bags on the board at once, this system must perform flawlessly under all conditions in order to calculate the correct score. In order to test the tolerance of this system,

bags will need to be tested in many different locations both on and off of the board. The antenna needs to be sized and positioned correctly so that it will receive signals from the entire board face. Also the shielding of the board is vital to the success of this project. Most likely there will be bags within the range of the antenna that will need to be shielded against. This is why it will be vital to rigorously test this system.

iv. Cost and Schedule

i. Cost Analysis

LABOR COST	
Employee	**Cost**
Kabir Singh	($40/hr) x (2.5) x (180 hr) = $18,000.00
Travis DeMint	($40/hr) x (2.5) x (180 hr) = $18,000.00
TOTAL	**$36,000.00**

PARTS COST		
Part	**Quantity**	**Total Price**
Cornhole/Bags Set	1	$120
Mircocontroller	2	$60
RFID Tags	8	$1.20
RFID Reader	2	$500
Antenna	2	$500
LED String	2	$10
7-Segment Display	4	$20
9 V Battery	6	$15
Proximity Sensor	2	$50
Inductive Proximity Sensor	2	$50
PCB	2	$30
TOTAL		**$1,356**

Total Project Cost = $36,000 + $1,356 = $37,356

ii. Schedule

Schedule		
Week	**Task**	**Team Member**
2/6/12	Finish Proposal	Singh/DeMint
	Research RFID System to use	Singh
	Research Inductive and Capacitive Proximity Sensors to use	DeMint
	Acquire Cornhole/Bags Set	Singh/DeMint
	Research power supply for RFID and Sensor system	Singh
	Work on Design Review	Singh/DeMint
2/13/12	Order/Acquire RFID System to use	Singh
	Order/Acquire Inductive and Capacitive Proximity Sensors	DeMint
	Order LED Lights	Singh
	Complete Design Review	Singh/DeMint
2/20/12	Design Shielding Mechanism for antenna to detect within vicinity of the game board	Singh
	Test sensors with various materials to decide which ones need to be put in the bags	DeMint
	Test RFID network and determine where tags need to be placed	Singh
2/27/12	Order microcontroller	DeMint
	Learn how to program microcontroller	Singh/DeMint
	Order 7-Segment Display	Singh
3/5/12	Work on Individual Progress Reports	Singh/DeMint
	Start programming microcontroller for RFID system	Singh
	Start programming microcontroller for sensor system	DeMint
3/12/12	Complete Individual Progress Reports	Singh/DeMint
	Program microcontroller for LED lights	Singh
	Program microcontroller for 7-Segment Display	DeMint

3/26/12	Design circuit layout for PCB	Singh/DeMint
	Get PCB fabricated	Singh
4/2/12	Attach RFID system and shielding mechanism to game board	Singh
	Attach Sensor system to game board	DeMint
	Attach Microcontroller to game board with all parts programmed	Singh/DeMint
	Attach power source	Singh
	Test the current design to check that major parts of the project are working	Singh/DeMint
4/9/12	Attach LED lights to game board	Singh
	Attach 7-Segment Display to game board	DeMint
	Start Working on Final Presentation	Singh/DeMint
4/16/12	Attach second board with each component to match the first board and connect this board to the single 7-Segment Display	Singh/DeMint
	Test all parts for correct functionality	Singh/DeMint
	Finish Final Presentation	Singh/DeMint
	Start Final Paper	Singh/DeMint
4/23/12	Demo	Singh/DeMint
	Presentation	Singh/DeMint
	Work on Final Paper	Singh/DeMint
4/30/12	Final Paper Due	Singh/DeMint
	Checkout	Singh/DeMint

[3] http://en.wikipedia.org/wiki/Cornhole