Electronic Bag Toss

Final Presentation
April 26, 2012
Game Explanation

- Two teams consisting of two players each
- Four bags per team
- Two playing boards spaced 27 feet apart
- Teams alternate tossing bags
- Each bag sitting on top of the board at the end of a round counts for 1 point
- Each bag though the hole during a round counts for 3 points
- First team to 21 wins
Project Introduction

- **Game Scoring**
  - RFID System
    - Tag
    - Antenna
    - Reader
  - Capacitive Sensing
  - Inductive Sensing
  - Bag Filler Material

- **Score Display**
  - 7-Segment Displays
  - LEDs
  - LCD
Objective

- Complete Electronic Scoring System
- Compact, standalone system
- Consistent proper functionality
- Aesthetically pleasing score display
- Easy to use human interface
System Overview

Microcontroller

Score Board

LCD Display

Sensors

RFID System

Board Two
Power Supply

- PSH-1280 F2 Battery
- 12VDC
- Battery Capacity 8 Amp Hr.

\[
Battery \ Life = \frac{\text{Capacity}}{\text{Current Draw}} = \frac{8000 \ mA \ Hrs}{720 \ mA} \approx 11 \ Hrs
\]
Sensor System (Inductive)

- Cutler-Hammer
- 30mm Shielded
- 12VDC Powered
- Sensing Range 10mm
- 5VDC Output
- Active Low
Sensor System (Capacitive)

- Cutler-Hammer
- 30mm Unshielded
- 12VDC Powered
- Variable Sensing Range
- Range Set to 10mm
- 5VDC Output
- Active Low
Emit Electromagnetic field and sense changes in field

- Inductive
  - Magnetic Field
  - Conductive objects

- Capacitive
  - Electric Field
  - Conductive and Dielectric objects
## Sensor System (Circuit)

### Circuit Diagram
![Circuit Diagram](image)

### Table of Values

<table>
<thead>
<tr>
<th></th>
<th>Inductive</th>
<th>Capacitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>14.25 kΩ</td>
<td>14.25 kΩ</td>
</tr>
<tr>
<td>R2</td>
<td>8 kΩ</td>
<td>14.25 kΩ</td>
</tr>
<tr>
<td>R3</td>
<td>14.25 kΩ</td>
<td>14.25 kΩ</td>
</tr>
<tr>
<td>Vout No Detection</td>
<td>4.7 V</td>
<td>4.8 V</td>
</tr>
<tr>
<td>Vout Detection</td>
<td>0.3 V</td>
<td>0.4 V</td>
</tr>
</tbody>
</table>
## Sensor System (Functionality)

- Red bags filled with sand and steel bb’s
  - Triggers both Sensors

- Blue bags filled only with sand
  - Triggers only capacitive sensor

<table>
<thead>
<tr>
<th></th>
<th>No Bags</th>
<th>Red Bag</th>
<th>Blue Bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inductive Output</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Capacitive Output</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Microcontroller Action</td>
<td>None</td>
<td>Add 3pts to Red</td>
<td>Add 3pts to Blue</td>
</tr>
</tbody>
</table>
Microcontroller (Arduino Mega)

- Input Voltage: 7-12V
- 54 Digital I/O Pins
- 16 Analog Input Pins
- Calculates scores based on inputs from sensors and RFID system
- Drives Displays
RFID System (Antenna)

- Used to transmit and receive signals
- Tuned at 13.56 MHz
- Reading distance is up to 50cm
- Transmitting power of 4 W
- Dimensions: 300x300 x 38 mm.
RFID System (Reader)

- High frequency multi-tag reader for identification of ISO transponders
- 2 operation modes: Scan-Mode/Polling-Mode
- Power supply: 12-24 V DC
RFID System (Reader)

- 13.56 MHz operating frequency
- Anti-Collision Detection
- 1 W transmitting power with external antenna
- RS232 interface
RFID System (Reader Software)

- ISO-Start
  - Reader Calibration Software
  - Tag Selection
  - Reader Mode Selection
  - Tag Identification
RFID System (Range)

- Antenna Range with 45mm x 76mm transponders vs. transmitting power
- Antenna Range with 45mm x 76mm transponders near metal
RFID System (Range)

- Influencing Factors
  - 1 W transmitting power
  - Perpendicular Tag Placement
  - Tag interference
  - Cable placement
  - Metal in red bags
- Measured Range
  - 16.5 inches from center of antenna in all directions

- Board Dimensions
  - 36in x 24in
- Antenna Coverage
  - 33in x 33in
RFID System (Serial Comm.)

- Arduino shield converts serial RS232 data from RFID reader using max232 chip
- Uses RX and TX on Arduino board to send in converted TTL serial data
RFID System (Tags)

- TI Tag-it HF standard transponders
- Consists of a 45mm x 76mm loop antenna and chip microprocessor
- Receives 13.56 MHz signal from antenna and sends back a coded signal to the reader
RFID System (Shielding)

- Aluminum Foil was used to shield outer perimeter of game board
- Reduces electromagnetic field in the space occupied by the foil
Human Interface (Switches)

- Power Switch
- Score Reset
- End of round
  - Scores RFID system
Simulate game being played on second board
Used switches to simulate 1 and 3 points for both teams
Display (LEDs)

- 8 High Intensity Green 10mA LEDs
- Driven by 8-bit Serial-In Parallel-Output Shift Register
- Light in circular pattern 3 times when either team makes a 3pt shot
Display (7-Segment)

- Two, 2 digit common cathode 7-segment displays
- Used to display current score for each team
- Resistor Calculation:
  - $I_f = 10\text{mA}$
  - $V_f = 2.2\text{V}$
  - $V_s = 5\text{V}$
  - $R = \frac{V_s - V_f}{I_f} = \frac{5 - 2.2}{10 \times 10^{-3}} = 280\ \Omega$
LCD Display

- LCD display module 16x2 characters
- Informs players of every point that was accumulated
- Determines the end of the game and accounts for any ties
Display Schematic
Project Conclusion

- Met all verification and testing procedures
- Project exhibits proper functionality of all parts in the system
- Completely scores entire game of bags
Ethical Considerations

- Rule Three IEEE Code of Ethics – “to be honest and realistic in stating claims or estimates based on available data”

- Rule Five IEEE Code of Ethics – “to improve the understanding of technology, its appropriate application, and potential consequences”
Resources

- Professor Jennifer T. Bernhard
- Bill Coulter, Technical Support Manager, FEIG Electronics