Final Project Proposal

Year: 2025 Semester: Spring Team: 1 Project: Electronic Skee Ball
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Team Members (#1 is Team Leader):
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Member 4: Maddie Flanagan Email: flanag24@purdue.edu

1.0 Project Functional Description:

Group 1 intends to create a more electronically enabled, miniature rendition of a traditional "skee-ball" machine to provide an alternative means of playing the game and an interface better suited for individuals with various disabilities or incapacities. In the traditional game, a user rolls a ball up a ramp (approximately 8 feet at approximately a 30 degree incline from the ground) with the goal of landing the ball in any of several holes positioned at the top end of the ramp. Landing the ball in certain holes yields a number of points assigned to that hole, and failing to land the ball in a hole yields zero points for that throw. A user is given a set number of rolls to earn points before the game is "over", and the goal of the game is to maximize the number of points earned.

In Group 1's rendition of the game, the ball is no longer rolled, but instead pushed up the ramp with a motor-driven mechanism when the user holds down a button for a certain amount of time. A longer button press results in a greater driving force from the launching mechanism, analogous to a "harder" roll. Likewise, the direction of the motorized mechanism is controlled by the user's movement of a joystick; i.e., the direction of launch mimics the orientation of the joystick. Upon landing the ball in a hole, the user earns points, and a short sound indicating success is played on an attached speaker. The point value corresponding to the hole is added to the user's score, which is displayed on an OLED display for the user to view throughout the duration of the session. When there is no game in session, the OLED display shows the highest score achieved on the game, including all previous sessions. While the user is pressing the button for launch, the OLED displays a "progress bar": as the user holds the button, the bar grows in width, and when it reaches full width, the ball is launched even if the button is still being held. Whether the user lands the ball in a hole or not, the ball is caught by the body of the game and returned to an area near its starting location to be retrieved by the user for additional attempts. If the ball inadvertently leaves the body of the game entirely (i.e., if it escapes all of the holes and the surrounding catching area), then the user may manually retrieve the ball and reinsert it into the game. After three attempts, the session is over, and a user may choose to start another session by moving the joystick and/or pressing the button to launch the ball.

"Scoring" is defined by the detection of an object within one of the designated scoring holes of the game. Shortly after the ball is launched, a scoring window is started. During this window, the central computer repeatedly reads from ultrasonic sensors positioned within each hole. If the distance read by any sensor drops below an experimentally determined threshold, the game assumes that the ball has entered that hole, so it halts reading from sensors and awards the user the points associated with that hole. If no sensor detects the ball within the scoring window, the game assumes that the ball has missed all holes entirely, so it halts reading from the sensors and awards the user zero points.

A single “session” is defined as a state in which the user has three attempts to launch the ball and score points. A session is started when the user makes an attempt to move or launch the ball (via interaction with the joystick or push button) while there is currently no session active. A session is ended when there is already an active session and the user completes three attempts. Thus, the skee-ball game has two states, denoted as “idle” and “active”: the idle state refers to the state between sessions, when a user is free to start a session, and the active state refers to the state in which a session already exists and a user is actively trying to score points within three attempts.

The geometry of the game itself is analogous to a scaled-down version of the conventional geometry. Team 1’s rendition is three feet in length (i.e., along the axis running through the joystick and the ramp) and one foot wide (i.e., along the axis running through the joystick and perpendicular to the ramp). The first approximately eight inches along the three-foot dimension serve as the area for retrieving the ball, controlling the direction of launch via the joystick, and launching the ball via the push button. The launch mechanism itself sits on a circular plate eight inches in diameter which hosts the ball and the launching motor. This plate is rotated to aim the ball by a joystick-controlled motor from below. To the left of the plate is a cut-out cylindrical shape having diameter of approximately two inches which serves as the retrieval mechanism for the ball, i.e., the ball moves up the ramp, lands in a hole, and rolls down through this cylindrical region to be easily retrieved by the user.

The “stretch” functionality of the Electronic Skee Ball Machine includes the usage of an alphanumeric keyboard for users to input a “username” or other form of identification string to designate themselves on a leaderboard prior to the beginning of a session. At the completion of each session, if the total achieved score is within the top three highest ever achieved, the score and identification string will be saved to the according rank. Furthermore, when there is no active session, the OLED display will show the top three highest scores achieved in the game, displaying both the identification string and the score achieved.

2.0 Team Member Expertise and Team Roles and Responsibilities:

2.1 Team Member Expertise:

2.1.1 Team Member: David Fall: My main area of technical expertise is in software development since I have both research and industry experience in software development, have taken numerous required and elective software-focused courses, and have completed numerous personal projects focusing on software development. My software experience has also involved much low-level programming and embedded software development through courses like ECE 40862 (Software for Embedded Systems). I also have experience in project management, having served as team lead for various engineering projects in previous courses along with other forms of leadership experience.

2.1.2 Team Member: Andrew Cali: My current area of expertise is embedded systems and some digital design. From experience with courses such as ECE 362 working with programming and interfacing the STM32 microcontroller and ECE 337 using HDL to design application specific integrated circuits, these experiences have given me a strong foundation and background working with embedded systems and digital design. I've been a teaching assistant for the past year, gaining further hands-on knowledge with the ECE 362 lab practicing with microcontrollers.

2.1.3 Team Member: Jennifer Ferguson: Interested in embedded systems and have a concentration in computer systems. Through my coursework in ECE 469 (Operating Systems Engineering), ECE 404 (Intro to Computer Security), ECE 473 (Intro to AI) and ECE 368 (Data Structures), I've gained hands-on programming experience. In addition, my internships have provided practical experience in controls systems software, security protocols, and hardware-software integration.

2.1.4 Team Member: Maddie Flanagan: I have a strong background in computer architecture and embedded systems, with both academic and professional experience that makes me well-prepared to contribute to system-level design and integration. Through courses like ECE 437 (Computer Design and Prototyping), ECE 337 (ASIC Design), and ECE 40862 (Software for Embedded Systems), I've gained experience in creating block diagrams, understanding system interactions, and verifying that components work together effectively. Additionally, my internship experience in design verification and automation has helped further reinforce these skills.

2.2 Team Roles and Responsibilities:

Role	Team Member
Team Lead	David Fall
Systems Lead	Maddie Flanagan
Hardware Lead	Andrew Cali
Software Lead	Jennifer Ferguson

3.0 Homework Assignment Responsibilities

Design Component Report		***Professional Component Report***	
A3-Software Overview	David Fall	A9-Legal Analysis	Jennifer Ferguson
A4-Electrical Overview	Andrew Cali	A10-Reliability and Safety Analysis	David Fall
A6-Mechanical Overview	Jennifer Ferguson	A11-Ethical/Environmental Analysis	Maddie Flanagan
A8-Software Formalization	Maddie Flanagan	A12-User Manual	Andrew Cali

4.0 Estimated Budget

I. Casing
   A. Description:
      1. This section deals with the costs of packaging the product, including the materials for the body, connections, any aesthetic inclusions, etc.
   B. Items:
      1. Existing miniature skee-ball case: $75
   C. Casing section total:
      1. **$75**

II. Power and Connection:
   A. Description:
      1. This section deals with the electrical components required of the product, including electrical connections, electrical components such as resistors and capacitors, the printed circuit boards for the final product, etc.
   B. Items:
      1. Printed circuit boards: $20
      2. Power supply: $20
   C. Power and Connection section total:
      1. $20 + $20 = **$40**

III. Total cost:
   A. $40 + $75 = **$115**

5.0 Project Specific Design Requirements

1. An ability for a microcontroller to write text to an OLED character display using the SPI protocol.
2. An ability for a microcontroller to generate audio on a speaker using the I2S protocol.
3. An ability for a microcontroller to drive a DC motor with variable power using PWM signal generation.
4. An ability for a microcontroller to read from an array of ultrasonic sensors by multiplexing their outputs onto a GPIO pin.
5. An ability for a microcontroller to convert analog input from an external joystick to a digital signal using analog to digital conversion.

5.1 Stretch Project Specific Design Requirements

1. An ability to read text from a standard alphanumeric keyboard using the UART protocol.

6.0 Sources Cited:

Not applicable; there are no cited sources in this document.