ECE 445 Project Proposal - Beer Mat

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What is the problem we are trying to solve?

You would be hard pressed to find a college student or graduate in the United States who has never played a game of beer pong. This game, in which players take turns attempting to throw a ping pong ball into cups of beer across a table, has over the years evolved from a simple drinking game to a ubiquitous American pastime. People of all ages play this game, with or without alcohol, at parties, tailgates, and even on their iPhones, where users can use the GamePigeon app to challenge their friends to a virtual game of pong over text. Professional tournaments are even held for the game, with the largest such tournament, the World Series of Beer Pong (WSOBP), regularly having over a thousand participants.

Given that it is commonly played in an informal setting, beer pong, similar to games of wiffle ball or pickup basketball, is often the source of heated arguments amongst participants. Throughout an average game, cups may be shifted, spilled, or tilted in ways that give one team an unfair advantage over the other, and with no impartial official to make final decisions on what to do in these situations, players are often left feeling slighted. In addition, especially after many games are played in a row, it can be easy to lose track of the score, how many games each team has won, and whose turn it is. For such a prevalent game to have so much unnecessary unpredictability is unacceptable, and our goal is to ensure that future beer pongers are presented with an even playing field, so that each game is fair and every victory is that much sweeter.

What is our solution?

To address these problems, we propose the construction of a mat that will indicate where to place each cup, whether each cup has the correct amount of liquid, and whether a cup was successfully hit by the opposing team. In addition, our design will indicate to players the current score, whose turn it is to throw, and how many games each team has won. This mat is intended to be placed upon a 6’ folding table, the typical surface used for a game of beer pong. In addition, this mat is intended to be portable, so that users can bring it wherever they feel a game of pong must be played.

The placement of cups will be indicated through the use of LED rings, which will also light different colors to indicate whether the correct amount of liquid is in each cup. In order for our mat to sense whether a cup has the correct amount of liquid, we will use pressure sensors placed under the cups. IR sensors under the cups will ensure that the cups are exactly centered how they are supposed to be. A mini LED screen on each side of the mat will display to both teams the score, wins, and whose turn it is.

Think of our solution as being to beer pong what a robot plate umpire is to baseball. By regulating the game through the use of technology, we eliminate the possibility of human error and ensure a fair game for all players. Figure 1 is a visual aid demonstrating how we intend our design to be used.

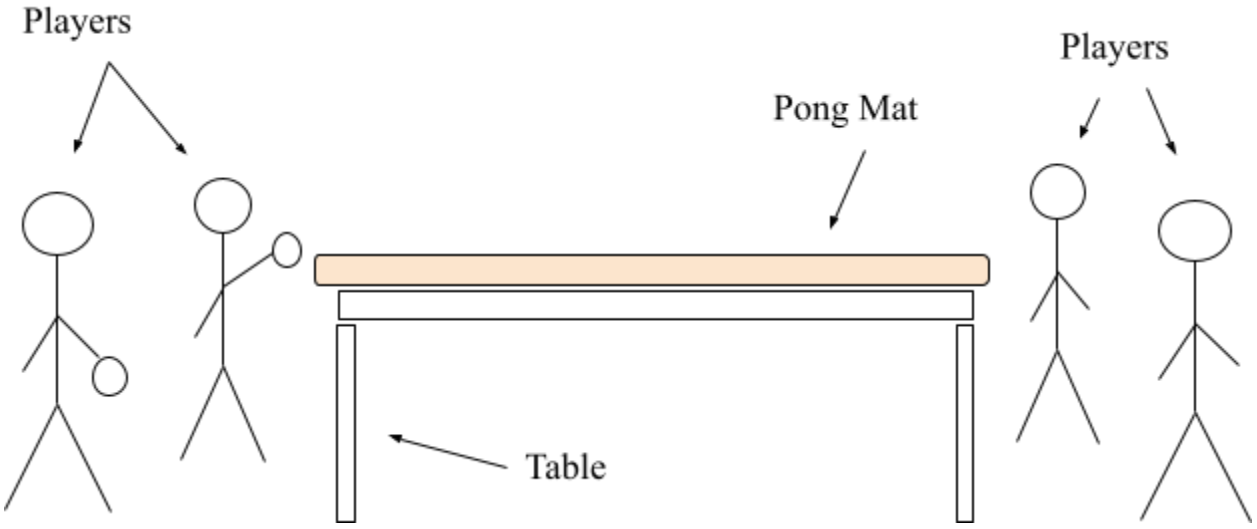

Figure 1

High Level Requirements

The three main characteristics we feel our design must exhibit in order to successfully solve the problems stated are as follows:

- **Portable**: One of the most appealing aspects of beer pong is its ability to be played wherever there are cups and balls. Our design should be portable enough to follow even the most adventurous ponger to wherever his or her chosen playing location may be.
- **Accurate**: There's no point in using a mat to determine proper placement and volume if said mat can't do so accurately. Our design must incorporate tight tolerances to ensure the proper placement and filling of cups, or else it will merely reinforce the problem that it is supposed to solve.
- **Intuitive**: Players need to be able to focus on perfecting their shot or defending against bounces, not figuring out how to operate the mat. Our design needs to be extremely simple to use in order to improve the game of beer pong and not serve as an anchor on the boat of fun.

Block Diagram

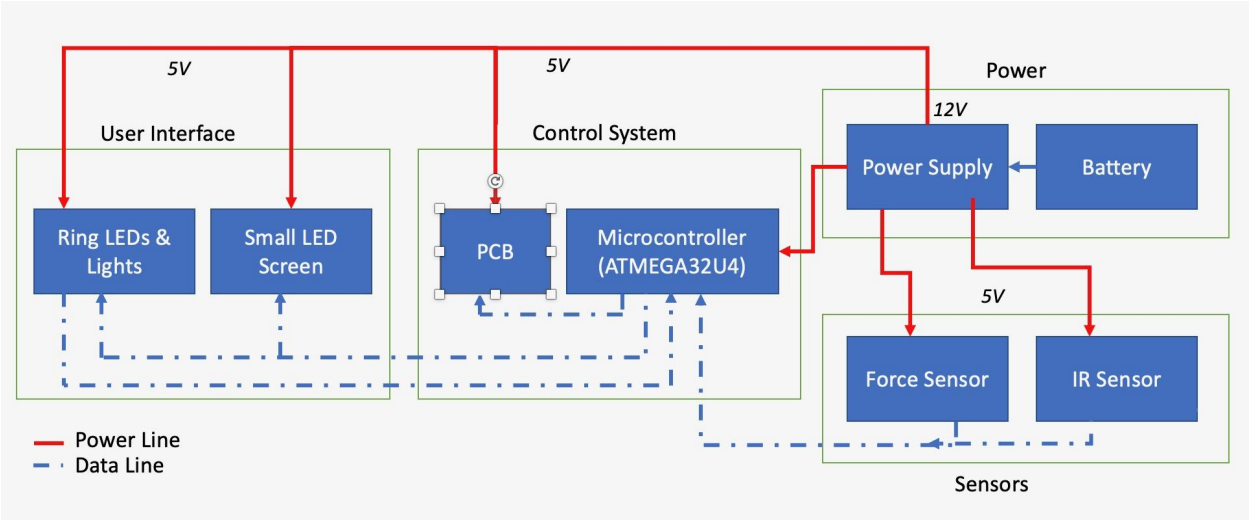

Figure 2

Block Descriptions

Functionality and Requirements of each component

- **Power**

In order for our project to be successful, we need a great foundation. That foundation comes from power. We want to start out using a 12V battery and power supply.

  - Battery
    - This is what powers everything in the project. Power begins to flow through this part of our project
    - Needs to supply the power supply with enough voltage and amps (12V and 3A)
    - Requirements: 12V size
  - Power supply
    - Connects to Sensors, Control system, and the user interface
    - Takes in power from the battery
    - Does not take in or send any data
    - Requirements: Supply 12 volts of power to the project, max of five amp hour
    - Test: We will be able to test using a voltmeter.

- **Sensors**

The sensors for our project will be force sensors and IR sensors. These sensors will be used for different things, such as weight management, and position management. The force sensors will be placed in a subsystem in which the cup will be placed on and will measure the weight to determine if the correct amount of liquid is in each cup. The IR sensors will relay information to the microcontroller about if the cup is within a correct position range.

    - Force sensor
        - This part is what detects water weight.
        - Needs to accurately measure over 100g to detect if there is enough water in the cup at a given moment
        - Takes power from the power supply
        - Relays data to the microcontroller
        - Requirements: Be able to hold two or more kilograms
        - Testability: Hold weight in a specific range, how sensitive the sensor is, and to make sure we can consistently get the same results using the same weight.
    - IR Sensor
        - This is what is used to detect if the cup is within bounds of the center
        - Takes power from power supply
        - Gives data to microcontroller
        - Requirements: Detect objects within five centimeter distance
- **UI**

The user interface we will be implementing consists of a small LED screen and ring LEDs. The LED screen will be able to provide a multitude of data, such as score, color indicators, and more. The ring LEDs will be the connection between the sensors and the user. Different colors around the cups will mean different things such as, the cup is not center, there is too much or too little water in the cup, or the cup is perfect.

    - Ring LEDs
        - Will surround each cup and change colors based on sensor data.
        - Powered by power system, display controlled by control system
        - Will be green if the correct amount of water is in each cup, red otherwise.
        - Requirements: Four or more different colors, not consume more than 24W of power
        - Things we can test: Brightness, voltage
    - LED Screen
        - Will display score of each game as well as score of series (games won by each team)

        - Will need to be compact yet easily readable.
        - Powered by power system, display controlled by control system

- **Control System**

The control system is the headquarters of our project. We need to make sure everything goes smoothly. Our PCB will need to connect everything together, whereas our microcontroller will take in data from various sources and send outputs to the user interface parts. The control system will need to work fast, so we need speeds over 8 MIPS. Keeping track of data can be done in the memory section of our microcontroller.

    - PCB
        - This is where our circuit gets connected together.
        - Our printed circuit board will contain the paths necessary to connect everything together
        - Takes in data from the microcontroller and power from the power supply
        - Tests: Voltage over components to ensure no short circuits
    - Microcontroller
        - The microcontroller is like the brain of our project. We need this to take in and output data to the rest of our project for the other components to use.
        - Requirements: Speed over 8 MIPS, memory over 16KB, and data transfer rate over 8 mbit/s
        - Requirement 2: need to support 5V operations
        - Takes in data from sensors, and converts it into usable data for the LEDs
        - Takes in power from the power supply

Risk Analysis

The block with the greatest difficulty to implement will be the pressure sensors, due to their need to detect a lightweight ping pong ball landing in them. They will need to be sensitive enough to detect the additional pressure created by a ping pong ball (about 2.7 grams) but insensitive enough to not trigger in the event of a cup being jostled or a few drops of water splashing into a cup.

Ethical Concerns

Our team does not foresee any ethical issues arising during the development of our project, seeing as all necessary testing can be done in a safe and harmless manner. The main ethical concern we have is the fact that our project, being an accessory for a game commonly played with alcohol, may encourage

unhealthy and unsafe drinking habits. However, considering the widespread popularity of the game of beer pong, we do not believe that our project will be introducing anyone to this game and perhaps by extension binge drinking. We do not want to encourage unhealthy drinking habits of any sort – rather, we hope with this project to help streamline an already immensely popular game that can be played in a safe and controlled manner.

Safety Concerns

We have no concerns regarding mechanical or lab safety. The one safety concern that we will need to address is the fact that beer pong is a game played with liquids, and that cups full of liquid will by design be in close proximity to our project and therefore to electrical components. Due to the relatively low voltage requirements of this project, this does not pose any extreme danger, but it will need to be addressed in order to prevent the destruction of our product and/or minor injuries to a user. This issue can easily be remedied through the use of protective encasing for sensitive electronics.