Lazer Pong

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***Abstract* — This project strives to innovate beer pong by creating an interactive electronic table with intelligent lighting, making the game more engaging. By combining beer pong's simplicity with game automation and atmospheric enhancements, we strive to offer immersion and accessibility. Our unique approach incorporates optical sensors for precise ball tracking, providing real-time feedback on successful cup shots and ball bounces. This interactive experience is communicated through dynamic displays, ensuring players of all ages can enjoy this twist on a classic game. The result is an inviting and engaging innovation, making beer pong more inclusive for a broader audience.**

***Index Terms* — AC-DC converter, complex polling systems, graphical interface, positioning system, real-time systems.**

I. Introduction

With the mission of designing an entertainment machine that will be as interesting to design as it is to use, this project is an electronic table that will allow the users to play beer pong with the assistance of intelligent lighting. This lighting, created by a display panel across the table surface, will show the player when and where scores are made, track the game score, and dance to any music that is playing. To inform the surface display of events that happen on the table surface, a sensor array that can detect a ping pong ball will be laid over the entire surface.

The primary objective of this project is to detect the position of a ping-pong ball while it is on or near the surface of the table. This will be achieved using an intersecting grid of laser transmitters and receivers. It will consist of one row and one column of laser transmitters, perpendicular to each other, producing collimated beams to shine onto one row and column of photodetectors directly opposite the lasers. The lasers will produce a low power, continuous wave beam that will incite a constant electrical signal through the photodetector. When this signal is broken, the electronic systems of the design will recognize the signal change and respond. To produce a safe and reliable laser grid, the lasers must be well-aligned and securely mounted to minimize risk of movement. For a standard ping pong ball, the diameter is measured at 40-mm. This laser grid must be tight enough to detect a break in the beam path in both the X-axis and Y-axis directions simultaneously. Thus, the lasers will be spaced with less than 40-mm between them to ensure that when a ball hits the table or lands in a cup, it will always break at least one beam path from each direction. When these beam paths are broken by a ball, the electronic systems will be able to see the active low signals and detect where the ball is on the board using the coordinates provided by the lasers. Using this positioning information, the board will know whether a ball has scored in a cup or simply bounced on the table and relay this to the LED programmable display that will be placed along the surface of the table. This surface display will serve to indicate to the player when a score is made and to illuminate cups that are in play, as well as to track and display the total score. Additionally, microphones will be placed around the table to inform music visualization effects, constituted by lighting patterns timed with the rhythm of any rhythmic sounds playing near the table. This surface display will be designed to be easily programmable by a simple microcontroller to produce a light-up surface display that acts reactively to activity on its surface.

II. Redesigning the Game

The game of Beer Pong offers a set of challenges for its implementation that must be considered carefully, especially given the project constraint of designing a table that is only half of a traditional Beer Pong table. The rules of the game must be analyzed to identify any potential conflicts with any other project design constraints, and to ensure that any ways that the technologies of this design might improve the game experience are identified. The upshot of this background research will be an alternate set of game rules and conditions, which will allow Lazer Pong to become a new game.

Research was performed to identify ways the game of Beer Pong can be revolutionized to enhance the overall player experience of the game. At its core, Beer Pong is a simple game where players throw ping pong balls into red solo cups [1]. We aimed to find ways to break outside of these traditions to expand upon the game's potential. For instance, the official World Series of Beer Pong (WSOBP) organization sets regulations for a "foldable table measuring eight feet by two feet" [1] based on the dimensions historically used for the game, but there is no true game theory behind these rules. In fact, the WSOBP itself admits that the purpose of these rulings is to "[Minimize] possible disputes between participants." [1] While there is nothing inherently wrong with these rules, many of them will hinder our strategies to enhance the game.

Looking at it closer, the game is centered around the experience of shooting a small, lightweight ball into a difficult-to-hit target [1]. This physical, skill-based challenge is widely enjoyable because of its low skill floor and high skill ceiling. New players find few barriers to getting started in the game, and experienced players find joy in perfecting their skill and strategy. This experience tends to be independent of some of the arbitrary rules of the game that exist solely to create a regimented competitive atmosphere [1]. Our goal is to isolate this experience of the game, facilitate it to the best of our abilities, and add extra features to maximize the player's access to this enjoyable skill-based challenge.

A. Win Condition

The biggest challenge in redesigning the game of Beer Pong for the Lazer Pong machine is in the game's objective. In traditional Beer Pong, the players are organized into two teams, and each player is assigned a side of the table [1]. The teams play back and forth, shooting into the cups on the opposite side of the table [1]. When a shot is made in a cup, it is removed, and the score is counted. Once all ten cups have been removed, the team shooting into those cups wins the game. Our design will not be able to facilitate this traditional game format, as our table will only have room for one set of cups. The goal of the game can be changed without reducing the enjoyment of the game itself, so our design will have to include a modification to this scoring rule.

To keep the project goals more in line with facilitating a recognizable Beer Pong experience, the primary game mode will involve a cup-removal scheme. Our design can support two or more teams scoring on the same set of cups, with each score counting towards the team that made that shot. Each cup would still be removed when it was scored in, and the game would be over when all ten cups were removed. Then, the winner would be the team that scored the most points. In the event of multiple teams scoring the same highest number of points, the tie could be left as is or a tie breaker could be assigned. This scheme keeps much of the gameplay structure that Beer Pong players are familiar with while introducing a new difficulty mechanic. The first few shots will be the easiest to score since there will be more cups close together, thus more "scorable area" to aim for. As cups are removed from the play area, there will be less scorable areas to aim for. Likewise, since players will not be allowed to move the remaining cups as others are removed, cup proximity is continuously reduced. In this way, this scoring scheme should introduce enough intrigue to justify the drastic change from the traditional ways.

B. Cup Weights

In its original spirit, the game of Beer Pong was played with beer in the cups [2]. This was done for two reasons: The cups needed weight so they could not be knocked over by the ball, and the game was originally a drinking game [2]. When you made a shot, the other player had to drink the cup. This would reward the winner with a victory, and the loser with a hangover. It was eventually recognized that the game encourages irresponsible drinking habits, not to mention unsanitary conditions for the ball and the drink. Because of this, the standard moved from filling the cups with beer to filling them with water [1]. They still had to be filled with something to provide ballast, and water would not dirty the ball, so it seemed the clear choice. However, since the design of Lazer Pong will make putting any liquid on the table surface risky, the cup ballast will have to be redesigned once again.

The cups must be clear and unobstructed for up to approximately 20-mm from the table surface to allow the laser grid to see through them at that height. The ball must also be able to fall to the bottom of the cup so that it breaks the laser grid, and the cups must be able to be removed from the table. This means that the cups cannot be fixed to the table, and so will require a physical ballast placed inside them. This ballast cannot add much thickness to the center of the bottom of the cup and cannot rise more than 20-mm up the side of the cups. The ideal ballast ended up being a flat washer, roughly the size of the bottom of the clear cup, that would keep the cup from tipping. The washer will not only be out of the way of the laser grid, but now the ball will tend to rest in the center of the cup, providing a precise location that could be aligned directly with the laser grid to maximize visibility.

C. Final Game Redesign

Beer Pong is fundamentally supposed to be a fun and enjoyable game. Many see it as an accessible, light-hearted, and fun-filled experience. Our mission with this project is not to overhaul the game itself, nor to expand heavily on it. The goal is simply to manage the game for the player more directly, and to influence the player to focus on the experience of the game by adding visual feedback to their gameplay. These changes to the game are solely to allow our implemented technologies to track the positioning of the ball to operate. Our game design changes are as follows:

1) The play area dimensions are 4’ x 2’.
2) The contents of cups include 1-2 2” flat washers, adhered to the bottom of the cup.
3) All players/teams take turns shooting at a set of ten cups. When a player/team scores, they get a point, and the cup is removed. Once all cups are removed, the player/team with the most points wins.
4) Touching the ball while it is in the air will be disallowed.
5) Cups are not reformed when the number of cups is reduced.

III. System Components

There were many different item types that were compiled together in order to create the Lazer Pong table. The following section will highlight each of the different parts that were incorporated into the final build, as well as provide a brief overview of each part selected.

A. Laser Transmitter

The laser transmitters constitute half of the parts in the laser grid that is established above the table surface. There are a total of 48 lasers, with the layout being a 32 x 16 grid. The chosen laser was the Q-BAIHE IR Laser Diode Module. This part was chosen because its operating wavelength is within the infrared range, it produces a low but sufficient output optical power, there is a collimating lens prefabricated onto the module, and it has a relatively low price point per item.

B. Photodiode

The photodiodes are the other half of the laser grid and will be receiving the light signal produced by the lasers in the laser grid. The DKARDU IR Infrared Flame Sensor Module was selected to be incorporated into the final build. The photodiode is responsive at the infrared wavelength that was selected for the laser transmitters, which enables proper functioning of the laser grid. This photodiode also comes with a black epoxy covering over the detector that protects it from responding to visible light. The photodiode comes attached to a transimpedance amplifier, which enables the lower voltage signal produced by the photodiode itself to be converted into a higher voltage signal that the MCU can actually interpret.

C. LED Array

The LED array is located underneath the table top and consists of a total of 512 individually addressable LEDs. The LED strips that were chosen to make the LED array were the BTF-LIGHTING WS2812B Fairy String. These LED strips were chosen because they provide a flexible length between LEDs that suit the needs of the final build. Without this there would be an immense amount of labor needed to cut, extend and then solder together each individual LED. The LEDs also have a waterproof rating of IP65, which is beneficial since the product is meant for a social setting where liquids may be near the product. The LEDs will function as a fun atmospheric enhancement to the table top as well as being able to provide the players with information about the game that is currently being played.

D. MCU and Voltage Regulator

For a project of this scale, few component decisions have the broad impact and overall design effect as the MCU. The STMicroelectronics STM32F2 series shows the most promise. STMicroelectronics is a well recognized brand with a history of top-notch quality. Specifically the STM32F205VC microcontroller was selected for its higher processing speed and memory capacity, and a similarly high pin count. Most importantly, it does all of this at a slightly lower price.

There are two main technologies used for voltage regulation: Linear low-dropout (LDO) regulation, and switching regulation. Since this design has simple needs from the voltage regulation component, not to mention that the ADC action of the microcontroller requires noise-free power, the LDO technology will be used to regulate the 5-V source power to 3.3-V VDD for the microcontroller. The Texas Instruments TLV70233 LDO regulator will handily cover the power requirements of the MCU, while enabling the PCB design to be as simple and straightforward as possible.

E. Power Supply Unit

We decided to acquire a preconstructed AC to DC converter that was available in the market. Considering the required voltage levels and power consumptions of all major components, it can be determined that the PSU will need to be able to provide multiple levels of voltage with a max of 5-V and a current of at least 18-A to supply at least 90-W. With these requirements, the BTF-LIGHTNING Switching Power Supply Device was well suited, as it balances the necessary requirements with its relatively low material cost. It is also from the same manufacturer as the LED strips for ensured compatibility. While the BTF-LIGHTNING PSU does have two output terminals, they can only output the same voltage level. The fix here was the implementation of two separate voltage regulators, regulating one output to 5 V, and the other output to 3 V. The voltage regulator component to implement here will be the Texas Instruments LM317T.

IV. Hardware Design

Our design can be thought of as four main subsystems working together: The optical laser grid, the surface display, the power delivery system, and the microcontroller embedded system.

A. *Optical System*

Since the physical components of both the laser grid and surface display will be required to complete the table surface, these two subsystems will be referred to together as the optical subsystem as displayed in the image below. This design component will be constituted by the physical table structure, the surface display built into the play area in the center of the table structure, and the array of laser grid transmitters and receivers placed around the perimeter of the play area.

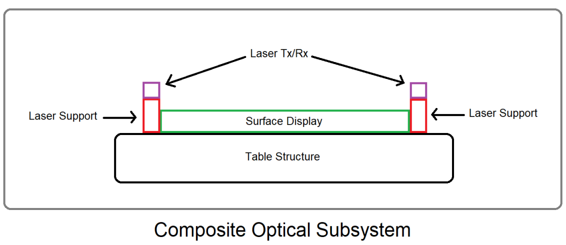

Fig. 1. Composite optical subsystem overview showing combination of laser grid with surface display. Image provided by the Lazer Pong project team.

The laser grid's design will serve to provide a solution for ball tracking during the gameplay, while the LED surface display will assist in tracking scores, cups in play, and other various visual effects. Overall these two systems will be designed to work in conjunction with each other.

The laser grid, composed of the laser diode modules and the photodetectors, will establish an optical signal which can be converted to an electrical signal to be sent to the LED surface display, communicating whether or not the signal has been tripped or not. This functionally allows a tracking positioning system for the ball. When it interrupts an established signal, the coordinates will be known and be relayed to the LED surface display. The laser grid will be able to detect the ball anywhere on the table, including inside of a scoring cup [3].

The laser transmitters and receivers will be oriented as through-beam sensors, which establish a signal by sending a direct beam path from the emitter to the detector. When an object passes through this beam, a change in the signal occurs. This change will be how the laser grid detects the location of the ball along the table.

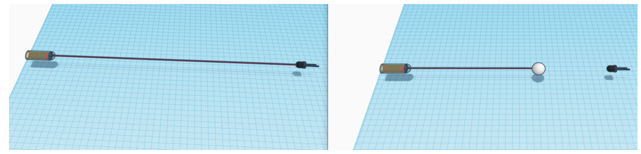

Fig. 2. Diagram showing how the through-beam sensors will be used for the laser grid (components in image not to scale). Image provided by the Lazer Pong project team

To design the through-beam sensor, the laser transmitters and receivers must both be positioned parallel to the surface of the table. From this parallel position, the two will be placed opposite of each other. They will be raised 20-mm from the table in order to detect the ball when it passes the beam path. Recall this height was chosen because the diameter of a standard ping pong ball is 40-mm. When the ball comes into contact with the table, the beam would be positioned at the center of the ball, which is where the ball is the thickest.

The table itself will be 2-feet by 4-feet, so to detect the ball everywhere over this surface there will be a total of 48 laser transmitters and receivers. The transmitter will be split into two directions, with 16 along the 2-foot side and 32 along the 4-foot side. In this setup the laser transmitters and receivers would be spaced evenly apart giving individual separations of approximately 38-mm between the centers of each module. Along with this, the laser transmitters and receivers will be securely mounted in custom holders. This will ensure the design of the laser grid will have the highest possible stability. These holders will be attached to the perimeter of the play area. This is done so as to not interfere with the integrity of the game.

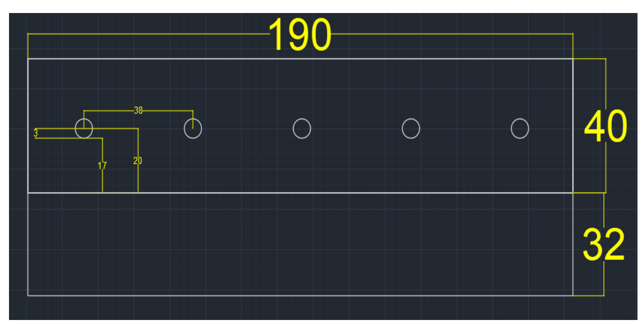

Fig. 3. Front view of a portion of the laser diode holder with dimensions. Image provided by the Lazer Pong project team.

For the laser diode modules, they are made of a brass house casing with a pre-built collimating lens. The casing is of a cylindrical shape having a length of 10-mm and a diameter of 6-mm. Along with this, the collimating lens on the output side of the laser diode module has a diameter of 3-mm. Having these small dimensions for the laser diode modules is good because it will be easier to hide them from the players. The laser diode modules come with a pre-built driver to control the laser's output. There are also red and black leads extending from the driver to which the power will be supplied. The operating voltage for the laser diode modules is 3-VDC with an operating current of 100-mA. The center wavelength of the laser's output is approximately 780-nm. They also have a low optical power output of around 3-mW, which is emitted in a dot shape after the collimating lens. This collimating lens can be adjusted, but will be kept in its original position to maintain the highest collimation.

For the holders it is crucial for them to be able to tightly and securely hold the laser diode modules as well as the photodetectors. The best way to make sure of this is by custom designing the parts using a sturdy material such as plywood. The center of the laser diode modules' emission side must be 20-mm above the table's surface, so the hole for the holder will start at 17-mm above the surface of the table. This is because the radius of the laser diode module is 3-mm. The width of this holder will be made from plywood of ¼-inch thickness (approximately 6.35-mm), which is almost as long as the device itself, but this will leave enough room for the laser diode module to be removed more easily should it need to be serviced or replaced. The holder must also have a height tall enough to be able to attach to the perimeter of the play area. The Lazer Pong table's thickness will be approximately 32-mm, so the holder has an extra 32-mm below where the table surface will start in order to be attached to the plywood that the LED surface display will be on.

The photodetectors are encased in a black epoxy that is in the shape of a half capsule. This black epoxy covering is crucial to the photodetector as it will block visible light from reaching the photodiode. With the LED surface display being so close to where the photodetectors will be, this factor was a major consideration. The dimensions of the encapsulant are 8.6-mm long and a diameter of 5-mm. After this there are the anode and cathode leads which have been pre-soldered onto a small board with the LM393 Dual-Differential Comparator. This will be what amplifies the signal for the MCU.

Given their slightly smaller diameter of 5-mm, the holder hole will start 17.5-mm above the table's surface. Similarly to the holder of the laser diode module, with a slightly smaller length of 8.6-mm, it will also be made with ¼-inch thick plywood. The hole diameter for the photodetectors was chosen to also allow the lip of the photodetector to act as a natural block from it going too deep as well. Again, the holders must extend an extra 32-mm past the table surface in order to ensure the ability for them to be attached to the table. The holders will be connected to the outside perimeter of the table by screws to help ensure stability.

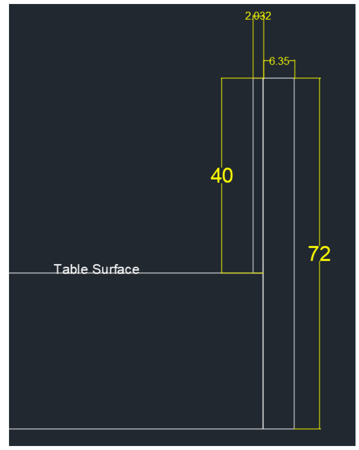

Fig. 4. Side view of the clear acrylic added to front of holders. Image provided by the Lazer Pong project team.

In addition to the holders for the laser diode modules and photodetectors, there will also need to be a way to shield them from the play area. With just the holders the components will be exposed to the outside environment on the side facing the play area. This is an issue as it will make it more likely for the parts to be touched or hit after alignment. To prevent this a barrier must be placed between them and the play area, but one that would not interfere with the optical signal being transmitted. A great choice for this would be a clear acrylic sheet, chosen due to their low cost and their opacity, which will minimally affect the laser transmitter or photodetector. The chosen thickness is approximately 2-mm. The clear acrylic will be attached to the plywood by the means of CA glue (or superglue). This is the method that will be utilized to add the clear acrylic to the front of the holders.

All together the design will create a 32x16 grid that will allow for 512 unique coordinates across the table. With this it will be possible to track the ball wherever it lands on the table.

B. Surface Display

A panel of individually addressable LEDs will be strategically positioned on the table surface. This LED array will serve multiple functions, including but not limited to indicating player scores, illuminating active cups, tracking and displaying the overall score, and synchronizing lighting patterns with the rhythm of surrounding sounds. The design is composed of a solid foundation, prefabricated LED strips, pixel isolation grids, and a light diffusing surface.

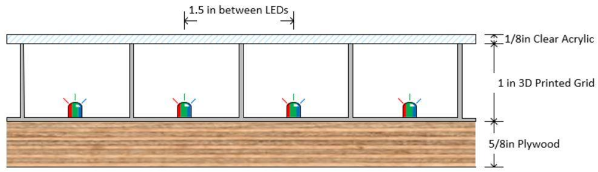

Fig. 5. Cross section of tabletop display. Image provided by the Lazer Pong project team.

To achieve a stable and solid tabletop and considering the other elements of the display, selecting a ⅝" plywood cut is optimal. This thickness strikes a balance between strength and weight, providing a sturdy surface capable of supporting the LED strips and other components of the display. The design here will be a 4'x3' cut of the plywood, while the actual display will still be 4'x2'. There will be an extra 6" buffer on each side of the display to allow for a designated location to put the cups once they have been scored.

The construction of the 4'x2' LED display will require a total of 32x16 LEDs to create each of the pixels in the 32x16 display. Since each LED strip provides 50 LEDs, we will require a combination of multiple strips to achieve our target. To be precise, 11 LED strips will be necessary to fulfill the requirement for 512 light sources. In order to create a single 512 LED strip out of these smaller strips, each will be connected to the next by the included male and female connectors.

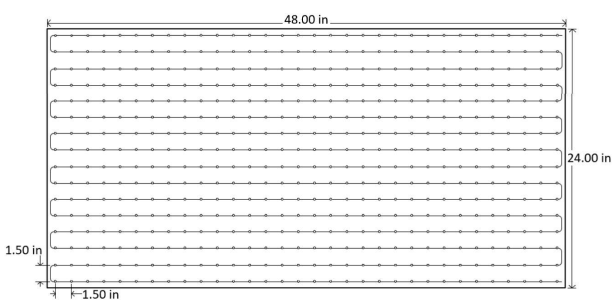

Fig. 6. LED strip pattern on table surface. Image provided by the Lazer Pong project team.

The next step in the LED display construction process involves designing the grids to isolate the individual pixels. To accomplish this, we will utilize Autocad to design the grid and a 3D filament printer for the actual printing. There are numerous benefits to producing our own grid pieces. One key advantage is the ease and cost-effectiveness of replicating each piece. By utilizing 3D printing, we eliminate the need for expensive manufacturing methods such as molds or tooling commonly found in traditional manufacturing. This not only reduces costs but also allows for rapid prototyping and customization. Such flexibility is crucial during the testing phase as it saves substantial time and material expenses, enabling us to swiftly address design flaws. Moreover, the accessibility of 3D printing has significantly improved in the last decade. Utilizing the printers in campus labs accelerates production processes, making them more efficient.

The printed grids will have dimensions of 6 inches by 6 inches, forming a 4x4 pixel arrangement. Each of these grid pieces will have a thickness of approximately 1 inch. This thickness ensures durability and provides a stable foundation for the display. Since the grid will be the thickest part of the display with an inch between the light source and the light diffuser it might consequently make the table surface brightness slightly lower than if we go with a thinner grid, but not low enough to change the thickness of the grid. Once all 32 grid pieces are printed, they will be affixed above the LED strips using a two part epoxy. This secure attachment ensures that the grids remain in place, maintaining the integrity of the display.

C. Power Distribution

To ensure a well-organized power distribution system, careful consideration was given to the connections and routing of every wire. From a high level, the overall power distribution will include: A main central unit that will take in the mains supply from a local outlet located under the table to discourage tampering from end users, a branch going from the first output of the central unit out into the LED strips on the table surface, and finally another branch from the second output of the central unit going to the voltage regulator circuits located on the PCB, which will then be routed to the laser diodes and photodiodes on the table surface, as well as the other PCB components, such as the MCU.

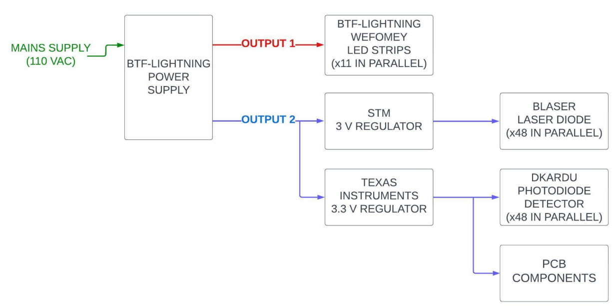

Fig. 7. Power Distribution Wiring Diagram. Image provided by the Lazer Pong project team.

The main power supply of the Lazer Table will be provided by the BTF-LIGHTNING Power Supply Unit. This unit will be connected to a standard local outlet to take in the mains supply of 110-VAC at 60-Hz. The PSU has internal circuits that convert the mains input into a voltage level of 5 VDC. Each output on the PSU then provides this constant 5 V voltage level to up to two loads, with the outputs capable of providing a maximum current of 30 A. It is worth noting that both outputs are only capable of providing the same level of voltage. There is no way on the unit itself to control or switch the voltage or current levels. This means that if other levels of voltage are desired, an external, separate circuit will need to be incorporated to take in the PSU's voltage level and step that up or down to the new level.

The chosen BTF-LIGHTNING Wefomey LED strips require a 5-V power supply to operate. So the branch connected to them does not need its voltage regulated. The strips contain 50 individual LEDs each, with simple positive and negative terminals located at both ends of the strip. These terminals will be connected to the first output terminal directly, with each additional LED strip being connected in parallel to the same output terminal, for a total of 11 strips to provide 512 individual LEDs.

The second output terminal of the PSU will host two systems: the laser grid modules and the MCU. The laser diodes operate at 3-V, and the photodetectors and other PCB components operate at around 3.3-V. This calls for two voltage regulators wired in parallel to the second output terminal.

D. Microcontroller Board

Each black box within the PCB design is shown in Fig. 9, with names and I/O drawn to represent the way they will interact in the PCB. If an arrow is drawn towards a block, it is an input. Likewise, an arrow drawn away from a block is an output. Text next to the arrows shows the nature of the output: The number of output lines, the voltage level if power is being delivered, and the data protocol if data is being delivered.

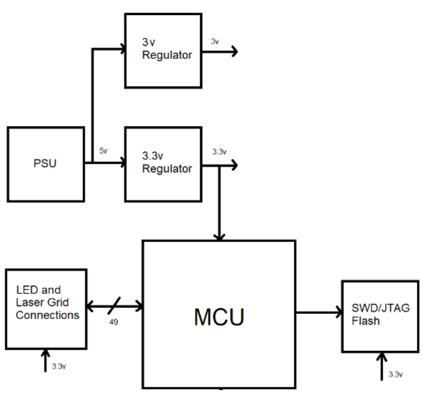

Fig. 8. PCB Block Diagram. Image provided by Lazer Pong project team.

There are 49 total I/O devices connected to GPIO pins on the microcontroller, and one connected to an ADC pin. 48 I/O connections to the laser receivers will be organized in groups of 16, each of which must share a single I/O port on the microcontroller. Thus, for 48 connections, 3 of the 5 I/O ports must be selected to accept these sensor signals. Two additional auxiliary pins were needed: a GPIO pin for the LED surface and an ADC pin for the condenser microphone.

V. Software Design

The software that will drive the automated functionality of the Laser Pong table will control the LEDs, IR Laser inputs, music visualization, and game state of the table.

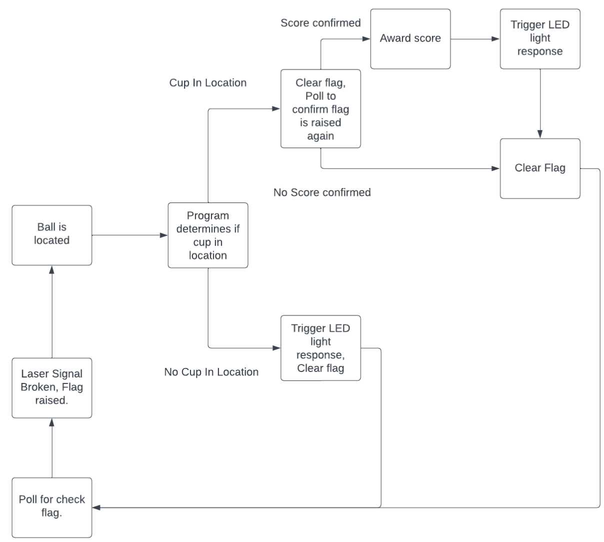

Fig. 9. Program block diagram. Image provided by Lazer Pong project team.

When the table is turned on, the software will begin by initializing the timer and GPIO pins that drive the functionality of the components of the table. A menu is used to control the game state of the table. It consists of a small section of LEDs to display the settings to the user. The menu communicates with the IR laser receivers to facilitate the touch screen function. Once the game has started, the menu will separate into two sections at the corners of the table near the player, and display the alternate turns and exit game selections. These options will stay during the game and are used to change turns and exit the game before the game has finished.

The laser receivers in the table will be used to determine the location of the ball, and if a score is made. Within the software, they will interact with the MCU and the LEDs to provide feedback for when a score is made or the ball hits the table. Each laser receiver will be individually addressable using an array of 16-bit registers where each receiver represents a single bit within the register. The software will poll these registers for any bits that have been flipped to a 1, and use this to determine the location of the receiver that has been triggered. This will allow the LEDs to provide feedback in that location, and for the MCU to determine if a score was made

The logic to control the game is simple, only needing to award points when a score is made and control the game state. Starting, resetting, and alternating turns will be done by the user with a start menu controlled by touch facilitated by the IR lasers. Programming this functionality will only require reading the user selections, and running the appropriate function to complete the task. The game will start with 10 cups on the table. The user will select how many players will be participating and the first player will begin their turn. Each player will be assigned a color that will be displayed via the LEDs to differentiate the players and indicate whose turn it is. Switching turns from player to player will be done by the user in the start menu. Because there is only one set of cups, the turns must be switched manually so the program will know which team to award points to. When the ball lands in a cup, a score is awarded, and the cup is removed. The game continues until all of the cups are removed from the table. The software then displays the winner's score. A visual effect plays to indicate that the game is over. Then the game state resets, and a new game can be played.

For the software to flash each light independent of the others on the grid, the LEDs must be individually addressable. To achieve this, the LEDs will be placed in an array where each LED represents a number in this array. When the software instructs an LED to flash, it will call the specific location in the array that represents the LED. This structure of the array will be exactly like the array that holds the location of the IR receivers. This is to make locating the LED in the position of the IR receiver that has a broken signal much simpler, as the X and Y coordinates of the IR receiver in the array will be the same coordinates as the LED in its array. The LEDs are addressed so if one were to flash each LED in an incrementing order, the LEDs would travel up and down the board in a snaking pattern. This will be resolved by using the 2D array to represent the LEDs in a row and column order. A looping algorithm will increment the location in the LED array, setting each LED to the proper location in the 2D array.

The game state of the table describes the sequence of events that make up the rules of the game. To enforce these rules, the software makes use of the IR receivers to track when a score is made. The software will receive the input from the IR receivers and use it to calculate the location of a signal break. This signal break indicates that the ball or another object is located on the table. Once the program successfully identifies the position where the signal break occurs on the table, it proceeds to execute the appropriate routine, which is contingent upon whether the break is detected within a cup's location. In the event that no cup is present at the identified location, a flag is raised and the program initiates a visual effect using the LEDs in that location. The software continues polling, but does not yet clear the flag. Once the break in signal is restored, it clears the flag. The program then resumes polling for flags and repeats the process. If the program detects a break in signal in a location with a cup, it promptly clears the flag associated with it and proceeds to poll once again, this time monitoring whether the signal remains interrupted. If the signal continues to be broken, it means that the ball has landed in the cup in the location and has not fallen out. This results in a point being scored. The program records the score and provides a visual effect to represent the score. It then clears the flag and resumes the polling process in order to detect any further signal breaks.

The software will also utilize a series of loops that will keep track of which of the player's turn it is and any related data, as well as the amount of remaining cups on the table. This lets the software determine which player will win the game, as well as when the game is over and all the cups are removed. The game state will begin when the game is started, creating an array that holds the relevant data for each player, including the number that represents the player, and their current score. The software then tracks the score of each player as they play the game, alternating players when the alternate turn is pressed. Once the game is over, the scores are compared and the highest score is declared the winner. The game state then resets and the user must use the menu to start a new game.

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