Cup Pong Scoring Device

Design Document Check

Group 57
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1 Introduction

We will build a portable cup pong scoring system for college students who like to party. The game is simple by nature, with the setup only needing a flat surface and cups. This leads to boring gameplay and can be ignored during a party unless you are one of the players.
Our product plans to solve this by making a cup pong environment with an additional stylish scoring system to keep spectators engaged.

2 High-level Requirements

- IR sensors must detect whether a cup has been taken away with 95% accuracy.
- The score display will update to match the corresponding game within one second of a cup's removal from the pad.
- Each module will be less than ten pounds and two feet in either direction.

3 Block Diagram

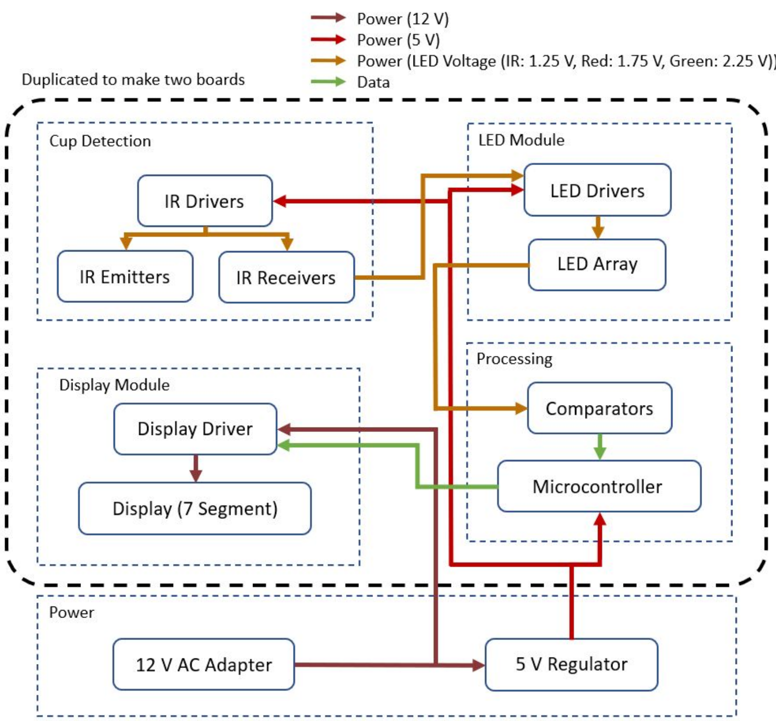

Fig. 1: Block Diagram

4 Physical Design

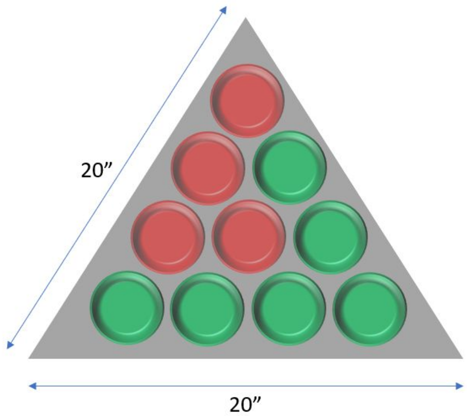

Fig. 2a: Triangular Board

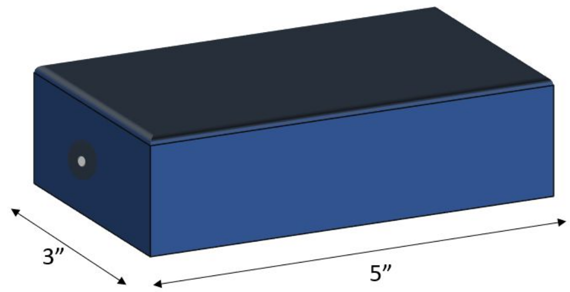

Fig. 2b: PCB Box with Barrel Adapter

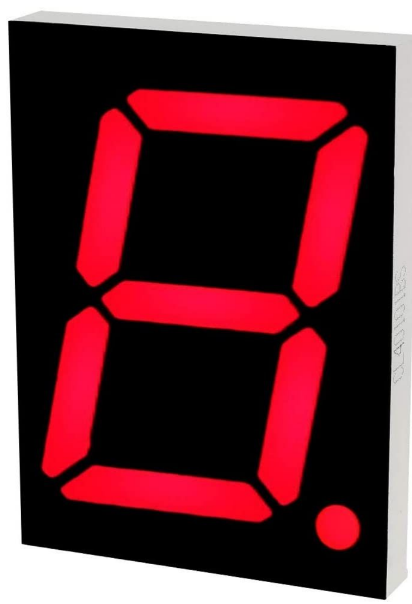

Fig 2c: Scoreboard Display [2]

Material will be ~0.75” plywood with a waterproof finish. There are ten circular bores for the cups to sit in, each going down 0.375” (or half of final overall thickness). By default, the LEDs beneath the cups will be green. Once a cup has been removed, the color will change to red. Our product incorporates two of these separate pads, along with the central scoreboard. The scoreboard is 4” diagonal and 0.6” thick.

5 Requirements and Verification

5.1 Cup Detection

Requirements	Verification
1) Detect if a cup is currently in the designated slot	1) a) Connect IR sensor and emitter to plywood base b) Connect both IR sensor and emitter to 5V battery c) Read voltage after the IR sensor when the cup is in the slot and confirm that it changes when cup is removed

5.2 LED Module

Requirements	Verification
1) LEDs must turn red when no cup is detected, and green when a cup is present	1) Put a cup into any of the designated slots and verify that the LEDs turn green. After removing the cup, the LEDs should turn red.
2) LEDs must have a consistent power draw and supply	2) We will use a voltmeter to sample power draw over time to confirm that we have no faulty LEDs that could cause unexpectedly high power draw

5.3 Display Module

Requirements	Verification
1) Must count up from zero as cups are removed.	1) Start with all 10 cups in position. Remove the cups and verify that the number increases (will stop at 9).
2) Number increases within one second of a cup being removed.	2) Repeat verification (1), however, time the removal of the cup and the display updating. The display should change almost immediately.

5.4 Processing Unit

Requirements	Verification
1) Take data from IR/LEDs	1) a) Wire LEDs to comparator b) Wire comparator to microprocessor c) Use a terminal to confirm that data being sent is correct
2) Send data to LED display	2) a) Take input data from comparators and output through digital pins b) Use voltmeter to confirm that wires are changing when cup is placed in or removed

5.5 Power Unit

Requirements	Verification
1) Takes 12V from the wall outlet	1) a) Connect power unit to wall b) Use voltmeter to check power
2) Converts 12V to 5V using a converter and a regulator	2) a) Connect 12V wire to 5V regulator b) Use voltmeter to check power

6 Plots

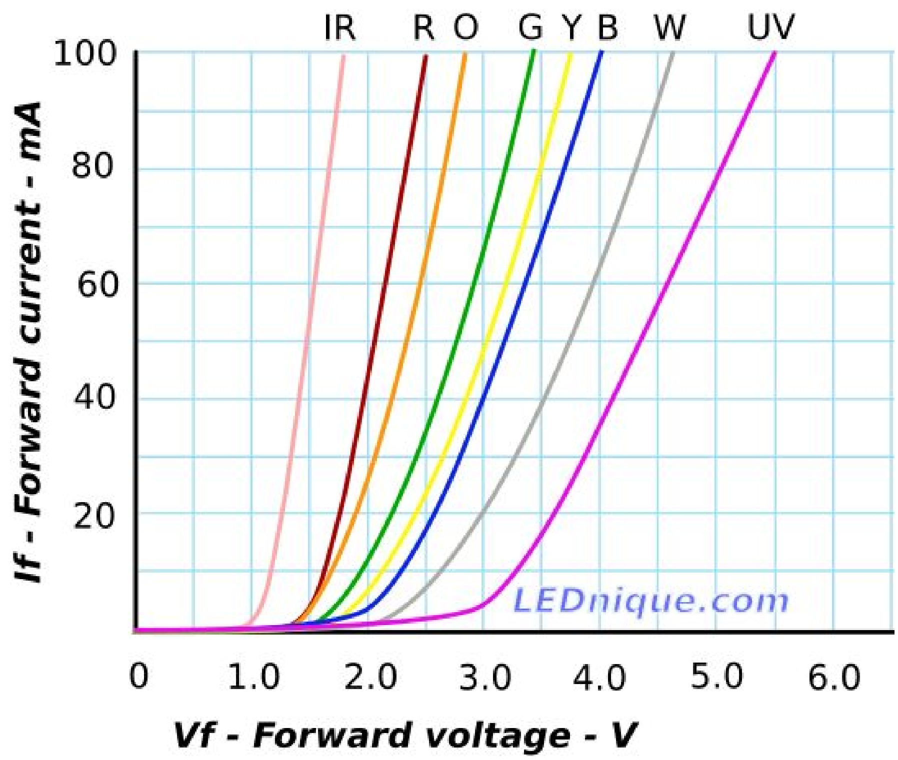

Fig. 4: IV Curves of Different LED Colors [1]

If driven at the general recommended forward current of 20 mA, IR, red and green LEDs will have forward voltages of ~1.25 V, ~1.75 V, and ~2.25 V respectively. The LEDs will be driven with resistors calculated for the specific voltage drops.

7 Circuit Schematics

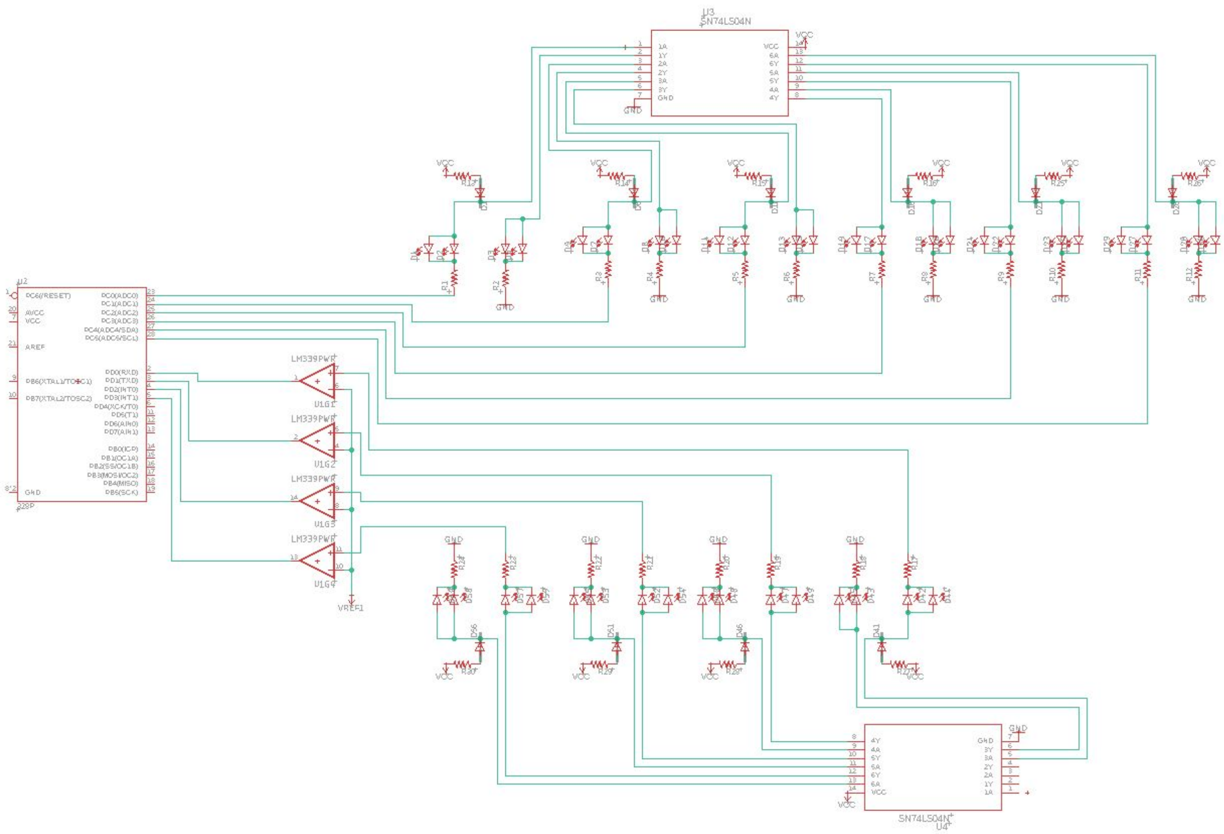

Fig. 5: High Level Schematic of LED Module

8 Tolerance Analysis

In our design we currently have two LEDs in each slot to produce light visible enough for players to see. We can wire the LEDs in parallel or series which each have their tradeoffs. With forward voltages of 1.75 V red and 2.25 V for green, 5 V is enough to drive two to three LEDs in series, however, the second and third will be dimmer. In parallel, voltage will stay constant and the current will split between branches. Recommended current for LEDs are around 20 mA. Currently we designed for two LEDs. Using Ohm's Law, we can determine a resistor size of 125 **Ω** with 5 V, 40 mA. Without physical components, we can only make mathematical assumptions, but ideally we would like to have 4 LEDs, which need a resistor of 62.5 **Ω** to generate 80 mA between four LEDs. This is not theoretically feasible because resistors at this size are usually rated for 0.25 W while 5 V at 80 mA is 0.4 W.

We decided to make the tradeoff to control the LED color of each slot through the voltage change of the IR sensor rather than sending the data from the IR sensor to the MCU and then control the color from there. This decreases the number of pins that we have to dedicate towards LED control, potentially removing the need for a third MCU, and simplifies the wiring that we will have to do later on. However, this does mean that we have to create a PCB for the inverter to connect to the LEDs and need to do more testing to ensure that we can consistently read the voltage of the colored LEDs in order to check if there is a cup in the slot or not.

9 Safety and Ethics

Our project relates to a popular college drinking game. User safety is always the top priority. Although we are not directly promoting consuming alcoholic beverages, we recognize that our end users will most likely be using it for that purpose. As an extension, we will in no way encourage underage drinking or over-drinking in accordance with federal law. In reference to IEEE Code of Ethics, we "hold paramount the safety, health, and welfare of the public" [2]. If any user suspects unlawful activity as a result of the use of our product, we recommend immediately contacting authorities.

Use of LEDs creates the risk of triggering seizures in those with photosensitive epilepsy. Flashing lights and patterns are particularly high risk. Flashes between 5-30Hz in particular are particularly dangerous [3]. Although our LEDs will not be flashing in our design we will include an epilepsy warning stick on our device to keep users aware.

Liquids near electronics pose a hazard. Although we plan on coating the wood with a waterproof seal, our users should ensure they are not creating a dangerous environment due to spillage. The power module will also be covered on all sides with the same waterproof coat.

10 Citations

[1] “IV Curves,” *LEDnique*. [Online]. Available: http://lednique.com/current-voltage-relationships/iv-curves. [Accessed: 26-Feb-2021].

[2] “IEEE Code of Ethics,” *IEEE*. [Online]. Available: https://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: 19-Feb-2021].

[3] E. Wirrell, “Photosensitivity and Seizures,” Epilepsy Foundation, 30-Sep-2019. [Online]. Available: https://www.epilepsy.com/learn/triggers-seizures/photosensitivity-and-seizures. [Accessed: 19-Feb-2021].