Final Project Proposal

Year: 2023\_\_ Semester: \_Spring\_\_ Team: \_\_3\_\_ Project: \_\_\_”Rigged” Card Shuffler\_\_\_\_\_

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Team Members (#1 is Team Leader):

Member 1: Zachary Williams Email: will2051@purdue.edu

Member 2: Brian Lee Email: lee3174@purdue.edu

Member 3: Dan Gue Email: dgue@purdue.edu

Member 4: Utkarsh Priyam Email: upriyam@purdue.edu

1.0 Project Description:

Card games using a traditional 52 card playing deck remain incredibly popular today and are often played with friends, family, or even competitively. While they are very fun and provide a great source of entertainment, nearly every card game involves luck-based drawing or dealing. This can become a source of frustration and detract from the entertainment value of these card games. Components of these games that may be described as luck-based can be eliminated if a player can perform controlled shuffles that result in the exact order of cards as desired. Therefore, a device that can perform such controlled shuffles would be incredibly useful in restoring the entertainment value of such games.

Our “Rigged” Shuffler is a device that allows a user to insert a 52-card deck of standard print size Bicycle brand playing cards and then provide user inputs via the on-board user interface (a set of directional buttons and an LCD screen). Then, depending on user inputs, the “Rigged” Shuffler will either output cards in a random order or in a controlled order as specified by the user. Potential user inputs will include options like where cards are in the resulting deal or which player is meant to win. Cards will be separated, reordered, and expelled in the desired order by a series of motors controlled by a STM32F091RCT6 microcontroller. Cards will be identified by an on-board Raspberry Pi by scanning cards with a camera, performing a computer vision identification process for each card, and then determining the ideal deal order according to the user's inputs. This process will be made as seamless as possible by a UART communication bus between the STM32F091RCT6 microcontroller and the Raspberry Pi.

We will be powering our product using wall power. We will then have a voltage divider in order to separate the supplied voltages into three separate voltages. The Raspberry Pi that we are using requires 5 Volts of power. The STM32F091RCT6 microcontroller that we are using requires 3-3.3 Volts. And the stepper motor that we are using will require 12 Volts of power.

2.0 Roles and Responsibilities:

Zachary Williams has had project leadership experience multiple times throughout his college career, being a design lead for his EPICS team and leading the ECE 362 final project. Additionally, he has significant experience with software and has a relative amount of experience with hardware and mechanical design. Because of this, Zach will be the team lead and will handle the mechanical design for the project as well as much of the embedded software for the project. Zach will also assist Dan in the PCB design effort.

Brian Lee has worked in systems engineering contexts before, including for previous ECE classes and as an intern on a network engineering team for medical devices. In these previous experiences, he has had experience with the process of ensuring mechanical, electrical, and software components of a system integrate smoothly and without error. Because of this experience, Brian will primarily fulfill the role of systems engineer.

Dan Gue has had previous experience in designing concise circuit layouts while working at his internship. In addition to this he has also had previous experience with both formatting and constructing concise and efficient PCB circuits. He has also taken labs and lectures that deal with electromechanical motion devices. He is very passionate and excited to be working on hardware PSSC’s. Because of these reasons, Dan will be fulfilling the role as hardware engineer.

Utkarsh Priyam has had previous experience in software development, from various software development internships to machine learning and computer vision research. Additionally, he has experience in designing and managing code development efforts, both for related software ECE courses and via employment. Because of these reasons, Utkarsh will be perfect for prototyping, designing, and generally overseeing the software development efforts for this project through the role of the software engineer.

2.1 Homework Assignment Responsibilities

Homework responsibilities are detailed in Figure 1:

| *Design Component Homework* | | *Professional Component Homework* | |
| --- | --- | --- | --- |
| A3-Software Overview | UP | A9-Legal Analysis | DG |
| A4-Electrical Overview | DG | A10-Reliability and Safety Analysis | UP |
| A6-Mechanical Overview | BL | A11-Ethical/Environmental Analysis | BL |
| A8-Software Formalization | ZW | A12-User Manual | ZW |

ZW: Zach Williams DG: Dan Gue BL: Brian Lee UP: Utkarsh Priyam

**Figure 1. Assignment Responsibilities**

3.0 Estimated Budget

| **Mechanical** | **Estimated Cost** |
| --- | --- |
| Card Dispenser | $50 |
| Wheel | $20 |
| Casing | $40 |
| **Electrical** |  |
| Electrical Components | $100 |
| PCB | $50 |
| Single Board Computer | $50 |
| Microprocessor | $40 |
| **Other** |  |
| Playing Cards | $10 |
| Shipping | $50 |
| **Total** | $410 |

**Figure 2: Estimated Budget**

Much of the mechanical items are planned to be machined, rather than bought, however, things like the card dispenser will be bought for relatively cheap. The casing and wheel are planned to be machined, likely through additive manufacturing like 3D printing giving a relatively low cost for the mechanical items. The estimated total for this category comes out to $110.

The electrical components needed include things like a camera for the single board computer, motors to drive the card dispenser and the wheel as well as any assorted components needed. On top of the assorted electrical components, a single board computer for running the computer vision software and a microprocessor for driving the motors and the UI are also needed, as well as the final printed circuit board for the completed project. The estimated total for this category comes out to $240.

The last category consists of things that do not belong in the other categories. This includes playing cards that we can use to train the computer vision and test our project, as well as the shipping costs for getting the other parts. The estimated total for this category comes out to $60.

These estimates take into account the fact that much of the larger things, like single board computers and microprocessors will be available in prototyping and development and will likely not require replacements because of this. If this turns out to be false, our estimate will likely fall short of our actual spending. With these categories together, the estimated total for our project is $410.

4.0 Project Specific Success Criteria

The following project specific success criteria are proposed for the “Rigged” Shuffler:

1. An ability for a microcontroller to operate multiple DC motors connected to a high-friction roller to consistently take only the bottom card off a deck with an error-free rate of at least 90%.\*
2. An ability for a microcontroller and the Raspberry Pi to communicate via a UART transmission line.\*
3. An ability for a microcontroller to control a stepper motor to precisely rotate the shuffling wheel.\*
4. An ability for a microcontroller to control an LCD screen via SPI to display device status and user inputs.\*
5. An ability for the Raspberry Pi to determine the rank and suit of individual cards with an accuracy of 75% or higher by taking a picture of it and processing the image.†

\* Hardware PSSCs

† Software PSSCs

5.0 Sources Cited:

No external works were used to write this report.