Alfredo Enriquez
Angel Lozano
Alondra Villagrana

# CSE 5408 - Final Report

1. Executive Summary:

- This report is designed to outline the requirements and goals of the design we have developed for the project in CSE 5408. The requirements listed in this document reflect those discussed with clients and the team. The following goes over in comprehensive detail of the design and implementation of a gaming platform device with a companion mobile application.

2. Problem Description:

- There is a need to bring back classic games to a physical media entertainment device that involves modern-day technology such as the smartphones in your pocket. A device that can help young developing minds grow and improve motor skills while still being competitive and fun enough to get all age groups interested. The device is also made for entertainment purposes.

3. Requirements Specification:

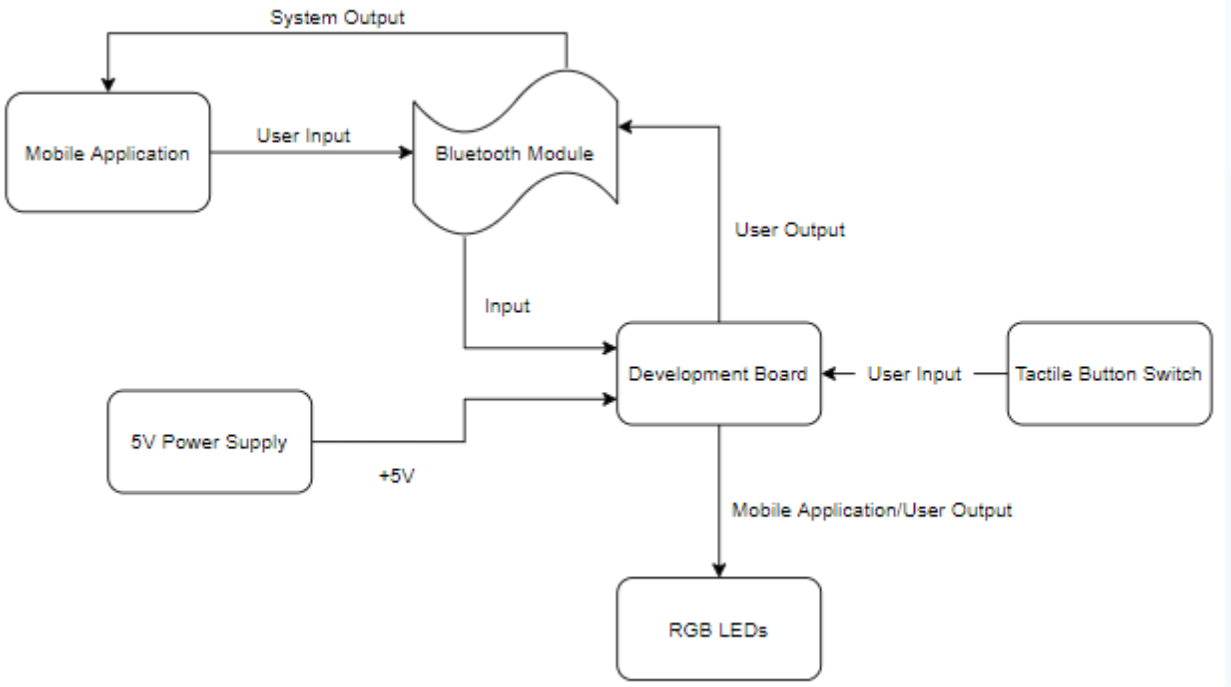
- External interface requirements
    - The user interfaces will consist of graphical elements and text in the mobile application for users. A user will need access to the device and is recommended to use an android device to play alongside the games. The mobile application is built on MIT App Inventor and communicates directly with the development board. Data is transferred through the HC-05 Bluetooth module.
- Functional requirements
    - Users can play without a mobile application. Pressing the second button from left to right on the board will start playing. Using the mobile application, the user can select a game, how to play, or credits from the main menu. Selecting the game, the user has the ability to record current high scores during that session and their score as they play.
- Performance requirements
    - The mobile application must be able to update user scores and high scores in real-time to provide players with accurate information. This

real-time updating is critical to provide the client with a functional product.

4. System Alternatives and Alternative Selection:

- The first design had planned to create a 3x3 button layout for a total of 9 buttons which would allow for multiple games such as tic tac toe, whack a mole, and Simon says. We were not able to meet these requirements because having to deal with shift registers to individually toggle each button with the least amount of input wires to the development board proved to be too difficult of a task to get consistently. We still planned to have a mobile device alongside the board so we scraped the design down to a 4 button layout to implement Simon says. This was all due to project timelines and meeting the deadline.

5. System Design:




- At the center of our design, we have our development board that is being powered by a 5V power supply. A battery pack was used to house a 9V battery for this project. There are two ways the development board can receive user input. Either from the tactile button switches or the mobile application. If the button switches are toggled, the data will be sent to the RGB LEDs to show user output and it will be sent to our Bluetooth

module (HC-05) where output data will then be shown on the mobile application. If user input is done on the mobile application. That data will be sent to the development board through the Bluetooth module which will then show output on the RGB LEDs. The only changes to the design are the number of switches and LEDs because of the scale down from 9 to 4 units each.

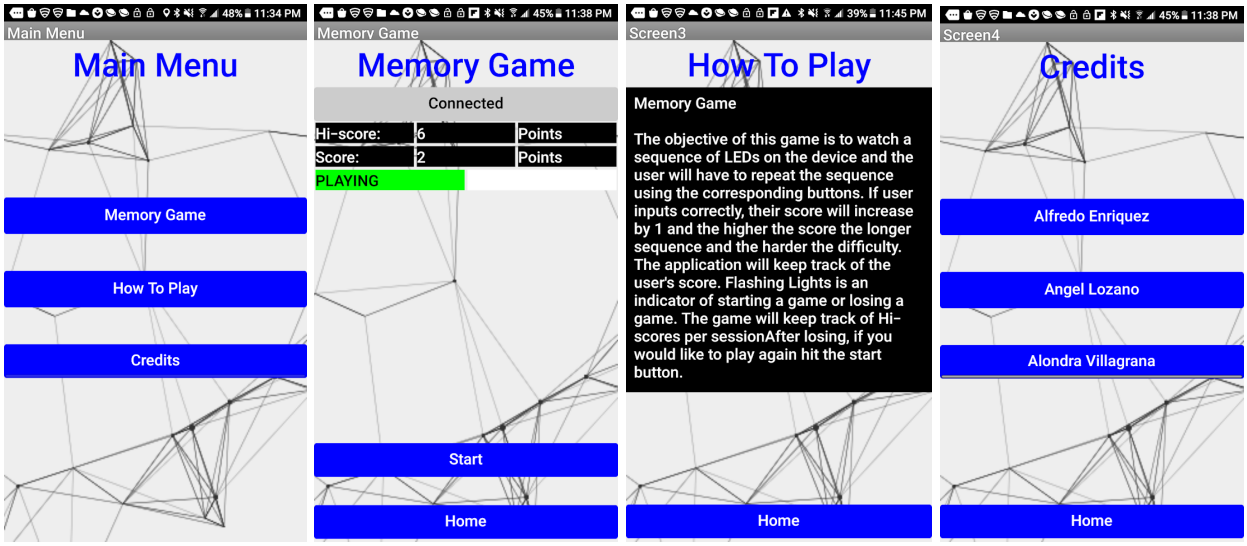
6. Detailed Design:

**Mobile Application:**

The Mobile Application block has two functions. It takes in the system output from the Bluetooth module and displays either the user output that has been sent from the development board or the user input from the mobile application. It also converts user input and sends it to the Bluetooth module. The data will then be transferred to the development board where it will tell the RGB LEDs what operation they need to perform.

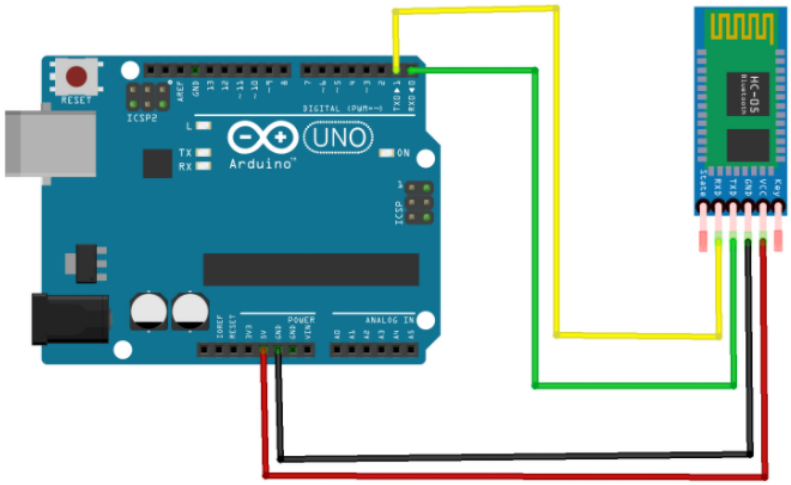
The Mobile Application will be created into an Android APK and installed onto an android device using the web application for visual programming MIT App Inventor as the operating environment. MIT App Inventor recommends the latest version of Windows 10 or 11 for use and the latest version of Android 11 or 12 for installation.

Acceptance testing begins with the home screen. Testing will check to see if all functions operate as expected. The User will have options to connect to the device via Bluetooth and select the memory game, how to play, and credits. The Output of this block will correspond to the data being displayed on the RGB LEDs, whether the player decides to play or not. Connecting to the bluetooth module and switching between screens should all be smooth and intuitive. During games, the input from the tactical button switch will be sent to the development board, to the bluetooth module, and back to the mobile application which will update and deliver a live feed of the score and session highscore from the game that is currently being played while also having an indicator.




## Bluetooth Module:

The Bluetooth Module block consists of the bluetooth module HC-05 which is an extension of the development board. This will be used to connect the mobile application to the device. This module has 2 methods of communication and can be used with most microcontrollers. This is because the module operates Serial Port Protocol, also known as SSP. It is compatible with any microcontroller that supports USART (Universal Synchronous/Asynchronous Receiver/Transmitter) which has a baud rate of 9600. The module is able to operate in two modes which are Data mode, pin set as “LOW”, and AT command mode, pin set as “HIGH”, but in this instance we will use it in Data mode. The module is connected through the Rx and Tx pins and has a range of about 100m.



**Development Board:**

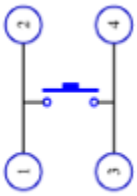
This development board is the component that links all others and the hub for transmitting signals and voltage in and out of all other components. The development board will take inputs from the bluetooth module and the tactile button switches and output them to the mobile application and LEDs. As it reads the inputs from the mobile application it knows what instructions to follow based on the users moves.

**5V Power Supply:**

The 5V power supply will power the development board, bluetooth module, and RGB LEDs. Luckily all components can be powered through this power supply without having to convert the value.

**Tactile Button Switch:**

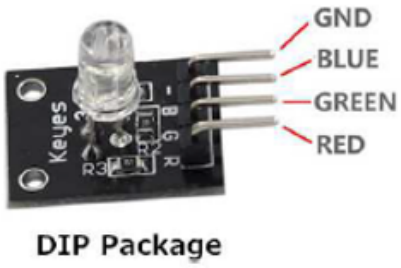
The tactile button switch will take the user input and direct it to the development board. It will be used to play the games by using momentary action. The switch will take the users' manual input for the memory game and create an input signal that will go to the development board allowing it to keep track of the users' gameplay and their scores. As the tactile buttons are selected correctly the development board will update the mobile application and LEDs accordingly. An added feature to the project is pushing down the second tactile button switch from left to right to start the memory game without the need of the application.

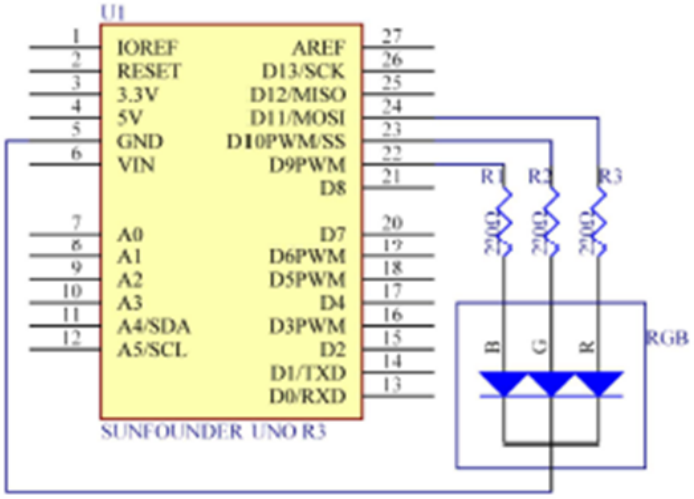



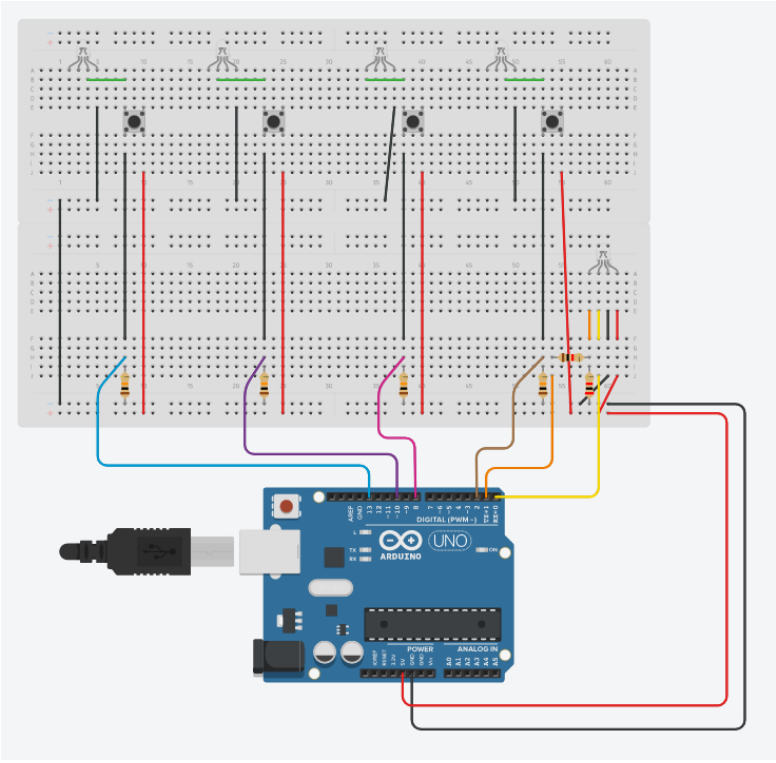

**RGB LEDs:**

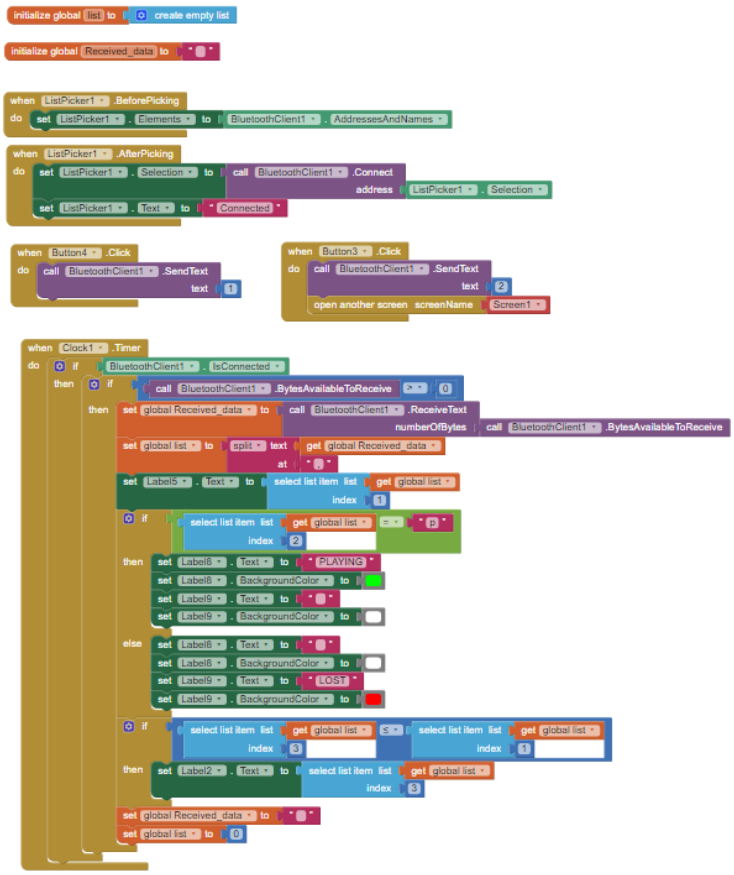
When the user selects to start the game, the development board will follow the instructions and light up the LEDs as programmed. For the memory game the LEDs will indicate what buttons the user must push. They consist of four pins led out, three of which are for the

primary colors red, blue and green, and a ground. The LEDs should update as the tactile buttons are selected correctly such as turning off, starting a new sequence or light up based on the game being played. An update to the LEDs is that only 1 pin for color was used as there was no need for the RGB functionality for the memory game.






7. System Test Plan and Results:

- System Test Plan
    - Arduino: Test each Arduino with a simple code to test its functionality.
    - HC-05: Connect the Bluetooth module to any functioning board and test for connectivity, reliability, and distance.
    - RGB LEDs: Run LEDs through a code that plays a sequence of lights to test each LED.
    - Tactile Button switch: Run switches through a code to test for just a toggle.
    - The rest of the components can be tested during the final testing stage.
- Results of the tests
    - Each unit must perform perfectly meaning all functions of the device must perform flawlessly to pass inspection.

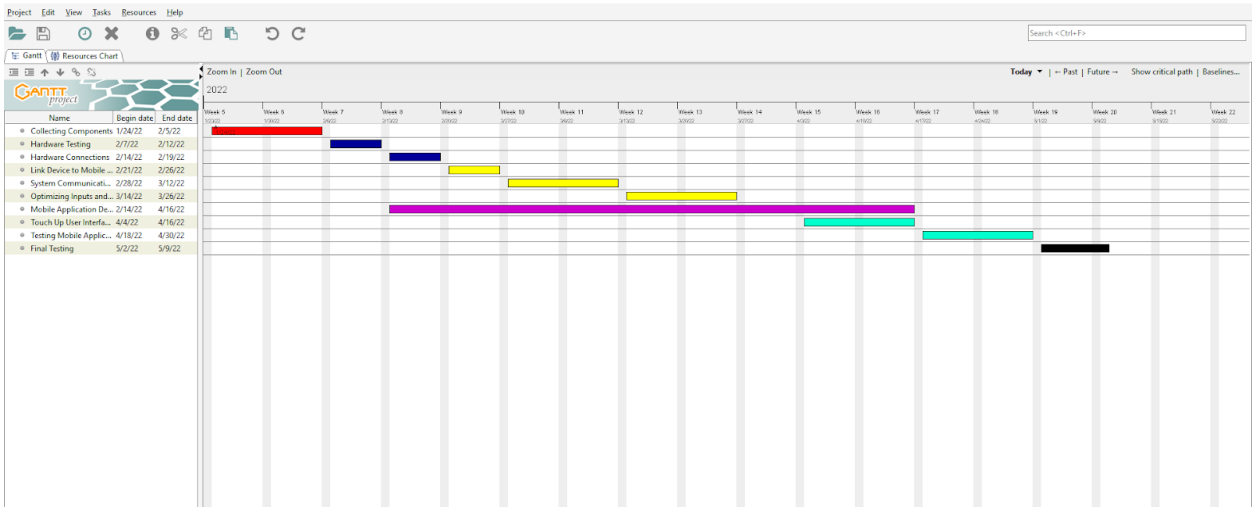
8. Economic Analysis:

- Arduino Uno Rev3 - $23
- Mobile Application - Free
- HC-05 - $5.44
- RGB LEDs - .79 cents x 4 = $3.16
- Tactile Button Switch - .05 cents x 4 = $0.20
- Four 10k, one 2k, and one 1k Resistors - $1
- 9V Battery Clip - $4.19

Total = $36.99

- If this design were to go to the market and be sold at scale, materials could be bought and assembled for cheap and a lot less than the total for this prototype. Over half of the product's cost is spent on the development board. If a cheaper solution is found such as designing and soldering our own boards/chips, finding quality Bluetooth modules for cheap in bulk, and the already extremely low prices of switches, LEDs, and resistors that can also be bought in bulk. Then we can see this design being made for no more than $10 with easy engineering labor. A product like this at its full potential could be sold for 3 to 4 times as much as the building costs.

9. Project Management:




- The above chart is the team's Gantt chart displaying the expected timeline for the project before starting the design. The actual timeline followed this chart exactly except the system communication took a week longer than expected.

- Each task was divided equally among the group members
- Collecting Components (2 weeks, 30 hours, 10 hours each)
- Hardware Testing (1 week, 15 hours, 5 hours each)
- Hardware Connections (1 week, 15 hours, 5 hours each)
- Link Device to Mobile Application (1 week, 15 hours, 5 hours each)
- System Communication (2 weeks, 30 hours, 10 hours each)
- Optimizing Inputs and Outputs (2 weeks, 30 hours, 10 hours each)
- Mobile Application Development (9 weeks, 108 hours, 36 hours each)
- User Interface on Mobile Application (2 weeks, 30 hours, 10 hours each)
- Testing Mobile Application (2 weeks, 30 hours, 10 hours each)
- Final Testing (1 week, 15 hours, 5 hours each)
- Some members were not able to make it to every session of the class meetings making it difficult to follow the timeline exactly but the work still got done on our own at home.

10. Summary and Future Work:

- The current design operates very well with the single-game but for future improvements, we would like to add a bigger layout, back to our original design where it would have had a 3x3 interface for a total of 9 switches and LEDs. We would also like to have all LEDs work as RGB LEDs so games like tic tac toe that need at least 2 different colors on each switch to work. This would also allow us to implement multiple games and get creative with light sequences. Making the device more portable is the goal is it is meant to be played on the go. Currently, the device is prone to getting wrecked just by a simple drop so making it durable would be great. And adding a global community high score would make the device even more competitive.

11. References

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