

DuelReality

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Abstract—*DuelReality is a gaming system aiming to change traditional user experience by combining virtual reality and physical reality into one. Implementing the Yu-Gi-Oh! Trading Card Game - gaming model, a two player game is setup with each player wearing the wristband device as the physical support for the gaming system. Each wristband device contains 5 RFID readers in order to read IDs of cards equipped with RFID tags, and a Bluetooth module to communicate with a user’s smartphone all being handled by an internal processor. A phone app serves as the midway connection between the wristband device and a web server that hosts the game model and performs any required calculations.*

I. INTRODUCTION

As technology became an essential part of our world, the preponderance of social interactions in our lives has diminished. The large number of people interacting on social networks without ever meeting once provides overwhelming evidence to the above statement. As Mark Fischetti from Scientific American puts it, technology “makes us less attentive to the people closest to us and even make it hard for us to simply be with ourselves” [1]. Thus, people prefer to interact virtually while failing to develop or strengthen relationships with people that are physically present. With that goes the fact that they embrace the opportunity given by the virtual world to display an ideal image of themselves to others. In the online gaming world in particular, users play everyday against hundreds of opponents, whom they view as digital profiles whose only attributes are points or scores.

The negative impacts of technology on social interactions is a fairly new problem that arose with the introduction of mobile devices like tablets and smartphones in the last decade. It is a problem that has often been overlooked because the benefits of new technologies largely compensate for their disadvantages. Thus, little effort has been made to address this problem.

Our gaming system makes use of modern technologies to allow users to play against each other while being physically present and develop meaningful relationships. In our system, we implement the Yu-Gi-Oh Trading Card Game (TCG)[2] as it is one of the most popular and successful card games in history with the Guinness World Record of “Best-selling trading card game company” [3]. Currently players only have two options of playing a traditional Yugioh TCG. They have the option of playing solely online against opponents, and the solution of playing face to face with a physical card set. Our model combines the two existing models to create a hybrid (physical/virtual) gaming system which will catch the interest of many users and draw them out of their virtual world.

To build our system, we will use RFID readers that will read card IDs from RFID tags placed on the cards. The readers communicate with an ATmega 2650 processor[8] which sends

the data to the user’s smartphone through a Bluetooth module. The bulk of our system is located inside the wristband casing shown in Figure 1. The readers will be placed under the card slots; the processor and the Bluetooth module under the capsule (top node); a 2600 mAh battery will be attached to the bottom of the wristband. We estimate the total weight of our module to be 0.6 kg.

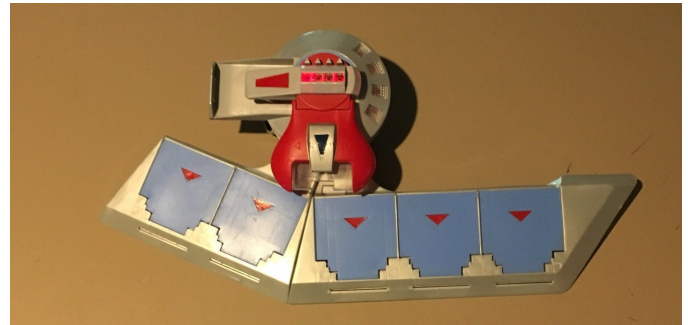


Figure 1. Wristband Casing that holds most of the components

Under the capsule in the top node, there is a strap that allows a user to attach the device to his forearm and wear it. Table 1 summarizes the system specifications.

Rich Gaming Experience	Minimum of 20 cards required in each player’s deck, supports 2 players
Lightweight Product	The total weight of each wristband device is less than 1kg, which is light enough to wear during game play
Wide User Base and Affordability	Device meets child safety standard and the cost for each device is less than \$100
Sufficient battery life	Battery life greater than 4 hours

Table 1. List of requirements and Specifications

II. DESIGN

A. Overview

In an attempt to reconcile technology and interpersonal interactions, we are building DuelReality. This gaming system will immerse users in the virtual world while facilitating physical interactions at the same time. The virtual aspect of the game will be the projection on a surface of the monsters associated with the cards played by the user and those of the cards played by their opponent, as well as current game

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statistics such as “life-points”. The fact that users use physical cards to play instead of purely virtual cards represent the physical aspect of the game.

We are using RFID technology[4] to read the attributes of the cards. Each card is equipped with an RFID tag [5] storing an ID. The data collected when a user taps a card on an RFID reader is sent to a microcontroller which then sends the data to a smartphone app through a Bluetooth module; which ultimately sends the data to a server.

We chose RFID technology because it works well incorporating the physical aspect of the game. The RFID reader we use is Mifare RC522 [6]. The read range of our RFID readers is between 0 and 50 mm. We are using Bluetooth Low Energy to meet the power requirements of our system. The operating current of our SH-HC-08 4.0 BLE module is between 10 and 30 mA [7].

Initially we considered using a GSM module on the wristband to upload our data to the server, but a GSM module would require users to buy a plan from an Internet Service Provider. For that reason we decided instead to create a smartphone app that is able to communicate to our system through Bluetooth; and to the server through the user’s Internet connection. This way, a user can just install the app on their smartphone and connect to the gaming system.

To verify power consumption requirements, we test our system at the worst possible working condition, which is when the components are drawing maximal power from our power source at the same time. The total current draw at the worst condition is about 320 mA. Since our battery has the capacity of supplying 2600 mAh, our device has the capability to work for more than 8 hours at worst condition, satisfying our system specification.

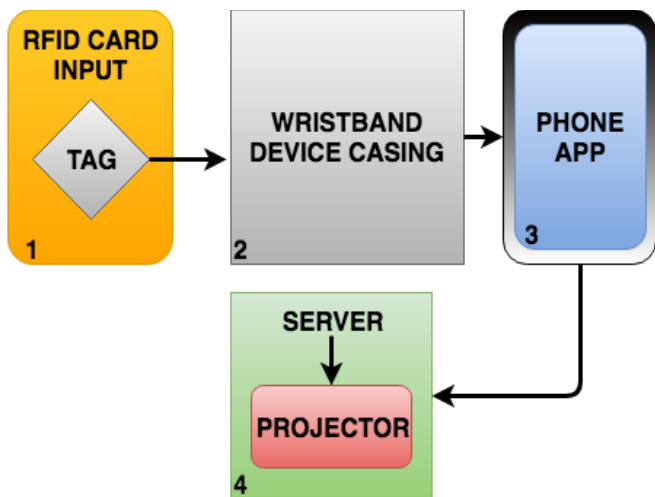


Figure 3. Block diagram

In our block diagram (see Figure 3), the first subsystem is an input card with an RFID tag attached to it. The RFID tags are relatively cheap and effective, 50 tags cost \$20 dollars [11]. Using these tags allows us to reduce the cost of our device as well as provide accurate card reading.

The second subsystem is the wristband casing itself which

includes the ATmega2560 processor[8], RFID readers, the LCD screen, the voltage regulator, which is an electronic circuit that provides a stable DC voltage independent of the load current, temperature and AC line voltage variations, the power supply, and the Bluetooth module, all of which will be installed on the wearable wristband device. These components allow us to meet our requirements which fall in the categories of power consumption, weight specifications, and child safety requirements. The Bluetooth module, the LCD screen, the 5 RFID readers and the processor draw a total of 320 mA which is well within our expected range at worst case scenario. The weight of the components is in total 0.15 kg; when we add that to the weight of the wristband itself which is 0.45 kg, we find the total weight of our device to be 0.6 kg. The battery that we are using meets the child safety standards of the Consumer Product Safety Commission.

The third subsystem represents the smartphone app that will be the link between our device and the server. It allows our system to support a 2-player mode since each player will be able to install the app on their phone to play.

The fourth subsystem is our server where the game algorithm will run and a projector that will receive messages from the server about the cards played and project the monsters associated to them on a surface. Implementing our game algorithm on a server allows us to significantly reduce the processing power and memory required for our processor which in turn keeps the price of our system low. Designing our system this way, we are able to keep our device inexpensive, light; support 2-player mode; meet Child Safety Standards; and enable users to play for more than 4 hours.

B. Block 1: Input Card



Figure 4. Card with RFID Tag used to transmit Card ID

Figure 4 represents an input card with an RFID tag attached to it that contains the card’s ID. RFID readers read the tags and send the data to our processor. To test this block, we repeatedly tap the card on the RFID reader. We record the number of times the reader read it correctly and note whether or not the card was touching the reader or if it was in the 50mm range. Using the results of this experiment, we are able to tell how close a card should be for a reader to read it.

C. Block 2: System Components

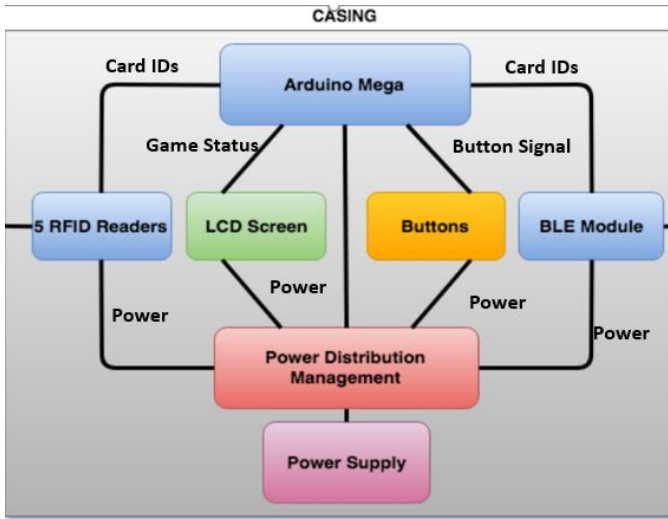


Figure 5. Wristband device casing encompassing processor, RFID readers, screen, buttons, Bluetooth module, power distribution unit, and battery.

Figure 5 represents the casing that contains the RFID readers, the microprocessor[8], the LCD screen[9], the power distribution management unit, the power supply, and the Bluetooth module. This block will be the bulk of our physical system. Our power supply is a 2600 mAh battery which outputs 5V. With a voltage regulator, we supply power to our components: 3.3V to each reader, 5V to the processor, the LCD screen and the Bluetooth module. The readers send card data to the processor which outputs it on the LCD screen and sends it to the Bluetooth module. To build this subsystem, we had to learn how to interface the readers and the LCD screen to the processor. To test this subsystem, we will tap a card on one of the readers and observe if the card attributes are displayed on the LCD screen and if they are successfully transmitted to our smartphone app through the Bluetooth module. On our smartphone we will be expecting to see the ID corresponding to the card that was played.

D. Block 3: Smartphone App



Figure 6. Phone App for data transmission between wristband device and server.

Figure 6 represents our Smartphone app. Our app will read the card IDs from the Bluetooth module and send this data to the server. To develop the app, we used Android Studio[10] as the development environment. The programming language was Java. Learning about an object oriented language in CompSci 121 and Data Structures was very helpful in designing the app since our courses were taught in Java. To test the app, we used an Android phone in developer mode. We ran it on the phone to see if it connects to and communicates with Bluetooth devices. We considered the experiment successful when we were able to send and receive data from Bluetooth devices.

E. Block 4: Server and Projector

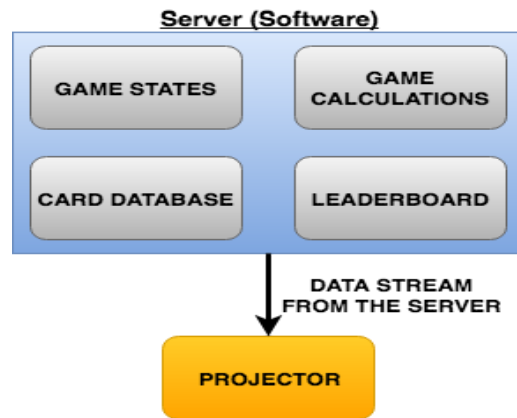


Figure 7. Server subsystem where all calculations, databases, and game states will reside. Projector will receive the current game state from server and project game against a surface.

Figure 7 represents the server portion of our system where most of the game play will actually occur. Running on a Google platform, our server is responsible for the game calculations, card database storage, current ongoing game states and sessions, as well as side features such as an online leaderboard that people can access from across the world. Essentially when a player initiates a “duel” with another, the two gaming systems connect to each other and create a session on an online hosted server. There, our system constantly waits to receive messages from both systems regarding new actions taking place such as attacks and new card placements. Once the messages are received by the server, after any necessary game calculation or state has taken place, the server pushes the updated states to each player’s devices, alerting the opponent of the last action of the other user. From the beginning, the server is responsible for game initialization, calculation, and end.

The bottom portion of our block titled “projector” is just as it sounds, it is a projector that projects the game to the user. The projector receives messages from the server and projects the game state: such as monsters, life points, attacks, etc., for all

connected users to see.

III. PROJECT MANAGEMENT

Proposed MDR Deliverables:

- Communication between one RFID reader and microcontroller ready. We will need to expand to multiple readers.
- Communication between the system and the Internet established.
- Provide steady power to readers, microprocessor, and Bluetooth module, and perform basic power consumption analysis.

From our MDR deliverables we were able to set up communication between the readers and our microprocessor, while displaying necessary values on the LCD screen. Communication between the Internet and a client is established. Lastly, our third deliverable is met using a battery, and a voltage regulator, to provide constant and steady power to our system components.

The team is working in unison, meeting once a week, and constantly staying in touch with messages and updates through a Skype group chat. Jerry and Hadi are working together tackling the software side of our system while Xiaobin is taking care of the hardware portion. Currently we are on track to meet our CDR deliverables.

Proposed CDR Deliverables:

- Allow user recognition and connection between two Bluetooth-enabled devices
- Be able to begin, play, and end a fully functional game between two systems.
- Complete PCB design that integrates an ATmega2560 Processor with power distribution functionalities.

5 Readers	\$12
Microprocessor	\$22
Bluetooth Module	\$8
LCD Screen	\$6
Wristband Casing	\$20
PCB Power Supply & Accessories	\$22
Total	\$90

Table 2. Estimated Budget (Per Device)

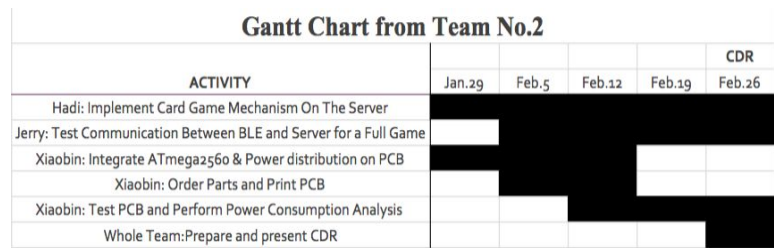


Figure 8. Gantt chart timetable up to CDR

IV. CONCLUSION

For MDR, we have the communication between the processor and the readers, and between the processor and the LCD screen established. We also have a smartphone app able to send and receive data to/from the processor. Our server is setup and we have been able to provide steady power to the processor, the readers, the LCD screen and the Bluetooth module. We achieved these goals by fostering discipline and following a thoughtfully built schedule. We also followed the pieces of advice from our faculty advisor and from our evaluators. For CDR, we expect to be able to start and finish a full game. Our Gantt chart in Figure 8 summarizes our plan to achieve this goal.

In order to do this, we will need to enable the app to send and receive data to/from the server; and allow users to login. We are also aiming to have our PCB design ready to connect the different parts of the device. We expect to encounter difficulties in implementing the communication between the app and the server. Delivering a properly working PCB will also be a challenge. We will achieve these goals by following our Gantt chart. We will also research the best strategies to quickly enable the communication between the app and the server and to efficiently design the PCB, as advised by our faculty advisor and evaluators.

ACKNOWLEDGEMENT

Team DuelReality would like to thank Professor Jackson for his continued support and advice regarding the project.

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