A Voice for Autism

DESIGN DOCUMENT

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1 Introduction

1.1 PROJECT STATEMENT

For our project, we are working with Micron to build a device that will help people with autism communicate. The goal is to build a tablet with a touchscreen interface, and an app that will run on the tablet, or be downloadable onto an Android device. There are other devices on the market that fill this need, but we can offer something unique to the public if we meet all the specifications outlined by Micron.

1.2 PURPOSE

This project is important because we have the chance to greatly improve the quality of life of many people. Ideally, this device would make lives easier for those with autism by improving their ability to interact with their surroundings, and get what they want out of life. There are currently devices on the market, but if we are able to create a budget-friendly, customizable device, then we will have something different to offer consumers.

1.3 GOALS

There are two main goals to accomplish: develop an application and create a customized tablet. The application will be available to download on the user's personal Android device, or they have the option of buying the tablet with the software installed. The app needs to be customizable, so that it can grow with the user. Our ultimate goal is to create something that will allow people to only have to buy one device, and be set for a long time. Most products for kids on the market are very unsophisticated, and the user would likely need to upgrade as they grow up.

2 Deliverables

For this project, our goal is to deliver two different levels of product. In an attempt to reach all audiences that we could aim for with our product, we will be creating both an application and a device. It is our hope that we can implement an offering that any user can attain and use effectively. Our "tablet" style physical device will be designed explicitly to withstand any wear or tear that could be expected of it in the average day of the user. This requires further development of both the case and the connections that are used in the device. In our second offering, we will be delivering an application that is able to run on android devices. This will allow us to both use the app on our device, as well as to aim to those users that are able to use a general phone without issue and may already have one. This setup to our structure is meant to save on costs to our users at every opportunity, this includes not delivering a product that is not needed.

3 Design

3.1 SYSTEM SPECIFICATIONS

3.1.1 Non-functional

The main non-functional requirement of the tablet is that it needs to be durable and aesthetically pleasing. Durability is the main concern because users may not have fully functional motor skills, and the device will be carried around everywhere with the user. We plan to design with this in mind.

The app should have a response time of less than half a second maximum for any UI selection, excluding loading the data for the given view. Data loading for the app should not ever exceed ~5 seconds, maybe split large views into chunks. The app should be portable and scale on devices such as iOS phones, iOS tablets, android phones, android tablets. The screen should not take more than 3 seconds to load the word and images.

3.1.2 Functional

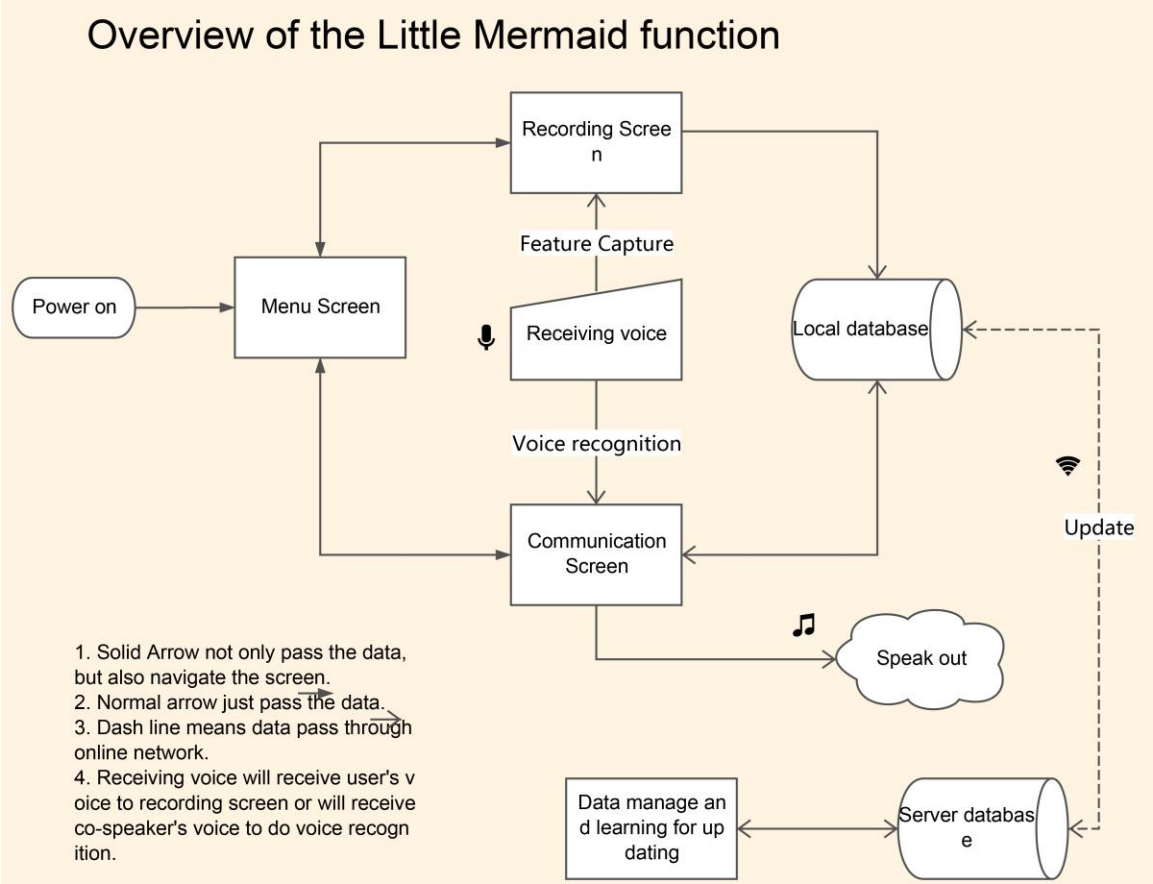
Starting with the hardware, the battery should be large enough to power the device for at least one day. However, we need to be careful that the device isn't too heavy, so, we need to optimize the battery for weight and charge. Also, we need to have enough memory for the app to store their database of words, and the application itself. We hope to also need to design an enclosure that will protect the device, and make it easy to carry.

The device with help will help with communication with other people. The app will need to be customizable, the text will need to be easy to read, and the concept of the app will be able to be understood by many.

3.2 PROPOSED DESIGN/METHOD

Our hardware team has decided to make two prototypes. The first prototype will be very basic using a Raspberry Pi and the official Raspberry Pi touchscreen. The procedure for putting everything together should be straightforward. Our plan for the second prototype is to create our own custom device. Basically, we will need to find a processor, touchscreen, and all of the necessary peripherals to complete the task.

The software sides decided to use Natural Language Processing (NLP) to solve this problem. NLP analysis natural language and recognize the sentence meaning. We would also apply the basic idea of machine learning to collect user's word preference to make a better suggestion. However, for the sake of developing time and learning curve, the machine learning part will be in a low level. The overview solution and learning process can be seen in the figure below.



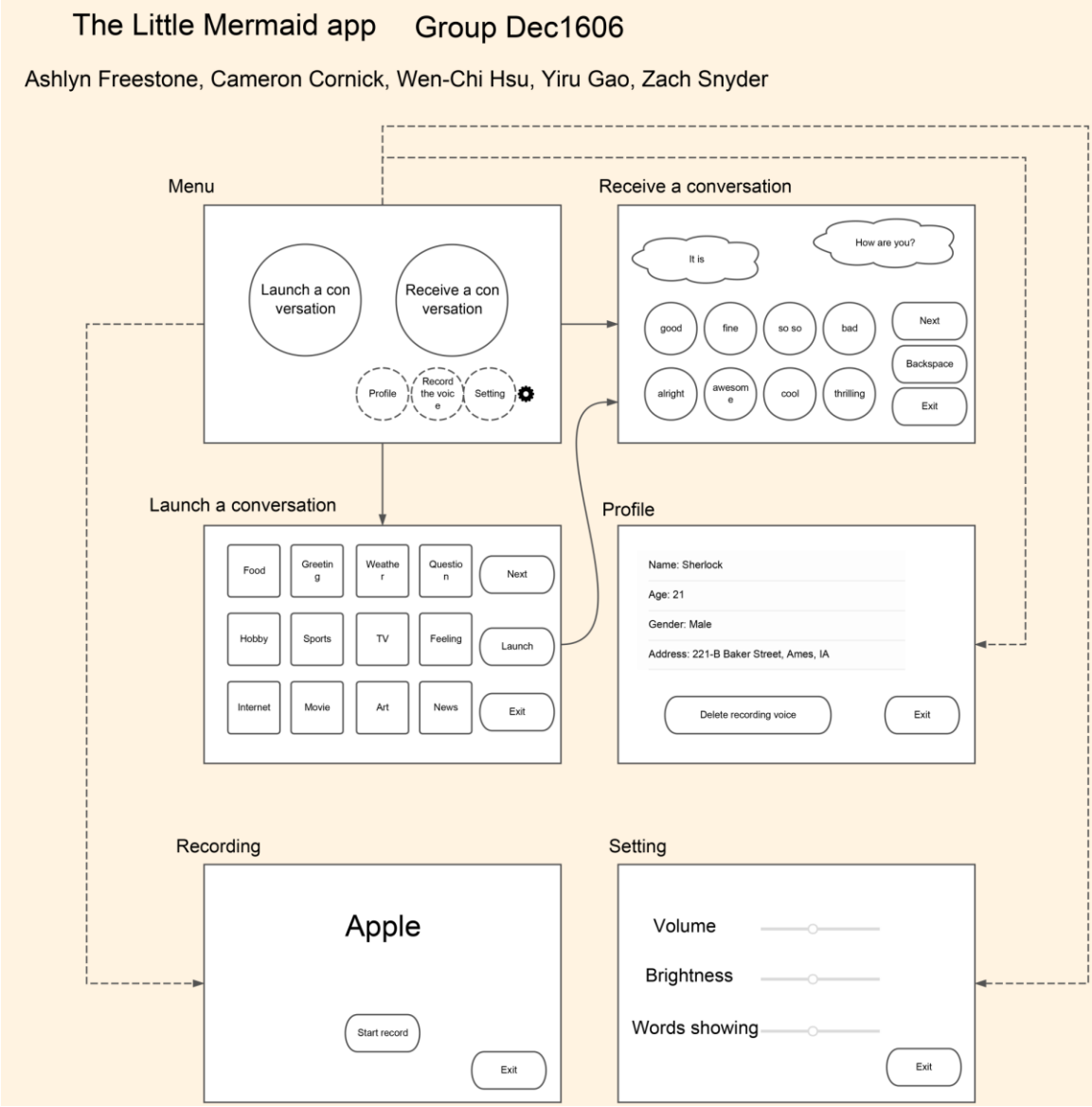
3.3 DESIGN ANALYSIS

We have analyzed our design in multiple ways. It is in regards to the various parts of our project that we have tested our design. It is at this crossroad of having a working prototype of both our hardware and software that we are seeing possible design issues on either end. Though, the design that we have settled upon allows us to iterate through to a working and coherent product. Our next step will allow us to have a fully working product that has both software and hardware.

4 Testing/Development

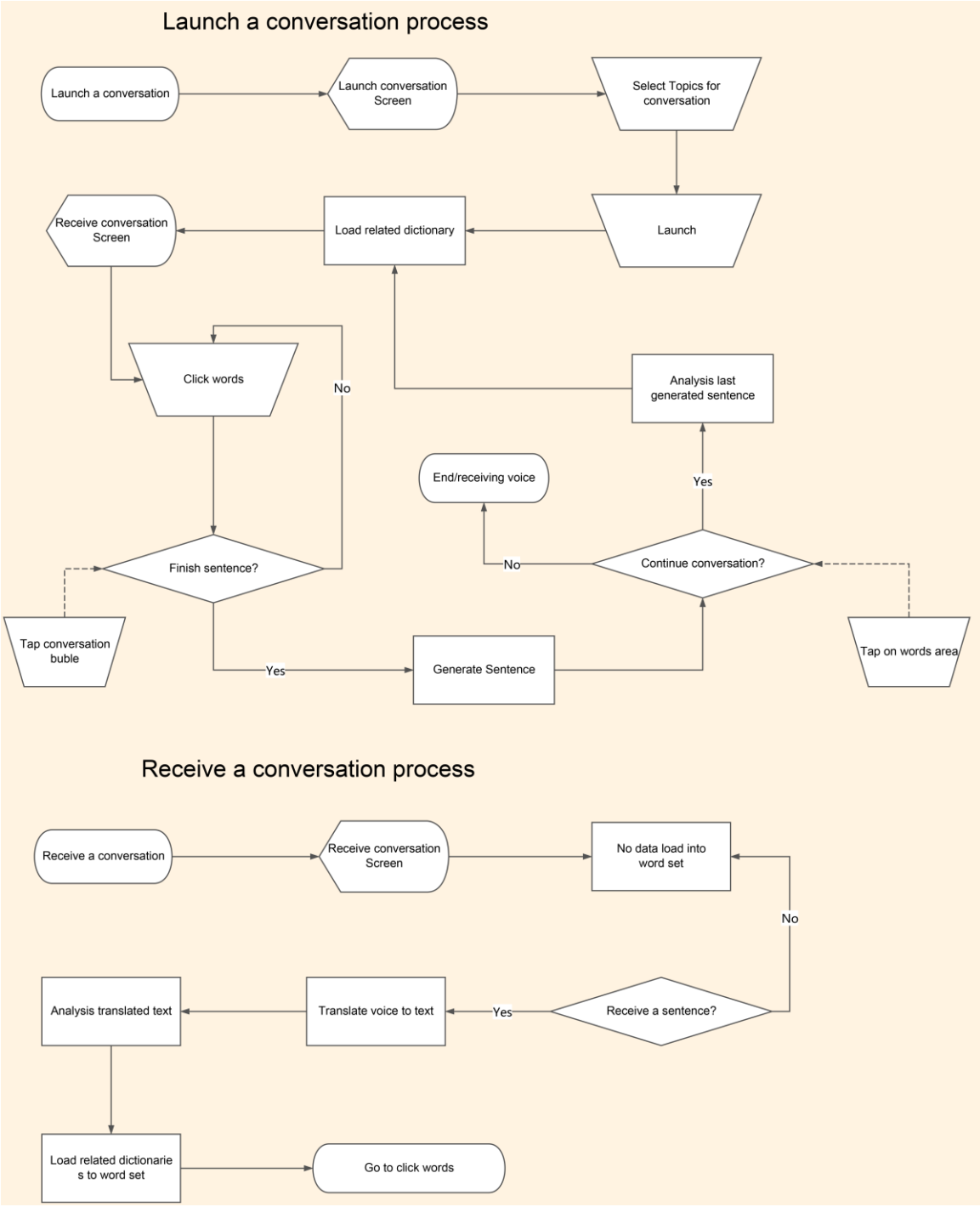
4.1 INTERFACE SPECIFICATIONS

The hardware and software interface will be in using the touchscreen to interface with the user and the communication application. This will involve investigating the connection and protocol of the touchscreen whether it will be I2C or Serial. This will go further were there will be a speaker and a microphone interfacing with the application in various ways on the ARM processor. The application will specifically interface in the following ways.



User will first enter Menu Screen and choose to launch a conversation or receive a conversation. When launch a conversation, user can choose several topic and combine them together to start a conversation. Starting a conversation will navigate user to receive conversation screen with related word choice. For example, if user chooses “Food” and “Feeling”, the word set will likely to have

"tasty", "delicious" and so on. Receive conversation is for listening other's speech. It will judge from recognition and generate a word set to let user select. The Launch and Receive is the core of this project, the detail process flow is shown in the figure below.



Profile will store user's information and will infect word selection. It also allow user to erase the previous recording data of voice. Recording screen will record user's voice feature and replace machine original voice with user's voice when user finish the all process of recording test. Setting

will change screen brightness, volume and words showing of receive conversation. Brightness and volume is essential design, since autistic people do not like too shining light and too loud sound. This is designed for their comfort to use the device.

The suggestion word will load from dictionary called WordNet. The WordNet has neural network structure and will suggest related word to the topic/sentence. However, forming a sentence also need to consider about grammar. For example, when we select "Food" and "Feeling" and intend to make a sentence like "I like the taste of that home-made restaurant". At the beginning of sentence, we still need a subject rather than a "Feeling" or "Food". The word suggestion would also affects by the factor of previous words selection. For example, if I choose "What", the next word is highly likely to be a noun like "weather" or verb like "is" for the next. We use Stanford NLP library analysis those situation to enhance the functionality of suggestion. Stanford NLP provides Java API that perfectly fits our goal.

4.2 HARDWARE/SOFTWARE

Hardware

We used a Raspberry Pi, a touchscreen, and a lithium ion battery for our first prototype. Using these parts, we were able to build a functioning tablet. Each part was essential for building the tablet. We have also been working on a battery charging circuit. For it, we needed multiple transistors and diodes, which were easily obtained in the parts shop. Everything else for the charging circuit was in our lab kits from EE 201 & EE 230.

Software

There will be three types test we think about. First one is M-M test. We plan to have two machine has app talk to each other and see if the machine can make a conversation or not. The topic will be narrow down into few in the first stage and will eventually become large scale and complex (We probably would use Siri to test spontaneous of language use). Second is M-H test. This will let a person speak to machine and see machine can recognize voice and generate right word set or not. The third one is A-H test. We will let autistic people to try this app and see if they will be comfortable to use it or not. We will make a survey to measure the result of the test.

4.2 PROCESS

For the battery charging circuit, we took the online schematic and ported it into Multisim. After this, we built it on a breadboard. We also talked to the part shop, and they recommended using an integrated circuit made for charging Lithium-Ion batteries. We think this a better way to go as the circuit will be able to charge batteries bigger than 3.7 Volts.

For the software application process, we use Agile development methodology focuses on keeping code simple, testing often, and delivering functional bits on the application as soon as other developer ready to build next function into the product. At the end of each cycle that each developer must present a valuable product increment. By focusing on the repetition small period of work cycles as well as the functional product we make, we can flexibly adjust small approved parts as the application progresses, this help us keep track the functional requirement the product need and decrease the impact of a remake our product.

5 Results

In our pursuit of this project we have completed multiple parts of our project. We have completed an investigation into the battery use and charging circuitry that is needed for our project. This was done over a couple iterations where we first started with a bought battery charging board while we investigated the multitude of charging circuits and which ones to use. The next step we took was, after finding what we thought a suitable circuit, to construct and test the circuit. It was at this point where the testing of the circuit failed and in seeking advice from others who had used batteries in their projects as well as ETG, we were directed to special made battery charging IC's to use for the device.

For the software application, we have based user interface created such as the clickable buttons with random category of text as well as the voice output function which generated speech voice while user selected button with text on it.

6 Conclusions

At the end of our first semester, we have completed a large amount of work. We have completed a first prototype where we have tried and tested a basic implementation of the requirements. We have also completed a first prototype on the software side of things that will allow us to build our finished product on top of the building block.

We have taken the approach that an approximate solution and feedback loop was going to be our best way of completing this project. This will be done by multiple iteration cycles, both in the software side and the hardware side. This is a great way to solve our project in that it allows us to fit to the need of our ideal consumer which is the main criteria for success of our product. This also allows us to flexibly meet unforeseen issues or solutions that will only serve to better the project.

7 References

DEC1606 Project Proposal from Micron.

8 Appendices