This is just an example to give you an idea of what is expected. Be sure to refer to the assignment document/rubric for the full expectations.

SMART BEDROOM MONITOR SYSTEM

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Introduction

This report introduces the different design modifications that have taken place since our value analysis to evaluate the most viable design options approximately five weeks ago. Also, it explains the different product changes or improvements that we have planned on if were to take the product into the actual market, not just as a prototype. With this report, the reader should be able to understand the revisions done to the design of our product along with the reasons for these changes and our overall project schedule.

The original design selected for our smart bedroom monitor system with the name *Sleep and Sound* consisted of four different types of sensors: pressure sensor, light sensor, microphone, and temperature sensor. The two pressure sensors and the temperature sensor were placed in an under-mattress sensor module while the light sensor and microphone were placed in a headboard sensor module. Each of these was connected to an Arduino Nano microcontroller that transmitted data to a Raspberry Pi 3 that served as the central hub. Transmission between the sensors and the central hub was completed using 3 different transceivers, one for each of the two sensor modules and one for the central hub module. This central hub module consisted of the Raspberry Pi 3 microcontroller along with the backend database and the front-end user application. This was the overall design approach for our product, which allows parents to learn about their children's sleep quality and room environment. Although we were able to plan ahead for many inconveniences in the development of our original product, some revisions still had to be made to the different modules. In addition, improvements and additions were made to our product in order to make it more competitive in the market. For the most part, we kept our well-thought original design, but still made these changes to fix errors and omissions.

Design Modifications

Sensor Modules

The headboard/bedstand sensor module from our original design contained both the light sensor and the microphone. The light sensor is for collecting the ambient condition near the bed to know if the room's condition is the best for the children's sleep. The microphone will detect if there are other sounds in the room apart from breathing and snoring that might interfere with the correct room environment for the children to have a good night's sleep. We chose the Sodial Microphone Sensor with High Sensitivity shown in the figure below but have not received it from our provider.

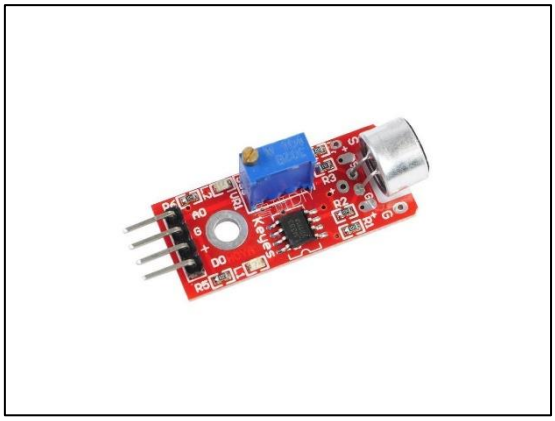


Figure 1: Sodial Microphone Sensor with High Sensitivity Sound Detection Module

Our plan is to implement the microphone sensor if we receive it on time prior to the final demonstration of a working prototype; however, the main ability of our product to track sleep quality of a children has been achieved mainly by the pressure sensors and light sensor which serve as a two-factor validation to check if the human subject is in bed. Including the microphone in our product will serve as a complement to the already existing and working prototype.

One of the customer requirements for our product was to make it as less intrusive as possible for the children being monitored, so he or she might not even notice that they are

being monitored by their parents. Since the under-mattress module consisting of the pressure sensors and the temperature sensor go under the mattress and under the sheets respectively, there was no need to worry about these sensors as they will not be in plain sight. The headboard/ bedstand module containing the light sensor and microphone can be placed anywhere in the room where it is still effective, but the child does not notice the sensors. To fulfil this and to make the device more appealing to the eye, we came up with the following 3D printed casing to put the light sensor and microphone along with a special Printed Circuit Board, Arduino microcontroller, and transceiver inside the 3D printed object.

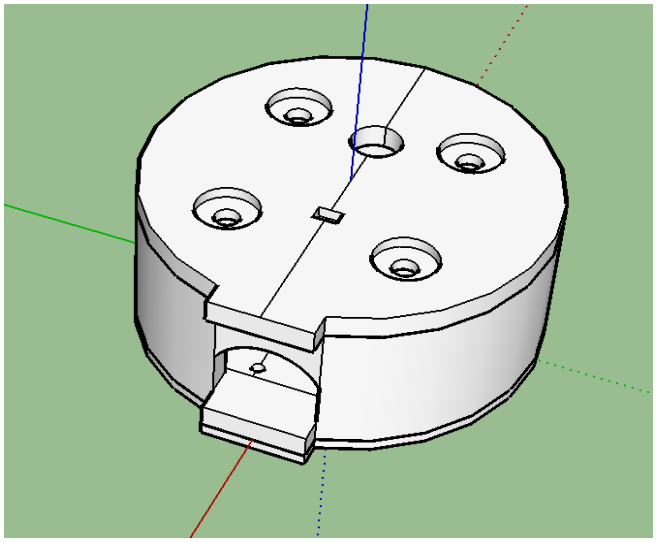


Figure 2: Artist Rendition of 3D Printed Object

Because of its appearance similar to a toy, the object can be placed on the headboard or nightstand without it being intrusive for the person in bed. If placed on the headboard, the light sensor will also be able to detect whenever the child is using electronics in bed along with the room environment to make sure it is ideal for good quality sleep.

In order to get rid of the breadboard containing the headboard/ bedstand module where we had our light sensor connected to the Arduino microcontroller along with a transceiver, we created a Printed Circuit Board that will allow signals and power to be routed between connectors and components and can be modularized with multiple sensors. The

purpose for this PCB is to implement our actual product where no breadboard is necessary for the sensor modules. This PCB will also be easier to implement inside the 3D printed object that will hide the headboard/bedstand module. The following picture shows the design of the circuit board we printed.

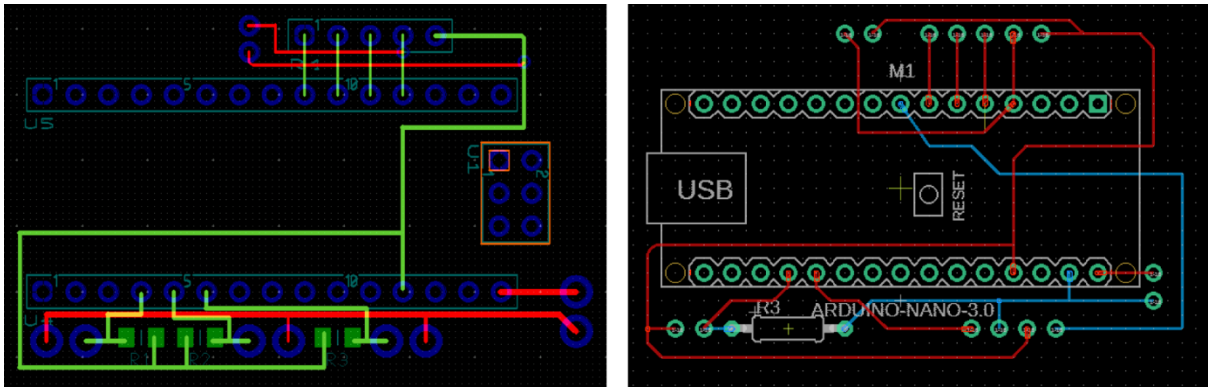


Figure 3: Design of PCB for Sensor Modules

Another improvement that we have planned for our sensor modules if we were to take our device into the competitive market is to break up the modules and use additional circuit boards to test the device using battery power instead of USB power. By using these 9V batteries to power the Arduino microcontrollers, we can guarantee that our product will be able to run for weeks without battery replacement.

Central Hub Module

The central hub module in our product also had many changes and improvements done to it, especially the frontend user application. Similar to the headboard/bedstand module, a 3D printed object will also be needed as a casing for the Raspberry Pi microcontroller. This will guarantee that even this module which does not necessarily have to be placed near the bed will not be intrusive for the person in bed.

Safety is an important topic, especially when talking about data regarding the children of parents. After recommendations from our Teaching Assistants, we implemented a user

authentication in the app where the parent will create their profile as a new user. They can sign out of their profile that has the sleep information of their children whenever they would like to sign out. If the user were to forget his or her username and password, retrieval of a new password is possible through the use of a link sent to the email with which the user first created the profile. The following pictures show the Application User Authentication Page.

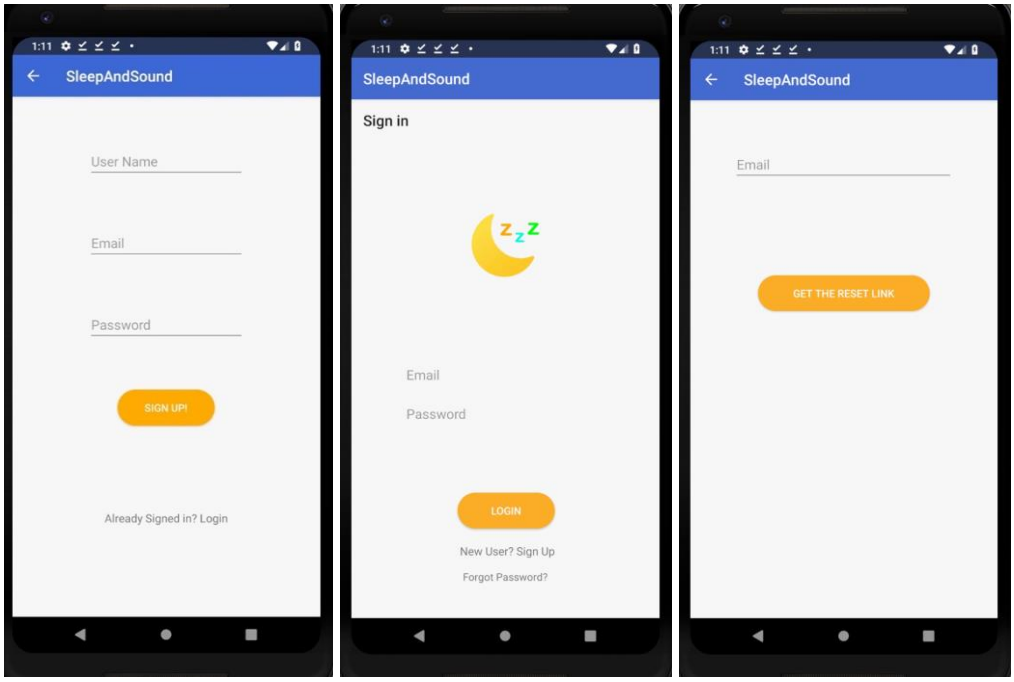


Figure 4: Left: Signup, Middle: Login, Right: Retrieve Password

Our previous approach is, in the central hub's onboard memory, generate a CSV file in which all captured data resides. We have altered this design to provide the customer with a better experience. Instead of having an intermediate CSV file sitting in between the user and the database, the MCU now send data to the database directly. Although we must structure the database architecture more carefully to ensure the data get stored to the right node, this way we can significantly reduce the system overhead and in turn provide a better user experience.

As for the final App, on top of viewing real-time data to see if the child is currently in bed or the lighting and noise condition in the room, the user is able to choose different dates

and view that day's data. Moreover, the App provides the user with data visualization so that they may learn from a glance the sleep pattern of the subject under monitoring.

To further the capacity of the design, the team implemented a product registration protocol. When a product is boot up for the first time, it would register itself on the database. However, the device still needs to be associated with a human subject (i.e., a child) to function. Through the App, the user can pull the listed of registered but un-associated hardware and associated with the kid in a one-to-one relation. By this, using a single App, the user can have multiple monitor systems being subjected to various persons. Each child can also their name, age, and picture in the app edited.

The following figures show the various App activities:

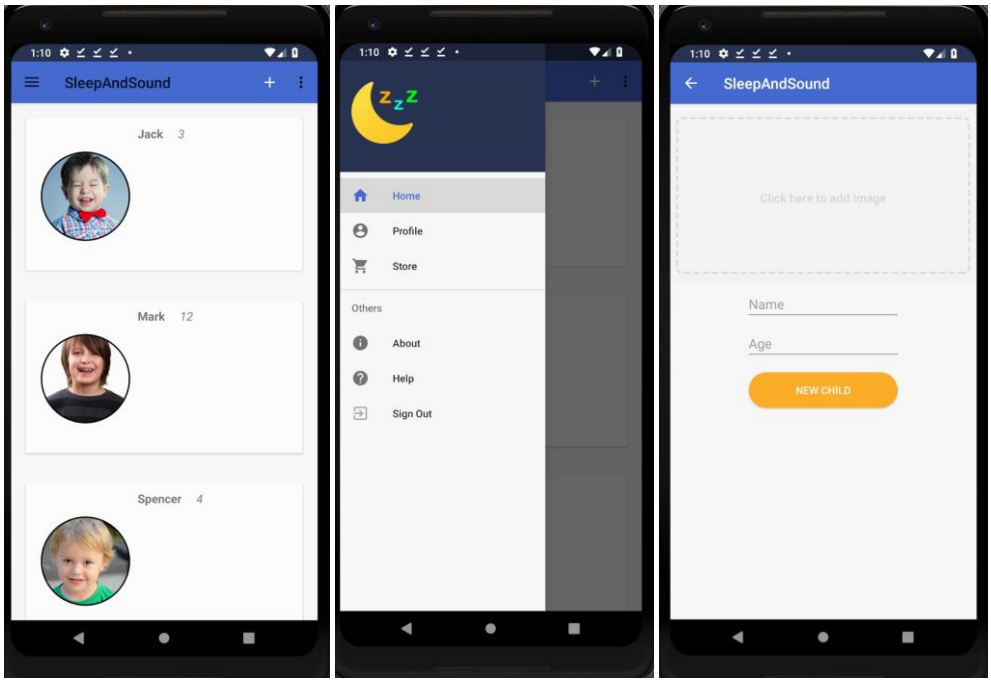


Figure 5: Left: Home View, Middle: Navigation Drawer, Right: Add Child

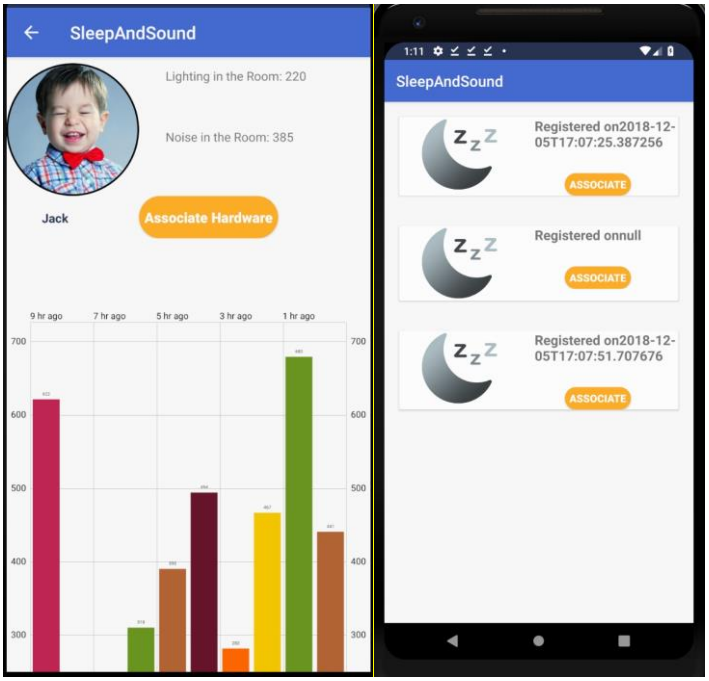


Figure 6: Left: Child View, Right: Associate Hardware

Instead of a bar graph, our plan is to have a line graph for the final demonstration of a working prototype in order to give better and more accurate data to the user. This line graph over time will tell users whenever the child was not in bed according to the pressure sensors and the temperature sensor. Room environment based on the light sensor and the microphone is another feature available for users.

Revised Design

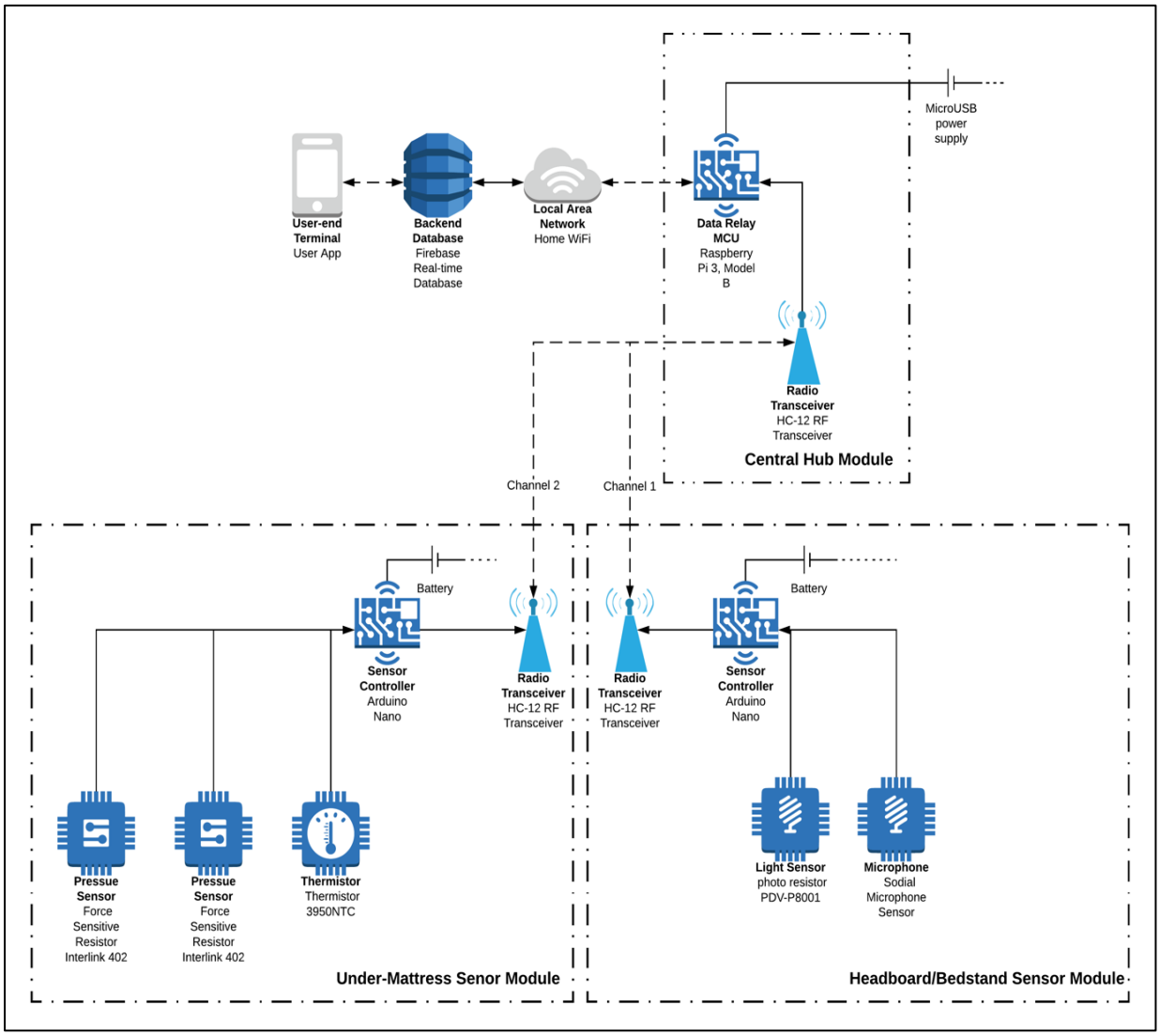


Figure 7: Overall Design Block Diagram

Our overall design block diagram remained the same with the three different modules: headboard/bedstand sensor module, the under-mattress sensor module, and the central hub module. Within each of the modules, improvements and modifications were made after revising errors and omissions from our original approach to each module. The only difference in this block diagram is the possibility of having the microphone sensor implemented or not because of the delay in shipping to us by the providers.

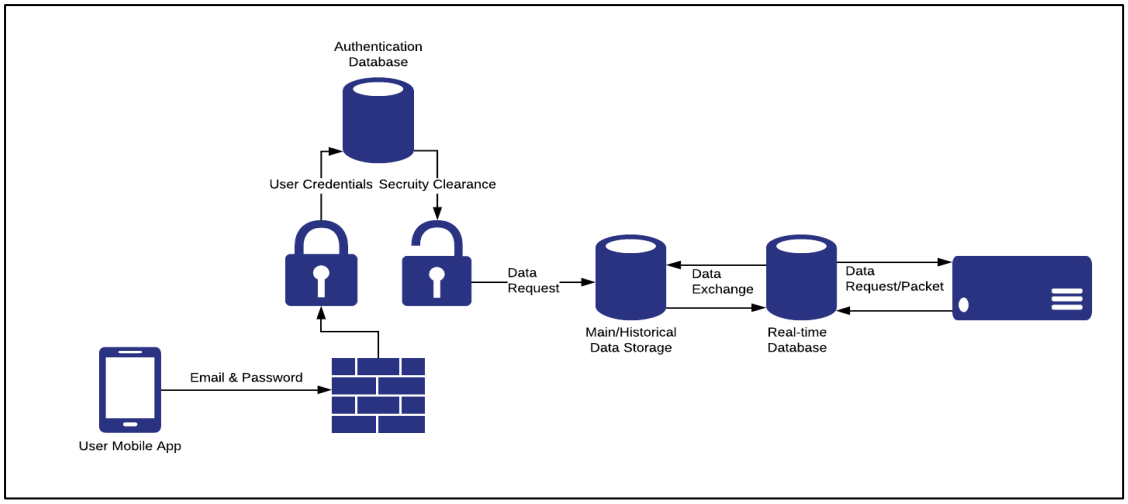


Figure 8: Database and Authentication Diagram

This block diagram shows how the user authentication page works to provide security to the data being stored about the sleep of the user's children. Once the user correctly enters his or her credentials, the data can start being requested to show in the application in real time. Also, it shows how the backend database is transmitting and receiving data from the central hub module through the data requested from the central hub.

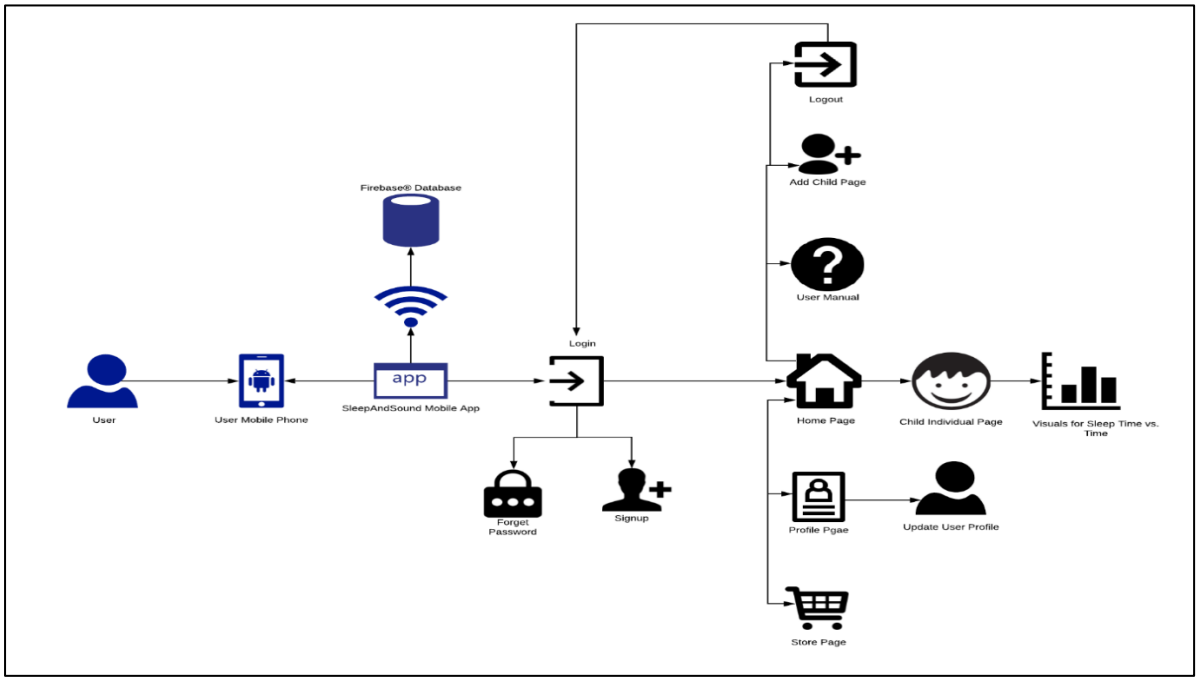
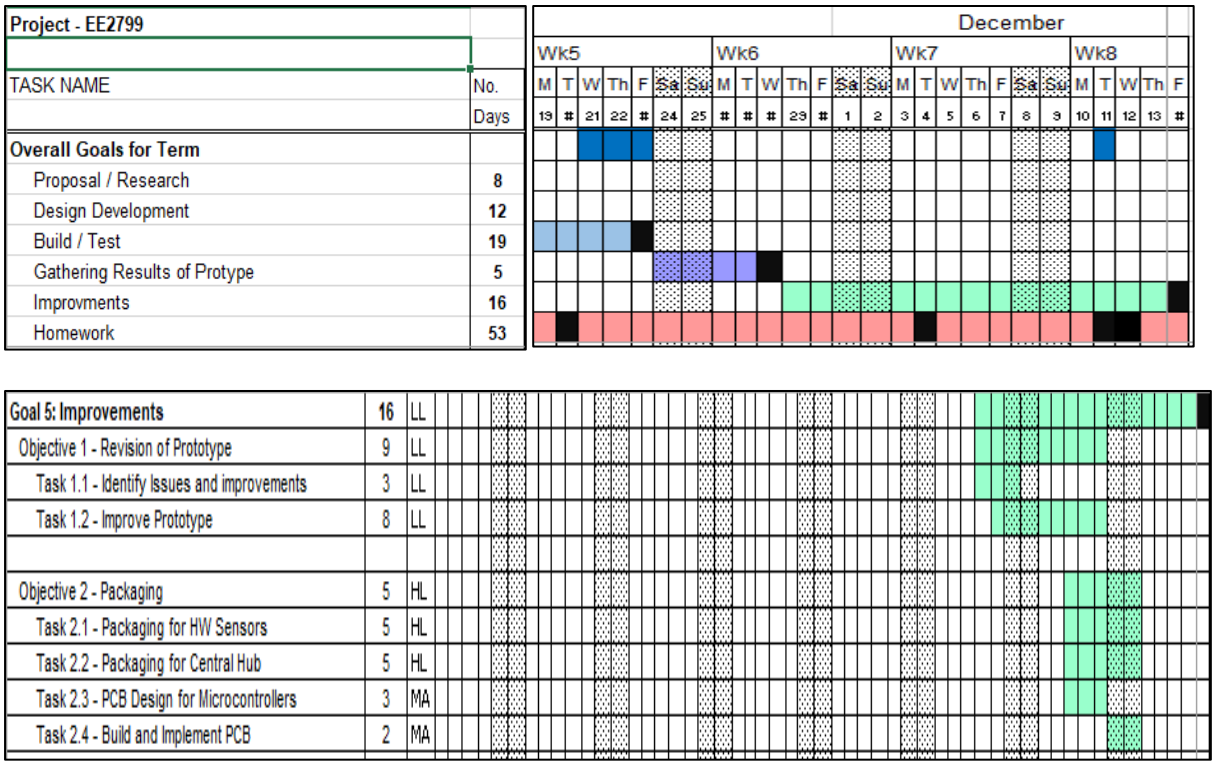
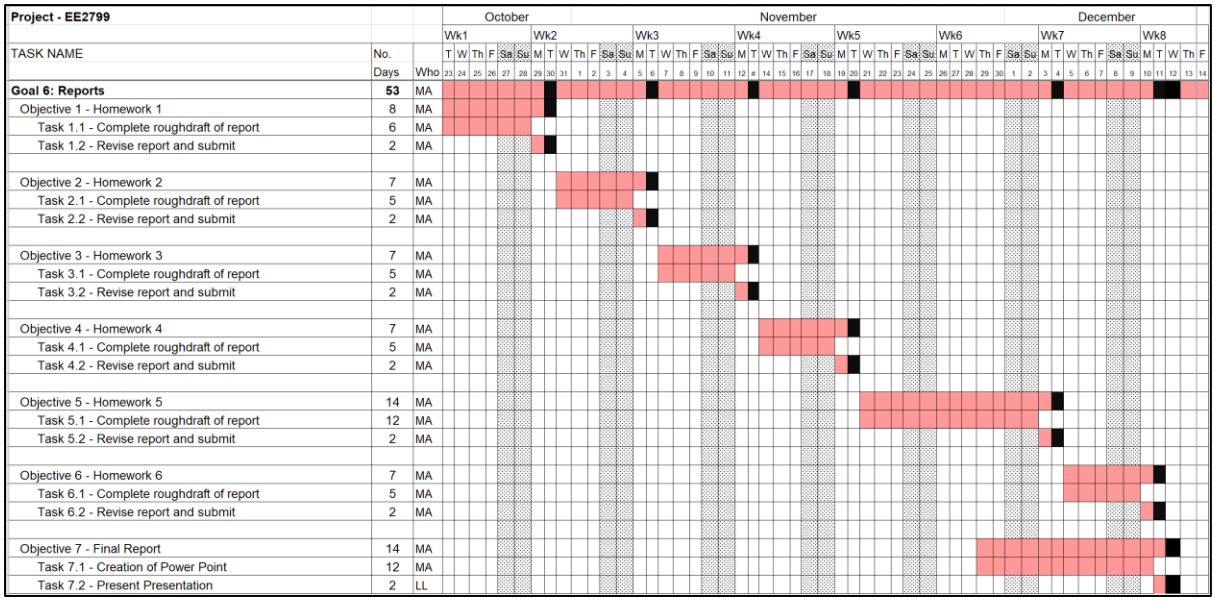


Figure 9: Frontend Mobile User Application Diagram

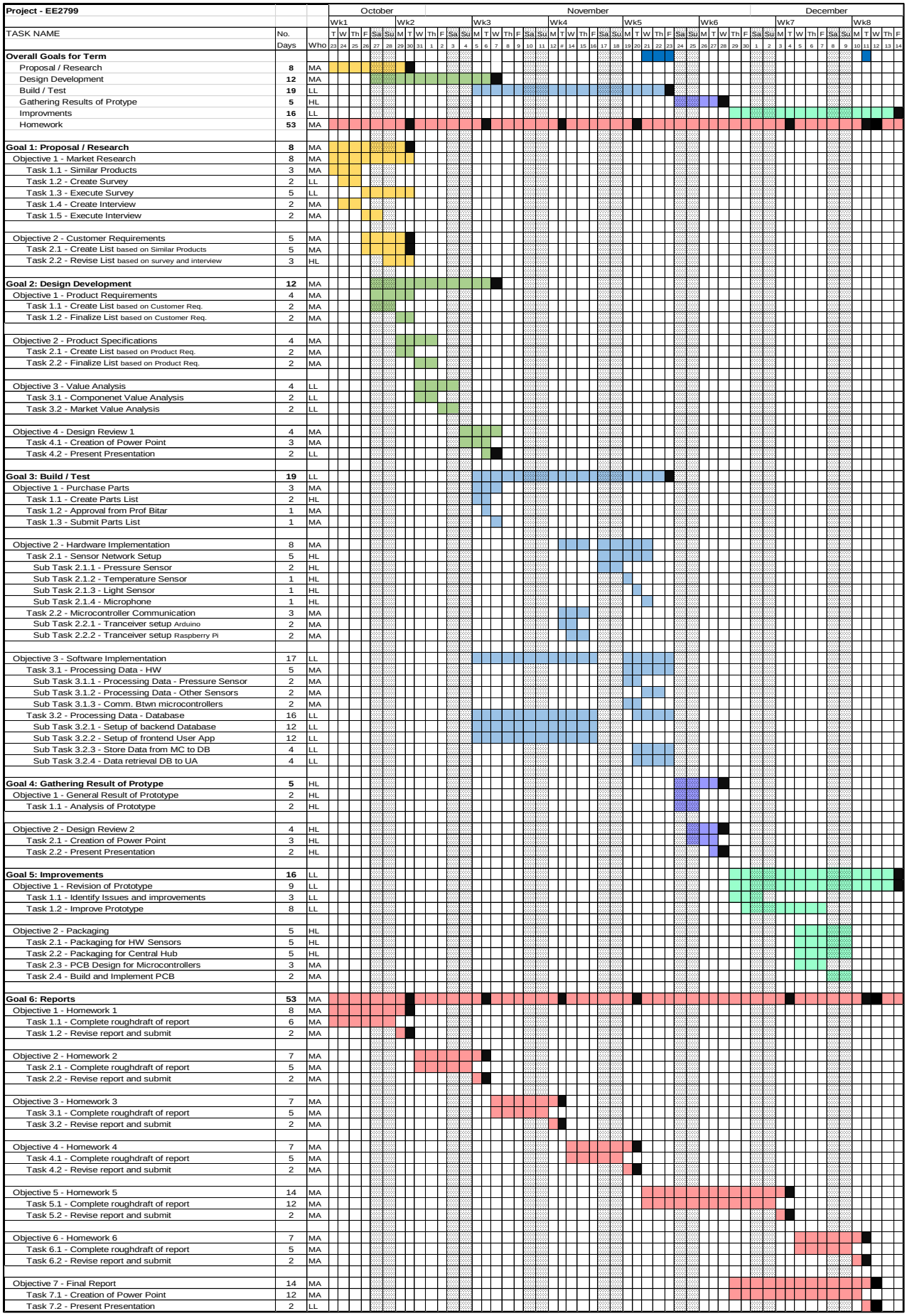
When first start up the App, the user will be asked to sign in. He or she can also go to ‘forget password’ or ‘signup’ from the login page. Once signed in, the user is brought to the App’s home page where the list of registered children is displayed. On this page, we also show user some thumbnail information such as children’s name, average sleeping hours, and last-seen-in-bed time. The children list is also colour coded base on the children’s current status (in-bed or not, is the bedroom dark or lighted). By clicking on a cardview of the children, the user can view more detail information about the selected child’s sleeping patter over time. The user can also navigate the App by using the drawer menu, from which they can go to Profile page, Update Profile, Store Page, User Manual, Add Child Page, or logout. All of these different features in the user application will make it more user friendly and provide more data to the users.

Gantt Chart





We are very satisfied with our great progress in the development of our product as everything that needed to be done was finished by the corresponding due dates. We already have a working protoype and plan on showing it along with the improvements discussed in this report next week at the final presentation in front of the CEI judges and the rest of the class. We were able to finish the product and move on to the improvements of the prototype about two weeks before the due date given to us. Currently, we are finishing the improvements and planning for the final demonstration of a working prototype. Our goal is to have a final presentation and the improvements set by Monday, December 10. This way we can use Tuesday, December 11 to prepare for the presentation on Wednesday. The final report will be started this upcoming weekend, and we plan on having it finished by second to last day of the term to have one day to proofread to turn in a high quality final report.


Project - EE2799
October
November
December
Wk1
Wk2
Wk3
Wk4
Wk5
Wk6
Wk7
Wk8
TASK NAME
No.
Days
Who
Overall Goals for Term
Proposal / Research 8 MA
Design Development 12 MA
Build / Test 19 LL
Gathering Results of Protype 5 HL
Improvments 16 LL
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Goal 1: Proposal / Research 8 MA
Objective 1 - Market Research 8 MA
Task 1.1 - Similar Products 3 MA
Task 1.2 - Create Survey 2 LL
Task 1.3 - Execute Survey 5 LL
Task 1.4 - Create Interview 2 MA
Task 1.5 - Execute Interview 2 MA
Objective 2 - Customer Requirements 5 MA
Task 2.1 - Create List based on Similar Products 5 MA
Task 2.2 - Revise List based on survey and interview 3 HL
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Task 1.2 - Finalize List based on Customer Req. 2 MA
Objective 2 - Product Specifications 4 MA
Task 2.1 - Create List based on Product Req. 2 MA
Task 2.2 - Finalize List based on Product Req. 2 MA
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Task 3.1 - Componenet Value Analysis 2 LL
Task 3.2 - Market Value Analysis 2 LL
Objective 4 - Design Review 1 4 MA
Task 4.1 - Creation of Power Point 3 MA
Task 4.2 - Present Presentation 2 LL
Goal 3: Build / Test 19 LL
Objective 1 - Purchase Parts 3 MA
Task 1.1 - Create Parts List 2 HL
Task 1.2 - Approval from Prof Bitar 1 MA
Task 1.3 - Submit Parts List 1 MA
Objective 2 - Hardware Implementation 8 MA
Task 2.1 - Sensor Network Setup 5 HL
Sub Task 2.1.1 - Pressure Sensor 2 HL
Sub Task 2.1.2 - Temperature Sensor 1 HL
Sub Task 2.1.3 - Light Sensor 1 HL
Sub Task 2.1.4 - Microphone 1 HL
Task 2.2 - Microcontroller Communication 3 MA
Sub Task 2.2.1 - Tranceiver setup Arduino 2 MA
Sub Task 2.2.2 - Tranceiver setup Raspberry Pi 2 MA
Objective 3 - Software Implementation 17 LL
Task 3.1 - Processing Data - HW 5 MA
Sub Task 3.1.1 - Processing Data - Pressure Sensor 2 MA
Sub Task 3.1.2 - Processing Data - Other Sensors 2 MA
Sub Task 3.1.3 - Comm. Btwn microcontrollers 2 MA
Task 3.2 - Processing Data - Database 16 LL
Sub Task 3.2.1 - Setup of backend Database 12 LL
Sub Task 3.2.2 - Setup of frontend User App 12 LL
Sub Task 3.2.3 - Store Data from MC to DB 4 LL
Sub Task 3.2.4 - Data retrieval DB to UA 4 LL
Goal 4: Gathering Result of Protype 5 HL
Objective 1 - General Result of Prototype 2 HL
Task 1.1 - Analysis of Prototype 2 HL
Objective 2 - Design Review 2 4 HL
Task 2.1 - Creation of Power Point 3 HL
Task 2.2 - Present Presentation 2 HL
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Task 1.2 - Improve Prototype 8 LL
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Task 2.1 - Packaging for HW Sensors 5 HL
Task 2.2 - Packaging for Central Hub 5 HL
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Task 2.4 - Build and Implement PCB 2 MA
Goal 6: Reports 53 MA
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Task 1.1 - Complete roughdraft of report 6 MA
Task 1.2 - Revise report and submit 2 MA
Objective 2 - Homework 2 7 MA
Task 2.1 - Complete roughdraft of report 5 MA
Task 2.2 - Revise report and submit 2 MA
Objective 3 - Homework 3 7 MA
Task 3.1 - Complete roughdraft of report 5 MA
Task 3.2 - Revise report and submit 2 MA
Objective 4 - Homework 4 7 MA
Task 4.1 - Complete roughdraft of report 5 MA
Task 4.2 - Revise report and submit 2 MA
Objective 5 - Homework 5 14 MA
Task 5.1 - Complete roughdraft of report 12 MA
Task 5.2 - Revise report and submit 2 MA
Objective 6 - Homework 6 7 MA
Task 6.1 - Complete roughdraft of report 5 MA
Task 6.2 - Revise report and submit 2 MA
Objective 7 - Final Report 14 MA
Task 7.1 - Creation of Power Point 12 MA
Task 7.2 - Present Presentation 2 LL

Conclusion

Although our overall design approach since our value analysis basically remained the same, we still had improvements to make, especially with the amount of time in advance with which we finished our prototype. These design modifications are also plans for our product if we were to take the product into the actual market. These changes done to our original design have all been made to completely fulfil the customer requirements like the 3D printed objects casing for the sensor modules and the central hub module to make it as less intrusive as possible. The user application has been updated as well to make it more user friendly taking into consideration the data that the customers would like to see. Seeing data from a previous date by choosing a day on the calendar and being able to track more than one child by associating the hardware to the app are features that our product now has that make it more appealing to users. Without a doubt, our contingency plans and strict scheduling helped us as we progressed with the development of our product. This way we had more than enough time to improve the product, fix errors and omission, and make it more marketable.

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