EECS 582 Senior Capstone Final Project Design

Infant Aid

Team 16

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Project Synopsis:

To prevent SIDS by using an app to monitor movement, temperature, breathing patterns, and other possible risk factors such as heartrate and sound of distress.

Project Description:

Sudden Infant Death Syndrome (SIDS) is the unexplained death of a baby less than one year old. Thousands of babies die in the U.S. each year without any apparent reason or warning signs. Although there is not a single cause of SIDS, there are many factors that can put a baby at risk for it. This project explores many major causes of SIDS and there are many factors that can put a baby at risk for it. The project explores three major causes of SIDS: suffocation from an infant rolling over onto its stomach, overheating, and respiratory infection. We will also be detecting external sound factors that can lead to SIDS, such as crying and sounds of discomfort. Programming for each of these modes will be done on the Arduino IDE software and uploaded to the Circuit Playground: a single board microcontroller containing features such as an accelerometer, a temperature sensor, an alarm, and buttons. An application is also created to alert parents if any of these causes are met. The application also includes a short quiz to determine any preexisting factors that could put the infant at risk of SIDS.

Project Milestones:

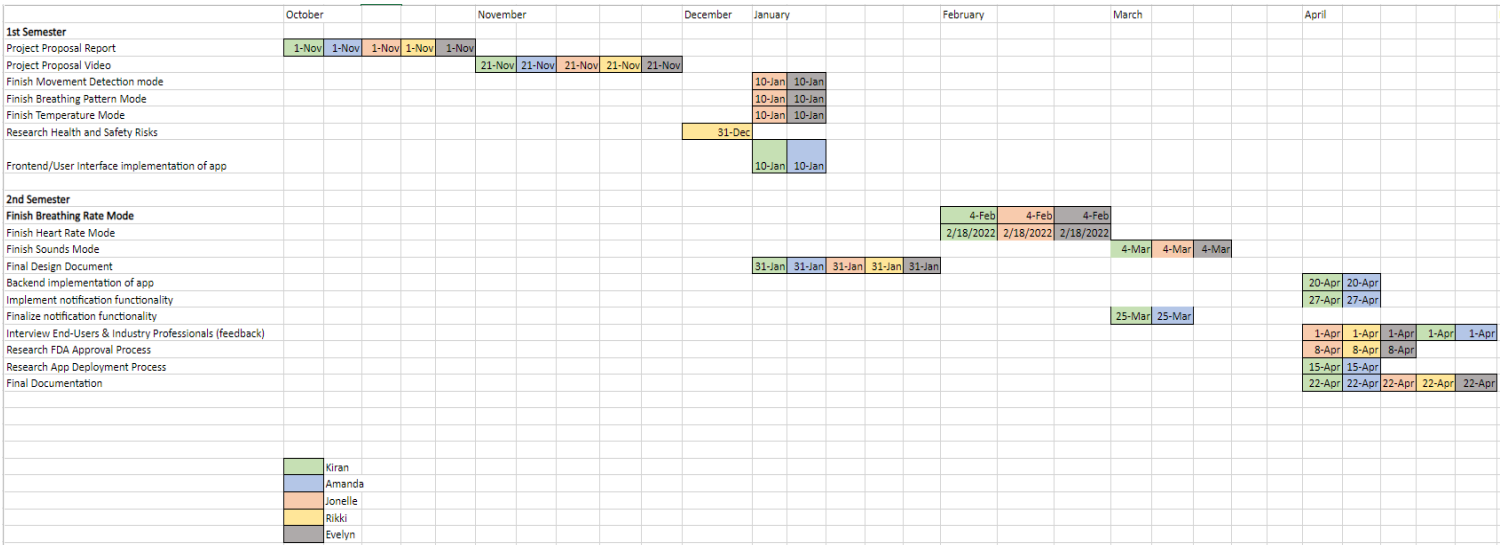
First Semester:

- Finish coding initiation of circuit (November 1)
- Finish rollover mode (November 15)
- Finish temperature mode (December 15)
- Research safety and health risks (December 31)

Second Semester:

- Heartrate mode (February 18)
- Front end/user interface implementation of application (February 25)
- Sound mode (March 4)
- Finalize App (March 25)
- Finish Final Documentation (April 22)

Gantt Chart



Project Budget:

Circuit Playground: ~$25 (Already acquired)

Battery: ~$2-3 (Already acquired)

Special Training: NA

Vendor: https://www.adafruit.com

Test subject - Baby doll: $10.99 (March 21)

Special Training: NA

Vendor: Amazon

3D Printer Filament: ~$16 (April 1)

Special Training: SOLIDWORKS

Vendor: Walmart

Final Project Design:

Circuit Playground Express - Hardware

The Circuit Playground Express is a microcontroller board with built-in sensors and LEDs. It is designed to be used with Arduino IDE and code.org. The board also has alligator-clip pads around it, so it does not require any soldering to make it work. It can be powered by AAA batteries, USB, or a Lipoly battery. Since the Circuit Playground Express already has built-in USB support, it can simply be plugged into a computer to write a program for it. Some of the features of the board include a motion sensor, temperature sensor, light sensor, sound sensor, mini speaker, push buttons, and 10 neopixels. The Circuit Playground Express is also very compact (seen in Figure 2) and can be transferred very easily since it has a diameter of approximately 2 inches and a weight of 8.5 grams. For our project, we are planning to connect the Circuit Playground Express to a laptop and program it with different detection modes. Each mode of the SIDS monitor will have its own separate program. Based on which button is pressed on the Circuit Playground Express, the board will change modes. For example, if the left button is pressed once, then the rollover mode will be initiated. If the right button is pressed once, then the temperature detector will be initiated. Lastly, if both buttons are pressed at the same time, then the breathing detector will be initiated. Our approach includes the board being attached to an infant's chest so it will not be a hindrance to the child but also be easily accessible to the parents if they choose to change modes. Below is an image of the Circuit Playground Express attached to a pocket. Because the Circuit Playground Express is so small, it could easily be attached to an infant's clothes without constraining the infant's range of motion and affecting the infant's comfort.

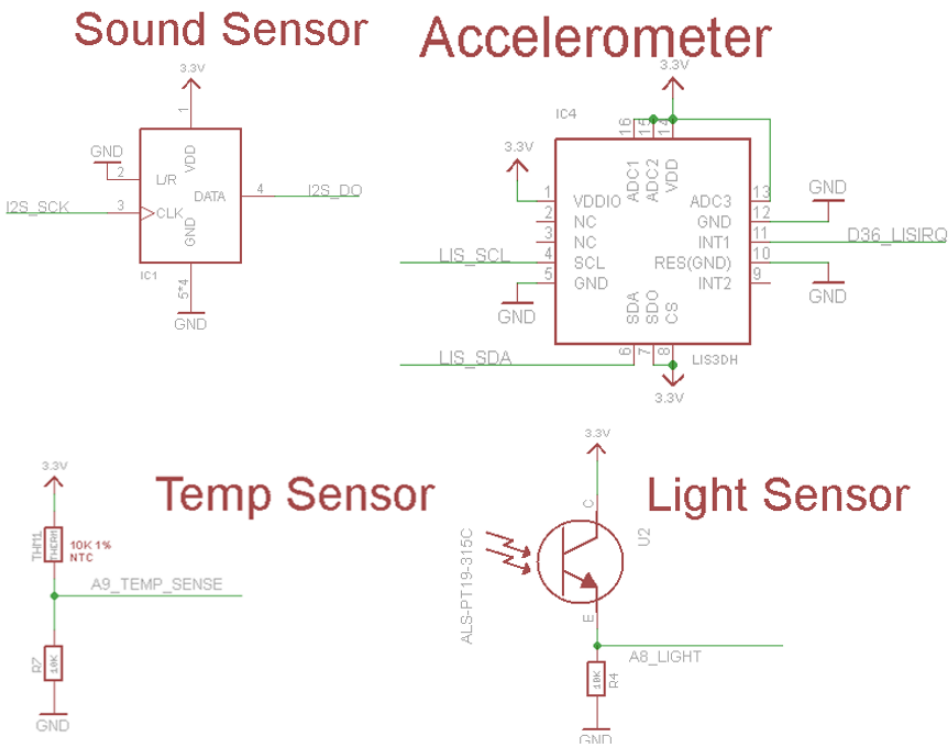


Figure 1: Circuit Playground Express Sensors' Schematics

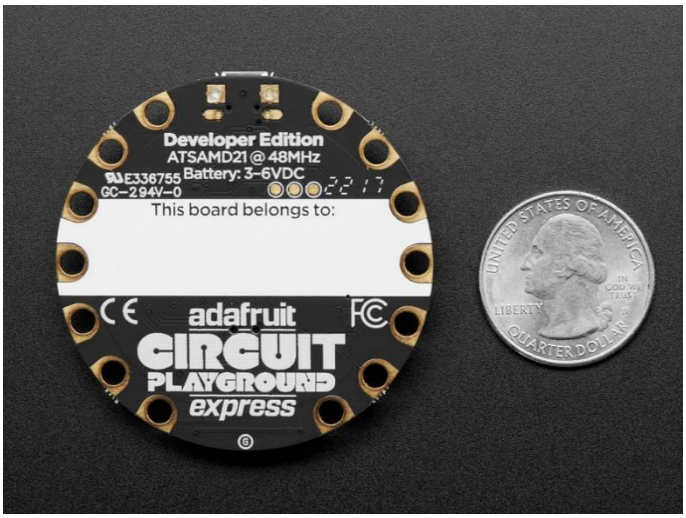


Figure 2: Circuit Playground Express Size Comparison

Interactive Interface (App) - Software

Currently, the plan is to program most of the hardware logic in CircuitPython, and this includes all the SIDS factors that we want to monitor. CircuitPython is a Python based language and adds hardware support for popular microcontrollers such as the Circuit Playground Express. If CircuitPython cannot support the features we would like to build into the Circuit Playground Express, then the project can be written in Arduino IDE. Arduino IDE supports full programming flexibility down to low level features.

The first SIDS factor monitored by the Circuit Playground Express is using the accelerometer to detect when a baby rolls over onto its stomach. The second factor is detected with the temperature sensor and will allow the user to monitor the baby's internal temperature to watch for a fever. The third SIDS factor is monitoring the babies' breathing patterns and will also use the accelerometer. More SIDS factors that we intend to explore are pulse detection and sound detections to determine if the baby is crying.

Along with programming the microcontroller Circuit Playground Express, there will be a web application created to transfer the information from the Circuit Playground Express and allow users to monitor data remotely. This can be accomplished in two ways. The first is via low energy levels of Bluetooth transmission supported by the Circuit Playground Express. The data will be transferred into a back-end data storage system. This data could then be displayed on a web application or mobile device application. With this connectivity, it allows users to check the status of the device being worn by an infant.

If for some reason the Bluetooth connectivity does not work or support the data needing to be transferred, there is also the possibility of transferring data via inferred signals between Circuit Playground Expresses. The first circuit playground would be worn by the infant as a monitoring device. A second Circuit Playground Express would be connected to a laptop and act as a beacon between the two devices. As actions are triggered, the first Circuit Playground Express acting as a monitor would send signals to the second Circuit Playground Express that is connected to a laptop. The data can then be collected and transferred in real time.

The wireless connectivity potential in this project can give extra information to the end user, which in this case is usually a parent or care giver, to allow them to have some peace of mind. Along with this, there is a possibility of sending notifications to the user of activity alerts or warnings collected by the Circuit Playground Express. This is something that we want to build into the project if hardware and time allows. Another feature that could be built into the project is a user login page. This allows the app to save the infant users' information across different devices and keep that information private. It also allows the user to look at the infant's previous data recorded in some history log.

Once the data is saved onto a device, it can be used to make future predictions and also test the accuracy of the reporting of the Circuit Playground Express. Unpacking these ideas allows us to use the data collected to create models of infant's movements, breathing patterns, temperature, sound patterns, and normal pulse rhythms individualized to the infant wearing the monitoring device. Though this monitor is not yet accurate enough to allow medical decisions to be weighed upon, it can give the user high level patterns that can be used to discuss with medical professionals.

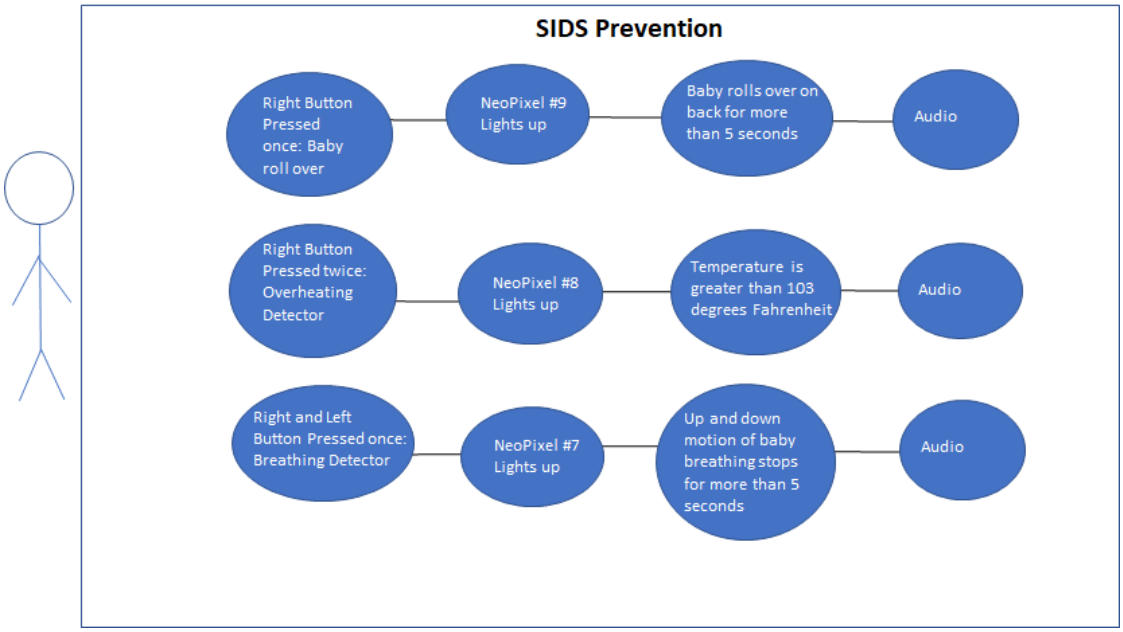


Figure 3: Use Case Diagram

Design Constraints

In this project, there is a constraint on what programming language can be used with the limiting factor being the Circuit Playground Express microcontroller. The Circuit Playground Express limits the software to Arduino IDE or CircuitPython. Javascript is available for the Circuit Playground Express but does not support the Bluetooth connection capability. This is a technical containing factor to consider.

There are multiple business constraints with this project that include budget, scheduling, and team limitations. Our budget allowed for the purchase of the Circuit Playground Express and battery. There have been multiple scheduling constraints in a five person group, whose members are all involved in multiple different activities and classes. This will affect the scope of this project and how many of the features can be implemented. These are constraints that can be considered and improved upon with future refinements and iterations of this project.

Ethical Issues

Privacy concerns: The main concern this project is addressing is to improve SIDS detection for infants. The more information that can be gathered, the better equipped parents and healthcare workers will be to improve infant care. Although the baby's information can be used to cater to SIDS more effectively, that information is extremely personal and will undoubtedly put the parents' and infant's privacy at risk. Moreover, the purpose of using the information may not always be known – so it can be risky. In addition to this, parents may be frequently contacted for more information or updates on their child, and this may not be something they necessarily want to disclose due to it being a very personal matter: the livelihood of their weak infant.

Intellectual Property Issues

There are not as many intellectual property issues as one might think when it comes to our project. While there are many diverse types and kinds of baby monitors out there for parents, our team has not found anything that specializes specifically in the prevention of SIDS. This monitor is different because the specifications designed to monitor the biological and environmental aspects of the infant are specific to SIDS and based solely on our joint research around the prevention of SIDS. We will not run into any hardware intellectual property issues because we are not building our own hardware, but instead using the already-developed circuit playground for our project, which we have accredited throughout this report.

Change Log

Budget- Added fee to get a baby doll to allow us to protype our project. We also added 3d printer filament if we are able create a custom 3d model for our circuit.

Programming language - The initial program language changed from Arduino IDE to CircuitPython. This change was implemented because most team members are more familiar with Python as a language. This will save time and efficiency with the logic being written.

Wireless connectivity - This changed to the pair of Circuit Playground Express used to implement the wireless connectivity to ensure the project's simplicity. If the Circuit Playground Express supports Bluetooth, then we can investigate utilizing it.