# Adaptive Wireless Wearable Neuro-Stimulator

PROJECT PLAN

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NOTE: This template is a work in progress. When in doubt, please consult the project plan assignment document and associated grading rubric.

### 1 Introduction

#### **1.1 PROJECT STATEMENT**

Combat SIDS (Sudden Infant Death Syndrome) through data analysis and hardware anklet development.

#### 1.2 PURPOSE

According to the Center for Disease Control, in 2015, there were 1,600 deaths due to SIDS alone. This accounted for almost half (43%) of infant deaths, leaving many parents not knowing why their children died. (https://www.cdc.gov/sids/data.htm)

#### 1.3 GOALS

Our end goal is to either find data correlation backing the suspicion that SIDS is caused by energy (lighting resonance) using information provided by radio stations. Additionally, regardless of that research we will also be developing a wearable anklet to track infant health and infant motion. Similarly, there will be a vibration motor for stimulation.

### 2 Deliverables

Graphs of data: Client gave us data to create graphs and see if the electrical energy in the atmosphere has an effect on the number of cases of SID.

Wearable device: We are tasked with creating a wearable anklet with a G-sensor, heart-rate monitor, a small vibration motor, and Bluetooth connectivity.

Software source code: We will give the code that we developed both for the UI as well as for the sensors itself.

Flow chart: An overall design of the software. Showing both software and hardware interactions.

System diagram: diagram of the anklet connection, PCB (if applicable), etc.

### 3 Design

#### 3.1 PREVIOUS WORK/LITERATURE

Currently there are no products available that will actually take action based on readings. There are many infant monitor products that will passively monitor and notify the parents if things appear to be wrong, however, there are none that will attempt corrective actions such as sending a vibration to the child like our anklet.

Devices like this include the Owlet smart sock, <u>http://www.owletcare.com/</u>, which can monitor heart rate and oxygen levels and notify the parents if something appears wrong.

#### 3.2 PROPOSED SYSTEM BLOCK DIAGRAM

Our system will consist of three separate sections. The device itself, which will do the monitoring and pulse actions. The android app, which will be accessible for the parents, that will display active information, with options to view historic data for their child. And finally, the web app, which will primarily be used by researchers to view historic data for all devices, filtered by any criteria neccessary.



#### 3.3 ASSESSMENT OF PROPOSED METHODS

There were a few ideas we had for the monitor and alerting system.

We could have multiple separate sensors placed upon parts of the body where they will be most effective, such as a pulse monitor on the wrist, a temperature monitor on the chest, and a stimulation emitter on a nerve. This would have required us to make each individual part communicate wirelessly and require more power. Therefor we decided to go for an all-contained unit.

This unit could then be put in multiple places on the person, the chest, arm, leg, etc. We decided to go for the ankle as it should produce the least discomfort while sleeping as well as a nerve being close to send stimulation to.

#### 3.4 VALIDATION

After the product is created, we should have a deterministic formula to send stimulation pulses. So we should be able to create a test suite containing variable inputs and verify the stimulation occurs when expected.

# 4 Project Requirements/Specifications

#### 4.1 FUNCTIONAL

#### Ankle Device

- The device can tell when it is on an infant
- The device has a temperature sensor
- The device has a heart rate sensor
- The device has an accelerometer
- The device can store at least 1 day's worth of data
- The device runs in a very low power mode when not attached to an infant in a "sleep mode"
- ✤ The device is rechargeable
- The device administers up to 3 pulses of vibration to infant's ankle when algorithm deems it necessary
- The device communicates with an android device via Bluetooth low energy
- The device can accurately tell what time it is
- The device can determine its own geographical location
- $\boldsymbol{\diamond}$  The device knows when it is attached to an infant or not
- The device "wakes up" when attached to an infant
- The device sends data to the paired android device via Bluetooth low energy

#### Android Application

- The android application communicates with the database via internet connection
- The android application requires a login
- The android application communicates with the device via Bluetooth low energy
- The android application creates time dependent graphs
- The android application uploads information from the device to the secure database
- The android application displays real-time updates from the device
- The android application will only display information pertinent to the current user

#### Web Application

- The web application requires a login
- The web application will display at least 6 months of data
- The web application will only show the data relevant to the current user
- \* The web application will communicate with the database via internet connection
- The web application will get its data from the database
- The web application allows the user to download a .csv copy of the currently displayed information

#### Database

- The database will store the information in a secure way
- The database will only allow access from authenticated users
- The database will hold all information in such a way that preserves the integrity of the information

#### 4.2 NON-FUNCTIONAL

- Data presented in application focuses on researcher needs
- All information is stored securely
- Pulse is administered when device deems it necessary
- Created circuit can read all necessary metrics and provides a good proof of concept for an actual device
- All applications are user friendly easy to use
- All graphs are labeled with titles and units
- \* Data displayed on web is downloadable in a format that can be opened in Microsoft Excel
- The parents/researcher is notified after the third attempt of stimulation from the device fails

#### 4.3 STANDARDS

Standards are important to deliver a quality product that will do what it is supposed to without issue. It is important for us to have standards for our processes because our device is intended to be put on children. As such, it is important for us to design a device that is well packaged and performs as expected. Our process could not be considered unethical because the device will be tested on ourselves before it goes on anybody else. Nothing we create will be allowed to be used unless we are certain it is safe to be worn.

We will be following the Agile organizational process in order to efficiently complete our coding tasks. All code that is submitted will need to be approved and looked over by at least two additional people. All hardware purchase decisions will need to be approved by the client and be as cost efficient as possible.

# 5 Challenges

With our group being mainly Computer Engineers, designing something that works with the human body would be a new struggle.

There is also the challenge of researching the parts needed for the design, as well as putting these parts together in order to create something that has these parts working together.

### 6 Timeline

#### 6.1 FIRST SEMESTER

- Meet with group, client, and faculty advisor for first time
- ✤ Analyze data received from client
- Create a high-level design for each piece of the project
- Order parts for the circuit
- Develop at least half of the desired functions for the android application and web application
- Create the database

#### 6.2 SECOND SEMESTER

- Build circuit designed first semester when parts arrive
- Design and implement embedded code
- Do iterative testing on each project piece: android application, web application, circuit, and embedded code
- \* Tests all parts together and ensure that everything does what it is supposed to
- Present final product to client

					Period Highlight:	8	Plan Du	ration	Actual Start	% Complete	Actual (beyond plan)	% Complete (beyond plan
ACTIVITY	Week start	Week Duration	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE	Weeks	3456	5 7 8	9 10 11 12 13	14 15 16 17 18 :	19 20 21 22 23 24 25 26	27 28 29 30 31 32 33 34 35 36
First Group Meeting	3	1	3	1	100%							
First Client Meeting	3	1	3	1	100%							
First Faculty Mentor Meeting	3	1	3	1	100%							
Analyze Data	4	1	4		20%							
Create High level design	5	2	5	1	100%							
Research Components	5	2	5	1	100%							
Circuit Design	7	3	7		0%							
Android App Design	7	2	7		0%							
Database Design	7	2	7		0%							
Web App Design	8	2			0%							
Create Database	9	2			0%							
Develop Android App	10	7			0%							
Order Parts	10	8			0%							
Develop Web App	10	7			0%							
Test Database	11	2			0%							
Fix and Re-Test Database	12	3			0%							
Test Web App	17	2			0%							
Test Android App	17	2			0%							
Build Circuit	18	4			0%							
Fix and Re-Test Android App	19	3			0%							
Fix and Re-Test Web App	19	3			0%							
Design Embedded Code	20	2			0%							
Develop Embedded Code Lest and Document Embedded	22	6			0%							
Code	28	2			0%							
Test Everything Together	28	2			0%							

# Adaptive Neruostimulator

### 7 Conclusions

We are looking to find out if supporting evidence exists for correlation between SIDS and energy of lightning resonance. The goal is be able to come up with a design and deliverable in the form of a wearable device which monitors the status of an infant which may serve in alerting if something may be wrong and in data collection.

In order to achieve these goals, we plan to first look through the data given by the client and research information to gather a base of knowledge. From this base, we can come up with requirements and begin our design around this. Designs will be have to checked closely with thorough research on materials.

Testing will involve covering different cases of inputs to make sure the output (such as vibration or alert) is what is as expected.

### 8 References

"Sudden Unexpected Infant Death and Sudden Infant Death Syndrome." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 17 Apr. 2017, <u>www.cdc.gov/sids/data.htm</u>.

https://www.heartmath.org/research/global-coherence/gcms-live-data/

# 9 Appendices

Spectrogram for week of 2017-08-26



Fig 1. Data from magnetic field detectors in different locations of world.