

# Adaptive Wireless Wearable Neuro-Stimulator

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Client: Adan Cervantes

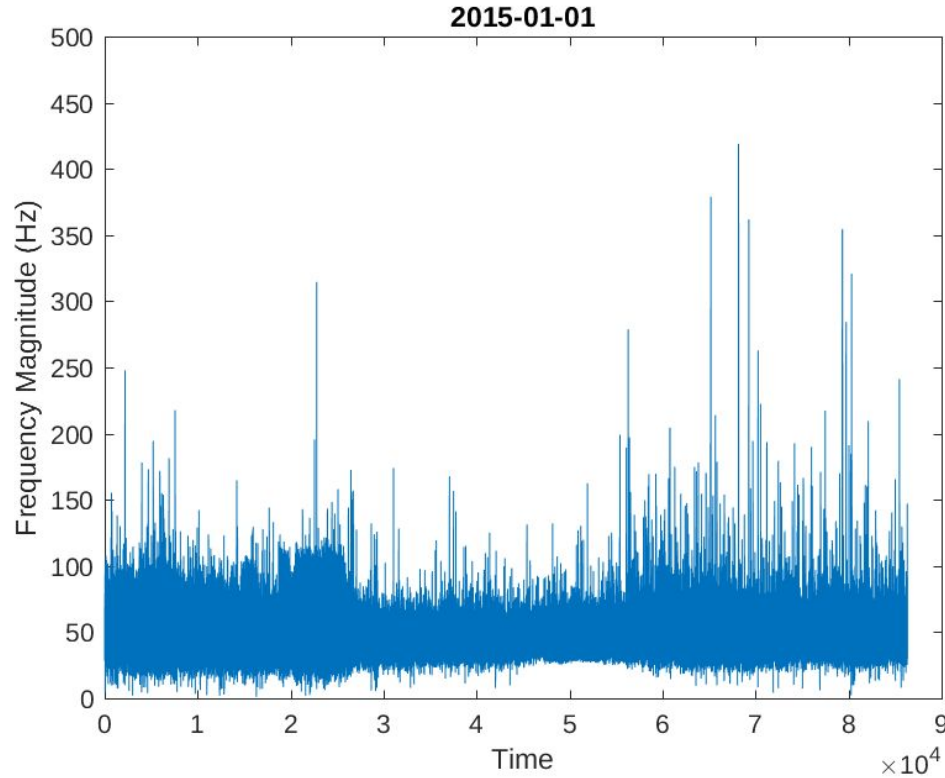
<https://sdmay18-22.sd.ece.iastate.edu>

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# Problem Statement

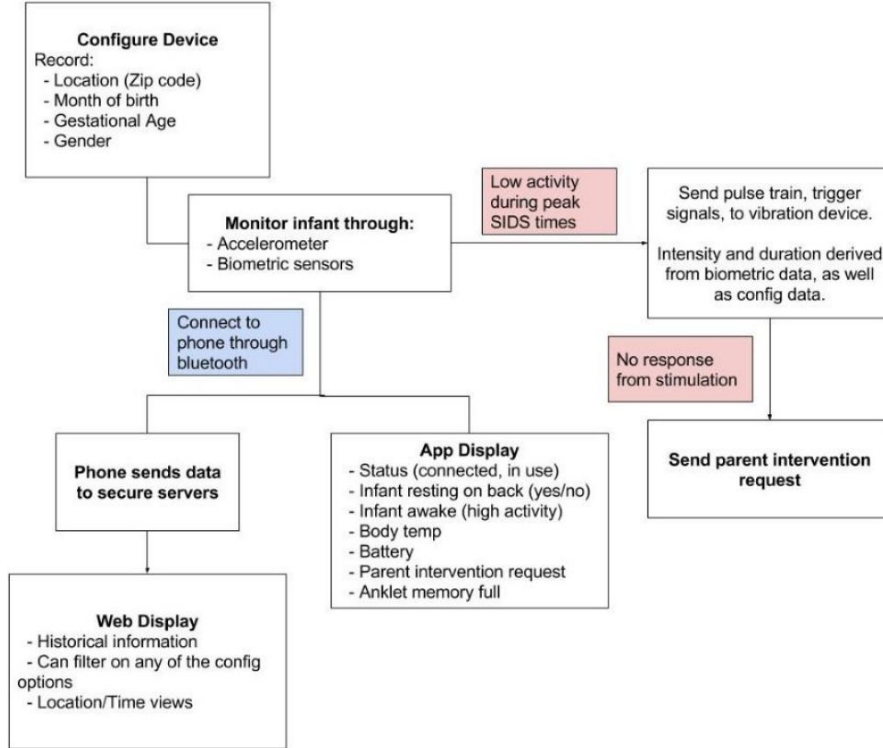
- The search for the cause and correlations to prevent SIDS (Sudden Infant Death Syndrome) is ongoing with many avenues being explored to explain sudden deaths.
- Our client has been researching SIDS and possible correlations between low energy waves emitted from lightning and the rate of SIDS.
- The task we are taking on is development of an anklet to monitor infant movement and other health metrics. The anklet is to provide a small pulse (vibration) to induce reflexive movement as stimulus to the infant.
- Also, there is an aim to find if there exists data correlation backing the suspicion that SIDS is caused by energy (lighting resonance) using information provided by geomagnetic stations.

# Research



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# Conceptual Sketches



Project split into 3 main sections

- **Wearable**
  - Embedded device for recording biometrics
- **Android app**
  - Display overview for parents
  - Display alerts from device
  - Upload data to database
- **Historical data website**
  - Input form for query parameters
  - Display graph of historical data

# Functional Requirements

## Web App

- The application requires a secure login
- The application will display up to 6 months of past data
- The application will allow the user to download data in .csv format
- The application will get all data from the database

## Wearable Device

- Device always on
- Device has a temperature sensor, heart rate sensor, accelerometer, and vibration motor
- Device will send vibration pulse based on stored configuration and sensors
- Device can store 1 week's worth of data

# Functional Requirements

## **Android App**

- The application will communicate with the database via wifi/cellular connection
- The application will require user to sign in
- The application will use Bluetooth to communicate with wearable device
- The application will display real-time information from the wearable device
- The application will upload data pulled from wearable to database

# Non-Functional Requirements

- Data presented by application focuses on the needs of researchers
- All information is stored securely
- When the algorithm deems it necessary, the device will be triggered to deliver 3 pulses of vibration by the android application
- All applications are user friendly and straightforward to use

# Technical Constraints and Other Considerations

- Limited experience with embedded code and circuit design
  - Parts of the original project proposal could not be accomplished
- The device must function and record data even when disconnected from phone
  - Data will be stored locally on device
- Must store large amount of historical data
  - Backups for primary server
- Must be able to display large amounts of data in a meaningful way
  - May have to limit the date range that data can be queried from



# Risks and Mitigation

- HIPAA compliance changes
  - This really can only be mitigated by continual monitoring of possible changes
- Data Server Loss
  - Deployment in multiple AWS regions provides the data redundancy needed
- Lawsuits
  - Create terms of use and define clear lines of what the product is meant to do

# Market Survey

- Monitoring device with research potential
  - Collect data from device which may be visualized
  - Data may be sent to database, client mentioned this data having potential in research
- Current devices on the market are exclusively monitoring
  - Based on client's idea, the device gives a small pulse to check on infant
  - Application may notify of situations where infant may be at risk

# Technology Used

- Website
  - MySQL
  - Amazon RDS
  - Javascript graphing library (<http://dygraphs.com/>)
- Android Application
  - Android Studio
  - Java
- Device Prototype
  - Arduino
  - C
  - Array of sensors
  - Bluetooth

# Cost Estimations

- Wearable (\$37.5)
  - Heart Rate Sensor \$2
  - Temperature Sensor \$1.5
  - Accelerometer \$7
  - Vibration Motor \$2
  - Evaluation Board \$25
- Website (\$913 per year)
  - Amazon RDS for MySQL meeting HIPAA requirements with multi-AZ deployment (db.t2.medium 4GiB) \$795 per year
  - Frontend server (t2.small) \$118 per year
  - Scaling once memory is reached is then as easy as upgrading instance size

# Functional Decomposition

- Wearable Device
  - Records biometric data when worn
  - Uploads the data to the app
  - Emits small pulse to ankle to trigger movement
- Android Application
  - Will receive data packets from the wearable device
  - Displays real time data and alerts
  - Batch uploads historical data to the database
- Web Application
  - Displays historical data in graph format
  - Allows user input to filter the queried data

# Test Plan

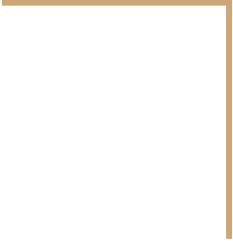
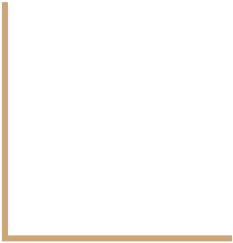
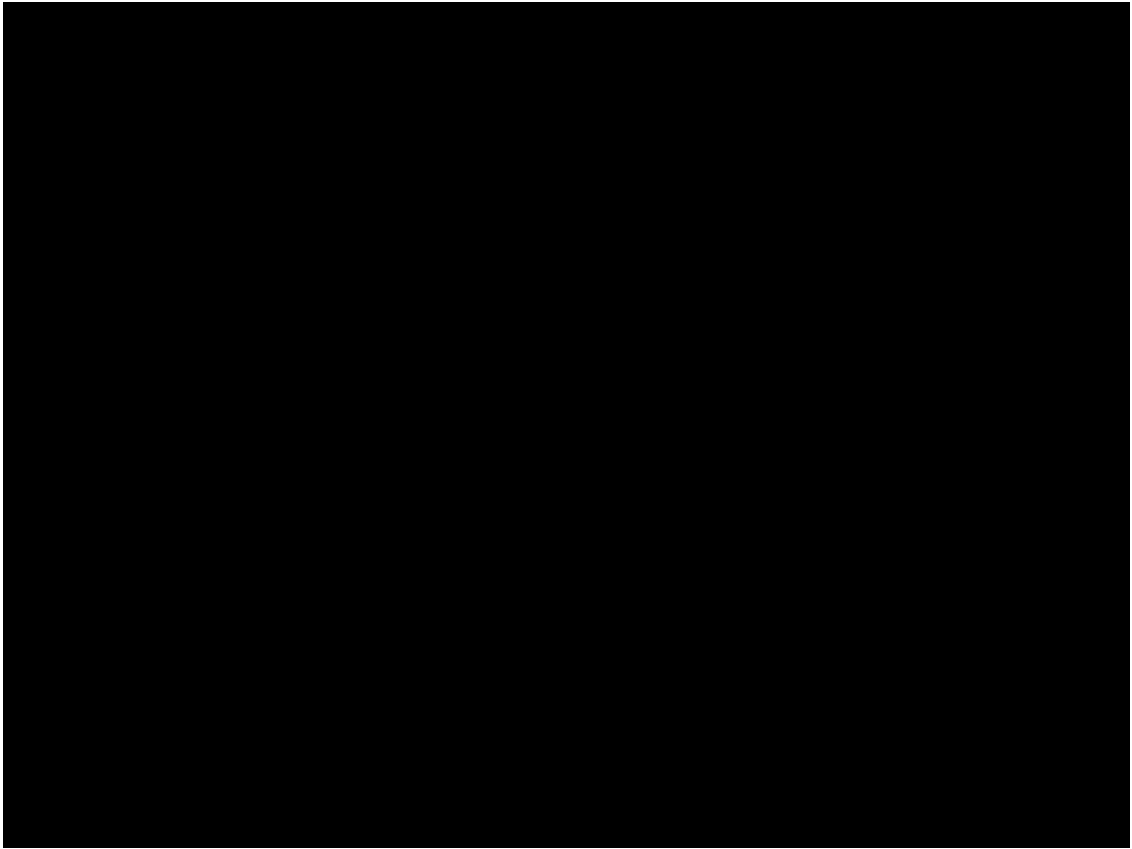
- Android Application + Website
  - Unit tests for methods
  - Integration/E2E tests for modules
  - UI automation tests for app
- Anklet
  - Unit tests for embedded code to verify functionality
  - Prototype anklet to verify recording and communication methods work
  - System testing to verify triggers
    - No movement for certain time triggers pulse
    - No response to pulses triggers alert
    - The sensors turn on when device is attached and turn off when detached



# Android App Demo



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# Individual Contributions -- Patrick Walsh

- Android Application
  - Created UI
  - Helped design application UI
  - Helped create software architecture
- Setting up meetings
- Main point of communication between group, client, and faculty advisor

# Individual Contributions -- Kevin Wang

- Android Application
  - Helped design app UI
  - Screen flow of UI
- Arranged times for some additional group meetings

# Individual Contributions -- Brian Weber

- Wearable
- Research into raspberry pi.

# Individual Contributions -- Matt Stephenson

- Wearable
  - Did multiple Iterations of selecting components
  - Reading data sheets
  - Analyzing based on different factors
    - Power Consumption
    - Ease of use with different evaluation boards
  - Looked into different evaluation board options
- Made sure necessary reports were submitted

# Individual Contributions -- Kevin Simons

- Data visualization
  - Created MATLAB script to graph magnetic data from sensors around the world
  - These graphs used by client for his research and by us for confirmation
  - Worked with client, and his point of contact, to understand how to convert the raw data to a visual format
- Website
  - Created Database to store all the user and biometric information
  - Created screen sketches of UI

# Spring Semester Plan

- Jump straight into development
  - Wearable
    - Add sensors to Arduino
    - Develop Sensor Interfacing Code
    - Link to Android App
  - Android App
    - Finalize UI
    - Create Backend Logic
    - Link To Database / Website
    - Link to Wearable
  - Web App
    - Create the user interface
    - Write the backend logic to execute the user's query
    - Link to database