Sleepwear Diagnostic System (SDS)

Presented by:

Allison Chew, CEO
Alex Manousiadis, CTO
Ekin Nalbantoglu, CAO
Eleanor Li, CCO
Jason Cheung, CRO

OUTLINE

- Our company
- Obstructive sleep apnea
- Market need
- Sleepwear Diagnostic System (1st prototype)
- Sleepwear Diagnostic System (2nd prototype)
- Web application
- Software functionality
- Future additions
- Budget and timeline
- Market and competitors

NAPNEA

Mission

- Cost-effective and reliable solutions for real-world clinical problems
- Accommodate patient interest

Values

- Feedback from medical experts
- Continuous improvement
- Avoid complacency
- Simple design

1 Safety

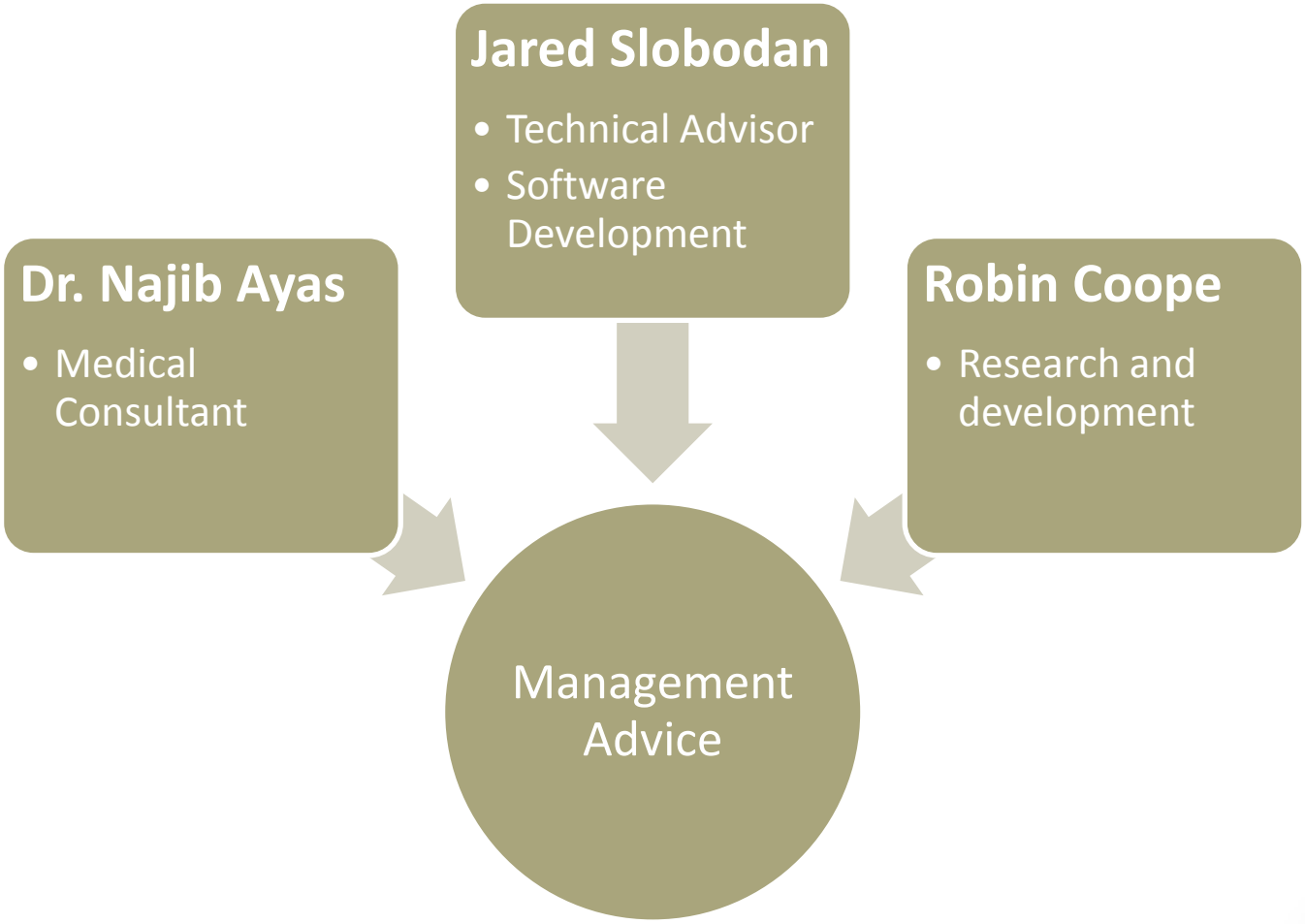
2 Market Leadership

3 Medical Advancement

Management

Allison Chew	Project manager Hardware, Embedded software, and Software GUI lead
Alex Manousiadis	Technical advisor Circuit debug lead
Ekin Nalbantoglu	Experimental setup and System testing Data analysis lead
Eleanor Li	Documentation editor / Technical writer Product manufacturing lead
Jason Cheung	Web developer Software analysis lead

Board of Advisors



Obstructive Sleep Apnea

- A physical blockage of the airway causing an interruption of breathing or shallow breathing during sleep
- Causes individuals to constantly and unknowingly wake up throughout the night
- Results in poorer sleep quality and insufficient oxygen consumption during sleep
- Long-term effects include high-blood pressure, fatigue, depression, anxiety, lower quality of life

Market Need

Medical Relevance

Only 4% of Canadians have been diagnosed

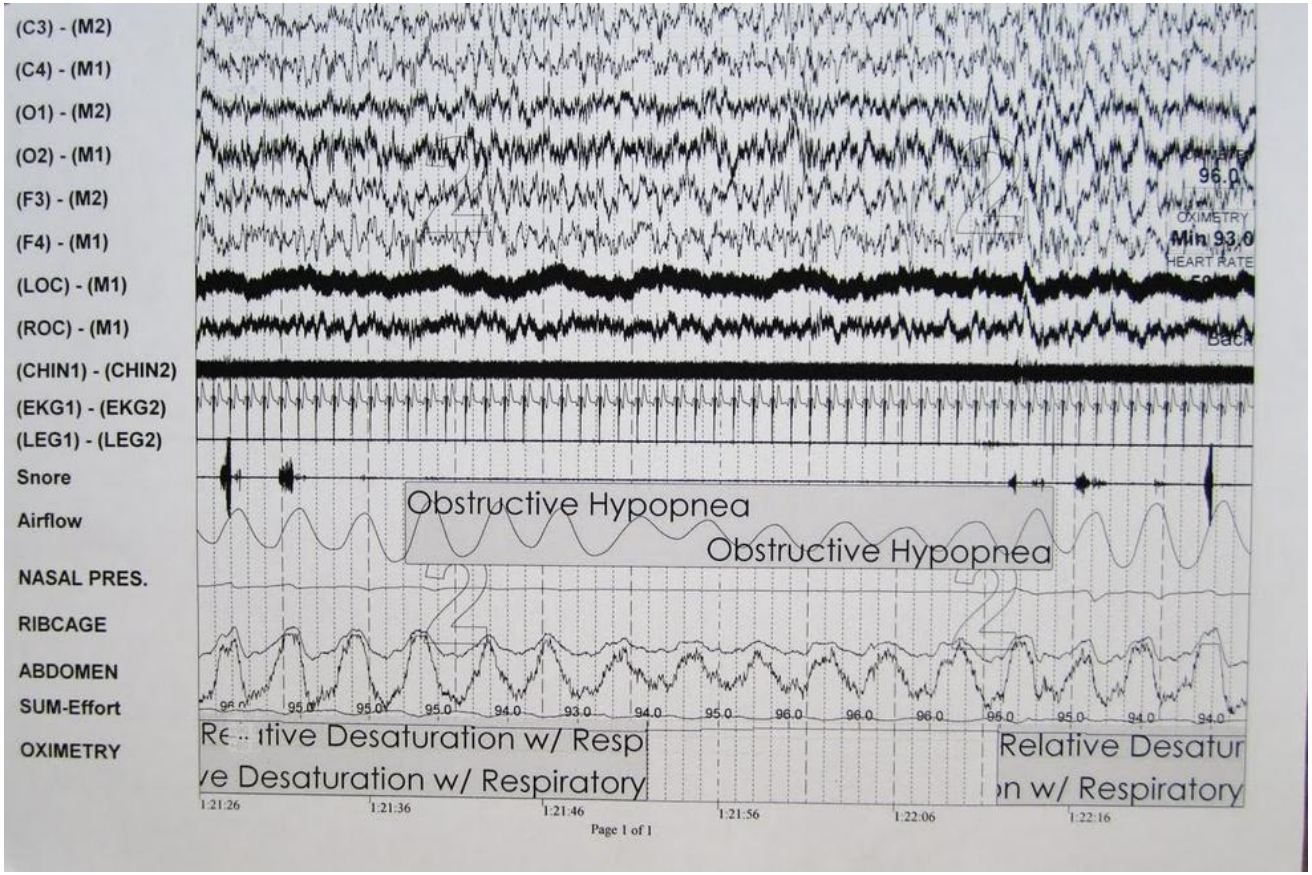
26% of those at risk go undiagnosed

Current Limitations

Sleep lab analysis is thorough but expensive

Take-home devices are unreliable and uncomfortable

Sleep Lab



- Very expensive
- Not conducive to regular sleeping habits

Pulse Oximeter

- Very uncomfortable
- Often inconclusive

Paradoxical Breathing

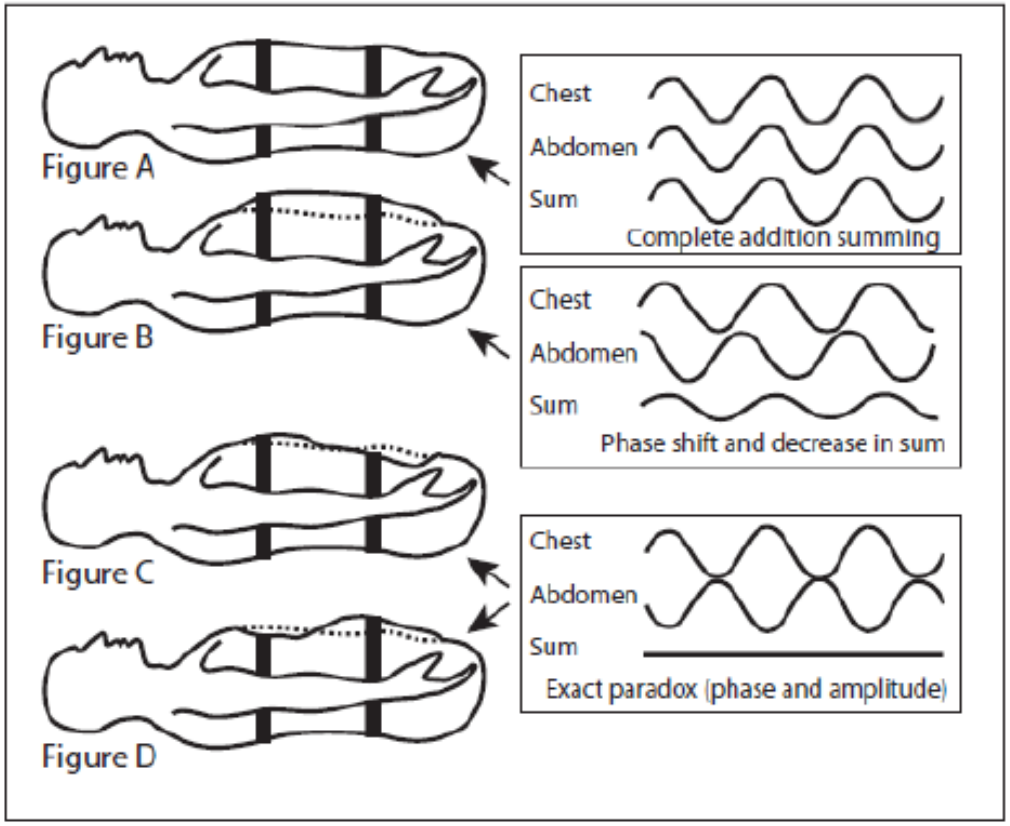
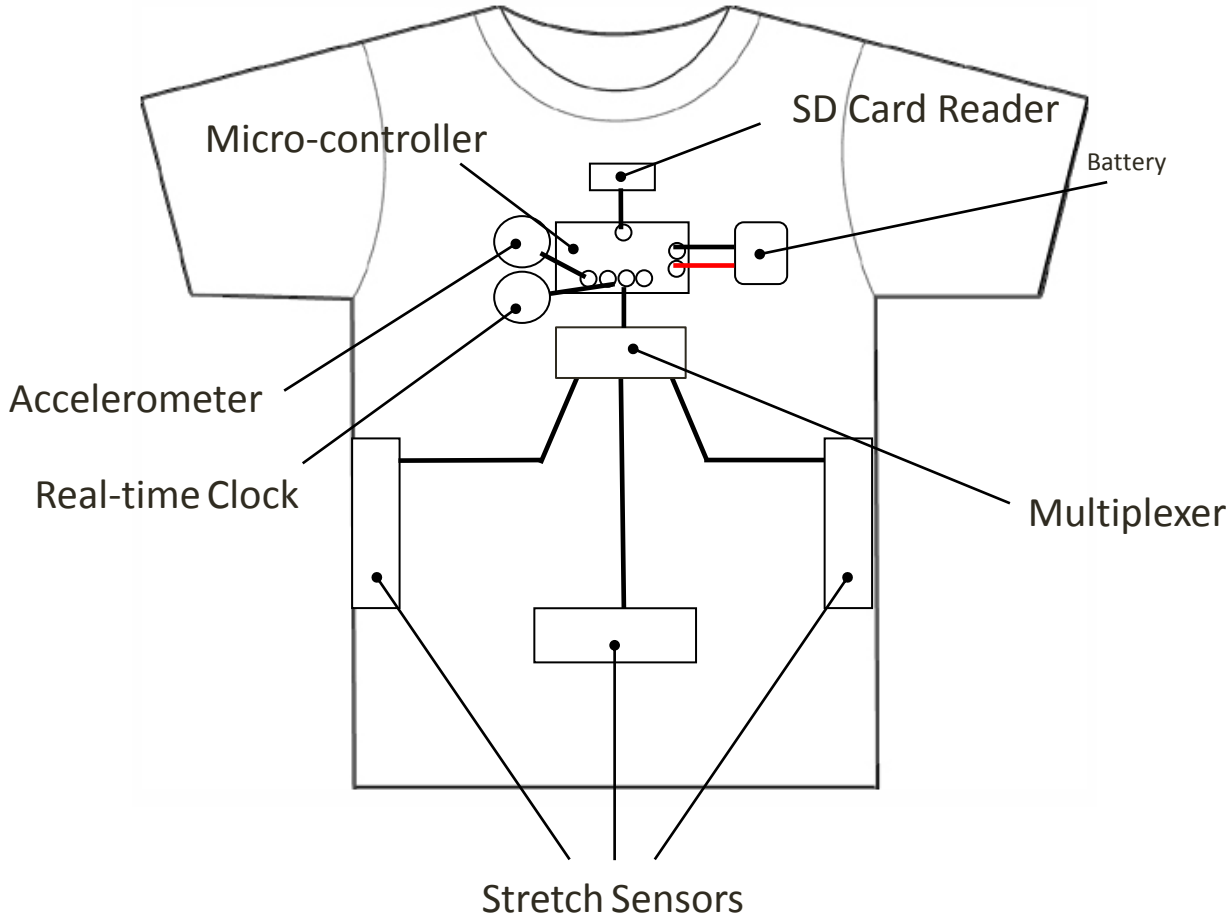


Figure A shows normal breathing. Figure B demonstrates what occurs during phase shifting, which is causing the sum channel to show alterations in the waveform.

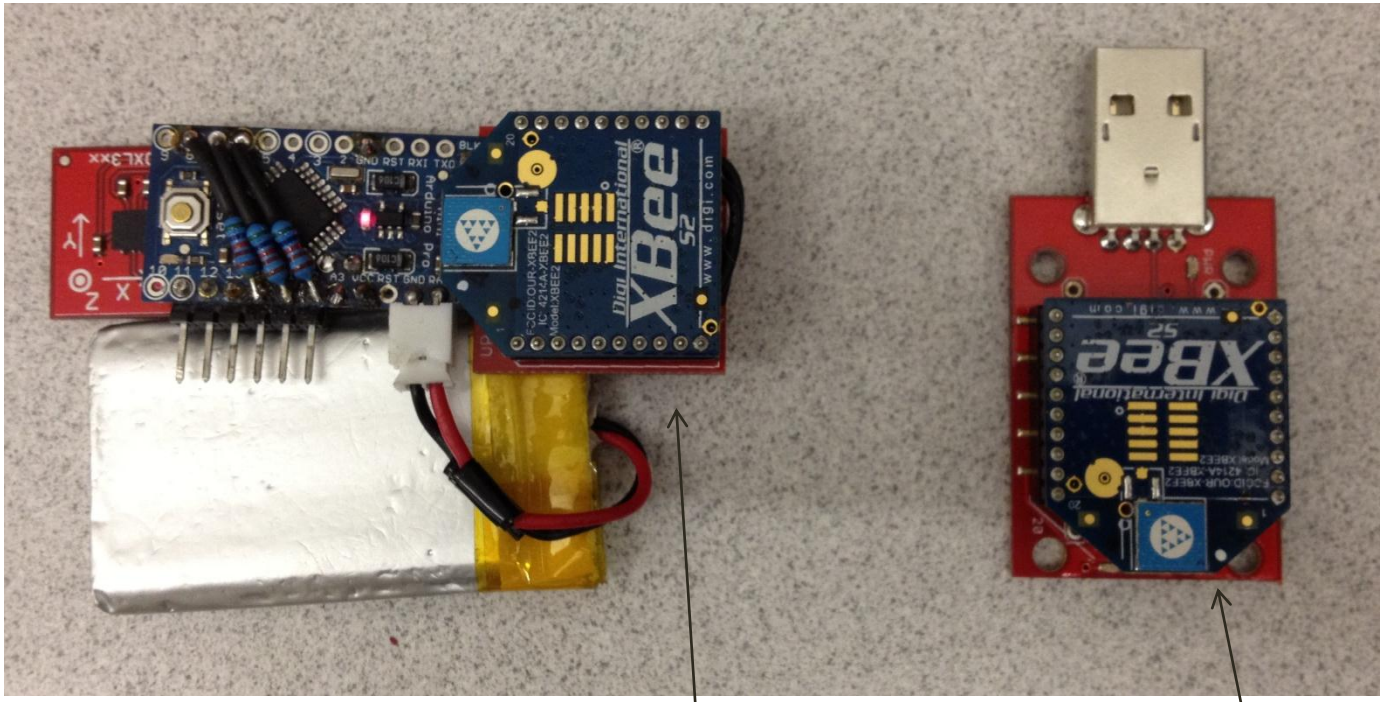
Figure C and D demonstrate what occurs with a patient who is having paradoxical breathing at night, causing the sum channel to be flat.

Sleepwear Diagnostic System - SHIRT



- Gathers and logs physiological data during sleep
- Comfortable – electronics embedded in shirt

First Generation Prototype

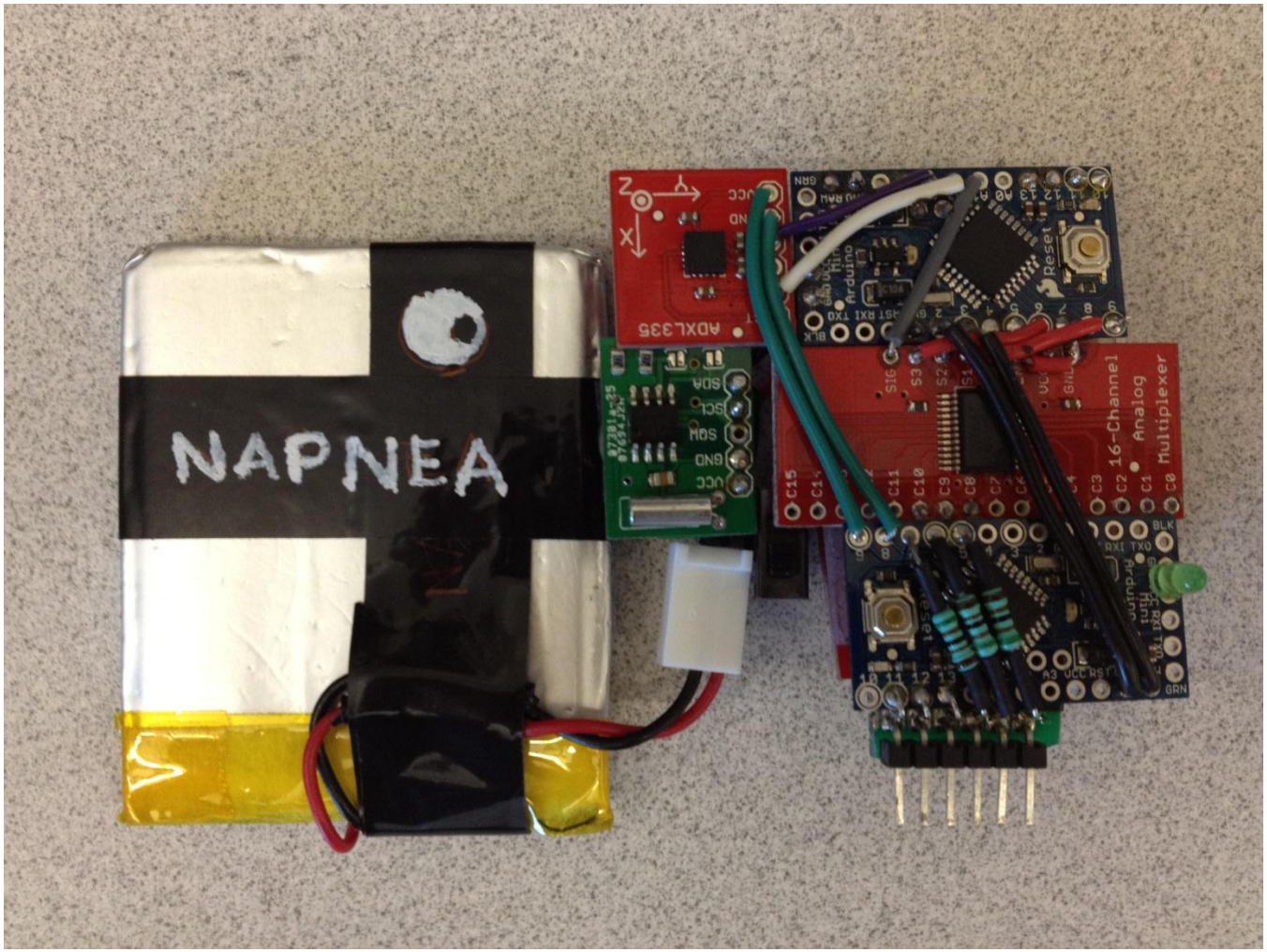


Wireless transmitter

Wireless receiver

- Please draw your attention to the side projector

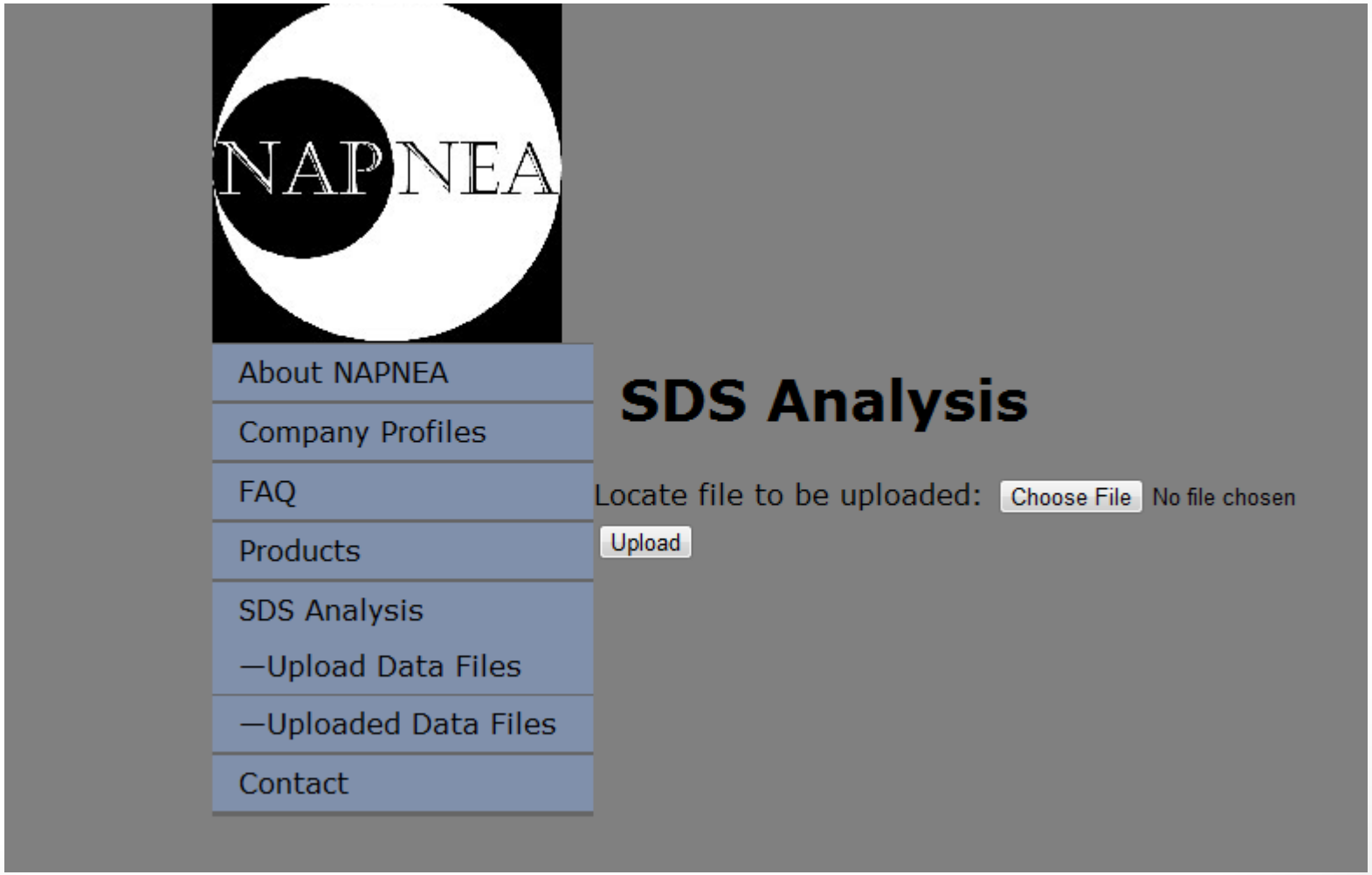
Second Generation Prototype



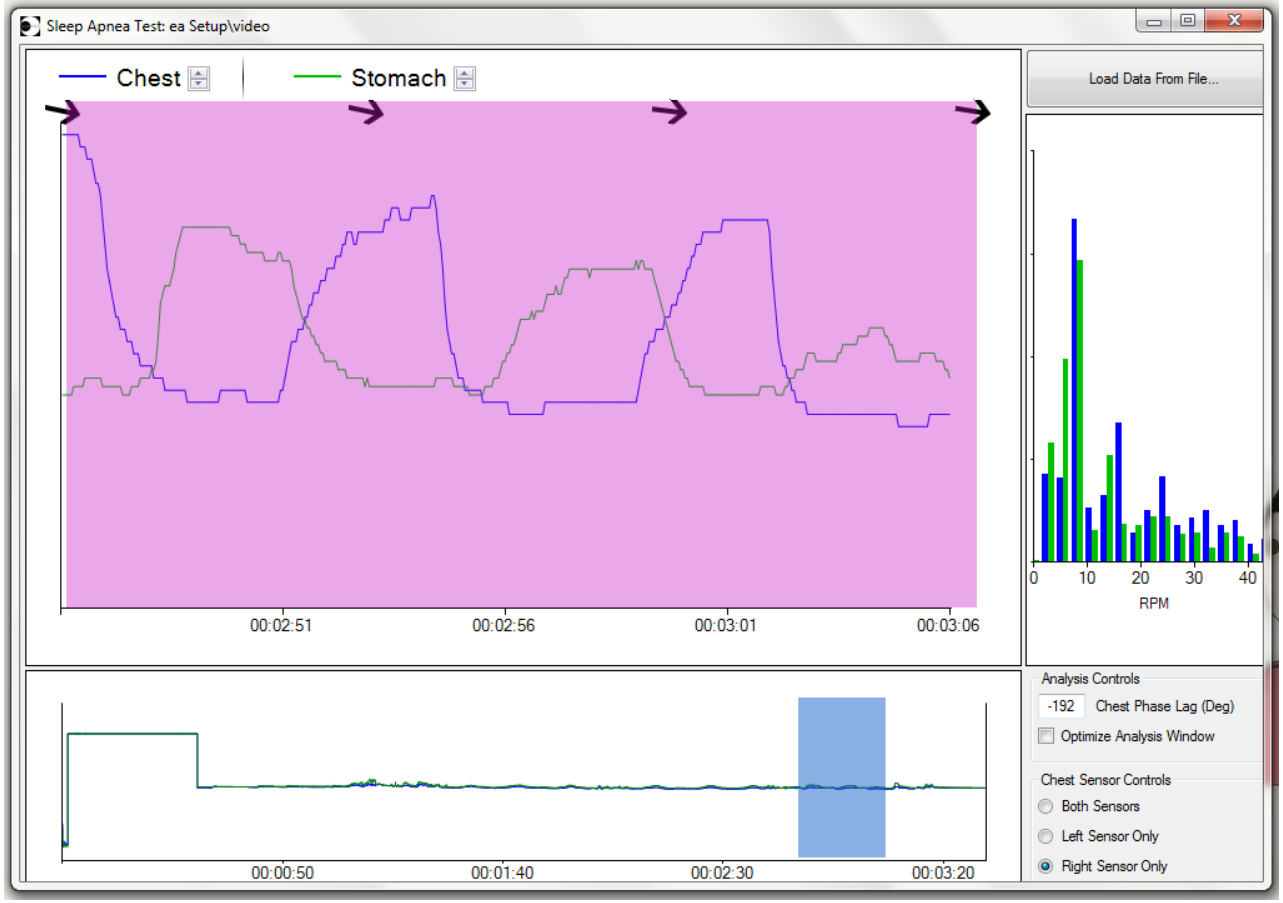
Second Generation Prototype

- SDS offers comfort and aesthetic appeal
- Patient can easily sleep in normal conditions and environments

Web Application

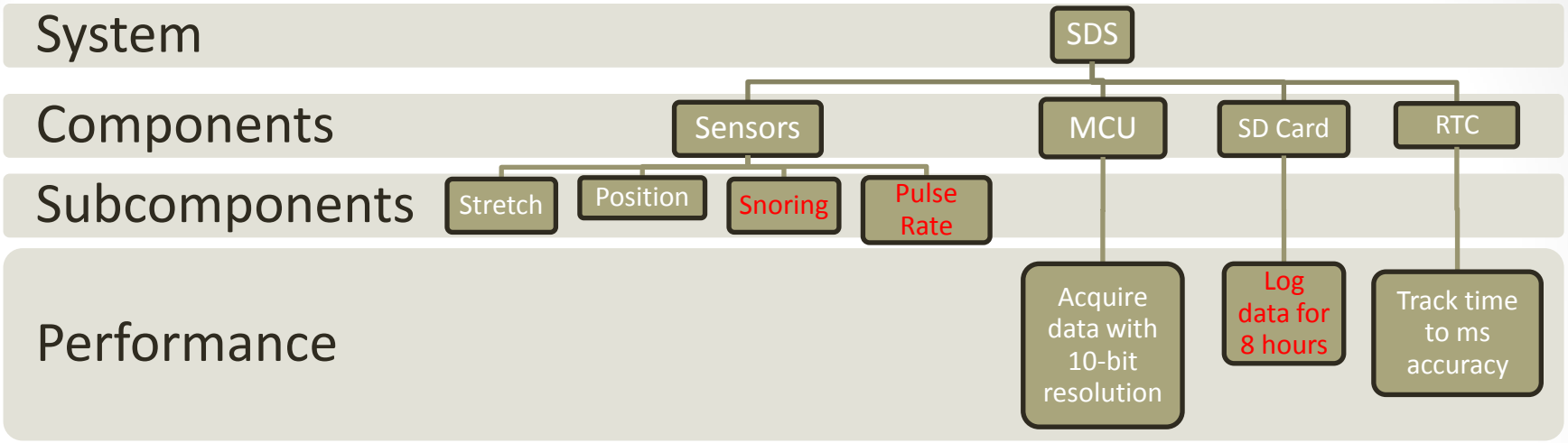


Sleepwear Diagnostic System - SOFTWARE



- Displays data from file
- Highlights potential apneic events

Future Additions

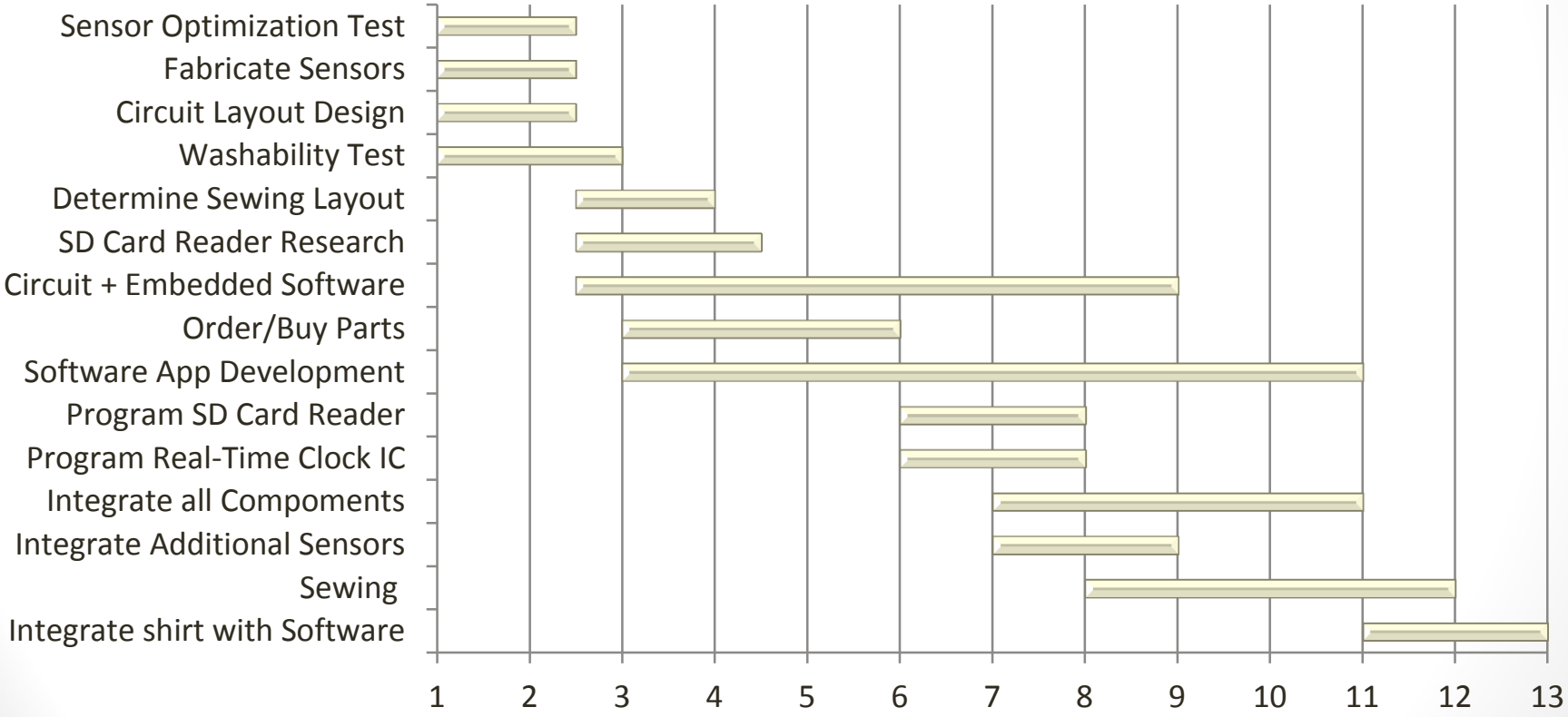


- Sensor modularity
- PCB and scale down components
- Mass production and uniformity
- Accommodation of different body types
- Web application functionality
- Apneic event zone-in

Budget Constraints

Item	Projected	Actual
Accelerometers	$75	$50
Stretch Sensors	$50	$165
Batteries + Charger	$50	$50
Electronic Components	$75	$65
Microcontrollers	$60	$60
SD Cards + Reader	$40	$25
Wireless Communication Devices	$50	$45
Shirts	$100	$50
Materials for Shirts	$100	$35
Contingency Fees	$100	$100
Total:	$700	$645

Time Constraints



Market Entry Plan

Task	1	2	3	4	5	6	7	8	9	10	11	12
Development RFP	■											
Website Development		■	■	■								
Product Development		■	■	■								
Prototype Testing				■	■	■	■	■				
QC and CSA standards				■	■	■	■	■				
Clinical Trials						■	■	■	■	■		
Install Partner									■	■		
Manufacturing Ramp-up										■	■	
Sales Team & Planning										■	■	
Organizational Systems										■		
Advertising											■	■
Sales Launch											■	■
Product Launch											■	■

Pricing

SDS

- $200 Retail per unit
  - Sold to clinicians and sleep labs
  - 33% profit margin based on prototype expense, but mass production will greatly increase this margin
- Rental to patients
  - Clinician rents out unit to patients for profit or refundable deposit

Sleep Lab

- $1000 - $2000 per night
- SDS is a small percentage of this cost

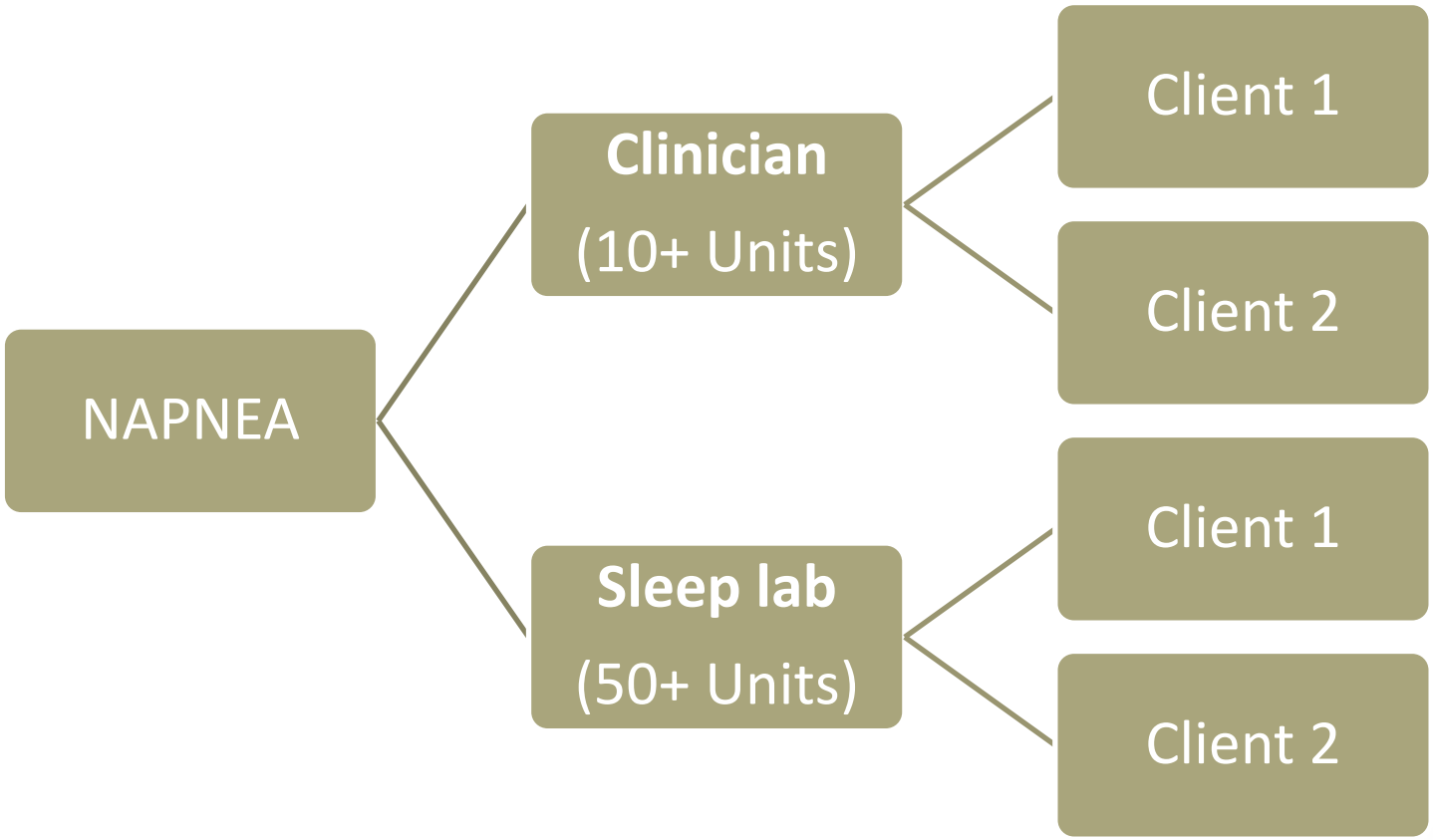
Competitors

Attribute	SDS	RUSleeping	SleepStrip	ARES	Watch-PAT200
Placement	Torso	Nose	Nose	Forehead	Wrist
Mode of detection	Respiratory effort, breathing mechanics, body position	Nasal airflow	Nasal airflow	SpO2, pulse, airflow, respiratory effort, snoring, head position	Pulse oximetry, body position, snoring
Data storage	On-device SD card	Small pager-like device attached to cannula	On-device CPU and display	Uploaded by clinician to web service	Wrist-worn CPU
Data information	Raw data and apneic event auto-find	Hourly apneic event score, number of nightly apneic events	Apneic severity score (0-3)	Raw data	Raw data
Lifetime	Indefinite	Disposable nasal cannula	One-time use	Disposable nasal cannula	Indefinite
Retail Price	$200	$790	$60	$3995	$4440





Sales Plan


NAPNEA
Clinician
(10+ Units)
Client 1
Client 2
Sleep lab
(50+ Units)
Client 1
Client 2

Video

- Please draw your attention to the side projector

Conclusion and Learning Outcomes

- Technical Skills:
  - Arduino
  - Analog and Digital electronics
  - Web Development
  - Software GUI
  - Sewing and other fabrication techniques

- Personal Skills:
  - Teamwork, work ethics, time management, delegation
  - Crucial for company success in addition to technical expertise

Acknowledgements

- Board of advisors
  - Jared Slobodan
  - Robin Coope
  - Dr. Najib Ayas
- 440/305 Panel
  - Andrew Rawicz
  - Mike Sjoerdsma
  - Ali Ostadfar
  - Moein Shayegannia
  - Jamal Bahari
- Max Donelan
- Andrew Blaber

Questions?

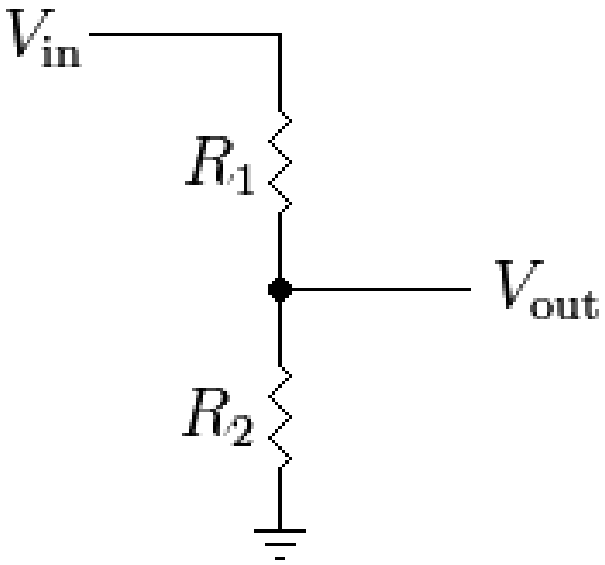
We thank you for your time.

We welcome any questions you may have.

-NAPNEA Management Team

Voltage Divider

$$V_{out} = \frac{R_2}{R_2 + R_1} V_{in}$$

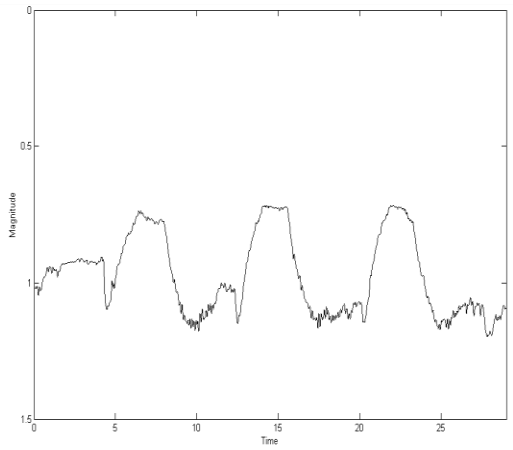


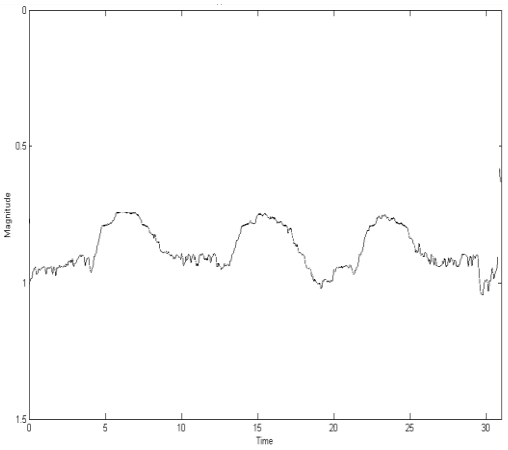
$$V_{max} - V_{min} = \left(\frac{R_{2max}}{R_{2max} + R_1} - \frac{R_{2min}}{R_{2min} + R_1} \right) V_{in}$$

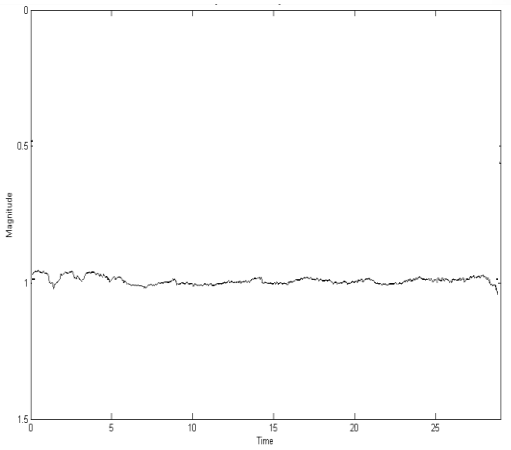
$$\partial_{R1} \left(\frac{R_{2max}}{R_{2max}+R_1} - \frac{R_{2min}}{R_{2min}+R_1} \right) = \frac{R_{2max}}{(R_{2max}+R_1)^2} - \frac{1}{R_{2max}+R_1} - \frac{R_{2min}}{(R_{2min}+R_1)^2} + \frac{1}{R_{2min}+R_1} = 0$$

$$R_1 = \frac{\sqrt{-R_{2max}{}^2 R_{2min} + R_{2max} R_{2min}{}^2}}{\sqrt{-R_{2max} + R_{2min}}}$$

Optimization Tests





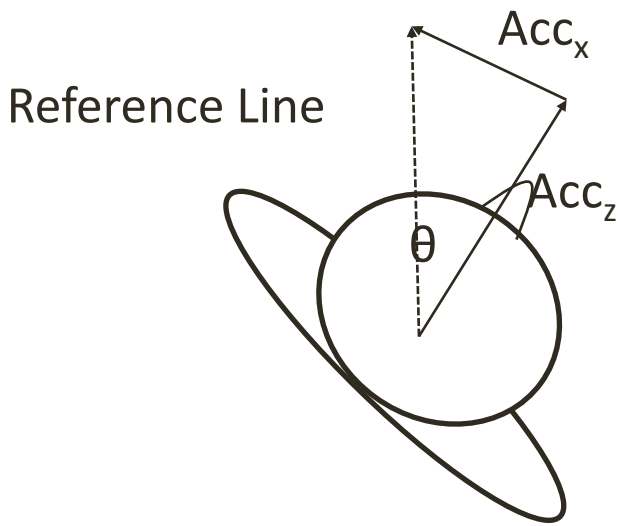


1. Stomach
2. Pec, sleeping on back
3. Pec, sleeping on side

Washability Test

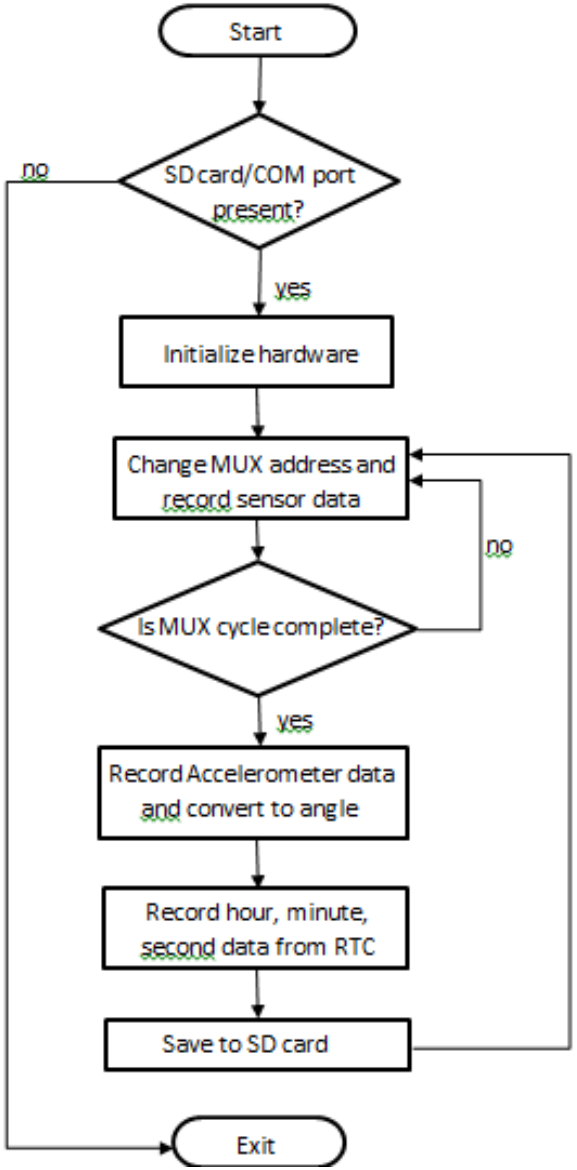
Sensor	Before wash (kΩ)	After wash (kΩ)
A	4.46~5.61	16.21~128.30
B	4.55~5.73	15.87~169.94
C	4.50~5.46	14.35~111.12
D	4.39~5.29	15.33~72.40
E	4.53~5.51	25.00~93.00
F	4.48~5.60	16.31~78.00

Accelerometer



$$\theta = \tan^{-1} \frac{Acc_x}{Acc_z}$$

Embedded Software



SDS Cost Breakdown

Component	Cost
Shirt	$25
3 Stretch Sensors	$1
Accelerometer	$25
2 Arduino Minis	$40
MUX	$5
RTC	$10
SD Card Writer	$10
2 GB SD Card	$10
Lining + Buttons	$5
Battery	$15
Wires, connectors, switch, LED	$4
TOTAL	**$150**