AlarmSense System

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The Team

Russell McLellan - President

- Document editor
- Wireless transmission

Taylor Robson – CEO

- Market research
- Alarm detection software

The Team

Adrian Tanskanen – Hardware Engineer

- Lead circuit design
- Testing and fabrication

Gordon Ho – Software Engineer

- Mobile application
- 3D CAD imaging

Background

- On industrial worksites, workers wear hearing protection
  - Cannot hear auditory alarms or each other
- Current solutions:
  - Visual alarms
  - Non-verbal communication

[1]

Background

- AlarmSense System
  - Noise cancelling headphones
  - Allows alarm frequencies through
  - Wireless communication with other workers

Market

- In Canadian construction, mining, and oil wells in 2013:
  - 65 000 injuries
  - 480 fatalities
  - Average cost is $40 000 per injury [2]
    - Government and company costs

- Everyday use lowers company operating costs
  - Raise efficiency and effectiveness

Market

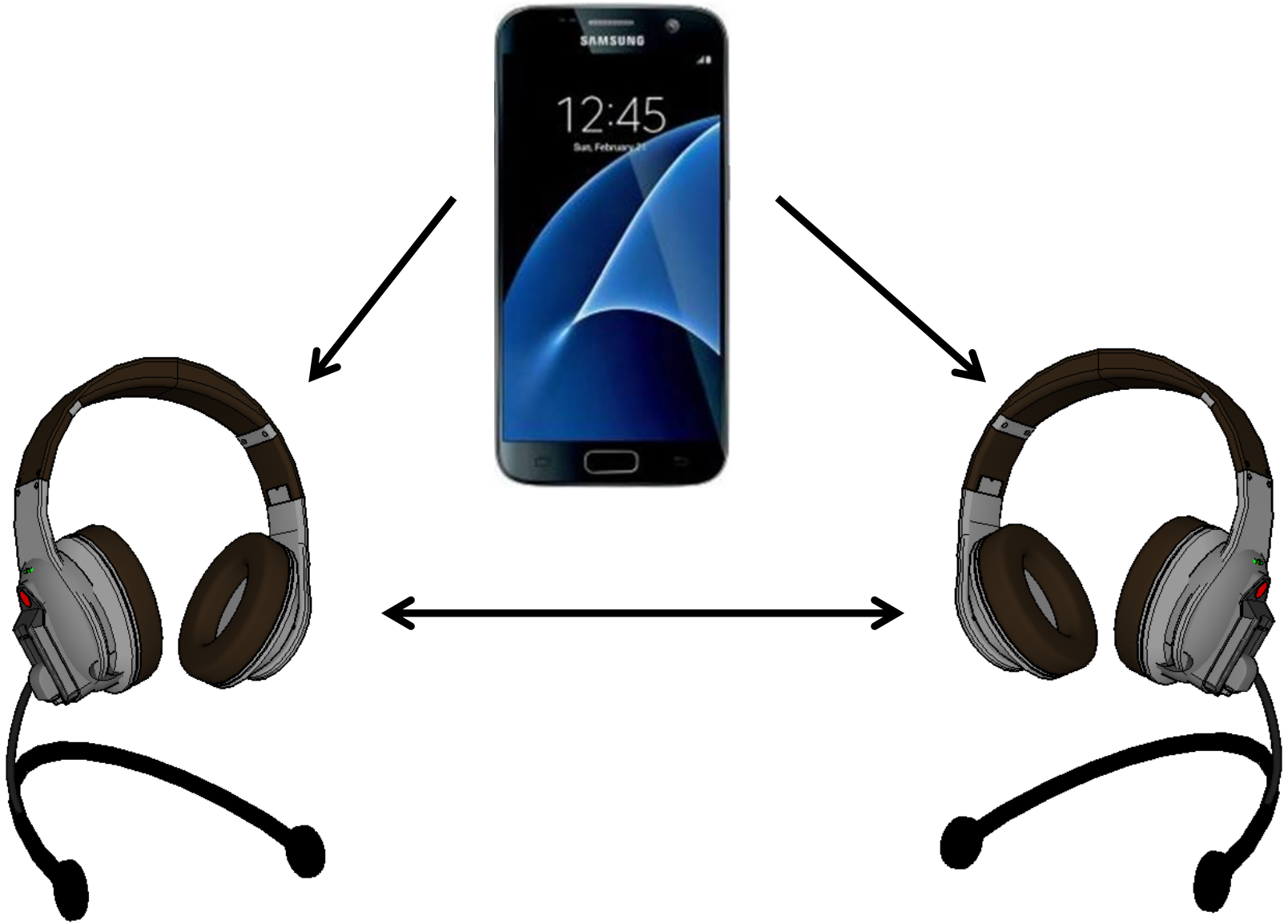
- Trade schools
- Government organizations
  - e.g. WorkSafe BC
- Independent businesses
- The system will only function if all workers are wearing it
  - Need to market the system to companies, not workers

Market

- No direct competition
- Projecting $500 per unit MSRP
- Compares to $600 in separate units [3, 4]
  - $100 high quality passive hearing protection
  - $300 active noise cancelling
  - $200 radio
- Workers usually spend $500-$1500 on PPE
  - We consulted with industry professionals [5, 6]

Contents

System Overview

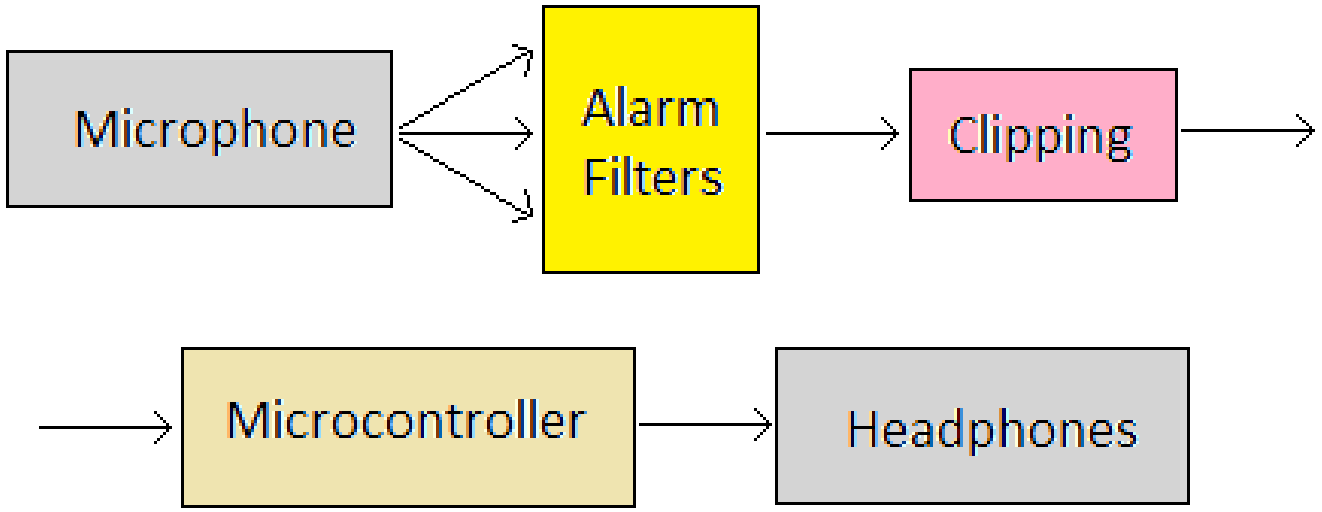


Alarm Detection

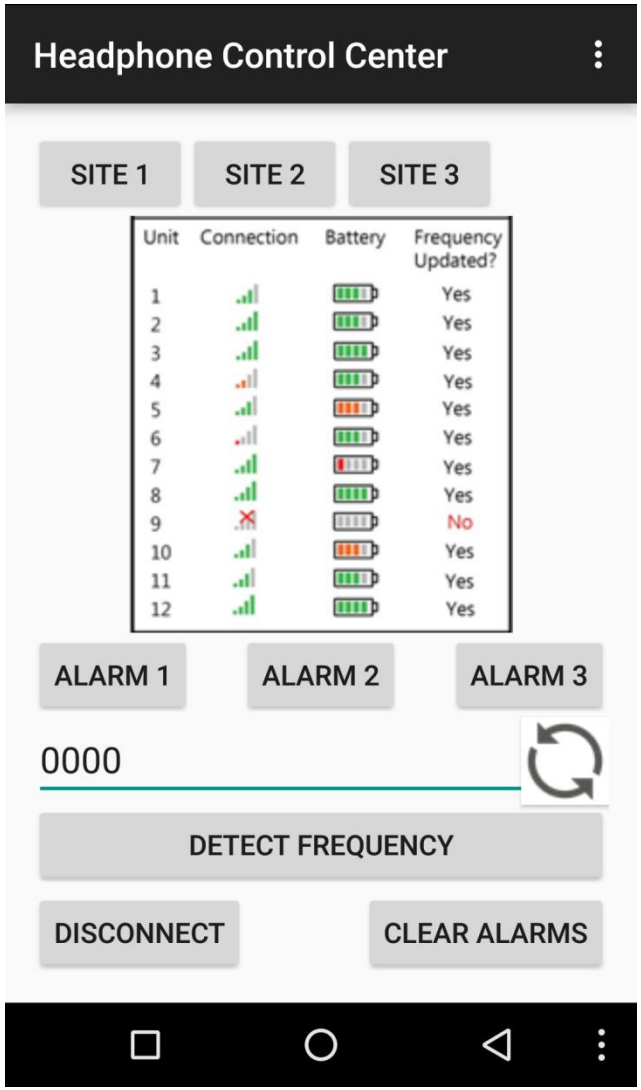
- See video

Alarm Sensing

- Combination of hardware filters and software detection
  - Can be tuned to one of three alarm frequencies
  - Future work would include arbitrary frequencies
- Works through industrial noise



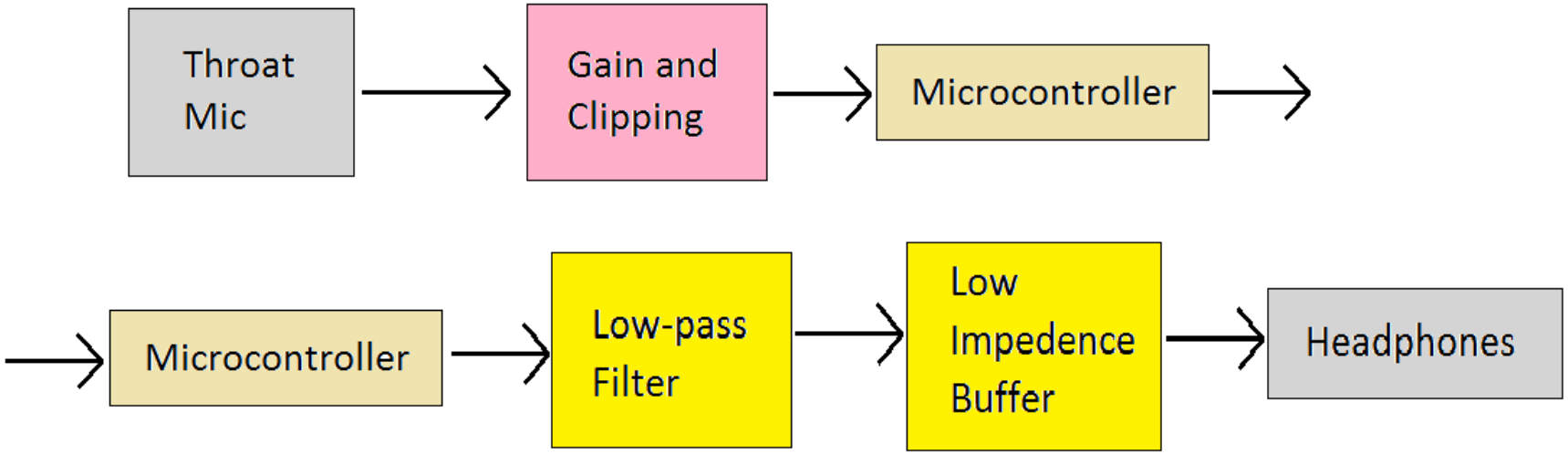
Mobile Application



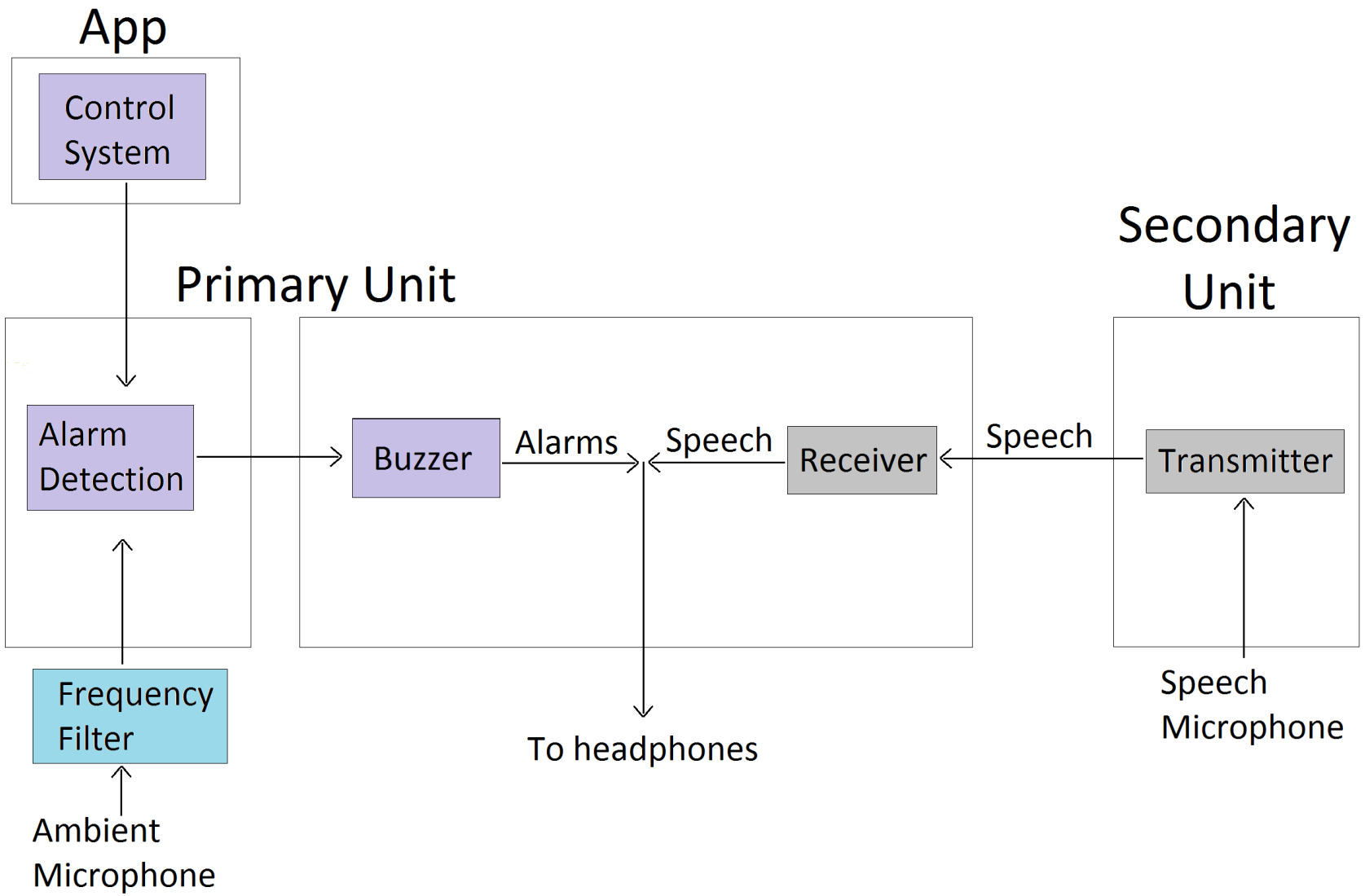
- System control
  - Sends alarm frequencies to the unit
  - Full system would include monitoring
- Can set different alarm priorities
- Measures the frequency of incoming sound

Wireless transmission

- Allows all workers to communicate in industrial noise
  - Uses throat microphone
  - Bypasses hearing protection



System Integration



Contents

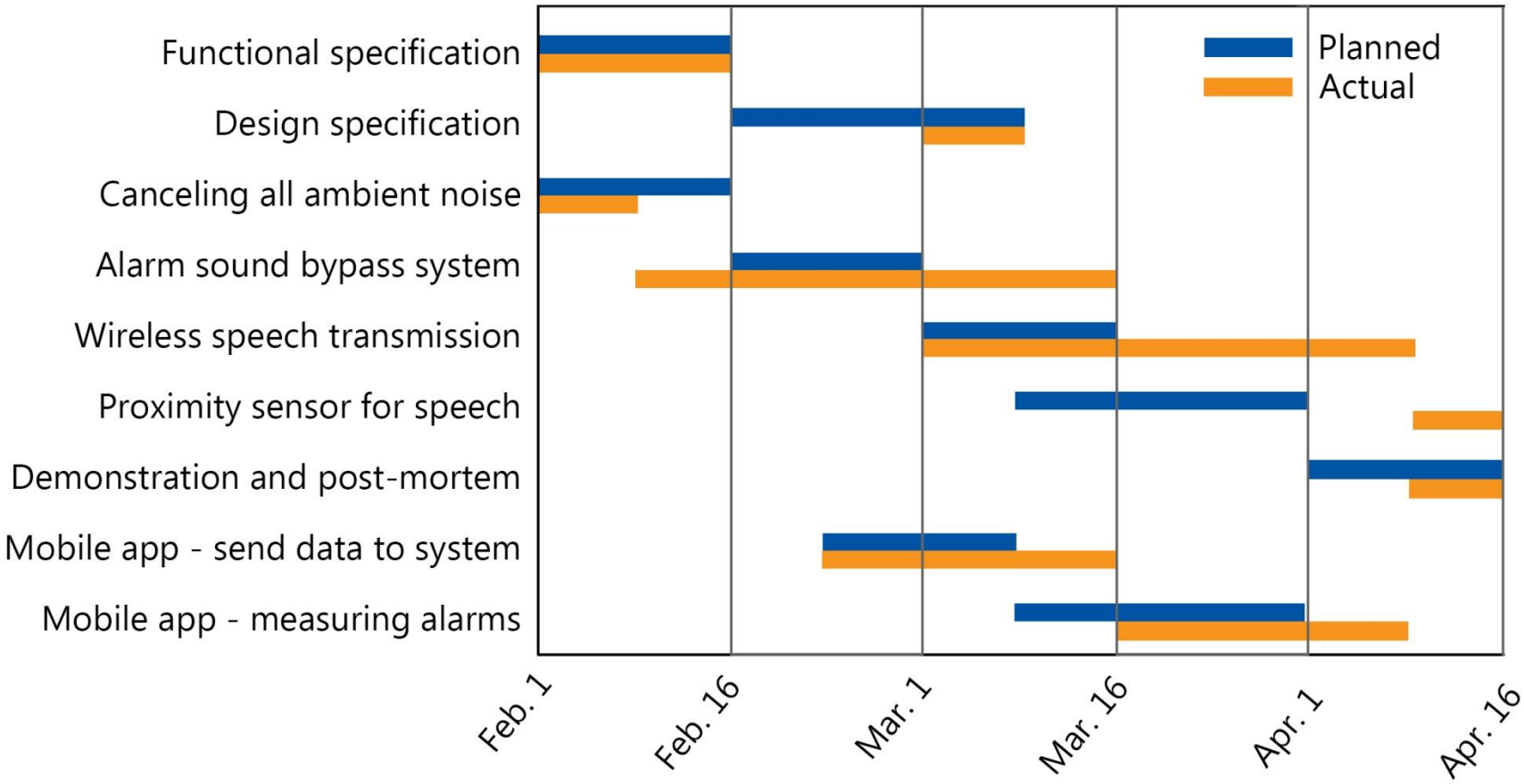
Budget

Component	Planned		Actual	
	Part	Cost	Part	Cost
Primary microcontroller	1x Intel Galileo Gen 2	$100	1x Genuino Uno 1x Genuino Zero	$101
Noise cancelling headphones	1x Sony 10RNC Noise Cancelling Headphones	$220	1x Bose QuietComfort 25 Headphones	$300
Noise cancelling microphone	1x Motorola Noise Cancelling Microphone	$200	1x Throat Microphone	$56
Proximity sensor	2x Ultrasonic Transducers	$10		
Secondary microprocessor	1x Genuino Uno	$25	1x Genuino Uno	$32
Receiver/ transmitter pair	1x Wenshing Wireless Receiver/Transmitter	$10	4x nRFL01+ Receiver/Transmitter	$60
Misc.		$200	Protoboards, batteries, Bluetooth module, trimpots	$402
Wasted		N/A	Genuino Due, Genuino Zero, Noise cancelling microphone	$214
Total Cost		**$765**		**$1165**

Funding

- ESSEF
  - $517 given based on our proposed budget
- Ourselves
  - Expected $248 total
  - Actual $648

Timeline


Functional specification
Design specification
Canceling all ambient noise
Alarm sound bypass system
Wireless speech transmission
Proximity sensor for speech
Demonstration and post-mortem
Mobile app - send data to system
Mobile app - measuring alarms
Planned
Actual
Feb. 1
Feb. 16
Mar. 1
Mar. 16
Apr. 1
Apr. 16

Work Breakdown

Task	Russell McLellan	Adrian Tanskanen	Taylor Robson	Gordon Ho
Report Writing	XX	XX	X	X
Microphone Circuits	XX	XX	XX	
Alarm Detection Hardware	X	XX	XX	
Alarm Detection Software		X	XX	X
Wireless Transmission Hardware	XX	XX	X	
3D CAD Modeling				XX
Wireless Transmission Software	XX	X		
Mobile App Design				XX
Material Acquisition			XX	XX
Physical Enclosure				XX

Contents

Problems encountered

- Logistical
  - Wasted money
    - Intel Galileo, Genuino Due, microphone
  - Caused by insufficient research
  - Frying components

- Team dynamics
  - Irritating loud noises for testing
  - Bought earplugs

Problems encountered

- Circuits
  - Feedback
  - Caused false positives on alarm detection
  - Added buffers
- Wireless
  - Inconsistent connectivity
  - Compensating capacitors
- Mobile App
  - Bluetooth connectivity
  - Many minor issues

Outcomes

- Split up work so everyone has an equal opportunity
- Theoretical vs actual hardware implementation
- RF transmitting and signal processing
    - Digital to analog conversion
- Mobile application development
- Working as a team

Conclusion

- Proof of concept developed
  - Showcases almost all functionality
- Not pursuing the project further
  - Due to diverging interests
  - Lack of investment

Acknowledgements

- Hsiu-Yang Tseng
  - Technical suggestions
- Jamal Bahari
  - Initial high level guidance
- Steve Whitmore, BCPID
  - User interfacing guidance
- Dr. Andrew Rawicz, P. Eng
  - Abstract analysis
- The ESSEF
  - Funding for the prototype

Questions?

References

[1] Epd.gov.hk, "Noise Management - Noise Control Ordinance", 2016. [Online]. Available: http://www.epd.gov.hk/epd/noise_education/web/ENG_EPD_HTML/m3/ordinance_7.html. [Accessed: 14- Apr- 2016].

[2] Association of Workers' Compensation Boards of Canada (2015). Detailed Key Statistical Measures Report [Online]. Available FTP. http://awcbc.org/?page_id=9759. [Accessed: 30-Jan-2016]

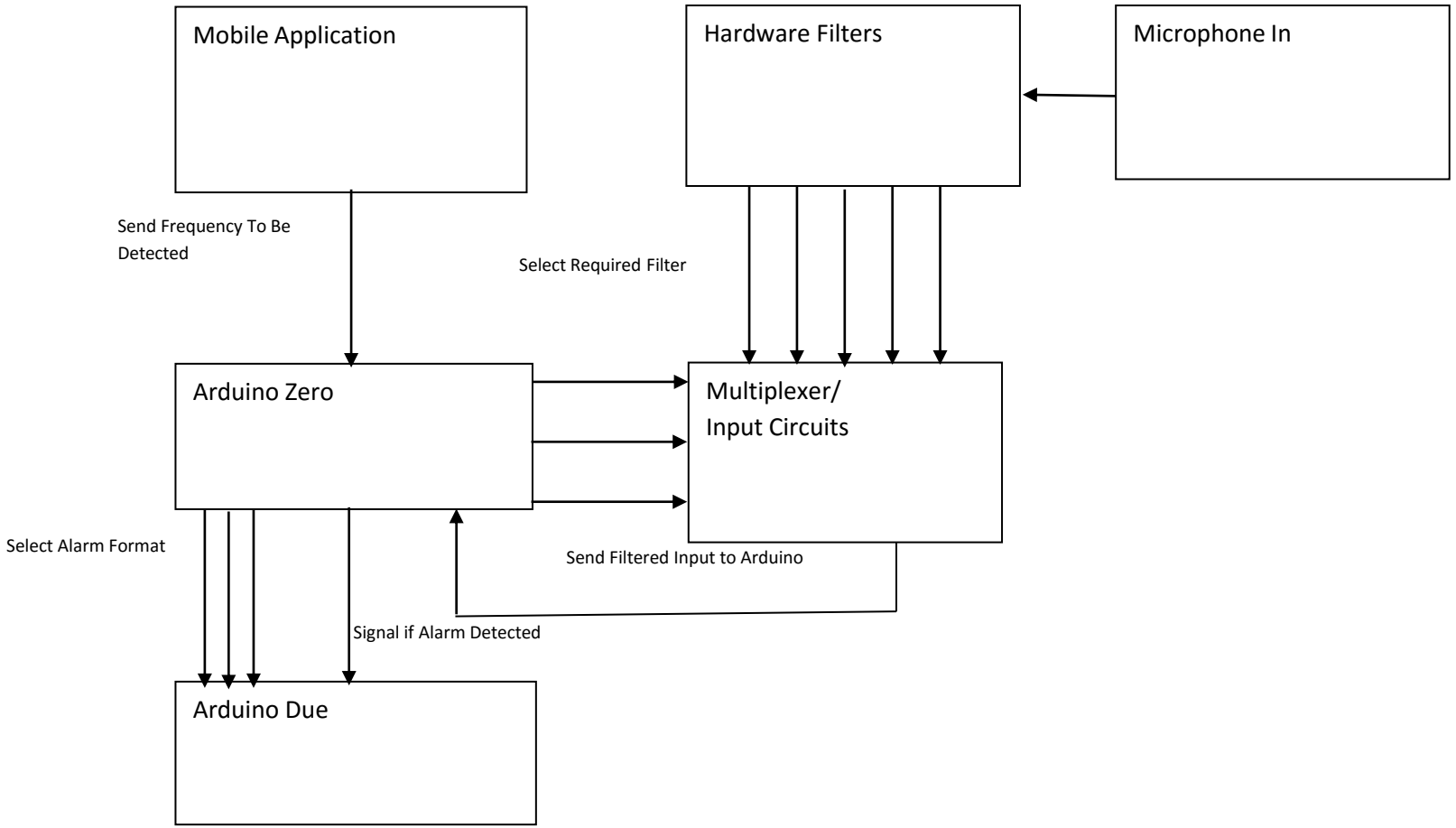
[3] Earplugstore.com, "3M Peltor MT53H7A4600-NA LiteCom BRS Two-Way Radio Ear Muffs Headset (NRR 26)", 2016. [Online]. Available: http://www.earplugstore.com/3m-peltor-litecom-brs2-way-radio-headset.html. [Accessed: 12-Feb-2016]

[4] Srstactical.ca, "3M PELTOR LITECOM PLUS 2 WAY RADIO HEARING PROTECTION HEADSET HEADSET", 2016. [Online]. http://srstactical.ca/featured/3m-peltor-litecom-plus-2-way-radio-hearing-protection-headset.html. [Accessed: 12-Feb-2016]

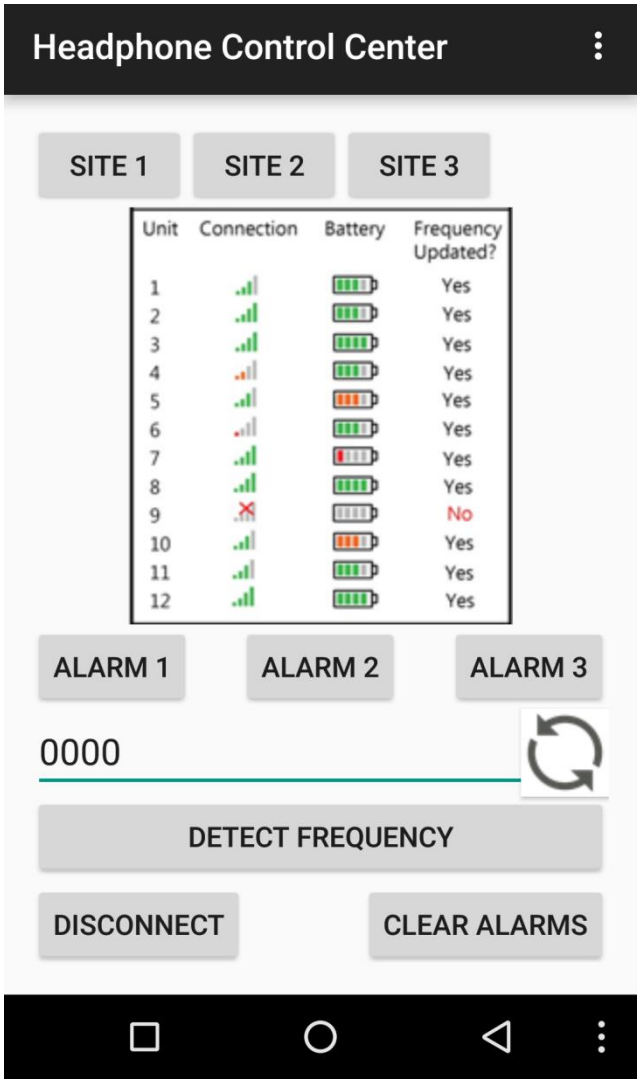
[5] E. Bikadi, personal communication, Jan 2016.

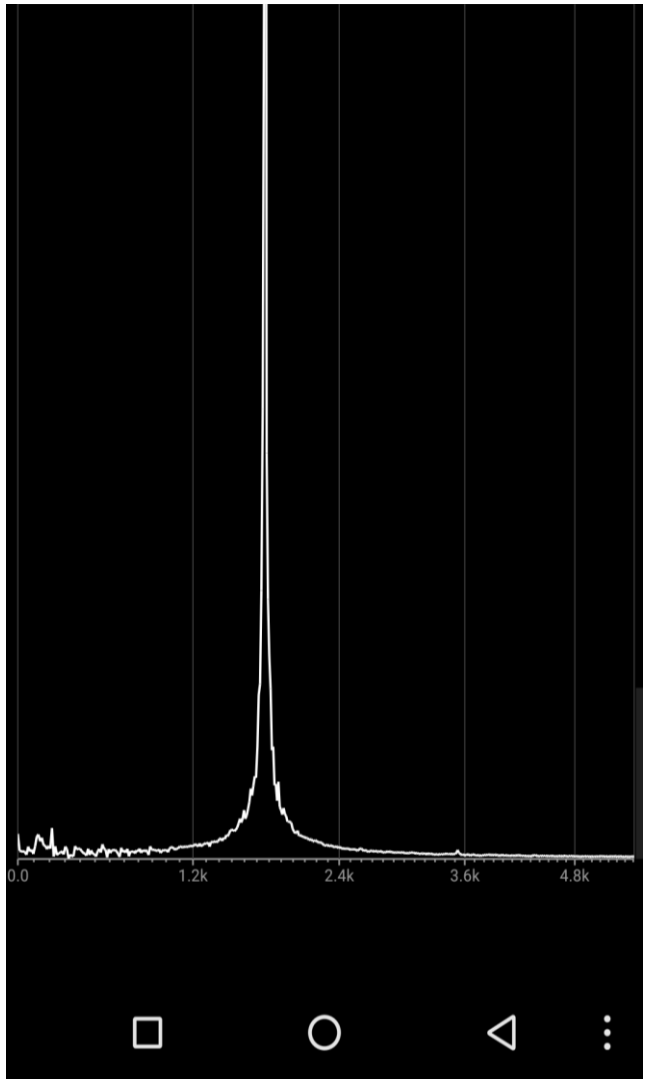
[6] D. Burns, personal communication, Jan 2016.

Circuits

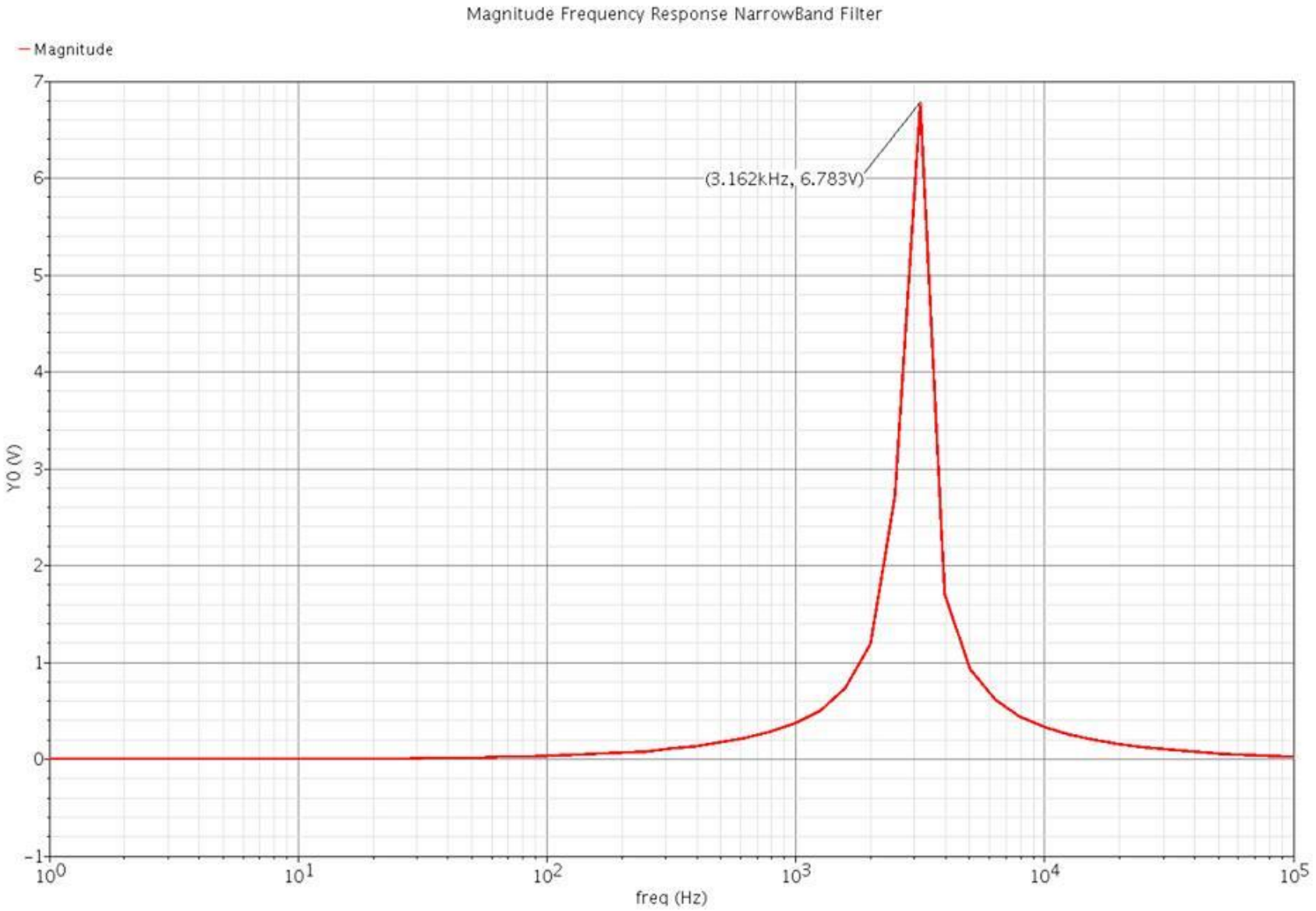

Mobile Application
Hardware Filters
Microphone In
Send Frequency To Be Detected
Select Required Filter
Arduino Zero
Multiplexer/
Input Circuits
Select Alarm Format
Send Filtered Input to Arduino
Signal if Alarm Detected
Arduino Due

Mobile App


Headphone Control Center
SITE 1
SITE 2
SITE 3
Unit Connection Battery Frequency Updated?
1 Yes
2 Yes
3 Yes
4 Yes
5 Yes
6 Yes
7 Yes
8 Yes
9 No
10 Yes
11 Yes
12 Yes
ALARM 1
ALARM 2
ALARM 3
0000
DETECT FREQUENCY
DISCONNECT
CLEAR ALARMS


0.0
1.2k
2.4k
3.6k
4.8k

Narrowband Filter



Alarm Detection

Alarm Detection

- During the noise, we are playing alarm tones
  - Taylor will signal when an alarm tone begins to play
- Volunteer, please gives a thumbs up when you hear the alarm
- We are testing all three alarms

Mobile Application

Voice Transmission

Voice Transmission

Raise your right hand

Voice Transmission

Hold up three fingers

Voice Transmission

Stand up