

Smart Headphones To Measure PTT and PWV

Leader: Ethan Hannon

BSAC: Rachel Nossen

BPAG: Mark Rice

BPAG: Mustafa Al-Sakhbouri

Communicator Carson Endries

BWIG Kyle Everson

Client: Dr. Jeffrey Koziol



DEPARTMENT OF
Biomedical Engineering
UNIVERSITY OF WISCONSIN-MADISON

Introduction

Problem Statement: Create working headphones with a microphone capable of listening to the users heartbeat to properly track their Pulse Wave Velocity (PWV) and Pulse Transit Time (PTT) for their health.

Project motivation: Other methods of cardio health simply use PPG sensing to track pulse. This method would be capable measuring and tracking blood pressure levels for the user.



The Importance of Tracking Blood Pressure

- High blood pressure has been on the rise over the past years [6]
- This project will address the difficulty and importance of tracking blood pressure
- Making a device to track blood pressure will benefit heart disease awareness

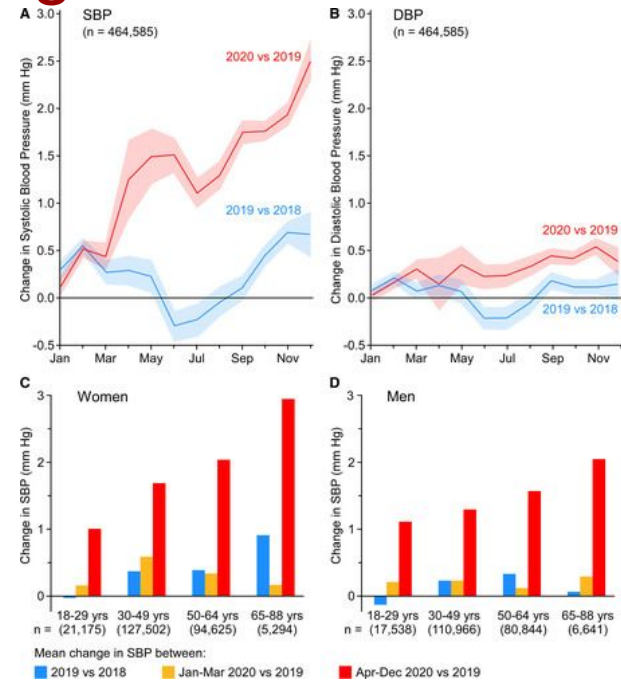


Figure 1. Male and Female Rising Blood Pressure Over the Years[1]

Background Information

What is PTT?

- Pulse Transit Time
- Related to PWV
- Time it takes for a pulse wave to go from arterial node to arterial node

What is PWV?

- Pulse Wave Velocity
- Reflects your arterial elasticity
- Great predictor of cardiovascular diseases

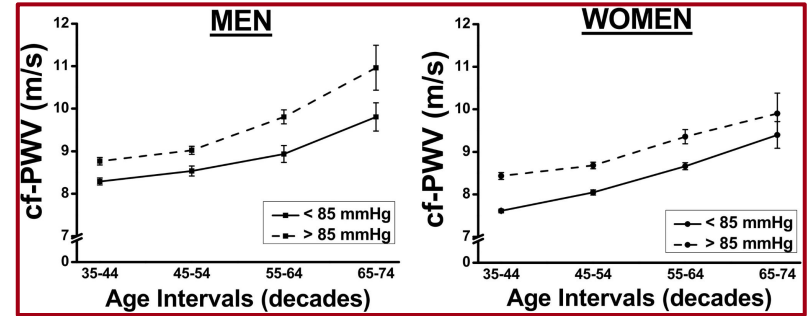


Figure 2. PWV for males and females over different ages [4]

$$PWV = \frac{\text{distance between the sites}}{\text{travel time between the sites}}$$

Figure 3. Pulse Wave Velocity Equation [4]



Product Design Specifications

- **Client Requirements:**
 - Must use a microphone to listen to heartbeat
 - Must work like regular headphones
 - Capable of linking fitness watch and recording device via bluetooth
 - Must be able to connect to a tracking program
 - Data recording should be continuous and stored on the app
- **Design Requirements:**
 - Record PWV and PTT accurately to determine blood pressure (50-80 diastolic and 100-120 systolic) [2]
 - Headphones should not exceed more than 20% the mass of regular ones
 - Microphone should be capable of ignoring most outside noise

Design Alternatives

- Blood pressure cuffs are commonly used
 - Manually pumped and not continuous
 - Accurate measurements
 - Often used by a doctor or nurse in a medical center



Figure 4. Blood Pressure Cuff[2]

Design Alternatives

- Many smart watches use PPG technology
 - Can only measure pulse
 - Often inaccurate
 - about 34% accuracy [7]
 - Provides estimates only



Figure 5. Apple Smart Watch
[5]

Preliminary Designs: Headband

- Over the ear headphones, traditional style
 - Can block out background noise
 - Fabricated with a 3d printer
- Pieces able attach/detach
 - Easy to test electronics

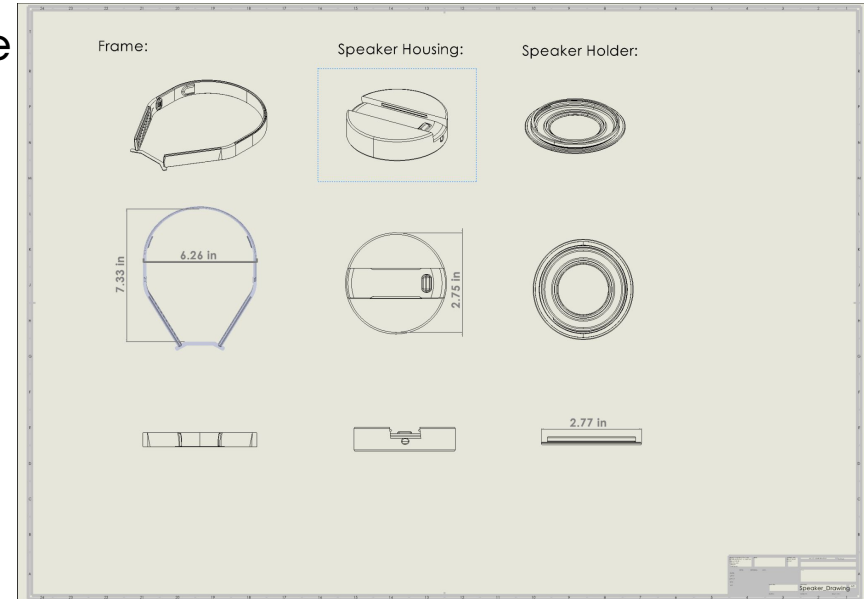


Figure 6. SolidWorks drawing of Headband Design

Preliminary Designs: Gamer Headphones

- Over the ear headphones
- Microphone can be adjusted
 - Normal mode: next to mouth
 - Hearing pulse: next to artery
- Focuses on using algorithms
 - Eliminate background noises

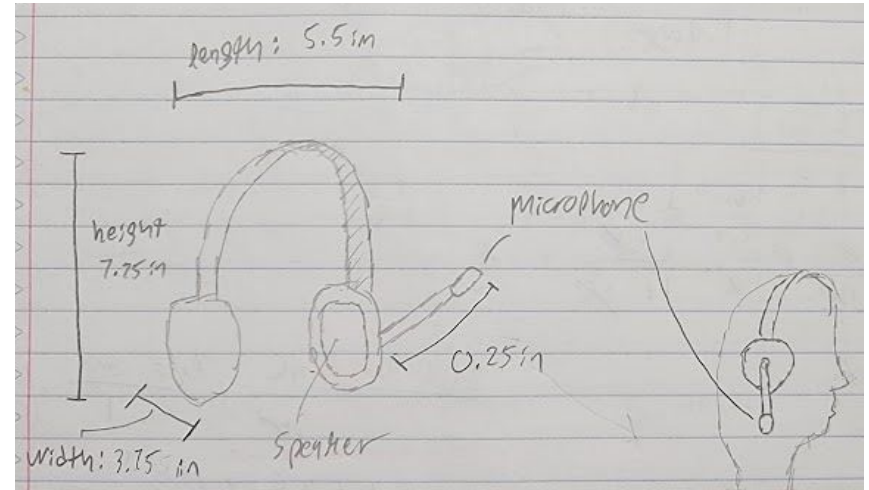


Figure 7. Gamer Headphones Sketch

Preliminary Designs: Wrap Around

- Wrap around earbud
 - Pros: lightweight, secure
- Microphone and LED
- Fabrication difficulties
 - Small
 - More complex parts
- Outside sound interference

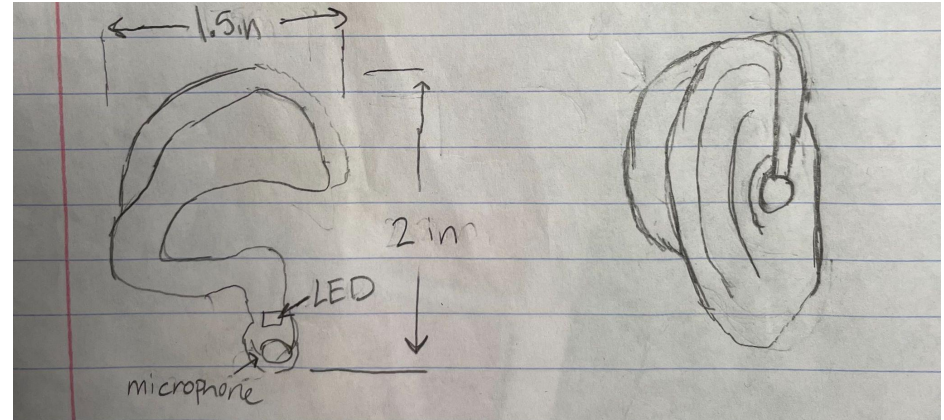


Figure 8. Wrap Around Design Sketch

Figure 9. Design Matrix

		Design 1: Headband		Design 2: Wrap Around		Design 3: Gamer	
Criteria	Weight	Score (10 max)	Weighted Score	Score (10 max)	Weighted Score	Score (10 max)	Weighted Score
Effectiveness of measurements	25	10	25	10	25	7	18
Ease of fabrication	20	10	20	6	12	10	20
Comfort	15	9	14	8	12	10	15
Ease of use	20	7	14	10	20	6	12
Cost	10	5	5	7	7	8	8
Safety	10	10	10	10	10	10	10
Sum	100	Sum	88	Sum	86	Sum	83



Future Work

- Headphone Fabrication:
 - Finding and building a new set of headphones
 - Finding a proper microphone to listen to heartbeat
- Wireless and App Work:
 - Researching proper implementation of bluetooth
 - Coding for data storage of headphones

Figure 10. A future app design



Acknowledgements

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