WheezeSense Algorithm – Home Monitoring Device for Pediatric Asthma

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Background

- Asthma affects over **6.1 million children** and is the **third leading cause** of hospitalization
- 83,200 ED visits from an asthma attack or episode are **"potentially preventable"**
- A **key symptom** of asthma is **wheezing** caused by mucus buildup and narrowing of bronchial tubes
- Currently, there is no device on the market that can provide continuous home monitoring of breath sounds to detect the presence of wheezing in young children

Objective

Given a sound input, the objective of the WheezeSense is to detect the **onset of asthma** through the **sound of wheezing** using a **wheeze detection algorithm** created by the team

Existing Solutions and Limitations

Existing wheezing devices are not designed for **home use** for **children under two years old.**

Device Name	Pulmo Track & Wheezo (handheld device)	Wireless/ wearable sound monitoring system	Our Design
Detects Wheezing	☑	☑	☑	☑
Chest placement		☑	☑
Designed for children	☑		☑
Home use	☑		☑

Constraints & Requirements

Constraints	Requirements
1. Time: 9 months	1. Code must take input and output graphic representation of data
2. Budget: $800	
3. ISO and ASTM Standards	2. Algorithm must filter background noises <150 Hz & >1000 Hz
4. Resources: Drexel Health Team and Sim Lab at DUCOM	
5. Coding Language: MATLAB	3. The false positive rate must be less than 10%
6. Limited available data	

Prototype

- Sensor placed over child's chest
- Sensor equipped with microphone and programmed with a wheeze detection algorithm
- Wheeze detection algorithm will record breathing noises of subject and discern normal breathing sounds from wheezing sounds
- Wheezing sounds are distinguishable from normal breathing sounds by higher frequencies and intensities combined, as well as sustained duration

LED Indicator
Arduino Board
Sound Sensor w/ Microphone
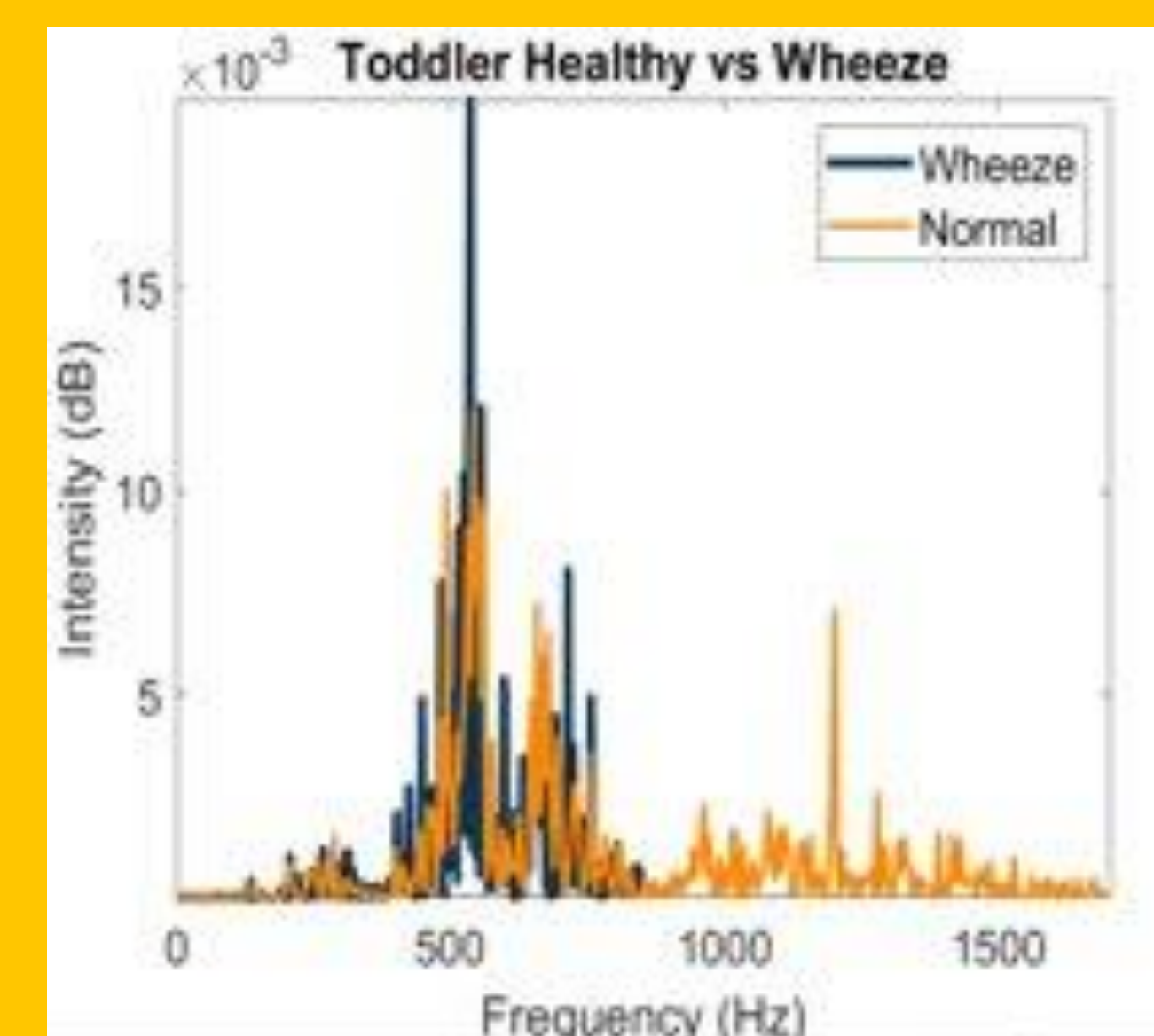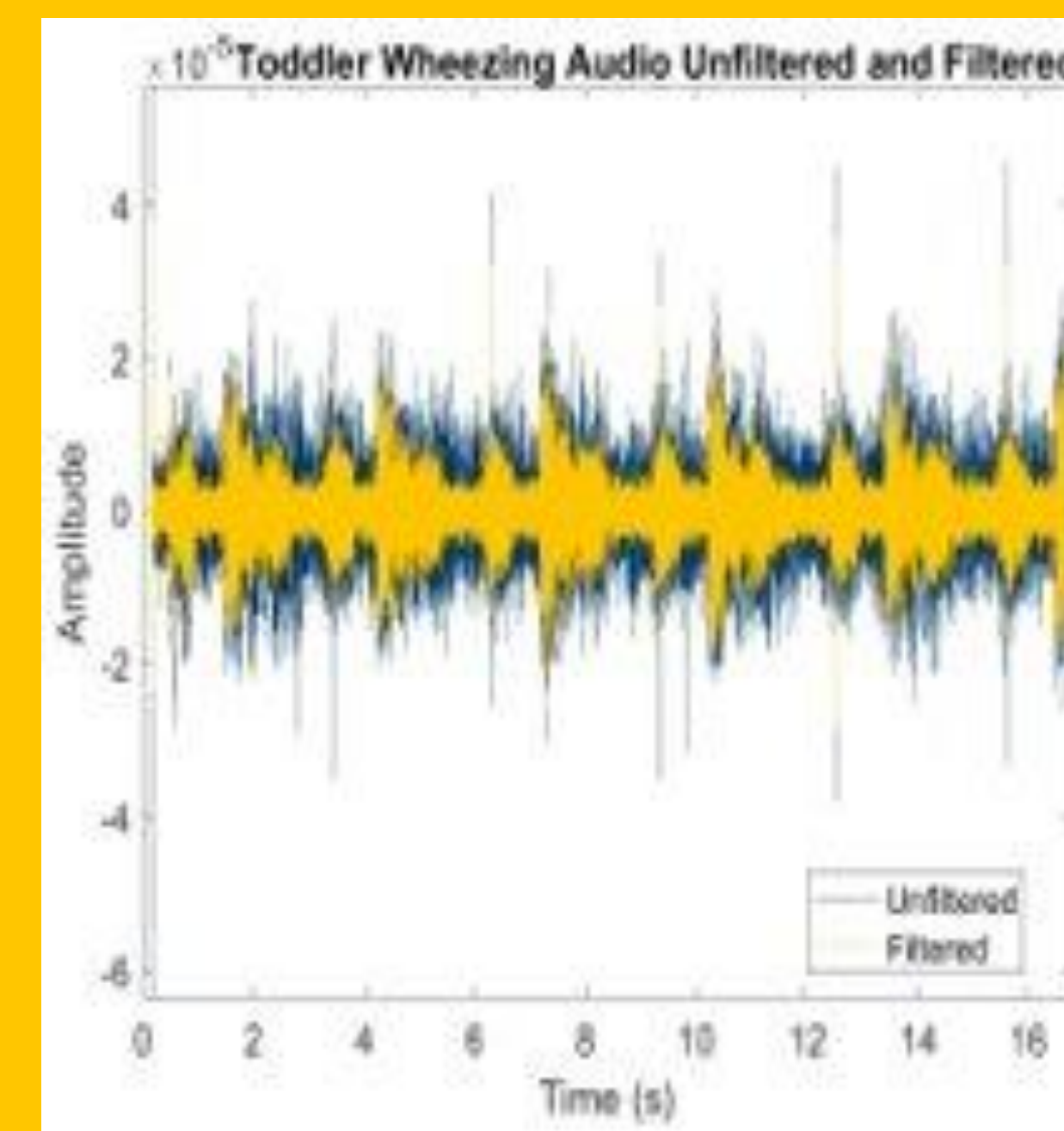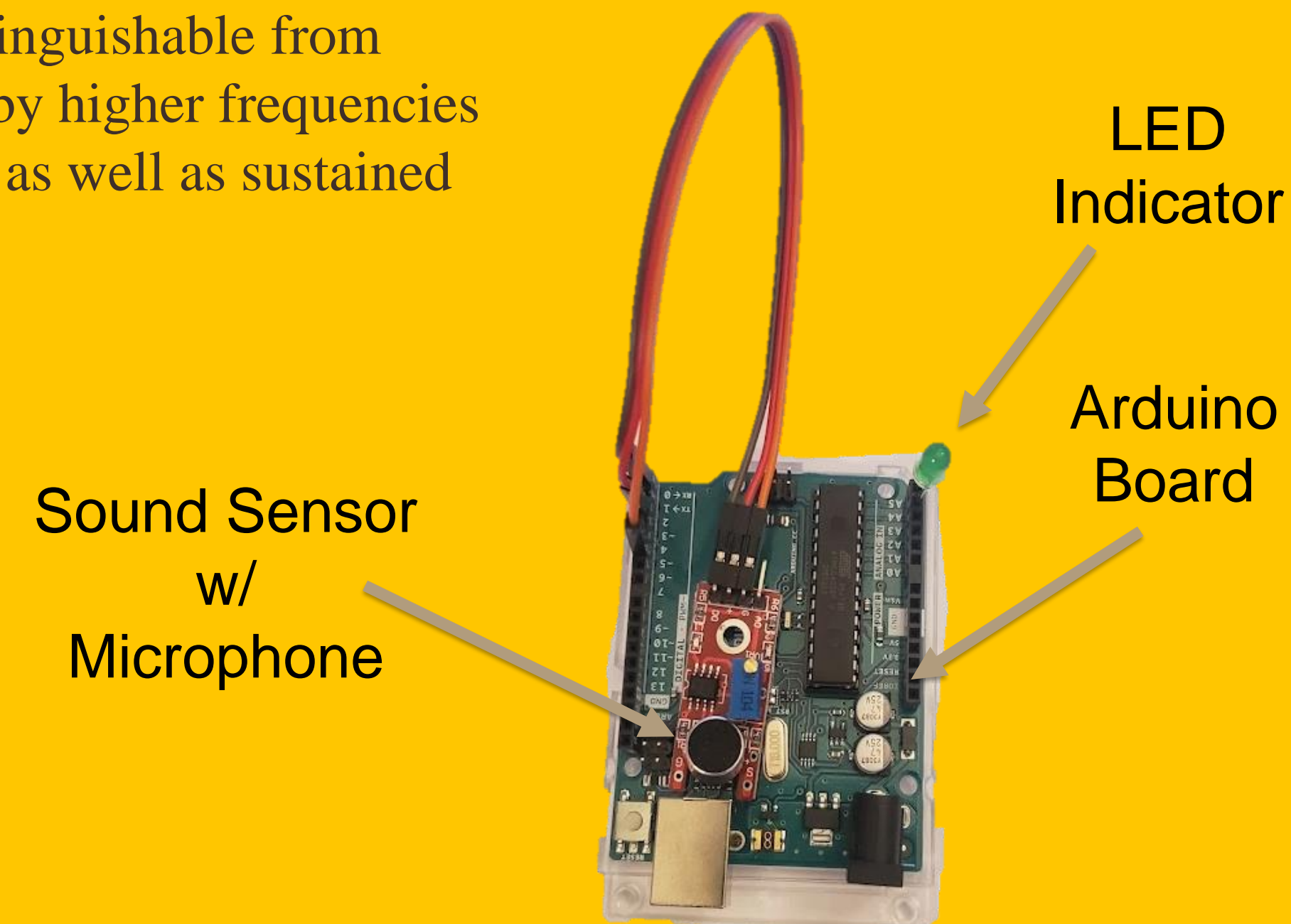
Validation

Test trials in Sim Lab

- Algorithm and sensor prototype trials run using DUCOM Sim Lab mannequins
- Newborn and toddler mannequins programmed with existing breathing sounds and used to simulate wheezing
- Blinded tests in which mannequin operator played breathing sounds unknown to team
- Algorithm prototype tasked with determining whether breathing sounds were "healthy" or were characteristic of wheezing

Requirement	Met: Y/N/TBD
R1 – Code outputs graph with determination of healthy or wheezing	Y
R2 – Algorithm filters <150 & >1000 Hz	Y
R3 – False positive rate ≤ 10%	TBD

Solution Design:

Algorithm Flow Chart

Import Breathing Recording → Noise Filtering & Segmentation → Fast Fourier Transform → Power Spectrum Integration → Wheeze Detection Criteria - Frequency - Intensity - Sustained duration → Graph and Determination

Conclusion

This algorithm will be the stepping stone for the development of the WheezeSense system. Using the algorithm, a team will eventually develop a sensor that detects the changes in the patient's breathing. This sensor will then send the message to a phone application where the patients' parents will be notified on what the next course of action should be.

Societal Impact

- The primary goal of this program is to give caregivers more information about their child's asthma, allowing them to make better informed decisions when it comes to the actions they should take, such as administering medication or taking them to the emergency department.
- Second, we hope that this program will help healthcare professionals by providing an accurate history of the patient's asthma progression based on the data recorded on the WheezeSense.
- Finally, this program will have a meaningful impact on insurances, since it will decrease or eliminate unnecessary visits to the emergency room.

Acknowledgements

References:.
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[2] Centers for Disease Control and Prevention. (2010) "National Hospital Ambulatory Medical Care Survey".
[3] Shaharum, Syamimi Mardiah et al. *Bosnian journal of basic medical sciences*
[4] Li, S.-H, et al. *Design of weearable breathing sound monitoring system for real-time wheeze detection.*