

I'M FEELING ODD! - CARDIO-PULMONARY MONITOR

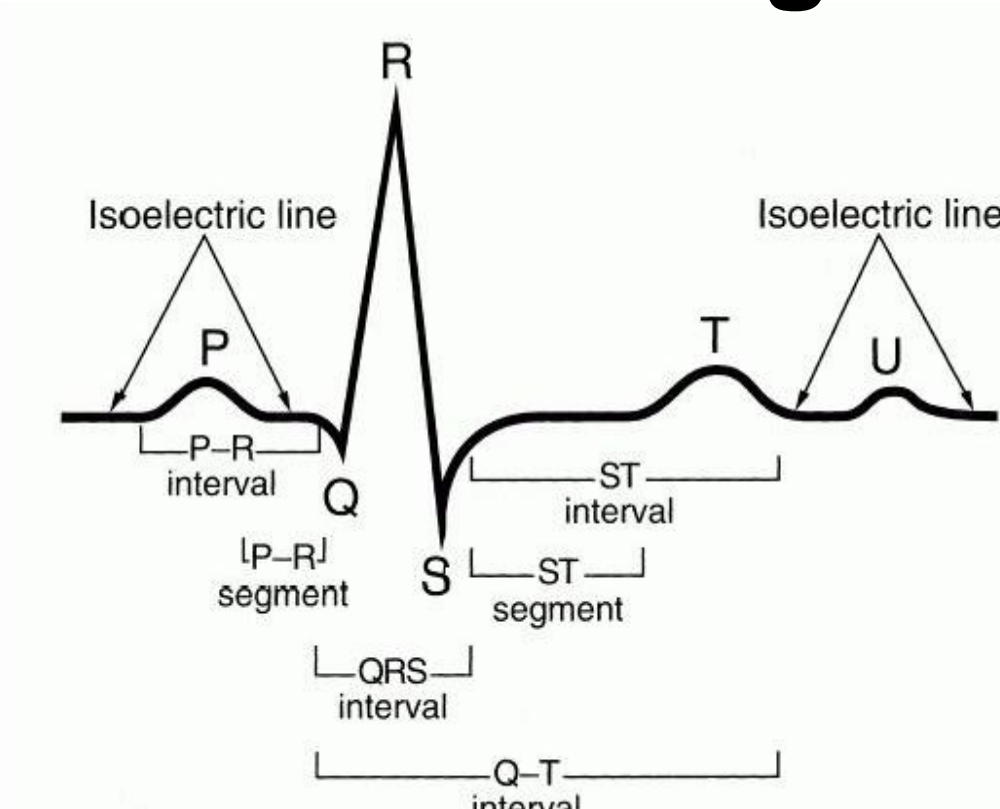
Ethan Green, Rashmi Rajashekar, Weisi Chen, Orlen Shiba, Ningyu Yang, Arjun Kurian – Meng '15
 BME • Pooja Ramchandra, Meng '15, ECE
 Advisors : Dr. Bruce Land, Dr. Jonathan Black

ABSTRACT

Globally, cardiovascular diseases account for approximately 17 million deaths a year, nearly one third of the total. Life threatening Cardiac events like Ventricular fibrillation, Angina, Arrhythmias as well as minor events like gastro intestinal disorder all cause similar symptoms like shortness of breath, dizziness, palpitations etc. There is always an ambiguity among the patients when such symptoms are experienced - if they require immediate medical care or is it just a false alarm. To overcome this, this project aims at building a system of self assessment that is safe, usable and provides actionable advice for abnormal sensations in the chest. The product is aimed to be an over the counter, non-intrusive, inexpensive and easy to use diagnostic device that provides continuous monitoring over a period of 24 hours. The resulting device consists of 2 main units- the sensor (patch) and the display unit. The false negatives should be less than 0.5% and should be regulatory compliant (FDA, IEC, UL). With this project, we aim to provide personalized health advice to the user by providing long-term monitoring that facilitates the capturing of sporadic events and produce actionable advice in real time.

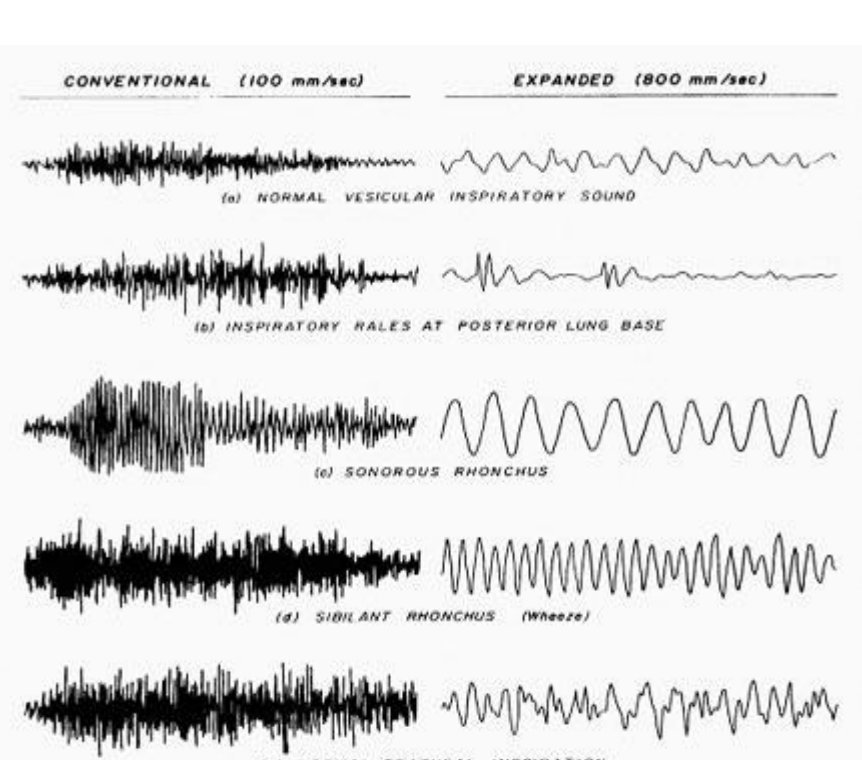
BACKGROUND

Electrocardiogram



Cardiac Electrical Activity
 Heart Rhythm
 Cardiac Physiology
 Direction, Position & Size
 Critical Cardiac Diagnostics
 Arrhythmia
 Muscle Dystrophy/Fibrillation
 Myocardial Infarction

Lung Acoustics

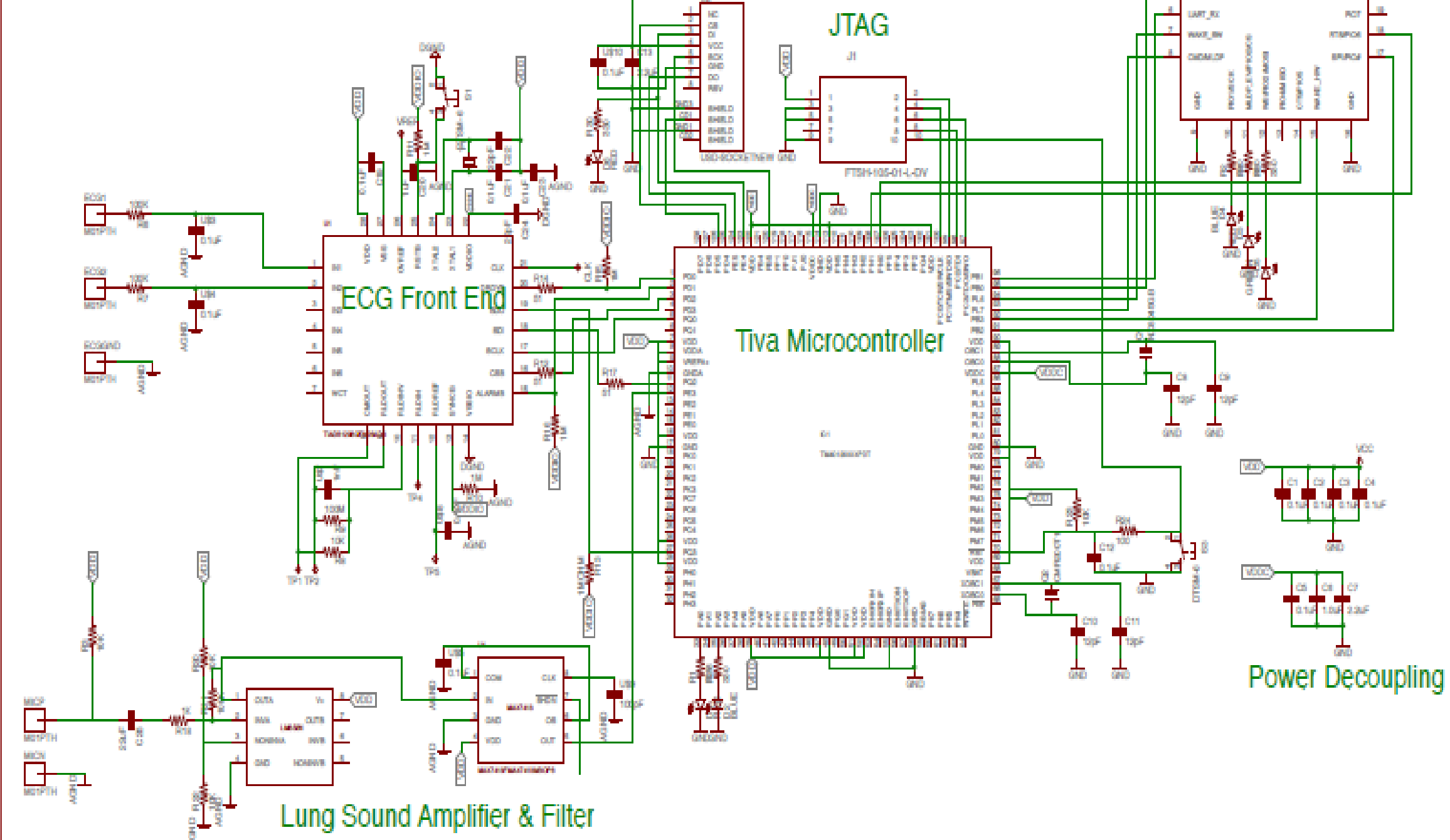


Critical Pulmonary Disorders
 Crackles → Pneumonia
 Wheezes → Pneumonia
 Asthma
 Emphysema
 Rhonchi → Bronchitis
 COPD

HARDWARE DESIGN

Offbeat Wearable ECG/Acoustic Processor

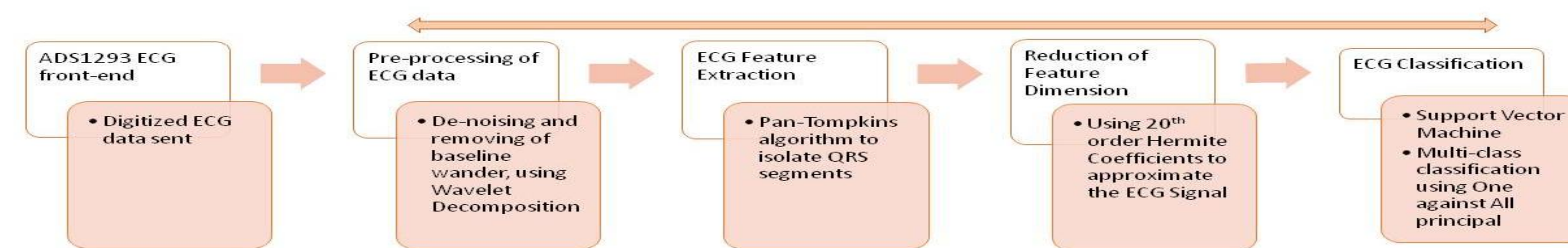
Revised 01/28/2015
 Designed by I'm Feeling Odd Team



IMPLEMENTATION

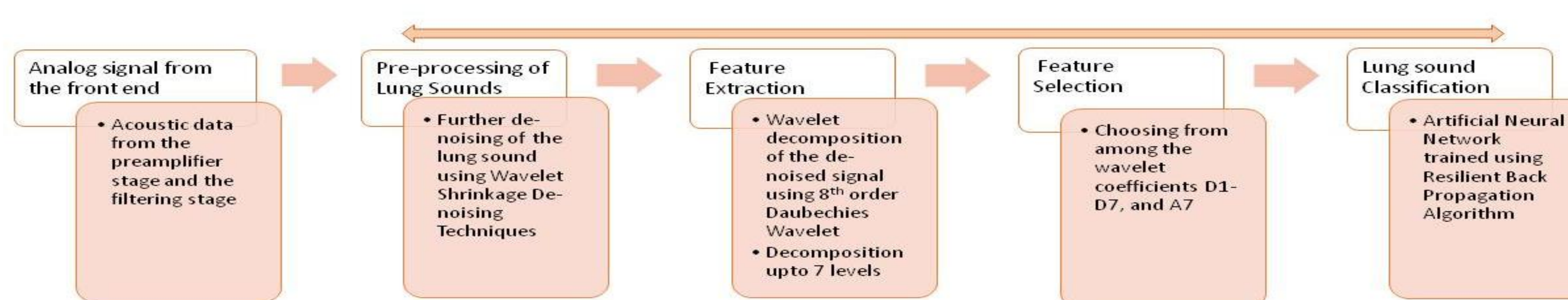
ECG Algorithm

TM4C1294NCPDT

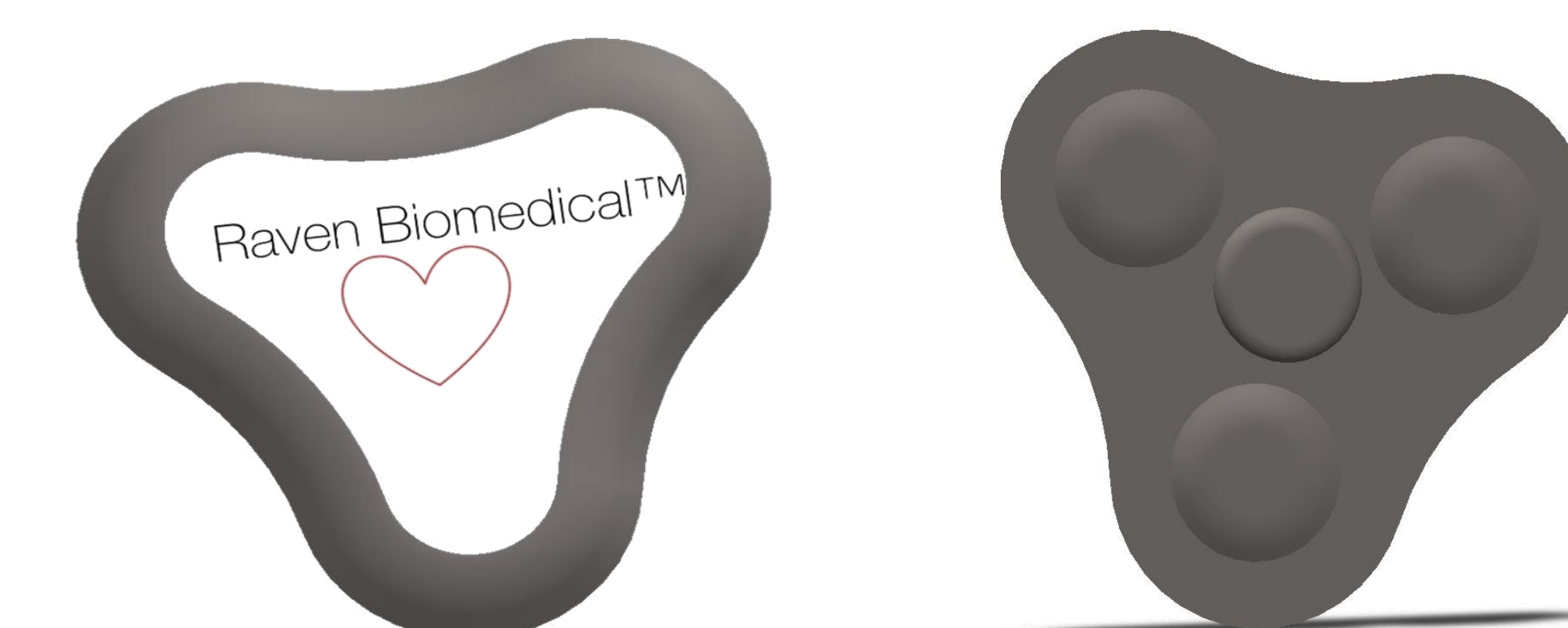


Lung Sound Algorithm

TM4C1294NCPDT

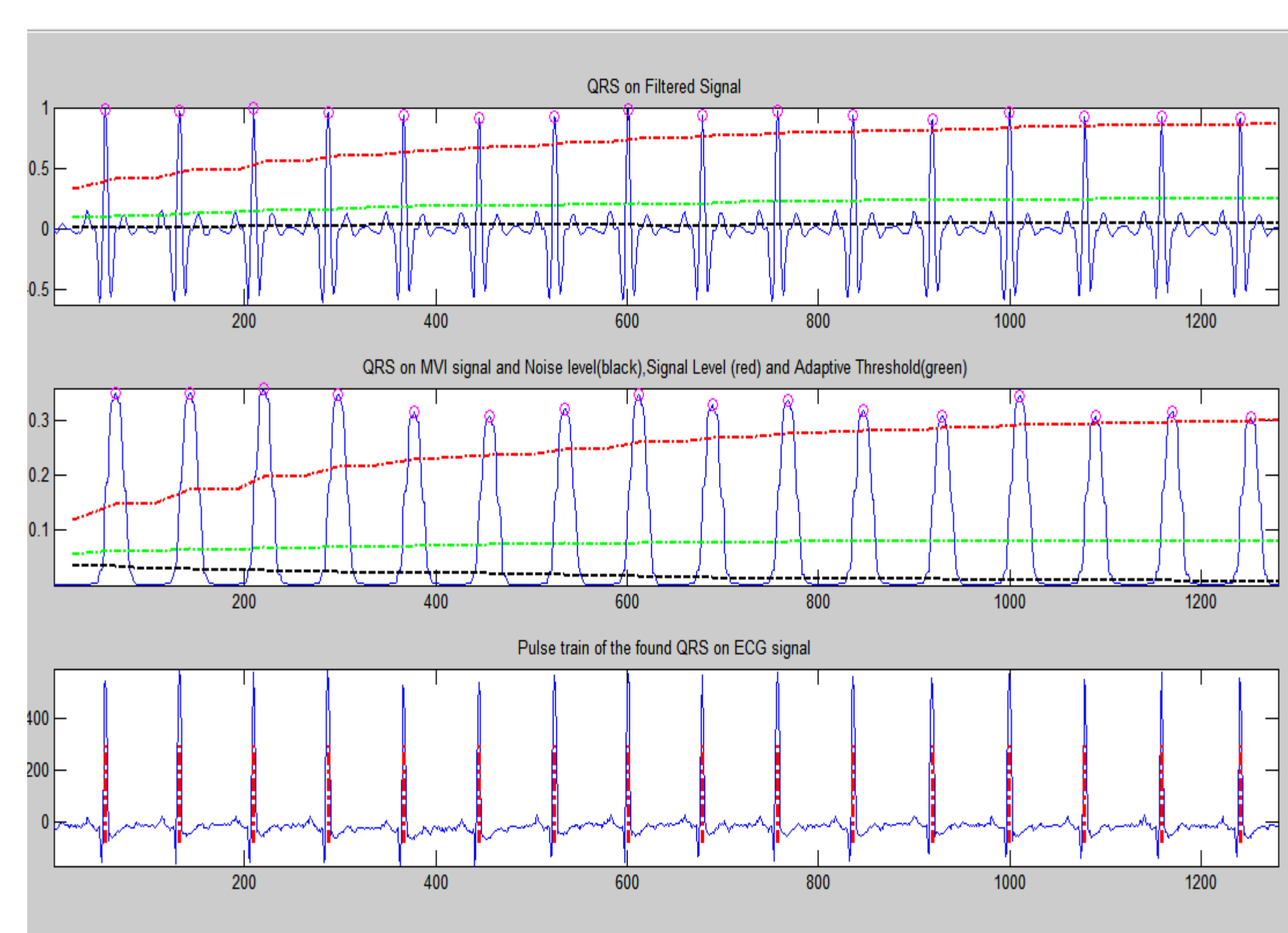


EXPECTED DEVICE



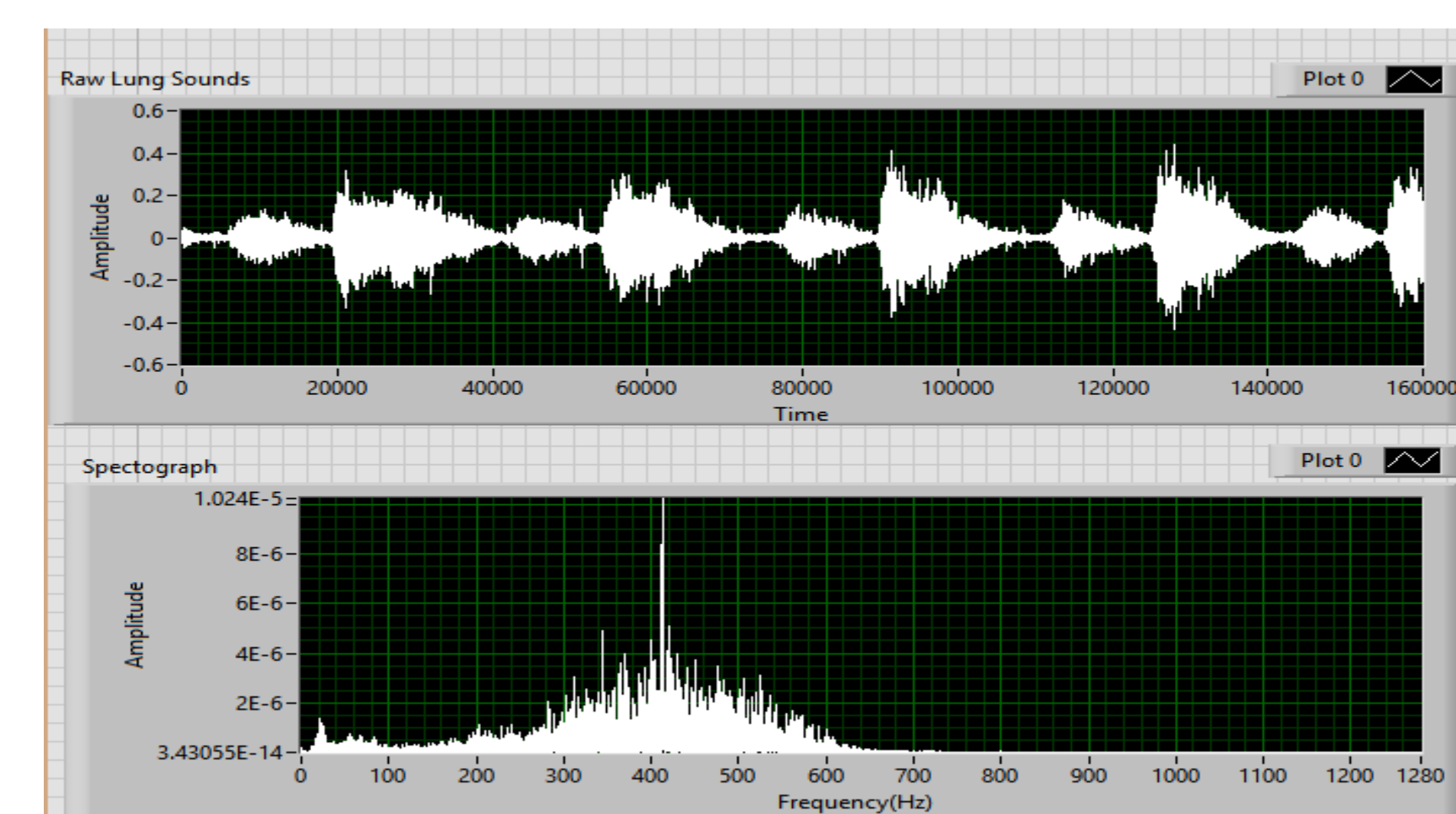
The hardware will be enclosed in a wearable unit made of a biocompatible polymer, designed keeping user satisfaction and comfort in mind. It will be approximately 6 sq inches in area and weigh less than 100 g. The module also contains BLE transmitter that transmits event specific information to the user via interface with the smart device e.g. smart phone, tablets.

RESULTS

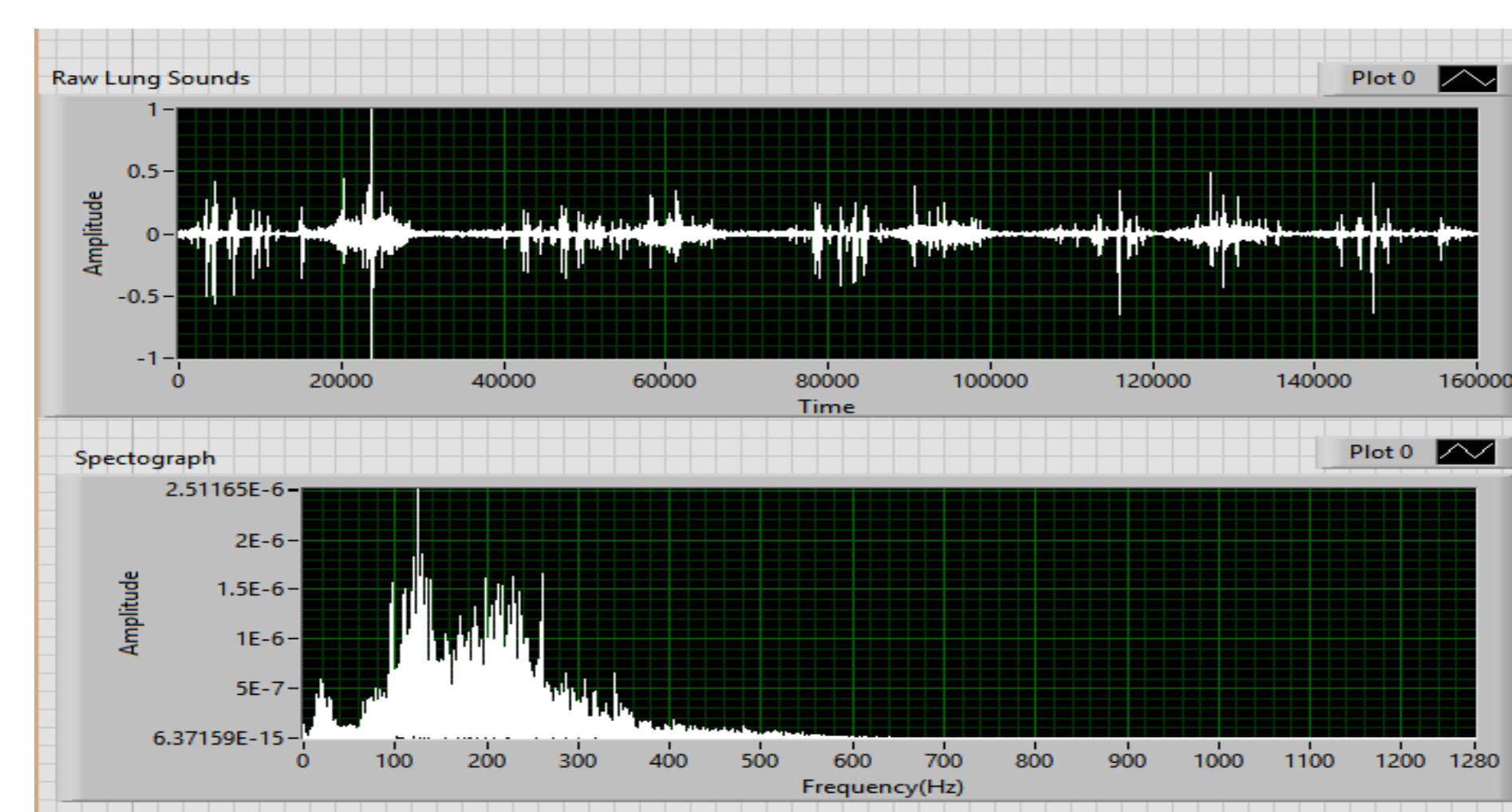


The Graph shows the detection of R Peaks using Pan-Tomkins algorithm. The QRS complex is extracted by segmenting the waveform at +/- 100 ms from the R Peaks. The Hermite coefficients are calculated to extract principle components. This data is then fed into the training algorithm of the SVM.

RESULTS



The Power Spectrum shows that normal lung sounds have a dominant frequency range of 300 to 500 Hz.



As expected, abnormal conditions have distinct differences in their power spectra for example above, crackles have dominant frequency range of 100 to 150 Hz.

SUMMARY

Our solution proposes a novel wearable device that can identify a cause of a peculiar sensation in the users chest and propose the best course of action to handle this. The device aims to achieve a high sensitivity of 98% and specificity of 100% and very low reaction time to identify sporadic events. Through this we aim to reduce spending from both the perspectives of the individuals and the healthcare individuals by differentiating between minor inconveniences and actual conditions that require medical attention. Hence we can also reduce time and human resources spent on the management of mild discomforts and reduce the chain of care.

APPENDIX

FDA Approval – Depends on the Intended use, Investigation Device Exemption, Class iii Consumer model

Liability Issues – Physician Prescription Model, Ensure Accuracy and Effectiveness through Clinical trails.

References

1. Indiana University – School of Medicine
2. "electrocardiogram." *Dorland's Medical Dictionary for Health Consumers*. 2007. Saunders, an imprint of Elsevier, Inc 29 Apr. 2015
3. Visual lung-sound characterization by time-expanded wave-form analysis", R. Murphy, S. Holford, and W. Knowler, *New England Journal of Medicine*, 296:968-971, April 28, 1977