An ECG Enabled Smartphone Stethoscope

ELECTRICAL & COMPUTER ENGINEERING

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Problem Statement:

Blood pressure cuffs are inaccurate and uncomfortable. By measuring ECG and heart sound wave simultaneously, blood pressure readings may be synthesized.

We implemented an ECG monitor to work with StethIO's Digital Stethoscope and applied machine learning to classify normal and abnormal heart sounds using Class Activation Maps

Figure 1: StethIO Digital stethoscope iPhone case

Requirements:

- FDA Compliant (Heart rate monitor)
- Costs of good under $10
- Dimensions of ECG compatible with Digital Stethoscope
- 4 hour continuous battery use
- Transmit ECG data via Bluetooth

Figure 2: Breadboard prototype of ECG Front End

Implementation: Software

Used a ResNet-10 based model to classify the heart-sounds into 23 classes.
Applied class activation maps to localize the features leading to the classification. Dataset comprised of a total of ~2500 heart sounds.

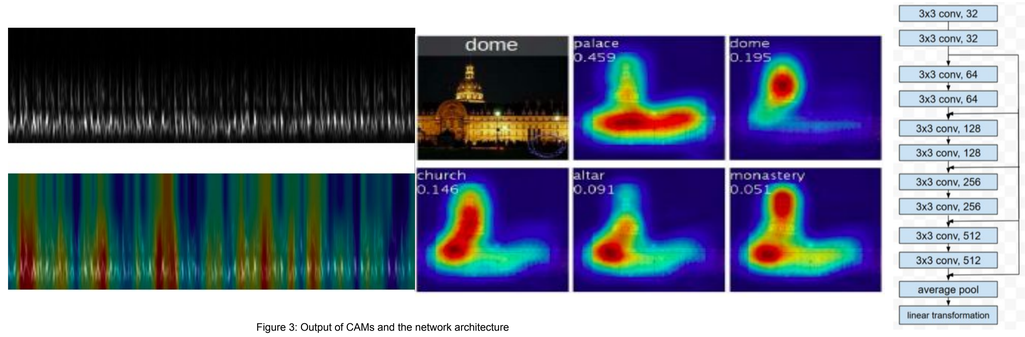

Figure 3: Output of CAMs and the network architecture

Implementation: Hardware

- Analog front end collects ECG data
- Hardware filters clean up signal
- Microcontroller transmits data via Bluetooth

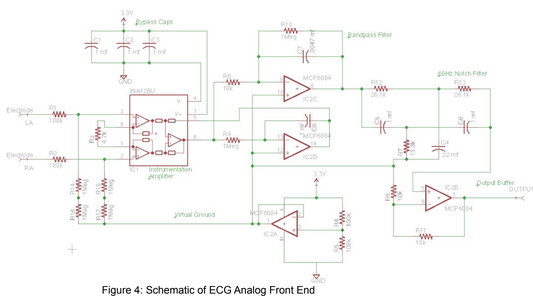

Figure 4: Schematic of ECG Analog Front End

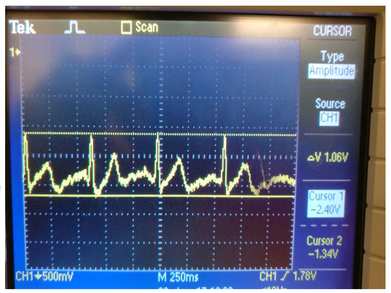

Figure 5: Oscilloscope Output of ECG Front End

Discussion of Future Work:

Future work includes segmenting S1s and S2s in the normal sounds. Trying data augmentation to improve the accuracy of the model. Achieved an accuracy of 87% in the classification. Following are the Loss and Accuracy plots:

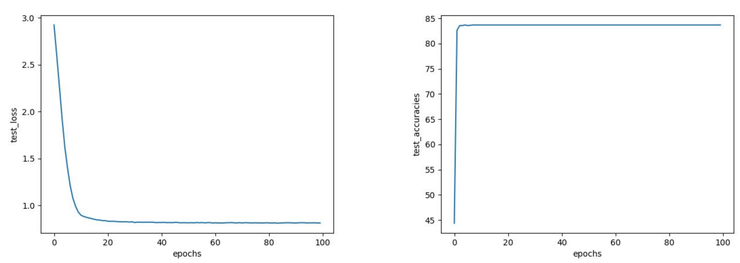

Figure 6: Loss and Accuracy plots

Conclusion:

- Designed and built a system to read and log ECG/EKG data
- Data is transmitted by a microcontroller to PC via Bluetooth
- Used ResNet-10 and class activation mapping to classify heart sounds into normal and abnormal. Ran for 90 iterations for the network to converge.

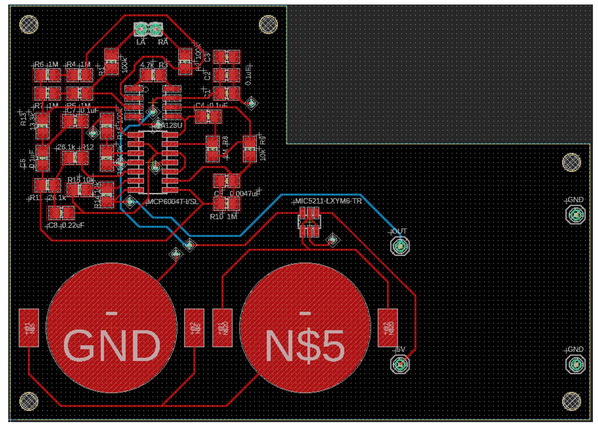

Figure 7: PCB Schematic for ECG Front End

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References:

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