ECG Shirt

ECE 445 Team 14

Ruthvik RK
Pooja Bhagchandani
Pakhi Gupta

(Sponsored by Dr. Hanna Erikson)
TA : Josephine Melia

PROBLEM

- Cardiovascular disease : leading cause of death in the world
- ~17.9 million people around the world die from heart attacks each year
- 659,000 people die in United States due to heart attack (1 in every 4 deaths)
- Around 2/3rd of heart patients show symptoms and require ECG monitoring.
- ECG (Electrocardiogram) diagnosis can take 4+ hrs

THE ECG SHIRT

- 3 Lead portable ECG that is embedded into a T-shirt An
- ECG/EKG: electrocardiogram
  records the electrical signal from one's heart
- Data transfer to mobile device through a bluetooth interface
- ML model analysis of ECG signals
- Frontend application
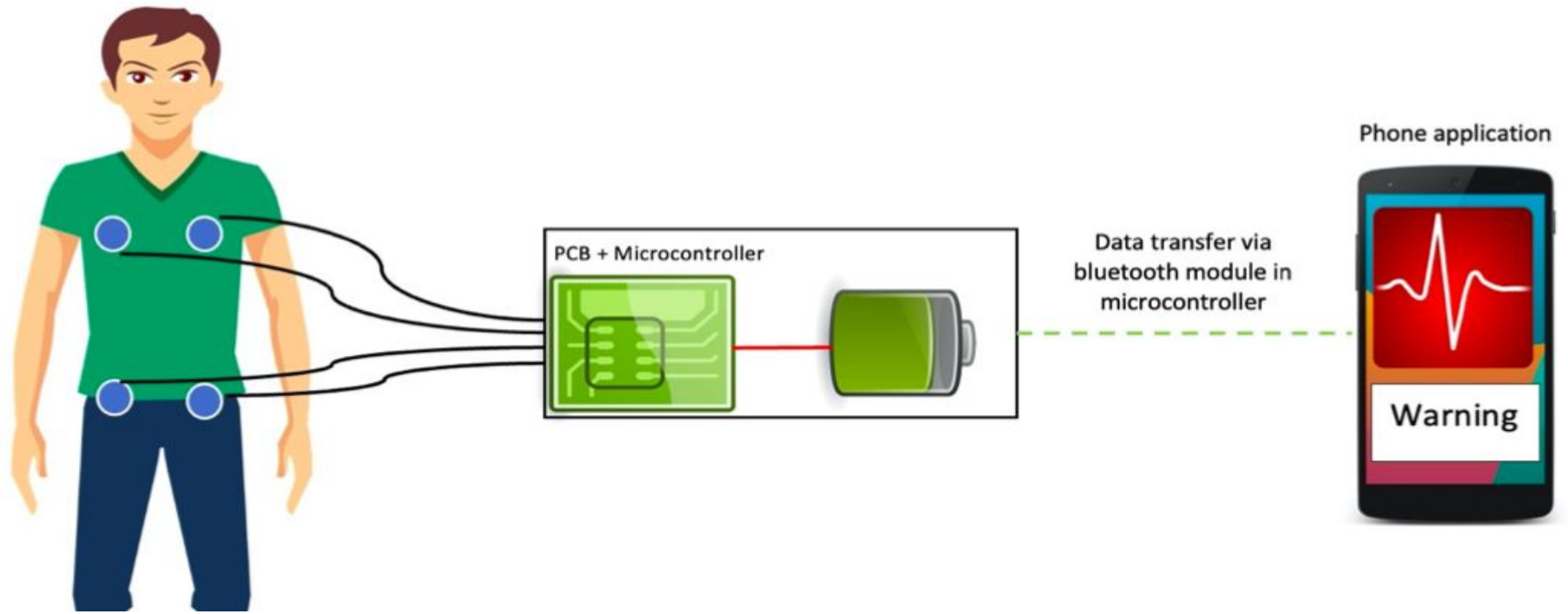
High level design of the project
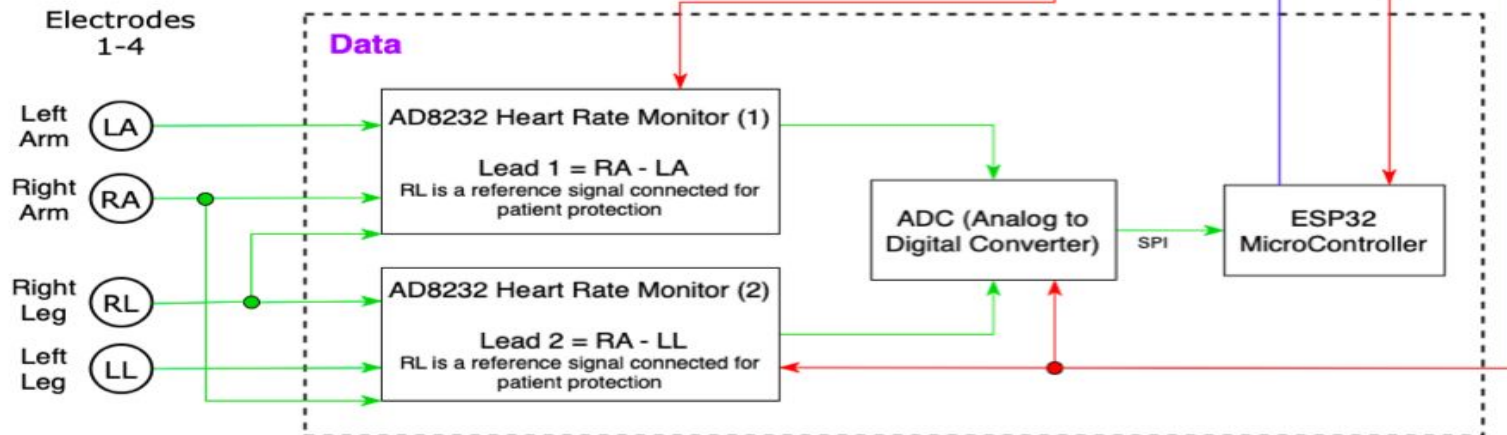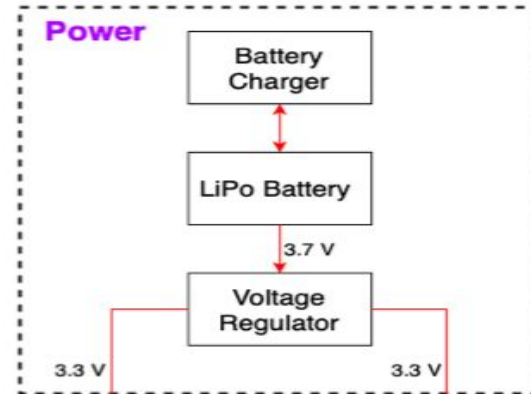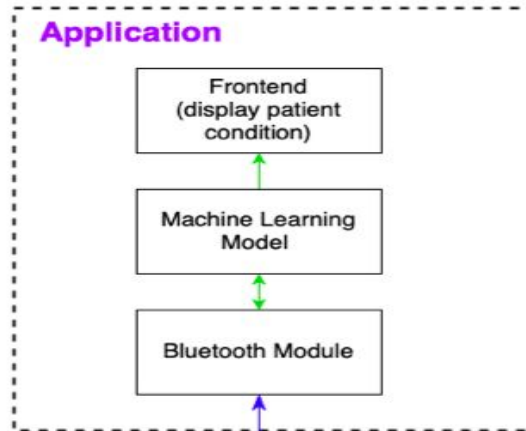
Power
Provides 3.3V±50mV from a 3.7-4.5V±50mV source.

Data
The input signals are filtered with the cutoff frequency of 0.5 Hz and 40 Hz.
Microcontroller can transmit data through Bluetooth at a speed of at least 100 Mbps.

Application
Machine learning model analysis time is within 180 seconds.
Data is received by the phone's Bluetooth module via the microcontroller's Bluetooth module at a rate of at least 100 Hz.

Video Demonstration of Project

ML Model Analysis

|										
312	3516.0	65.0	1	160.0	67.0	4.0	1.0	AT-6 C 5.5	1986-09-13 14:47:09	sinus rhythm. normal ecg.
325	636.0	72.0	0	170.0	71.0	3.0	1.0	AT-6 C 5.5	1986-09-14 18:37:16	sinus rhythm. left ventricular hypertrophy. st segments are depressed in v5,6. q waves in ii, iii, avf. t waves are low or flat in limb leads and v5,6. consistent with ischaemic heart disease with old inferior myocardial infarction.

Two patient records, one of a healthy person and one of a person experiencing a myocardial infarction
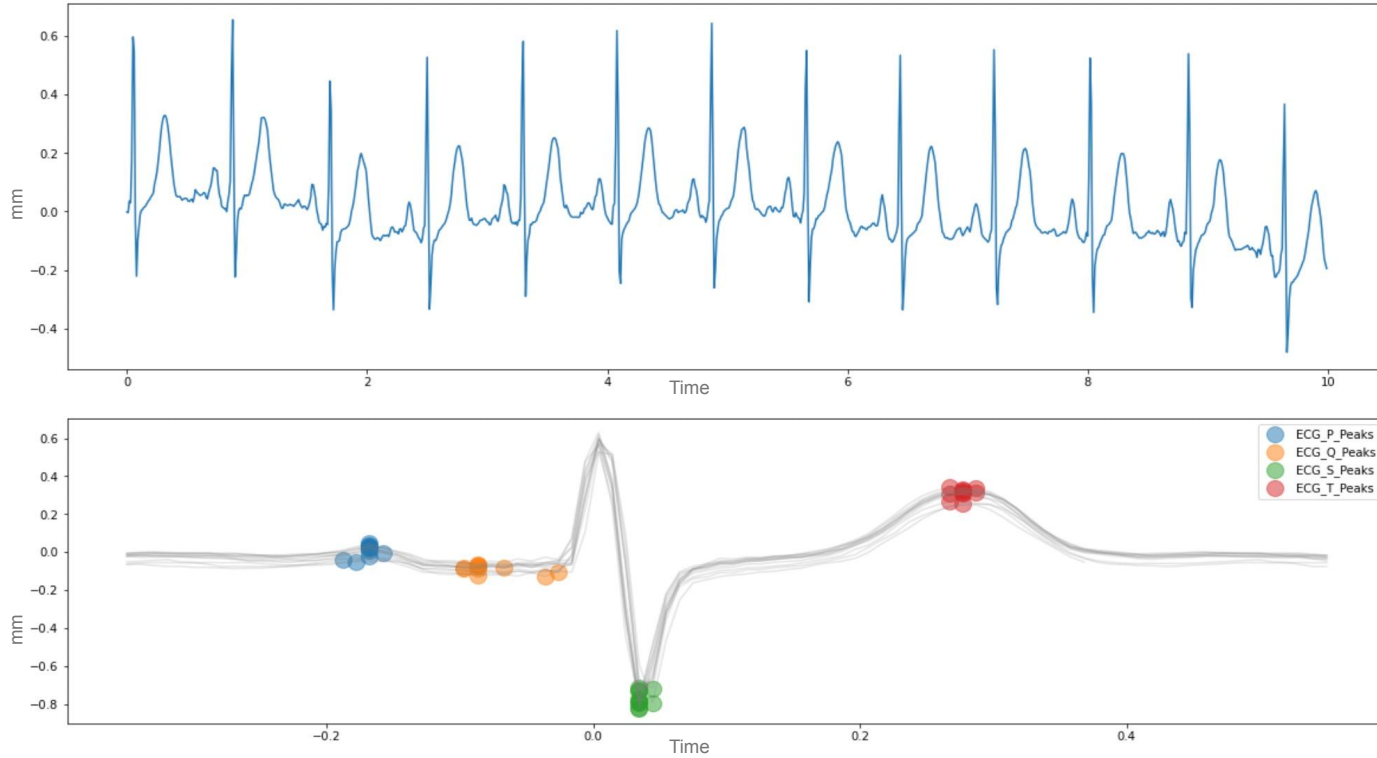
ECG Signal and PQRST points on the signal of a healthy person

```
PR wave evaluation:   0.17 True
QRS wave evaluation:   0.09 True
QT wave evaluation:   0.39 True
P wave evaluation:   0.07 True
PQRST feedback: Healthy
ST Elevation evaluation:   -0.613499999999999
ST feedback: elevation/depression NOT present
Patient Evaluation: Healthy
```

Final analysis of a healthy person after PQRST wave checks and ST elevation check
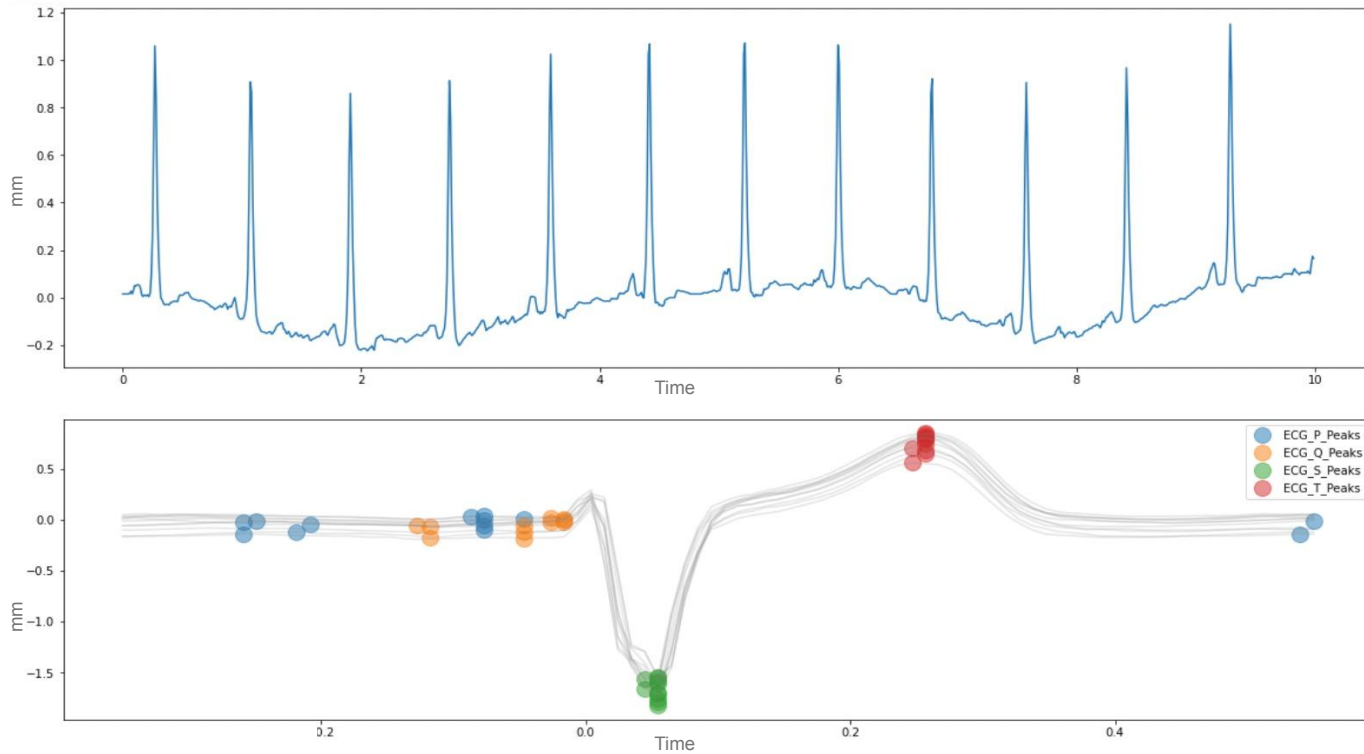
ECG Signal and PQRST points on the signal of a person at risk of a myocardial infarction

```
PR wave evaluation:  0.16 True
QRS wave evaluation:  0.06 False
QT wave evaluation:  0.36 True
P wave evaluation:  0.05 True
PQRST feedback: Needs further assesment
ST Elevation evaluation:  2.151090909090909
ST feedback: elevation/depression present
Patient Evaluation: WARNING!
```

Final analysis of a person at risk of a myocardial infarction after PQRST wave checks and ST elevation check

CHALLENGES

- ❏ Part selection: microcontroller
- ❏ PCB design
- ❏ Clear ECG signals
  - ❏ Heart rate monitor with band pass filtering
  - ❏ ML model
- ❏ Training ML Model on dataset
- ❏ Integration into t-shirt

FAILED VERIFICATIONS

❑ Frontend and backend full integration
❑ Intaking user's signals into the ML model

SUCCESSES

- ➢ Portability
- ➢ 3 lead ECG with minimal noise
- ➢ Bluetooth transmission
- ➢ Trained and accurate ML model
- ➢ Frontend mobile application
- ➢ Cost effective

LEARNINGS

- ➤ Team work
- ➤ Adaptability
- ➤ Presenting evidence
- ➤ Time management

FUTURE WORK

➤ Expanding to 12 leads
➤ Increasing user comfort
➤ Waterproof shirt
➤ Increase compatibility
  ○ Athletes
➤ Further entrepreneurial opportunities

THANK YOU!

Conclusion

Our 3 lead ECG can:

- Measure the user's heartbeat and transmit it via bluetooth
- Perform various analysis on the heartbeat through the ML model to detect a myocardial infarction
- Display the result on an application interface

The next iteration could be improved by:

- Decreasing noise
- Increasing number of ECG leads
- Making shirt comfortable
- Making the system waterproof
- Make compatible for usage by athletes by offering other functions through ML model.

Conclusion (2)

Major takeaways from ECE 445:

- Being a **team player** in a class where every team member brings something unique to our skillset from their past experiences.
- Being able to **adapt** and rise to engineering challenges. None of our teammates ever used PCBs and some of the digital components used here but that did not stop us from figuring it out.
- **Presenting evidence**: Given the Advanced Composition style class that ECE 445 is, we have gained experience in formal documentation and presenting evidence to make a case and write a scientific paper in an acceptable format.
- **Time Management**: With the number of weeks ticking down, what seemed to be a easily doable project, tested us.

PCB Design