ECG
(Electrocardiogram)

Initial Project Document
(Divide and Conquer)

University of Central Florida
College of Engineering and Computer Science

Senior Design 1 EEL 4914
Dr. Samuel Richie and Dr. Lei Wei

Group 12

Mark Nguyen	***Computer Engineering***	*markngn@knights.ucf.edu*
Ivan Duarte	***Electrical Engineering***	*jduarte20@knights.ucf.edu*
Zack Briones	***Electrical Engineering***	*zackbriones@knights.ucf.edu*
Krystian Plaskota	***Electrical Engineering***	*kplaskota@knights.ucf.edu*

Objective:

To provide an easy to carry reliable EKG that would have the capability of displaying a refined analysis of heartbeat pulses as well as detecting irregular rhythms or abnormalities in heart behavior.

Project Description:

An ECG/EKG is the medical instrument that can measure the heart activity and convert it into an analog signal which can be recorded on paper or digitized on an LCD screen. ECG and EKG are synonymous and used interchangeably, it is short for “electrocardiogram” or “electrokardiogram” which was the original term used by its inventor, Willem Einthoven. An ECG machine can be used to detect abnormal rhythms caused by damage to the conductive tissue or electrolyte imbalances or it can identify damaged heart muscle in specific areas. ECGs work by detecting and amplifying the tiny voltage changes on the skin that are caused when the electrical signal in the heart muscle is charged and spread during each heartbeat. The signal recorded as the difference between two potentials on the body surface is called an “ECG lead”. Each lead is said to look at the heart from a different angle. Typically ECGs have 3 leads but some can have upwards of 12 leads. Once the signal is amplified and filtered, it gets passed into an ADC so it can be sampled and displayed on an LCD screen using a microprocessor.

Making an ECG is an appropriate idea for senior design because it utilizes a lot of the knowledge learned from previous classes. Filtering out noise, amplifying a heart signal in the low millivolt range, and creating a portable power supply that is rechargeable with a battery management system would be a challenging problem that requires our knowledge gained from electronics 2 and analog filter design. Being able to sample an analog signal and make it a digital waveform will require our knowledge from digital signal processing and embedded systems and computer science 2.

Our ECG is going to be small, low cost, and portable. We will construct a single lead ECG system primarily used for basic heart monitoring, various arrhythmia checking, and pulse measuring. Given the tight time constraints, experience of our group, and how mature the market is for ECGs, our device is purely for educational purposes and should not be mistaken for a credible medical device for diagnosing actual heart problems. The reason we are making a single lead ECG and not three lead is because one lead is sufficient enough to detect basic heart arrhythmias. One-lead ECGs can also be used to accomplish 3-lead recordings if measured sequentially. We plan on implementing a few safety features such as lead-off detection for electrodes and ESD protection.

Project Requirements:

1. Display output will be ported to mobile devices. Supported mobile devices include both iOS and android OS which are the two major mobile devices OS. Requirements for the device would be considered upon the approach taken. An ARM X\Fusion\Bionic A5 - A13 processor based architecture for iphone approach or a Qualcomm snapdragon microarchitecture from ARM processors for Android approach.

2. Power Source
a. First Power source would be AC- from wall 120V 3A max.
b. Second Power source would be DC - rechargeable battery 12 / 24V 7 AH (lithium Ion or Lead acid battery).

3. MCU (Microcontroller)
a. MSP430 ultra low power MCU would handle logic information for Input / Output basic commands. Commands would be for: additional sensors, usage detection, temperature control, etc.

4. Power Supply board
a. This board would transform voltages, regulate voltages and provide clean power to prevent voltage spikes that would damage adjacent modules.

5. Software
a. Android application to show output results using C, C++, C#...
b. Matlab would be the primarily software which would intake the data for visualization into a mobile device.
c.Tensorflow deep learning and machine learning would be the detector for irregular responses acquired during the data intake of the heartbeat.

6. Sensors
a. Defibrillator Electrodes; For Use With Lifepak
b.Temperature Amphenol Advanced Sensors RL0503-5820-97-MS

ARM Processor Typical Architecture

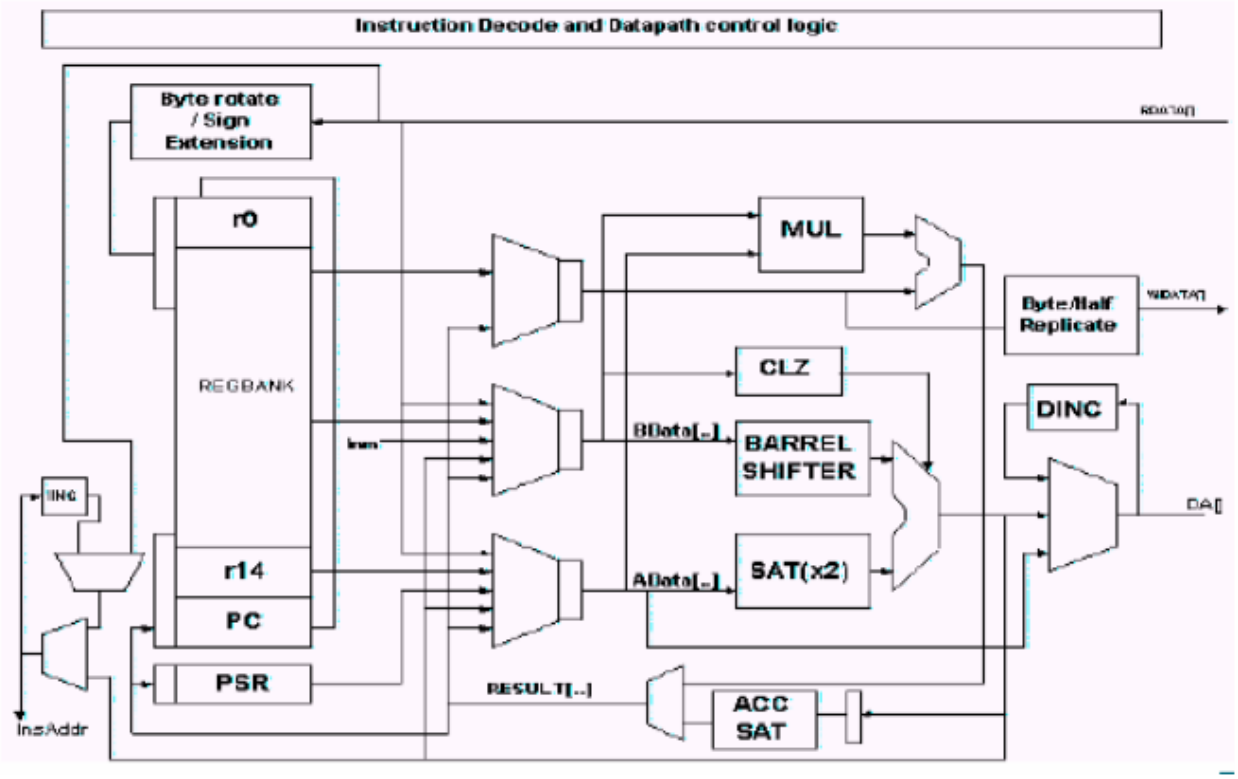

Fig 1

House of Quality:

Table 1 shows the basic requirements that help our team to determine which trait of the design will benefit the outcome and which trait will hold it back.

	Ease if use	Accuracy	Performance	Goal
Cost	↑↑	↑↑	↑↑	≦ $666
Size	↑↑	N/A	↑	< 12 x12 x 6 (inc)
Quality	↑↑	↑↑	↑↑	≧ 90%
Efficiency	↓	↑↑	↑↑	≧ 80%

Table 1

↑↑ : Strong positive correlation ↑ : Positive correlation. ↓ : Negative correlation

Parts List:

Part Name:	Cost
DC 12V 8000mAh Super Rechargeable Portable Lithium - ion Battery Pack	$ 35.99
Bluetooth Module	$ 30.00
MSP430G2553-Q1 MSP430	$ 11.00
DIN Style Compatible Disposable ECG Leadwire	$ 65.00
50 mA Switched Capacitor Voltage Boost with Regulated Output	$ 10.00
Passive elements	$ 20.00
Active elements	$ 20.00
Miscellaneous chips	$ 30.00
Header pins	$ 15.00
Wires / ribbon cables AWG 200 > up	$ 15.00
PCB	$ 20.00
Tensor Flow / Software	$ 100.00
BJT / FET's	$ 15.00
User mobile device	$ 0
Push Buttons / switches/LED lights	$ 15.00
Additional items	$ 99.00
Total Cost	$ 500.00

Table 2

Budget and Financing:

Estimated cost for this project is roughly $600.00; We plan on self financing this project.

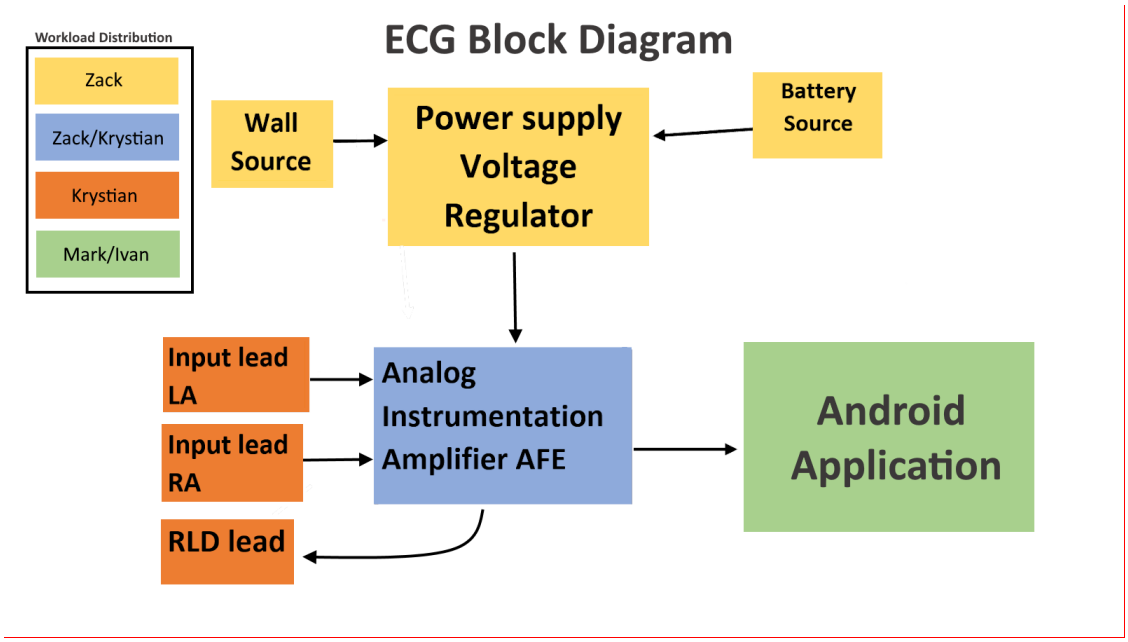

Fig 2

Above in Fig 2 is a basic block diagram of our project. It shows our 1 lead ECG: LA, RA, and RLD. The heart signal is determined from RA and LA and the signal is passed into an instrumentation amplifier with a very high common mode rejection ratio. RLD is used for canceling out noise. The signal is then passed into an ADC and processed by the microcontroller. The signal will then be transmitted to an Android application showing the heart pulse as well as other measurements from the individual connected to the ECG. Each input will have protection circuitry to protect the individual who is connected to the ECG from fault currents.

Estimated Milestones:

Number	Milestones	Completion Date	Status	Responsible
Senior Design 1				
1	**Project selection**	**1/10/20**	**Done**	**Everyone**
2	**Divide & Conquer V1**	**1/31/20**	**Done**	**Everyone**
3	**Research requirements and update DV document**	**2/7/20**	**Done**	**Everyone**
4	**Divide & Conquer V2**	**2/14/20**	**Done**	**Everyone**
5	**Begin writing draft paper and researching assigned roles**	**2/24/20**	**In progress**	**Everyone**
6	**Submit 60 page draft**	**3/20/20**	**In progress**	**Everyone**
7	**Work on 100 page draft**	**3/25/20**	**In progress**	**Everyone**
8	**Breadboard testing project components**	**4/1/20**	**In progress**	**Zach - Krystian**
9	**Begin research app development and screen interface/build**	**4/1/20**	**In progress**	**Mark - Ivan**
10	**Recording & Data abstract**	**4/3/20**	**In Progress**	**Everyone**
11	**Submit 100 page paper**	**4/3/20**	**In Progress**	**Everyone**
12	**Submit Final Senior Design 1 document**	**4/21/20**	**In Progress**	**Everyone**

Table 3