DREXEL UNIVERSITY
Senior Design
Electrical and Computer Engineering

PROGRESS REPORT
Fall 2015-2016

Team Number **ECE-**[redacted]

BATTERY FREE RFID HEART RATE MONITORING SYSTEM

Team Members

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1. Abstract

A baby's heart rate is a crucial parameter in determining whether the baby's health is intact. Our senior design project's objective is to develop a monitoring system that would employ a battery-free passive Radio Frequency Identification (RFID) tag to monitor heart rate using Electrocardiogram (ECG) signals. This system would operate without a battery and would be constructed with easily available off-the-shelf components.

An RFID tag would be used as an on-off keying device, wherein it would normally be transmitting, but would turn off every time a heartbeat is detected. The detected heartbeat would be sent back to the RFID reader connected to a microprocessor to calculate the heart rate. Our team's primary focus would lie on designing a band or onesie that would incorporate two electrodes for recording the ECG signals, configuring a RFID reader that would capture the signals from the RFID tag, designing a microprocessor that would calculate the heart rate using the received data and send it to the cloud, designing a mobile app that would monitor and keep track of the heart rate. Different electrodes such as conductive fibers and dry foam would be tested to determine the best type suited for recording ECG signals. The group would develop a local processing unit to receive data from the RFID reader and upload it to the cloud and also set up a local alarm system as an emergency system for rapid action to be taken. A mobile app would be developed that would receive data from the cloud which would enable the user to access past and current data pertaining to the infant's heart rate.

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2. Problem Description

One of the most common lethal infant conditions is called Sudden Infant Death Syndrome (SIDS) which contributes to around 80% unexpected infant death [1]. Based on the statistic from Centers for Disease Control and Prevention (CDC), about 1500 infants died of SIDS in 2013, which is the leading cause of death in infants that are 1 to 12 months old [2]. SIDS usually occurs during sleep time, between 12 am and 9 am [3], without any struggle or noise [4]. The mysterious cause of SIDS and the challenge of predicting it make it very difficult to be prevented. However, studies show that decreased heart rate is one of the precursors of SIDS accidents. The increasing number of SIDS incidents and the difficulty of predicting them makes the development of a real-time heart rate monitor all the more crucial and imperative to prevent SIDS. Such a system would constantly provide an infant's heart rate information in real-time to the physicians and caregivers.

Besides preventing SIDS, monitoring the infant's heart rate is also helpful in bringing attention to other factors and issues that may affect its health, which would allow the doctors to deal effectively with the issue. As heart rate is the indicator of life activity, heart rate detection is vital in infant monitoring. Once an abnormality occurs in an infant's heart rate caused by disease or other conditions, it should be promptly detected and handled rapidly before it endangers the infant's life.

The objective of this project is to design a wearable, passive and unobtrusive heart rate monitoring system. The existing heart rate monitors in the market require customers to place powered electrodes on the body of the infant. The electrodes are either powered by AC power or by batteries, which need to be replaced or recharged frequently. There are two main disadvantages of such powered active monitoring systems. First, placing powered electrodes on infants is intrusive and may cause discomfort to the fragile infants. Second, replacing or recharging the batteries is not only cumbersome but may also cause monitoring failures once the batteries are not replaced promptly.

In the proposed system, an integrated battery-free PCB with an RFID tag and passive electrodes would be incorporated onto a wearable garment, which would be the only component needed to be placed on the infant. The signals from the RFID tag would be wirelessly captured by the RFID Reader and transmitted to a processing unit that would then output the heart rate information. This heart rate information would then be transmitted wirelessly to the network cloud and downloaded onto the user's mobile phone via an app. Once an abnormality, such as too high or too slow heart rate, is detected, an alarm on the processing unit would get activated and an immediate warning would be sent to the app users. By removing intrusive components from being placed on the infant, such a system can minimize the discomfort caused. In addition, this would ensure continuous long-term monitoring in virtue of the system's battery-free nature.

3. Proposed Work and Deliverables

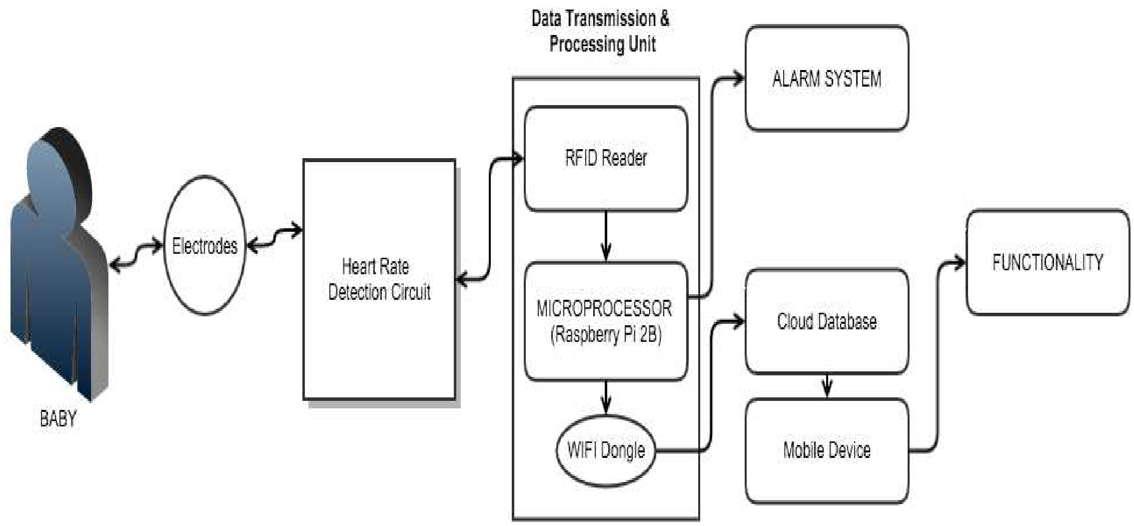
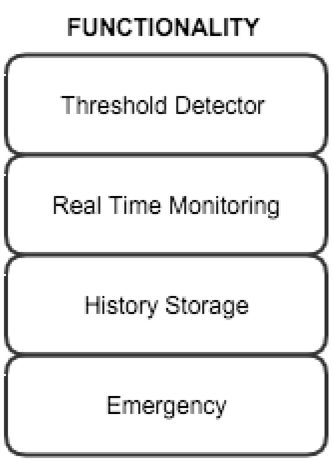


Figure 1: Block Diagram of the Battery Free RFID Heart Monitoring System



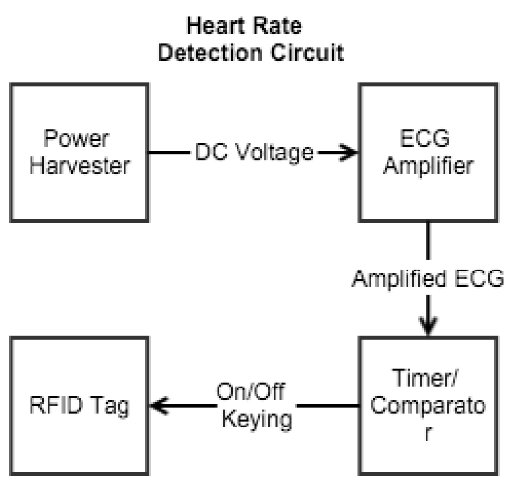


Figure 2: Functionality

Figure 3: Heart Rate Detection Circuit

To tackle the issue of infant deaths happening due to reasons such as sleeping face-down among many others, the team's goal is to design and build a battery-free heart rate monitoring system that the baby may wear on as a onesie or a band, which would constantly present heart-rate data to the parent's/guardian's cell phone via a mobile app. The intention behind making it battery-free was to make the whole gear non-intrusive and to also leverage the capabilities of an RFID reader-tag system. The step-by-step method of executing this solution is presented in the diagram shown in figure 1.

3.1 Electrodes testing and placement

As seen in figure 1, the first aspect of the design is to gather the ECG data from the infant. This would be done using electrodes integrated onto a onesie or a band. The deliverables here are to decide after systematic research and testing whether conductive fabric or dry foam electrodes are the most suitable and how they can be integrated onto a onesie or a band. Designing the onesie or band and research on the placement of the electrodes is another deliverable for the team. The ECG data would then be recorded and decoded by the "Heart Rate Detection Circuit" circuit consisting of the power harvester, ECG amplifier, RFID tag and comparator. These aspects of the design have already been designed and built by the Ph.D. student advising the team. The deliverable for the team here is to rethink and decide on how to integrate this circuit onto the onesie; leave it as a standalone device or fabricate the circuit as a part of the garment or come up with another solution.

3.2 RFID reader and microprocessor

An RFID reader will be used to power the RFID tag to gather the ECG data onto the microprocessor, which in turn would be connected, to an alarm system. The deliverable here is to decide on the RFID reader to be used and the programming of the microprocessor. A Raspberry Pi microprocessor would be used and it would be programmed to alert the people near the infant and the parent having the mobile app about abnormalities in the heart rate of the infant through an alarm system. The microprocessor would also be connected to the cloud where all the data and analysis of the infant's current and past heart rates would be made. Another senior design group has undertaken this task of creating a network cloud where this data would be sent.

3.3 Mobile app

The next deliverable is to design a mobile app on android platform that would receive the processed ECG data from the cloud and present it to the end user (parent/ guardian) in a simple and clear way. As shown in figure 4, the app's functionalities would include a "thumbs up" and a "thumbs down" icon to reflect the connectivity status to the Internet. The "On" sliding feature is to give the parent the option to collect the heart rate data when they want. Thus the parent would be able to retrieve the infant's heart rate data only when the app is connected to the internet (via Wi-Fi/data plan) and when the app is "On." The microprocessor-alarm system would be retrieving the heart rate data 24/7 real-time (as long as the RFID reader is powered on), which would alert the people nearby about any abnormalities. Hence by having the "On" feature, there is no compromise on the true intention behind this project - the safety of the infant. Its inclusion is to allow the parent to access the heart rate data at discretion and if only the history of the heart rate is required then the parent may just click the "History" button and the history would be displayed in a tabular form with the timestamp in column 1 and the corresponding heart rate in column 2. The heart rate of the baby would be graphed in real-time versus time on the x-axis. The "Emergency" button is for the parent to call 911 immediately. The "Latest heart Rate" text box is a feature that would just output the current heart rate of the infant in real-time when the app is “On”.

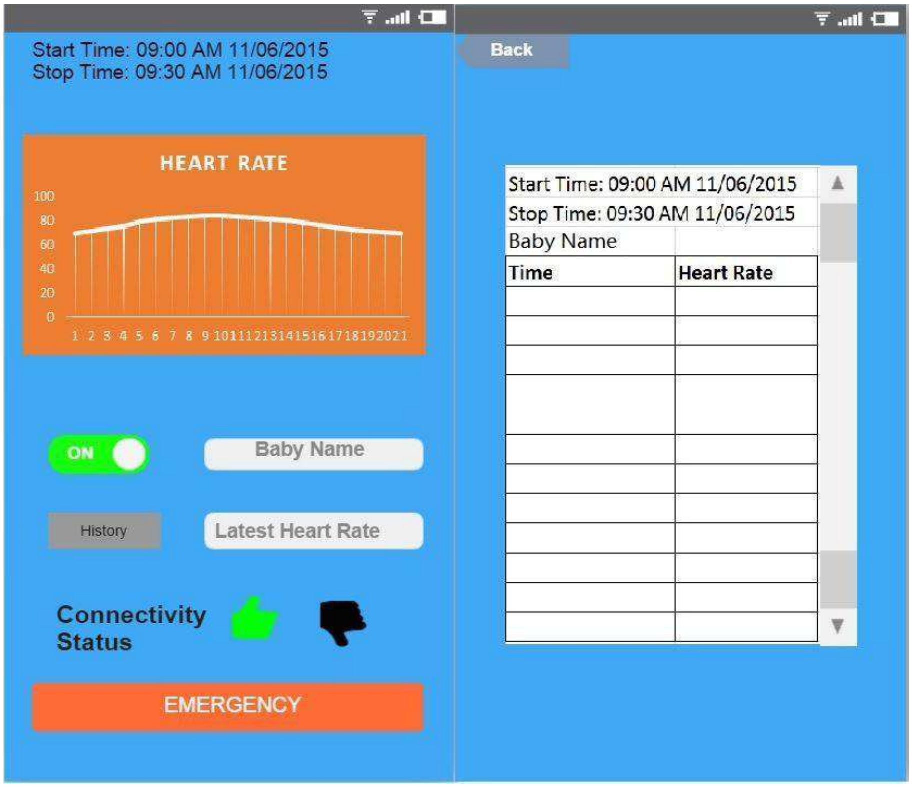


Figure 4: Graphic User Interface (Mobile App Platform)

3.4 Market Survey

Table 1 illustrates a comparison of the different functionalities offered by various infant heart rate monitors in the market. The major feature that differentiates our product with the others in the market is that our device would not need to be charged since it would be RFID powered. Also our deliverable is to present this product (the wearable design and app) in a new and innovative way different from that which is available in the market by the end of spring term.

3.5 Metrics for success

The criterion at the end of nine months that would determine if an acceptable solution to the problem had been obtained would be:

1. The onesie or band containing the electrodes and the heart rate detection circuit is non-intrusive, easy to wear, appealing and safe in all aspects.
2. The onesie can read signals from an ECG signal simulator and the microprocessor is able to identify all abnormalities and trigger the alarm system as and when the ECG signal simulator is varied.

3. The microprocessor is successfully sending the data to the cloud, which in turn is being received by the mobile app. The mobile app is able to show real time heart-rate data of the infant and also stores the history of heart-rate data for up to 2 weeks.

Product Name	Powered Devices on Baby	Charged Required	Real Time	Heart Rate	Respiration	Local Alarm	App Alarm	Position Detection	Cost ($)
ECE-32 System	No	No	Yes	Yes	Possible	Yes	Yes	Yes	700
MIMO	Yes	Yes	No	No	Yes	Yes	Yes	Yes	199
Owlet	Yes	Yes	Yes	Yes	No	No	Yes	No	249
Monbaby	Yes	Yes	Yes	No	Yes	No	Yes	Yes	169
Sproutling	Yes	Yes	Yes	Yes	No	No	Yes	Yes	299
Angelcare	No	No	Yes	No	No	No	No	No	76

Table 1: Decision Matrix for Comparing Baby Heart Rate Monitors

4. Completed Work

4.1 Determination of the state of system

The heart rate monitoring system consists of wearable band/ onesie embedded with an RFID tag and conductive fabric/ dry foam electrodes. The band/ onesie will communicate with an RFID reader, currently Speedway, which continuously transmits data to a microprocessor via serial connection. The microprocessor, Raspberry Pi 2 Model B, will be used to manipulate data, and it is connected to the local alarm system with wired speakers. The microprocessor continuously processes the information received from the reader so that in case of an abnormality it can trigger the alarm system. At the same time, the microprocessor will upload manipulated data to the cloud server via Wi-Fi. A developed android app will download real time data via Wi-Fi and allow the user to visualize the heart rate.

4.2 Hardware

4.2.1 Raspberry Pi 2 Model B

The group has decided to use Raspberry Pi 2 Model B as the local processing unit. Raspberry Pi 2 Model B is the second generation of Raspberry Pi. It has 1GB RAM, which is fast enough to manipulate collected data and upload the result to the cloud server. The group purchased Raspberry Pi 2 Model B Starter Kit from Amazon.

4.2.2 Electrodes

4.2.2.1 Electrodes Decision Matrix

Electrodes	**Motion Artifacts**	**High signal to noise ratio**	**Skin-electrode Impedance**	**Design Application (Biocompatibility for Babies)**	**Long term Use**	**Detectability of ECG waves**
Wet	Stable low motion artifacts	Higher noise compared to Conductive Fabric	Low impedance	Cause skin Irritation from gel	Not suitable	Best
Dry	High to Low motion artifacts	Higher noise compared to Conductive Fabric	High impedance	Cause skin Irritation	Suitable	Good
Conductive Fabric (thread)	Relatively high motion artifacts	Lower noise	High impedance	Does not cause skin irritation	Suitable	Better
Dry Foam	High to Low motion artifacts	Lower noise	High impedance	Does not cause skin irritation	Suitable	Better

Table 2: Decision matrix for Comparison of Electrodes

The team researched different types of electrodes, which were wet, dry, dry foam and conductive fabric electrodes. The electrodes decision matrix (Table 2) includes electrode characteristics such as motion artifacts, signal to noise ratio, skin-electrode impedance, design application (biocompatibility for babies), long-term use and detectability of ECG waves. It was researched that textile electrodes with an area greater than 4 cm would not cause significant distortions to ECG's low.

4.2.1.2 Electrodes Testing Plan

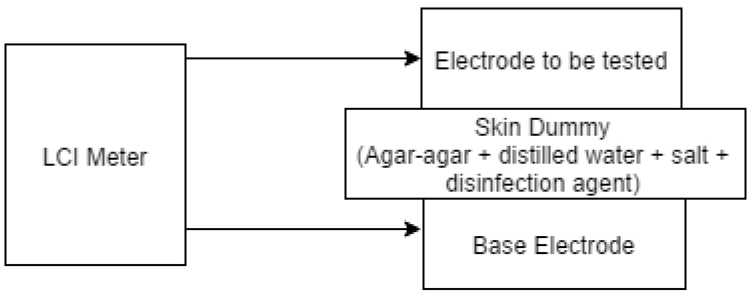


Figure 5. Block Diagram for Electrodes Test

A testing plan was created to test the electrodes. The goal of the testing plan is to determine which electrodes would best fit and meet our design specification for the product. The plan will contain contact impedance test between electrode and skin and a function test with a simulator for noise. The success criterion for testing is to ensure the impedance between tested electrodes and skin is lower than 155 H[7].The materials that we are going to use in testing are textile/dry foam electrodes, a skin dummy, a second electrode covered with gold and high precision LCR meter (Appendix C- figure 6).

The first step is to prepare the skin dummy, which is made of agar in a biology lab. Agar is a gelatinous substance derived from seaweed, distilled water, disinfection agent and salt. To prepare the skin dummy, distilled water is mixed with salt and disinfection agent until conductivity is 29.3 μS cm−1 = 10 kHz conductance of wet skin tissue. Second 7g/100 ml agar-gar is mixed with solution to get good stability and flexibility. To mimic the cylindrical shape of the arm the surface of the agar is curved [7].

The second step is to place the test electrodes on top of the skin dummy and fix them with a plastic stamp. The third step is to place another fixed electrode at the bottom of skin dummy covered with gold. The weight of the applied force on the plastic stamp can be varied to simulate different contact forces. The fourth step is to perform two-point measurement to analyze electrode interface by using high-precision LCR meter.

The fifth step is to vary the force applied between 2.1 N and 23.5. This is done to identify if there is a limit where higher pressures no longer improve the quality of the contact impedance. The final step is to measure the impedance between the two electrodes with a frequency range of 5 kHz and 1 MHz The total impedance Ztotal = Ztest + Zskin + Zgold = Ztest because Z skin and Z test remain constant when the electrodes varied. The impedance against frequency is plotted to determine impedance change across frequency. With this we can identify the electrode, which meets our design specification.

The testing plan for obtaining the signal-to-noise ratio is to use discrete wavelet transform–based denoting procedure with soft wavelet coefficient thresholding [8]. The noise waveform estimates are obtained as the differences between original and de-noised ECGs, Welch's periodogram method using tapered cosine window is used to calculate the power spectrum [8]. The power spectrums are calculated in a frequency range of 0 to 250 Hz. Finally, power spectrums of corresponding activity stage are averaged for the electrodes. 2-sample t test is used determine the statistical significances of observed differences among averages. A second strategy would be the flat line test method where the input signal from the ECG simulator to the electrode would be zero such that any signals detected in the biopac system may be labeled as noise since only noise would be left. A bit more research and analysis is to be made on both these testing strategies before coming to an absolute conclusion.

4.2.3 RFID Reader

The RFID reader is the most expensive component in the heart rate monitoring system. Seven different RFID readers on the market were researched. Three success criteria were used to identify which RFID reader meets our design specification. The decision matrix is shown below in table 3.

Firstly, the RFID reader should detect RFID tag in a reasonable distance by providing enough power output for the antenna. After calculating the diagonal distance of a standard crib, the RFID reader should detect RFID tag in the range of 3 feet. The maximum value of RFID tag detection range is highly dependent on output power of the RFID reader. The larger the power output (dBm), the longer the distance it can detect. Secondly, the RFID reader should also have a reasonable small size that can be easily mounted on the baby’s crib. Last but not the least, the price of the RFID reader also has a big weight in our decision matrix due to our limited budget. The PhD student owns two of the RFID readers listed the table 3 which the team plans to use to help reduce the budget. Moreover, in the future, developing our own RFID reader to would reduce the cost of the heart rate monitoring system, which will increase product’s future market potential.

By comparing the seven different RFID readers showed in the decision matrix (Table 3), IP30, IMPINJ Speedway and U GROK IT meet our product specification than the rest of the RFID readers. These RFID readers have large power outputs and are relatively small in size. In addition, our team does not have to purchase IP30 and Speedway.
Our team initially worked on the IP30 to see if the IP30 RFID reader can successfully connect to the Raspberry PI 2 using Bluetooth. However, after testing, IP30 does not work because Raspbian is not compatible with the IP30 Bluetooth module. The team then turn to IMPINJ Speedway RFID reader, which is another RFID reader in the lab with large enough power output and will be compatible with Linux.

RFID Readers	Power Output	Distance (Feet)	Antenna Required	Output Port	Size (portability)(lb.)	Sensitivity	Cost (US Dollars)
IMPINJ Speedway	32.5 dBm	NA	Yes	Ethernet	1.5	-82dB	1585
TSL 1153	25 dBm	6.5/3.5	No	Bluetooth/USB	0.346	NA	1297
U GROK IT	30 dBm	25	No	Audio Port	0.375	NA	500
Motorola	30 dBm	NA	No	MiniUSB	0.875	NA	1624
Scanfob	Na	1.31	No	Bluetooth	0.066	NA	649
Mini Me	10 - 18 dbm	0.25	No	Micro USB	0.13	-84dB	199
IP 30	30 dBm	0.2-20	No	Bluetooth	0.95	NA	1362

Table 3: Comparison of Various RFID Readers

4.3 Signal Processing

4.3.1 Cloud Database

The main purpose of the cloud database is to receive manipulated heart rate data from microprocessor and provide data for the mobile app.

Our team communicated with another senior design team who are working on the topic “Software Infrastructure for Secure and Scalable Medical Sensor Networks”. After discussion among team members, both teams agreed that the heart rate monitoring system would be a client for their sensor networks. The sensor network will serve as the function of cloud database.

4.3.2 RFID Reader Data Receiving

William Mongan from Computer Science Department provided the team with code, which communicates data from RFID reader to processing unit. The code consists of two parts. The first part is to create a dummy server to store the data. And the second part is to control the RFID reader. These code were written in Python, and were expected to work with Linux, which is the Raspberry PI 2 programming environment. However, the team did not have a chance to test the code on Speedway.

4.3.3 User Interface

The main purpose of the Android mobile app is to provide an easy way for parents to monitor baby’s heart rate. The user interface has one primary screen and one secondary screen. The secondary screen is under the button “History”. The app would have four main functions.

The first function is to check connectivity status and start monitoring process. The green sliding button starts the monitoring process. And two thumb signs on the bottom of the primary GUI. The thumb up element in green means the connectivity status is well; otherwise, the thumb down element in black shows up. Thumb indicators remind parents the connectivity of monitor system. The connectivity status is high dependent on the WIFI stability. If the WIFI environment is not stable, the local alarm system will be the backup. The second function is to set up a passive/active alarm systems for guardian or parents for the child. This alarm system will ring cell phone’s tone to warn system detection’s emergency situation of the baby. At the same time, parents can press “Emergency” button on the cell phone to ring 911 or other professional medical sources for emergency help. The third function is to visualize real time heart rate data. User will see the most recent five heart rates on the real time visualization window. It can provide user a quick review of most recent data. The fourth function is to track the history heart rate data. By clicking the “History” button. The history data will be displayed in a chart, and user can scroll the slide to view all historical data.

5. Work Schedule / Proposed Timeline

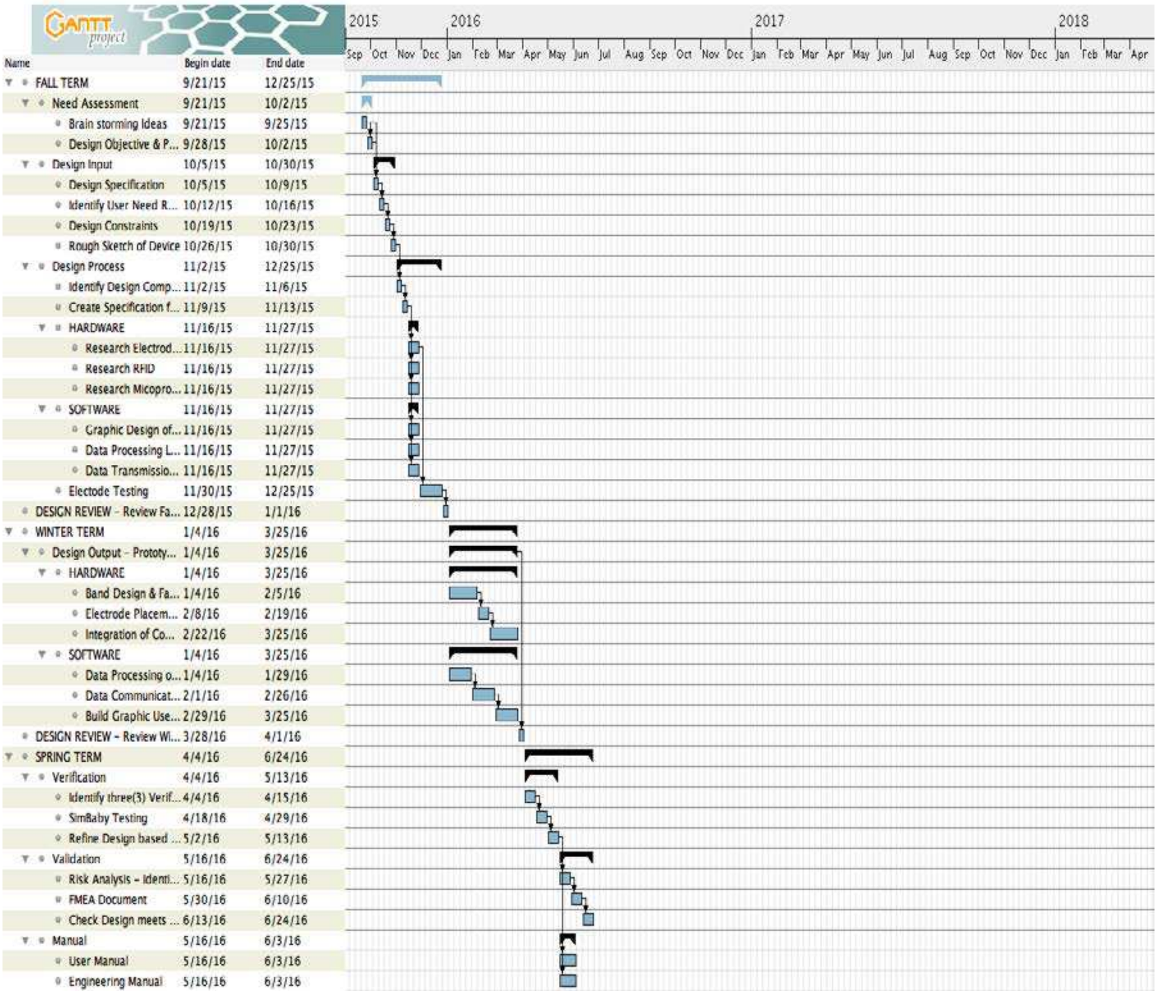


Figure 6: Project timeline / Gantt chart

The following Gantt chart shows the plans for this project. The project will cover 3 quarters, 9 months: Fall Term, Winter Term and Spring Term. During the Fall Term, the group discussed the need assessment, design input and design processes. During the Winter Term the group will perform prototyping of the hardware and software part of the project. The group will perform verification and validation during the Spring Term. There are two major design reviews implemented in this schedule. These design reviews are located at the concluding stages of Fall Term and Winter Term. The purpose of the design reviews is to recap each term and ensure the product is on track.

The team for this project includes 3 electrical engineering students, 1 biomedical engineering student and 1 advising faculty. In addition, a third party company will be needed to support the process for manufacturing the material for the conductive fabric electrodes / dry foam electrodes, and the microprocessors.

6. Industrial Budget

Industrial Budget		
	Cost Item	Total
Engineering Salaries (9 months)	Electrical Engineer (yearly)	$80,000
	Electrical Engineer (yearly)	$80,000
	Electrical Engineer (yearly)	$80,000
	Biomedical Engineer (yearly)	$75,000
	Overhead (25% total salaries)	$78,750
	Health Insurance (5k/year/person)	$20,000
	Total cost (year)	$413,750
	Subtotal (9 months weighting)	**$310,313**
Rent and Company Space	Rental rate per square feet per year	$22
	Office space square feet required	2,200
	Total cost per year	$48,400
	Utilities	$3,000
	Maintenance	$1,000
	Yearly cost (total)	$52,400
	Subtotal (9 months weighting)	**$39,300**
Hardware Test Equipment	ECG simulator	$900
	Laptops (4 units)	$3,800
	RFID Reader	$2,700
	Conductive and Dry foam electrodes (200 units each)	$300
	Textile bands and baby onesies	$600
	LCR meter	$1,400
	Raspberry pi (4 units)	$280
	Total	**$9,980**

Software Licenses	Microsoft Office Professional	$800
	MATLAB	$6,450
	Java app development kit	$100
	Total	**$7,350**
Other Costs	Expert Consultant ($170 100 hours)	$17,000
	Web Hosting	$500
	Prototype Fabrication	$50,000
	Laboratory miscellaneous costs	$1,000
	Total	**$68,500**
Subtotals		$435,443
Risk (10% of subtotal)		$43,544
Total budget for project (9 months)		**$478,987**

Table 4: Industrial Budget

7. Out-of-Pocket Budget

Out Of Pocket Budget		
	Cost Item	**Total**
Tools and Test Equipment	Raspberry Pi	$70
	Dry foam electrodes	$8
	Conductive fabric electrodes	$20
	Textile fabrics and baby onesies	$20
	RFID Reader	$500
	Expendables	$40
	Contingency cost (30%)	$197
	Total cost (year)	**$855**

Table 5: Out-of-Pocket Budget

8. Societal, Environmental or Ethical Impacts

The existing technology for monitoring baby's heart rate as shown in Table 1 are expensive. With this device, we plan to make it affordable so that low-income families can purchase it. Provide a cheaper and more effective heart rate monitor that is accessible to all families irrespective of economic/ social status. With this device the baby's heart rate can easily be shown to the physician of the child. The information is securely stored on a cloud, which can be accessed with permission granted by the parent/ guardian.

We plan to use conductive fabric / dry foam electrodes, which are reusable and long lasting. This eliminates the needs of having to dispose the electrodes after each use making the device environmentally friendly. The device uses a less harmful electromagnetic wave Radio Frequency to power it and collect the data for processing.

Radio Frequency at very high power density is known to cause tissue damage called thermal effects [1]. Federal Communications Commission suggests extremely high power density of Radio Frequency could be damaging to the body based on research studies. With our device the power density (0.0001W/m2) is extremely low therefore it would have no biological effect/ damage to human tissue or be a health hazard. The 1992 ANSI/IEEE exposure standard limit for antennas operating in the 900 MHz range is 0.57 mW/Cm2 [1]

The group has made it a mandate that actual data that is recorded by the device is exactly the same as what is presented to the user. The device would meet to the FDA requirement of medical devices and also engineering standards. The device would not include any design part that was not reported in the design process just to unknowingly to the user increase its efficiency.

With the growing concern of medical data security the group is aiming to protect patient data by marking the reader and tag information so that only right parties (users) have access to the information.

9. Summary/Conclusions

The framework and blueprint of the proposed system was determined. Firstly, intensive research has been done on the alternative materials that can be used on the electrodes. Based on the various materials, electrodes testing plan has also been developed to determine the most suitable materials for our design.

Secondly, research has been done on the RFID reader, which is the most expensive component of the proposed system. Tests have been conducted on the RFID readers on hand. The decision matrix on RFID readers was created for comparison purpose based on the test conducted and online datasheet. The final choice on the RFID reader will be made at the beginning of the winter term.

Thirdly, based on the design specification, Raspberry Pi 2 microprocessor was chosen to be used as the local processing unit. The code for transmitting the data from the RFID reader to the Raspberry pi was successfully developed. The algorithm and code for processing the received data to calculate the heart rate and then transmit it to the cloud server will be developed in the winter term.

Fourthly, the framework of the user interface on the mobile devices was developed and the basic functions, which will be presented on the final app, were determined.

In conclusion, by the end of the fall term, the framework of the proposed system has been determined and researches and/or tests have been done on each component of the system. Testing plan on the materials for electrodes was made. Progress on signal transmitting was made and the completed code for processing and transmitting data will be developed in the winter term. By the end of the winter term, a system with basic function should be developed.

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Appendix A: Design Constraints Summary

Team Number: ECE-[redacted]
Project Title: **BATTERY FREE RFID HEART RATE MONITORING SYSTEM**

Summary of the Design Aspects:

The design of battery free RFID heart rate monitoring system consists of hardware and software components. The hardware would include an RFID reader, Printed Circuit Board (PCB), Conductive Fabric/ dry foam Electrodes, Microprocessor (Raspberry Pi 2B), RFID antenna and Chest band / onesie. The Software would include the algorithms for determining the heart rate, the algorithm for communicating with the network cloud and the mobile form graphic user interface. With all these parts integrated together the device would be used to measure and monitor the heart rate.

Design Constraints:

Economic: The group aims to build a less expensive but efficient heart rate monitoring system compared to market products. Currently, the total cost of the prototype would seem to be expensive because we are using in house (university owned) equipment. Once the prototype is fully functional most of the cost appreciating equipment like the RFID reader and antenna can be replaced less expensive ones thereby marking the price down

Manufacturability: The components for the monitoring system are manufacturable. Some of the products exist on the market like the RFID reader and antenna. The group will obtain conductive fabrics for Third Party Company and be designed by the group to serve as the electrodes. The chest band material would be purchased.

Sustainability: The electrodes and chest band are reusable and resizable respectively therefore would not have to be disposed or replaced after each use. Each component is designed to last for at least a year therefore making the monitoring system a sustainable one.

Environmental: The materials used for the electrodes are reusable therefore would prevent wastage. The Energy form for powering the monitoring system uses a less harmful radio frequency at very low power density.

Ethical, health, and safety: The monitoring system uses a benign electromagnetic spectrum radio frequency at a lower power density which does not have biological damage to human tissue. The group plans to ensure the monitoring system meets to FDA standards and requirement. The group has plans to ensure the monitoring system is designed to do what it is designed for.

Social: It is the group's desire to make the product as affordable and accessible to every family. The system will have a mobile platform, which can easily be downloaded without having to buy an extra monitor to control the device. The system performs local processing which can trigger the alarm in case of an emergency without being connected to the mobile device.

Political: There is probably no political constraint with the project. The project is to follow FDA guidelines for product development. The entire requirement would be followed and tested before the product is released.

Standards and Regulations

[1] L. Beckmann, C. Neuhaus, G. Medrano, N. Jungbecker, M. Walter, T. Gries, and S. Leonhardt, "Characterization of textile electrodes and conductors using standardized measurement setups." Physiol. Meas., vol. 31, no. 2, pp. 233–247, 2010.