REMOTE MONITORING SYSTEM THAT INTEGRATES HEARTBEAT SENSOR WITH RADIO FREQUENCY

By

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CERTIFICATION OF APPROVAL

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May 2012

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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Mohd Ashraf bin Abdul Rahman

ABSTRACT

Nowadays, there are no technology used to prepare and alert the firefighter for heart failure problem while working during fire and rescue. This problem can be encounter by using the heartbeat sensor to detect the heart rate condition. If there is no alert system for this problem, the firemen may collapse due to heart failure and the rescue mission will be delayed. The main objective of this project is develop the heartbeat sensor embedded with the RFID system that capable to monitor the heart rate and at the same time create awareness for the firefighters for any abnormal heartbeat condition. This technology provides many benefits for the firemen and the rescue mission. In this project, the RFID reader will be placed at the fire engine while the RFID tag with the heartbeat sensor will be attached around the chest strap of the firemen. The heartbeat sensor is to be put on the chest and cover it with the firemen uniform. The sensor will be carry by the firemen for the whole rescue mission and the heart rate is monitored from the fire engine. An alarm will trigger for any abnormal heart rate. Methodologies of this project will be discussed and improved as the project progress.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Radio Frequency Identification (RFID) is a technology that is using the radio frequency waves to transmit a signal in wireless system. This kind of technology is a next generation technology that can be used for identification, tracing and tracking, etc. [1]. It uses a tag which is attached to an object required for several purposes. Recently, RFID technology is gaining attention and applications in many fields of industry especially in healthcare industry.

One of the healthcare devices is the heartbeat sensor. It is used only for health and medication purpose to monitor the heart disease patient. Most of the heartbeat sensors are using the Bluetooth signal to send the data. The RFID system can also be applied for the sensor and would give a better performance because the benefits of RFID technology are much better than the existing technology.

It is not only for healthcare industry, the RFID system can also be applied for a safety purpose. For the time being, it has not yet been widely used for safety purpose. It can be applied in order to monitor the heart rate of one person at a time in a greater distance [2]. For example to monitor the firemen heart rates while the emergency situation or location. It will monitor the heartbeat condition whether too fast, too slow or irregular. It also can differ from normal condition to life threatening condition [2]. By applying RFID system for the firemen, it increases the safety precautions for the fire fighters.

1.2 Problem Statements

1.2.1 Problem Identification

Heartbeat sensor is widely use in healthcare industry but not in safety industry. For the firemen, while the emergency situation occurs such as entering a building on fire, the condition of the firemen is unknown and cannot be observe. Their condition should be monitor from the outside of the building for their own safety. One of the most important aspects to be monitored is the heart rate of the firemen. Any abnormal heart rate change indicates medical attention [3]. This is such a big risk for the firemen if any unwanted situation occurs. With the RFID heartbeat sensor, if the heart rate of the firemen is at abnormal condition, the firemen will be informed to leave the building for his own safety. This is where the heartbeat sensor is required.

1.2.2 Significant of Project

The project is to design a system for the safety of the firemen when the process of saving the victim during the emergency or fire happens. This device will help the firefighters to monitor the heart rate of the firemen and automatically reduce the risk for the firemen while working. The device will continuously transmit the signal of the heart rate of the firemen and trigger an alarm if any abnormal heart rates occur. The alarm is a signal to save the firemen. This system will help to eliminate the problem of any collapse firemen in the building of fire.

1.3 Objective

1.3.1 The objective of this project is to study and design a heartbeat sensor embeds with RFID tag.

1.3.2 To develop a continuous heartbeat system for monitoring from fire engine.

1.3.3 To generate alert to rescue team to save the firemen that have heartbeat level drop below predefined limit.

1.4 Relevancy of Project

To achieve the objective and accomplish the project, there are several task and study need to be done. The task is on software and hardware part which to develop the database using Microsoft Visual 2008 and MySQL program, and the other task is on the hardware of the RFID. A research and study on RFID to embedded it with the sensor. Study on the sensor is also required in order to understand how it works and to relate it with RFID technology.

This project will be apply and used by the firefighters in order to reduce the risk and increase the safety precaution for them in the future. In future, this project can be applied to all firefighters rescue mission and give a lot of benefits to them and the percentage of successful rescue can be increased. Many kind industries can start to apply the RFID technology and make some improvement for a better future.

1.5 Feasibility of Project

The project will be done in two semesters which will include two area, research and development of the prototype itself. Part 1 of the project which is the study and research will be done in Semester 1 and for the development; modeling and testing of prototype will take part in Semester 2. The modeling part can be started in part 1 in order to make sure the part 2 project is in smooth planning.

The objective is to develop a sensor embedded the developing technology which is the RFID for the firefighter rescue mission. To achieve the objective, study and research on this field need to be completely understood and recognize especially on RFID technology before begin the project. With the provided time for two semesters, this project is feasible to be done.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this section, an overview regarding RFID and heartbeat sensor will be discussed. The system of RFID is a big topic and can be divided into many sub topics. This future technology will be explained in detail on how it works, the applications, the system's parts, the system's function, the operating frequency to transmit the data and information and the concept applied by this technology. This technology will be integrated with the sensor to develop a long distance monitoring heartbeat sensor. The heartbeat sensor is the personal monitoring device to measure the heart rate. The application of the sensor, how it work and existing product will be discussed generally in this section.

2.2 Bluetooth Technology

Bluetooth is a wireless technology to exchange data over a short distance. It uses a short wavelength or low power **radio wave** to transmit data. This Bluetooth system is well known use for mobile phone to transmit and receive data between two or multiple mobile phones. The Bluetooth system communicates on frequency of 2.45 GHz or within the range of 2.402 – 2.480 GHz. This frequency band has been set as the use of industrial, scientific and medical device. In order to avoid any interference with other system, Bluetooth devices send a very weak signal. The power of the signal is about 1 milliwatt. Due to this low power of signal, the range of transmitting data of Bluetooth devices is about 10 meters radius. The Bluetooth system can be connected up to 8 devices at the same time with all the devices in the range of 10 meters. All the connected devices will not interfere with one another.

One of the advantages of the Bluetooth system is, even though it is a short distance transmitting system, it doesn't require line of sight between communicating devices. In Bluetooth system, there are master and slave device. Frequency-hopping spread spectrum (FHSS) is a technique to transmit radio signals by rapidly changing a waveform among many frequency channels. Master as transmitter and slave as receiver. Bluetooth uses a radio technology which is frequency-hopping spread spectrum. For the master device, it will randomly choose frequencies within designated range, changing from one to another. In the case of Bluetooth, the transmitters change frequencies 1,600 times every second, meaning that more devices can make full use of a limited slice of the radio spectrum.

2.3 Radio Frequency Identification (RFID)

Radio frequency identification (RFID) is a new technology that gives a lot of benefits to its consumer. It has been existed for few decades and only now this technology being accepted because of its low cost and its potential [4]. RFID technology has been improved and it is much better compare to the bar code technology [5]. Nowadays, it has been widely applied in many field and industries. Present forecast show that it will grow fast in 10 years and in 2016 the total value market will grow from €500 million to €7 billion [6].

It is a technology using a wireless system, using the electromagnetic (EM) wave as its medium to transfer the data from the tag to the reader. RFID technology generally consists of the **RFID reader, RFID tag**, and the **host computer**. The RFID tags can support a large set of ID including other added data.

2.3.1 RFID Tag

There are two types of RFID tag which is the active tag and passive tag. These two types of tag have its own different operational. The power source of these two types put them in two different classes. The RFID tag will be attached or embedded in the object that needs to be identified or tracked. It will be identified by the reader by reading the tag's ID and then providing the background database of the object. The reader is able to view the existence of the object [7].

i. Active Tag

The active tag is the tag that requires a source or battery which is the integrated battery [4], [5]. Because of the battery, the active tag is much larger in size and expensive compare to the other type. This type of tag is support by the battery as its power source which will have a stronger signal transmission. The frequency for the active tag operates at 455MHz, 2.45GHz or 5.8GHz. Due to that the distances of data transmit is much greater. The distance range is from 20 to 100 meters. With this capability it works best for the tracking system. The amount of power source is proportional to the data transmission distance [4]. One of the problems the active tag it have a limited life spans.

Figure 1: RFID Active Tag [8]

ii. Passive Tag

The passive tags require no battery for the power source. It is much smaller in size and inexpensive compare to the active tags. One of the best things about passive tag is that it has indefinite operational lifetime. But the range between reader and tag is small. There are three parts for the passive tag: the antenna, semiconductor chip and encapsulation [5]. The semiconductor chip is attached to the antenna. The function of the antenna is to capture the energy and transfer tag's ID. For encapsulation, it is use to protect the antenna and chip, and maintain the tag integrity. In order to produce the smallest size of passive tag, the size of the antenna should be reduced but the current antenna technology limits it [4].

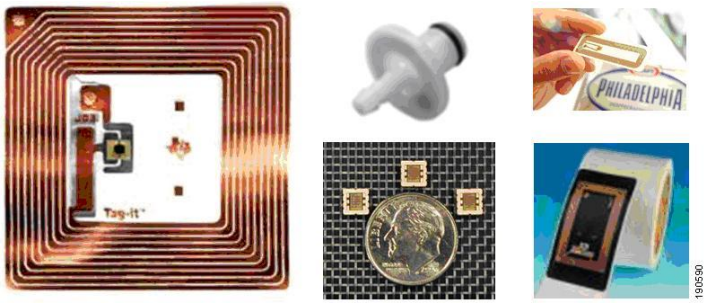


Figure 2: RFID Passive Tag [9]

The concept of the passive tag is simple. It just needs to capture the energy to power up the tag and at the same time the tag will transfer its ID. The energy or power is transmitted by the reader whether in Magnetic Induction or electromagnetic (EM) wave for near field and far field concept. The near field concept use the magnetic induction as its energy and far field use the EM wave. Both type of energy is enough to power up the tag [5].

a) Near Field

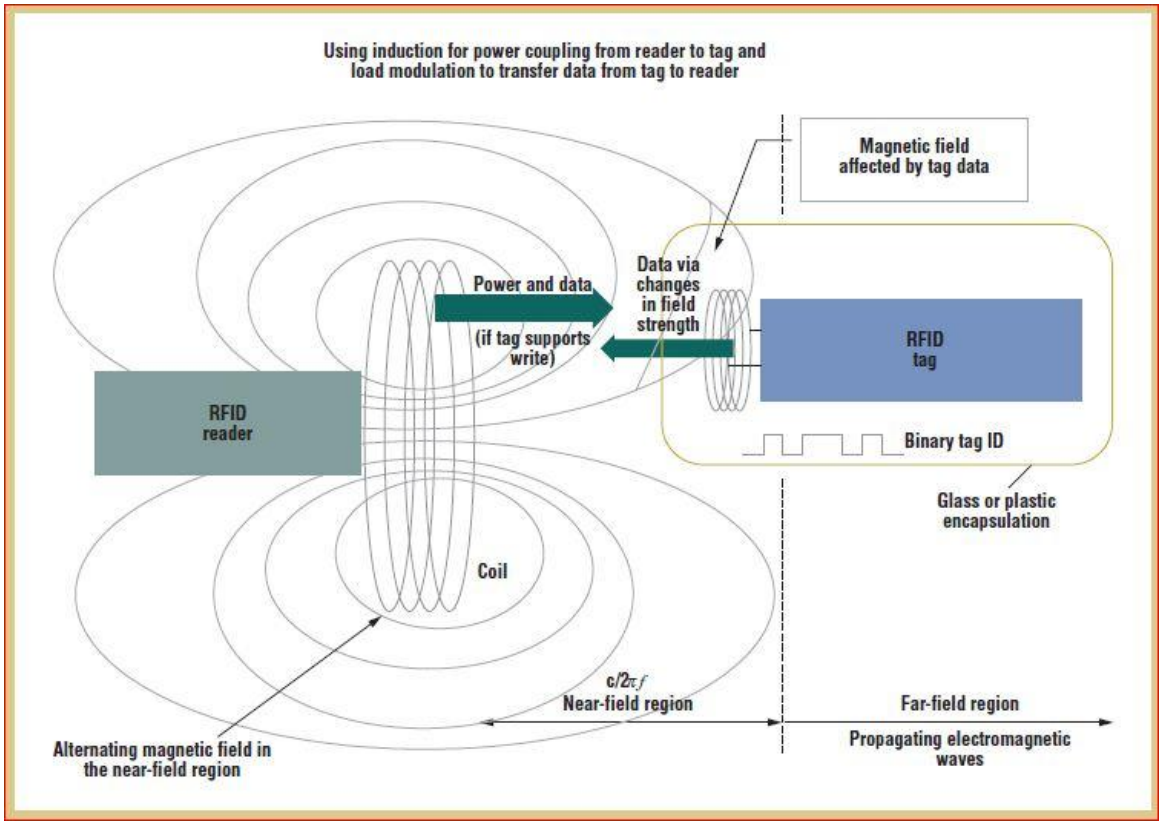


Fig 3: Near Field Power Mechanism [5]

For the near field power mechanism, the reader will pass a large alternating current through the coil at reader part. The flow of alternating current through coil will produce the alternating magnetic field. There is also a small coil at the tag to receive the magnetic field. When the tag gets near to the reader and receives the magnetic field, an alternating voltage will appear at the tag at the same time will power up the tag. After the tag has been power up, the tag will send back the data to the reader using load modulation.

The distance or range for the near field mechanism is approximately $c/2\pi f$. The range for near field region is shown Figure 3. According to the equation c is the speed of light, $3 \times 10^8 ms^{-1}$ and f is the frequency. The smaller the value of frequency, the range will be greater.

b) Far Field

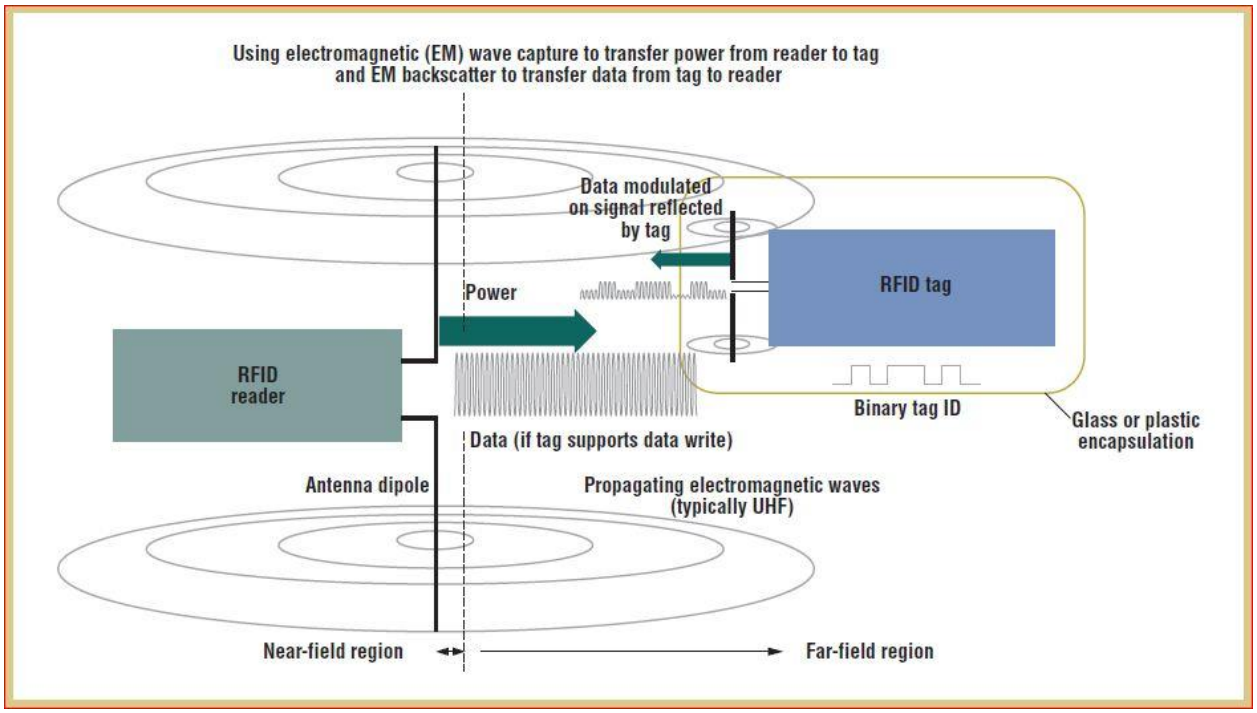


Fig 4: Far field mechanism using EM wave [5]

Far field mechanism is using the EM wave to power up the tag which can give a larger distance compare to near field mechanism. As shown in figure 4, the comparison between far filed region and near field region. The EM wave will propagate through the dipole antenna at the reader side. The far field mechanism will operate at frequency greater than 100MHz [5]. So the suitable frequency for EM wave is the ultra-high frequency (UHF) band at 2.45GHz. The tag will capture the wave using the small dipole antenna at the tag side. The type of energy receive is alternating potential difference. The EM wave backscatter to transfer the data and its ID back to the reader [5].

2.3.2 RFID Reader

RFID reader is the transceiver part which is the transmitter and receiver. The readers transmit signal or wave to the tag and receive the backscatter wave in terms of data and tag's ID. There is an antenna at the reader to send and receive signal. It is also use to communicate with the tags and electronic module that is network to the host computer. The data receive from the tag will be decode by processor [10].

RFID reader may have an internal data and information store. It also can be part of localized system such as local area network (LAN) and wide area network (WAN). In this part, the reader consists of radio frequency transmission for receiving and decoding data. It also has the capability to communicate with the host computer. Within the possible range of communicating between host computer and tags, there is the module relays message that allows one reader to communicate with hundreds of tags at the same time [10].

There are two type of RFID the fixed reader and mobile reader. For the fixed reader, it read the tags at still position and setup in specific zones to create a "bubble" of the RF energy that can tightly be controlled. For mobile reader, it can read the tag in mobile situation. It is a handheld reader.

Fig 5: RFID Reader

2.3.3 Host Computer

It is one of the most important parts for the RFID system. The host computer acts like a brain for the whole system. All data and information from the tag will be processed by the host computer. The RFID reader will cross-reference the data within it internal database before it is send to the host computer. The reader and host computer communicate through a secure wireless link [11].

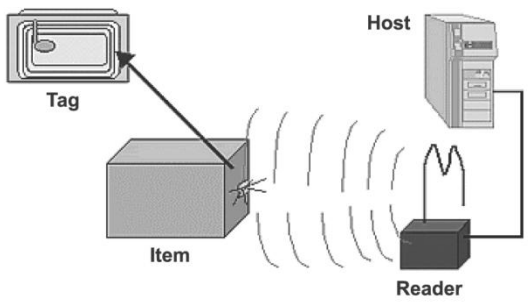


Fig 6: RFID System [12]

2.3.4 Operating Frequency

Frequency refers to the size of the radio waves used to communicate between the RFID systems components. It is generally safe to assume that a higher frequency equates to a faster data transfer rate and longer read ranges, but also more sensitivity to environmental factors such as liquid and metal that can interfere with radio waves. RFID systems currently operate in the Low Frequency (LF), High Frequency (HF) and Ultrahigh Frequency (UHF) bands [13].

Each frequency has advantages and disadvantages relative to its capabilities. Generally a lower frequency means a lower read range and slower data read rate, but increased capabilities for reading near or on metal or liquid surfaces.

Frequency Band	Type of Frequency	Operating Range	Applications	Benefits	Drawbacks
125KHz to 134 KHz	Low Frequency	< 0.5m	• Access Control • Animal Tracking • Vehicle immobilizers • Product Authentication • POS applications	Works well around water and metal products	Short read range and slower read rates
13.56 MHz	High Frequency	< 1m	• Smart Cards • Smart shelve tags for item level tracking • Library Books • Airline Baggage • Maintenance data logging	Low cost of tags	Higher read rate than LF
860 MHz to 930MHz	Ultrahigh Frequency (UHF)	3m	• Pallet tracking • Carton Tracking • Electronic toll collection • Parking lot access	Electronic Product Code (EPC) standard built around this frequency	Does not work well around items of high water or metal content
2.4GHz	Microwave	1m	• Airline Baggage • Electronic toll collection	Most expensive	Fastest read rates

Table 1: Frequency Features [14]

2.3.5 RFID Applications

RFID technology has been applied in several field of industry. This technology is developing and has a promising future. RFID applications focus on logistic, toll system, ticket, healthcare security and identification systems [15].

i. Logistic

One of the most famous RFID applications is supply chain management. RFID tags are attached to goods, items or parts in the supply chain and all items are tracked by RFID readers from manufacture to point of sales. Megatrux, a top 100 logistics company in the world, has applied Motorola RFID plan to its supply chain management [16]. RFID also has a great value in product delivery. We could track the handing process and current location of the product from pick up to delivery with RFID tag attached on it. It helps to relieve incorrect delivery owing to human mistakes.

ii. Toll System

Toll systems using RFID technology to facilitate electronic toll collection is widely deployed, especially in highway and car park. The RFID toll system enables vehicles to check-in and check-out automatically under a fast, contactless, secure and convenient environment. However, cars must be queuing up and pass through the toll system gate one by one [17]. Nonetheless, RFID based automatic toll systems relieve the traffic jam problem caused by the long queue in human manned toll station.

iii. Ticket

Small size and flexible antenna of RFID tags, they have been widely applied in e-tickets for exhibitions, stadiums, theme-parks and entertainments. Compared with ordinary ticket, the e-ticket is more resistant to fake tickets and facilitates contactless automatic identification. Moreover, it also provides extra functions, such as guess allocation, flow controlling of people, etc. RFID technology is a secure, reliable and

convenient tool for personalized information services. RFID enjoys advantages in speed, accuracy and convenient over traditional tickets. Therefore, RFID tagged e-tickets will gradually replace traditional tickets and facilitate intelligent applications in exhibitions, games and theme-parks.

iv. Healthcare

Healthcare demands for extreme accuracy in drug distribution, handling and processing. Institute of Medicine (IOM) reported that the human carelessness is one of the major causes of medical errors [18]. RFID technology could aid the medical staff in performing their duties and reduce medical error [19]. Another major RFID application in healthcare center is the access control of staffs and patients. Each of them is issued with a RFID card recording their access permissions. The control center can locate patient or staff by the readers deployed in different locations. The center can also track patients and control the access of medical equipment and restricted zone. Some hospitals tag all equipment and use the tag to track equipment. This helps managing inventory and ensuring proper maintenance of equipment.

2.4 Heartbeat Sensor

A heartbeat sensor is a heart monitoring devices that is used to measure the heart rate. It gives a reading in beats per minutes (bpm). Most of the heartbeat sensor is used for health industry and mainly, it is use to monitor the heart disease patients. Some of this technology is use by the sportsman for their exercise activities.

Mainly, the heartbeat sensor is design like chest straps and as a wristwatch. The sensor will be attached around the chest strap. By using the chest strap type of sensor, it will give more accurate result on sensing the heartbeat. It is because the heart generates its own electrical signal which is also called an electrical impulse which can be recorded by placing electrodes on the chest. This is called an electrocardiogram [20]. The electrodes are the sensor. The produced electrical impulses detected by the sensor and measure it.

It will measure the heart rate and send the data to the wristwatch. There are some inventions for this kind of technology but using the RFID is still in study.

Fig 7: Heartbeat Sensor with Chest Straps and Wristwatch [21]

Before the wireless technology was discovered, there were several method used to detect or measure the heart rate. Unreliable heart rate monitor try detecting the heart rate at the earlobe or fingertip using the inaccurate photo optic techniques [21]. Nowadays, using the wireless technology and research on the electrocardiogram a better heartbeat sensor was developed using electrocardiograph techniques [21]. This method requires chest strap sensor and wristwatch.

2.4.1 Existing Product

The wireless heartbeat sensor has been develop and mostly for healthcare industry purpose. The idea is to monitor the patients from longer distance without risking the patient's life. Some of existing products are:

i. Automated emergency contact

Wireless devices for emergency contact produce by Life Alerts. The range for this device is 150 foot. If the user is at risk or in trouble, he or she can press the emergency button. The signal will be transmitted to the base unit which notifies at the monitoring unit and will trigger the emergency services [22]. This system is not practical if the user collapse or unconscious.

ii. Heart disease management

Products by Carematix and CardioNet are a management system for the heart disease patient. This system will receive information and data from the patient before monitoring unit send the data to the physician. By doing this, they can avoid to go to the hospital or being hospitalized. This product consist sensor that is connected to the transmitter and receiver and connected to the PC where data is stored [23], [24].

2.5 Heart Rate

Heart rate is the number of heartbeats per unit of time, typically expressed as *beats per minute* (bpm). Heart rate can vary as the body's need to absorb oxygen and emit carbon dioxide changes. A normal heart beat rate is between 60 and 100 beats per minute [25]. During an intense activity or situation, the heart rate is going to be greater than 100 bpm and maybe can reach up to 90% of maximum heart rate. The *maximum heart rate* is the highest heart rate an individual can safely achieve depends on age. Maximum heart rate can be calculated by using this formula:

$$HR_{max} = 220 - Age$$

There is also a condition of slow heart rate which is below than 60 bpm. This condition can cause symptom such as fatigue, lightheaded and short of breath [25]. But slow heart rate is normal for athlete during their rest. There are many factors that can influence heart rate, such as:

a) Activity level
b) Fitness level
c) Air temperature
d) Body position (standing up or lying down)
e) Emotion
f) Body size
g) Medication

2.6 Fatalities Statistic

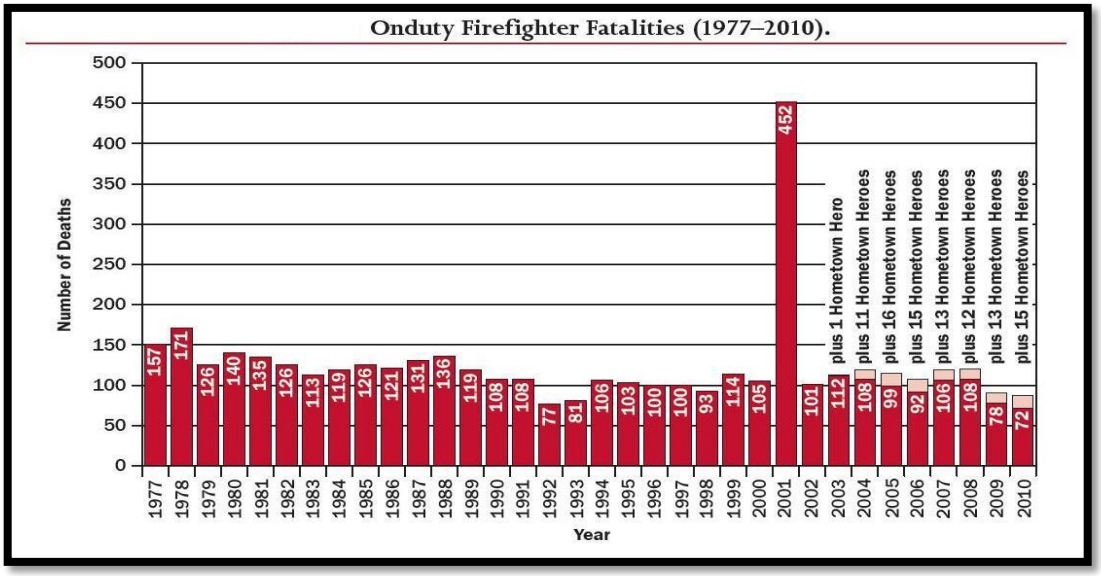


Figure 8: On duty Firefighter Fatalities [26]

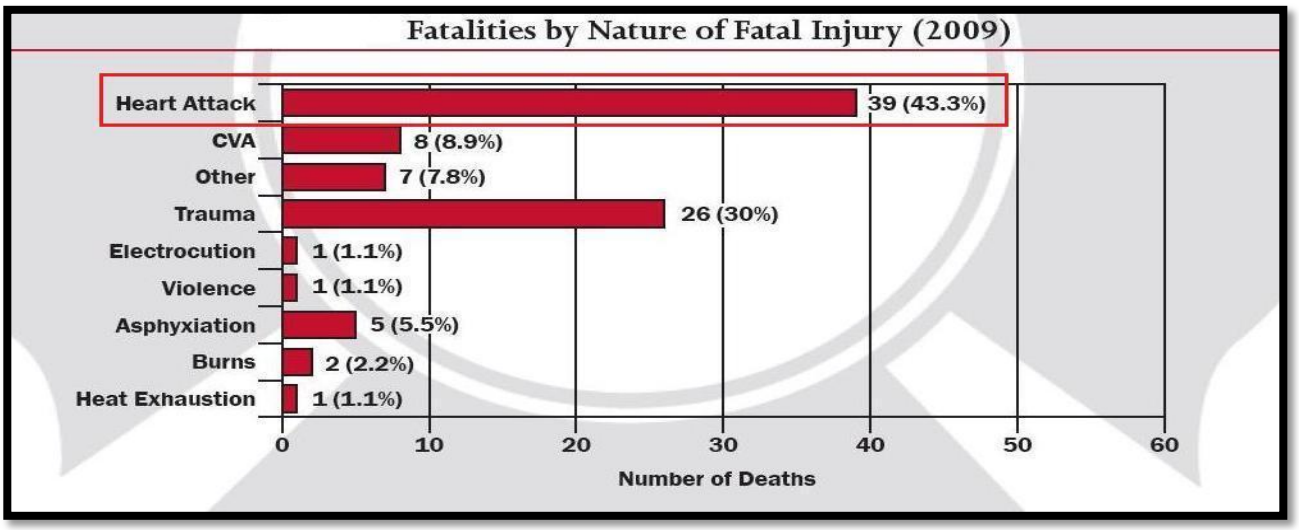


Figure 9: Fatalities by Nature of Fatal Injury 2009 [26]

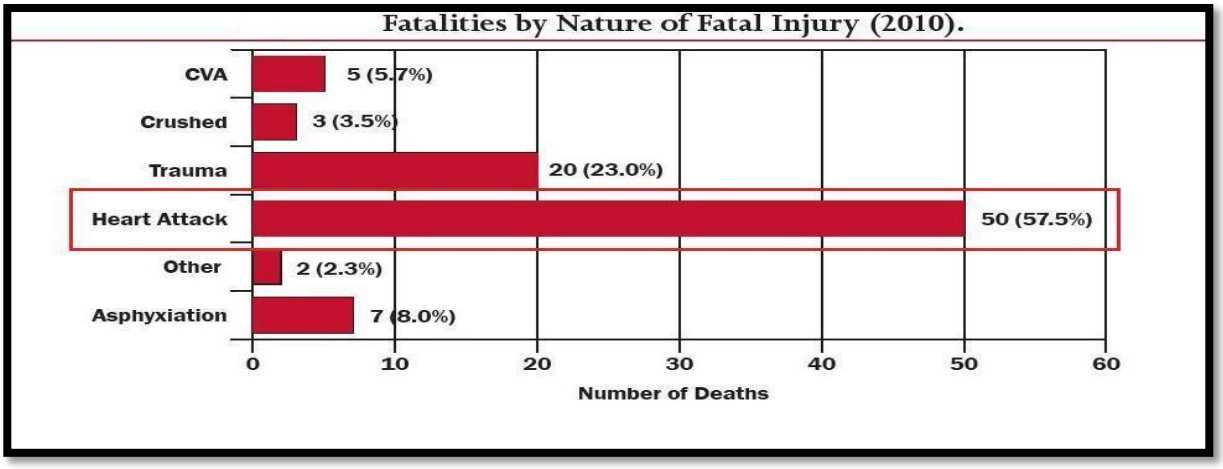


Figure 10: Fatalities by Nature of Fatal Injury 2010 [26]

The statistic shows the fatalities of firefighters from 1977 until 2010. The number of fatalities is almost the same every year. The next graph show the fatalities by nature of fatal injury and it show that the fatalities due to heart attack is the highest for 2009 and 2010. Heart attacks are the most common line of duty deaths for firefighters according to the National Institute for Occupational Safety and Health (NIOSH) [26]. Workplace factors like extreme physical exertion and exposure to contaminants, stress, and noise can be linked to the risk of heart attack. Fire suppression, alarm response, rescue, and training exercises require heavy physical exertion. Heavy turnout gear, respirator use, extreme fire heat, and exposure to the elements also increase physical demands on the body. Inhaling smoke contaminants and particles can result a shortage of oxygen in the body, which can lead to heart stress.

CHAPTER 3

METHODOLOGY

3.1 Flow Chart

The following flow chart explains the methodology in executing the project:

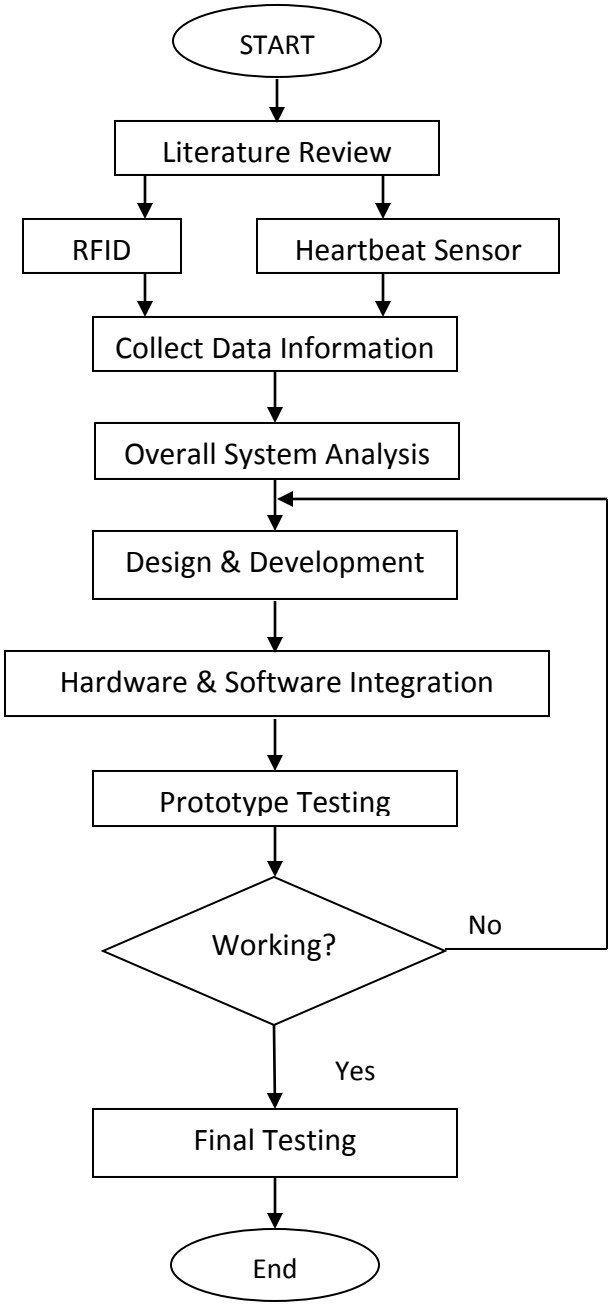


Fig 11: Project Methodology

3.2 Gantt Chart

In order to effectively monitor the progress of this project, a Gantt chart consists of one year duration had been constructed.

ACTIVITIES	FINAL YEAR PROJECT 1													
	WEEK NO.													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Selection of Project Topic														
Preleminary Literature Review														
Visit Company														
Due of Extended Proposal														
Hardware and Software Selection														
Conduct Experiment and Perform Testing														
Proposal Defense														
Critical Research Work														
Draft Final Report														
Due of Final Report														

Table 2: Gantt Chart

3.3 Tools Required

There are certain tools required for this project for software and hardware. For the hardware the tools required are the heartbeat sensor, the RFID tag, RFID reader, and some electronic circuit.

The heartbeat sensor, there are two type of model which is the chest strap model and finger sensor model. The chest strap model will be chose rather than finger sensor model. The chest strap model is the most common style and it consists of two components: a chest strap that fastens around the chest and wirelessly transmits continuous heart rate data to a wristwatch receiver. But for this project the wristwatch receiver is going to be replaced with the RFID reader and host computer to receive all data and information from the heartbeat sensor. The reasons of choosing the chest strap are the chest strap model provides continuous heart rate information and its accuracy is much better compare to the finger sensor model.

Next is the RFID tag and reader. The RFID tag will be attached or embedded with the heartbeat sensor. The tag will transmit all the data and information from the heartbeat sensor to the RFID reader. The suitable type of tag for this project is the active tag. It is because the active RFID tag has a greater transmission signal which will result to greater transmission distance. The transmission distance approximately around 100 meter. For the reader, it will transmit a signal and receive the data. The operating frequency for RFID reader depends on the manufacturer. Usually the operating frequency use for the active tag is 433MHz.

There are two type of software to be used, MySQL and Microsoft Visual Basic. Microsoft visual basic is use to integrate the hardware and the software and to give command data logging for the system. MySQL is a relational database management system. It runs as a server providing, multi-user access to a number of databases.

3.4 Proposed System

Basically, the function of the system is to monitor the heart rate of the firemen by integrating a remote monitoring system with the heartbeat sensor with the RFID tag. This system will be used to generate alert to rescue team to save firemen with heartbeat below predefined limit.

Firstly, during the rescue mission, firemen will wear a chest strap type of heartbeat sensor with RFID tag. The active RFID tag will transmit all the data from the sensor to the RFID reader. The data is send to the host computer from the reader to be analyzed and processed.

At the host computer, there is a maximum limit and minimum limit for the heart rate reading to generate alert. If the heart rate reading given by the sensor is too low, the system will generate alert or alarm to the standby rescue team at the fire engine to rescue the firemen who is in danger.

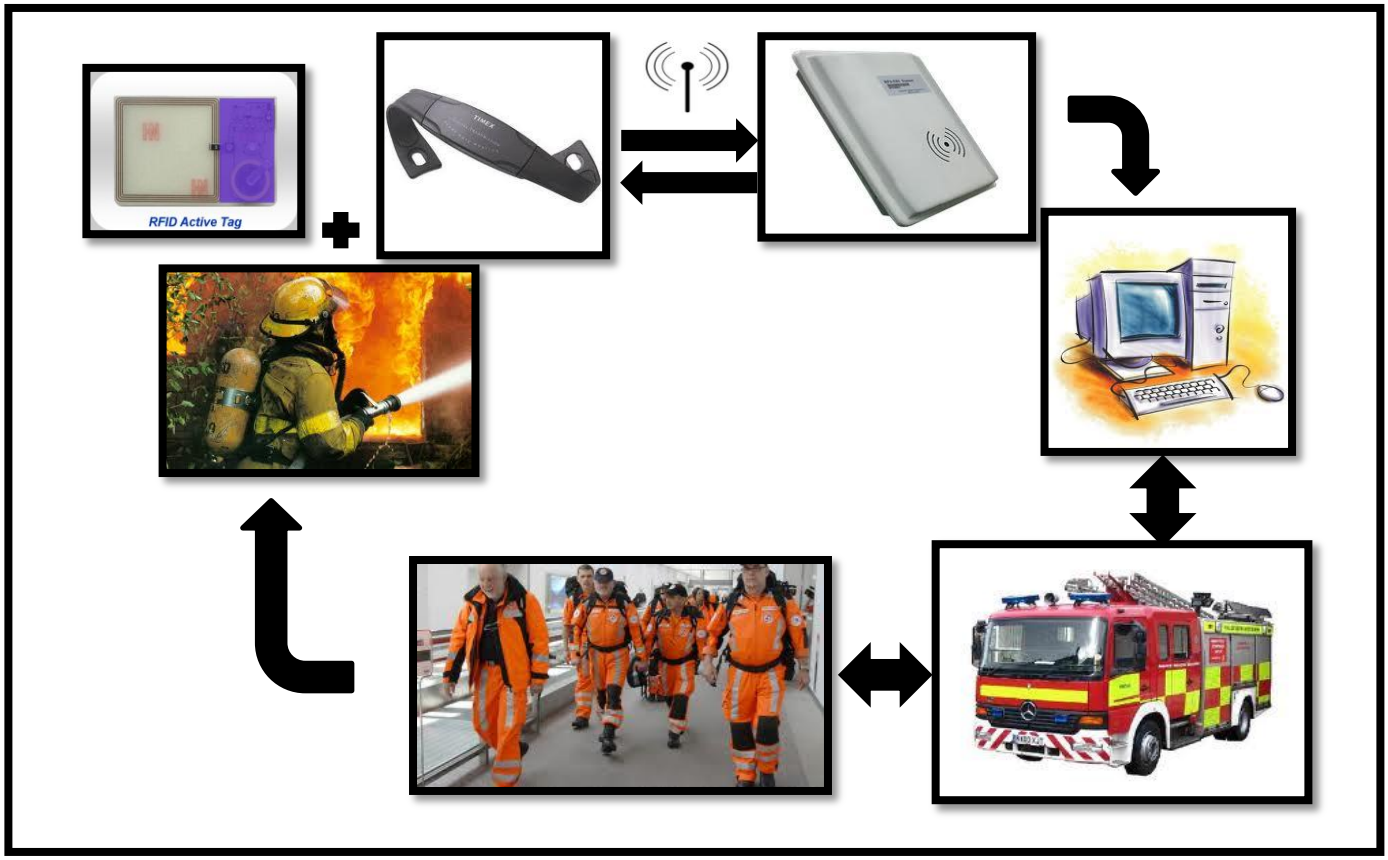


Figure 12: Proposed System

CHAPTER 4

RESULT & DISCUSSION

4.1 Comparing with existence system used by BOMBA

Figure 13: Walkie Talkie

Most of firefighter in the world used this type of systems and there is no exceptional in Malaysia too. It is the easiest and the cheapest way for firefighter to communicate. Hence, they are easily can check on each other condition especially during fireground.

But there are several disadvantages using this system. As we know, while using walkie talkie we are required to push button for us to talk with others. If the firefighter is lifting someone else and it is hard for them to acknowledge and respond at that time.

Furthermore, while in fireground, we can barely heard others talking through walkie talkie and this make the instruction from the leader are hard to understand and could be miscommunication. This can increase the amount of injury and will getting worst if there is no new system to being replaced with the existing one.

It is also not a practical system. For example, during fireground for the operator to manage and monitor everyone for every second is impossible. It is because, are they should talk all the way while in rescuing people? Hence, they will just monitor them in

every 5 minutes to make sure all the firefighters in a good condition. Unfortunately, there is a high possibility anything bad can happen in every single minutes and that is why walkie talkie system is not practical anymore.

In this result and discussion, the author will present the experiment and work progress regarding the Hemodynamic Rescue I-Monitoring System.

4.2 System Interface

Interface is a tool and concept that refers to a point of interaction between components, and is applicable at the level of both hardware and software [27]. In this project, the system interface is applicable at the level of software. The interface is where the user of the Heartbeat Monitoring system will log in, register and store their basic information. The user also needs to register the identification number of the heartbeat sensor with their user identification number. This system interface was design using the Microsoft's Visual Basic 2010.

Figure 14: Welcoming Window

The welcoming window, it is use to start the monitoring system. Next windows after button Start was click, the window of 'Main Menu' will appear. At this window, user can select to proceed to System Administration or to view the heartbeat record.

Figure 15: Main Menu

The user can proceed to System Administration in order to register or store their information and the heartbeat sensor information.

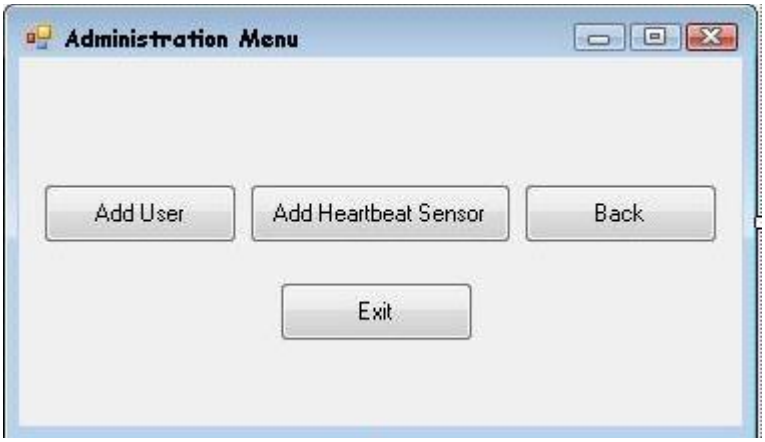


Figure 16: Administration Menu

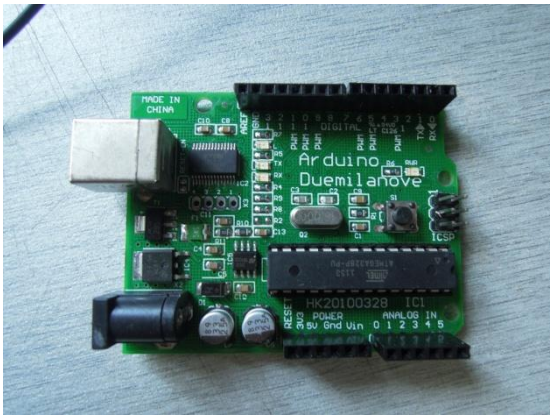
Figure 17: Add User

Figure 18: Heartbeat Sensor Registration

All the data and information regarding the user or the firemen and the information of heartbeat sensor in term of Sensor identification number and Tag Identification number will be update and store into a database. The database system is using the MySQL software.

4.3 Proof of Concept

In this chapter, the author has done some experiment in order to test the transmitting signal between transmitter and receiver. This experiment was test by using the Arduino Duemilanove board.



.Figure 19: Arduino board

The Arduino board was connected to the RF transmitter and receiver. This connection was test in order to proof the concept about transmitting the signal form transmitter to receiver.

Figure 20: RF Transmitter and Receiver

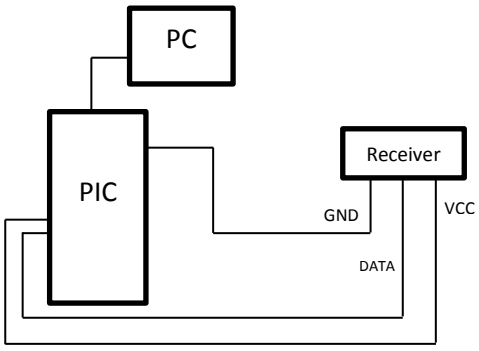


Figure 21: Block diagram of Receiver

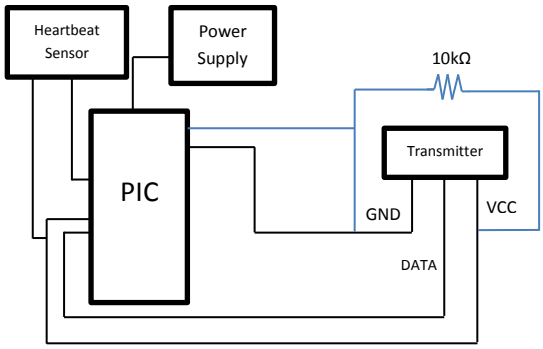


Figure 22: Block diagram of Transmitter

The block diagram in figure 21, show the connection for receiver circuit. The receiver circuit is connected to the computer. The entire data receiver is send to the computer to be analyzed and display. In figure 22, it is the connection of Transmitter circuit. The Ardunio board is used to integrate the heartbeat sensor with transmitter. The transmitter circuit is power up with the power supply

In this experiment, the variable resistor was used to replace the heartbeat sensor. By changing the resistor value, is will give a different value of voltage through the output. It is the same concept as heartbeat sensor. The heartbeat sensor will detects the heart rate in term of analog signal and then convert it into voltage signal. The voltage signal represents the value of beats per minute (bpm).

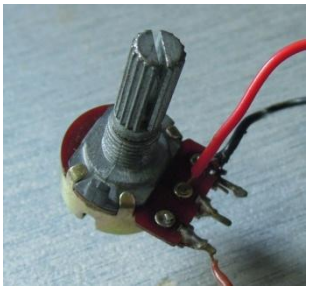


Figure 23: Variable Resistor

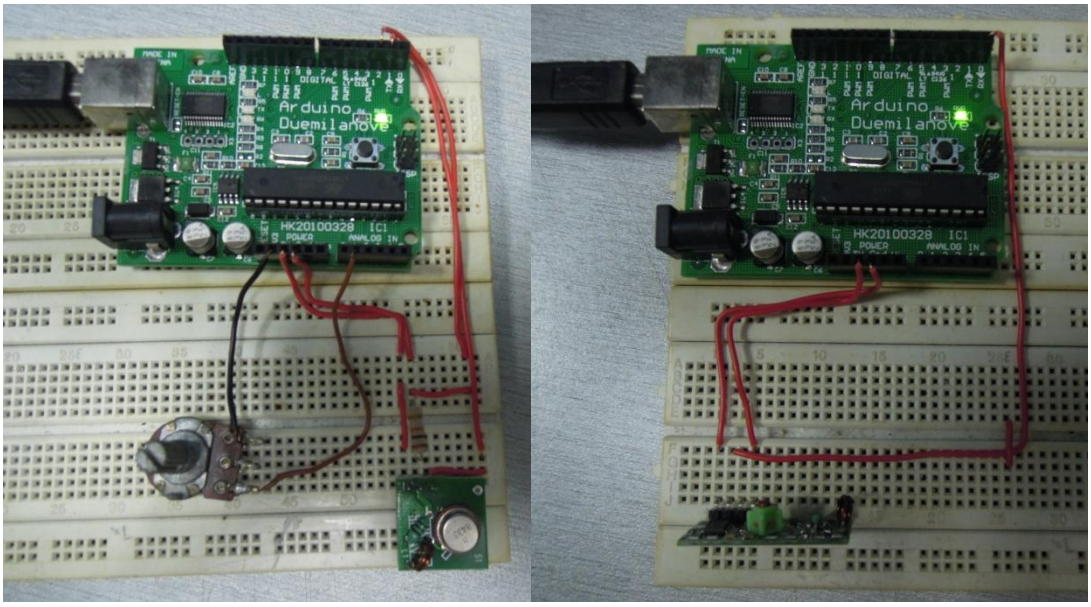


Figure 24: Transmitter and Receiver

Figure 25 shows the picture of the real circuit diagram of transmitter and receiver. The transmitter is sending data to the receiver. By varying the value of variable resistance, it will give a different input and different voltage. This voltage will indicate as the heart pulse. After the data receive by receiver, the computer will analyze the data.

The Arduino software can produce a graph from this experiment. The data receive will produce a graph indicate as heartbeat. By changing the resistor value it will produce a fluctuate graph.

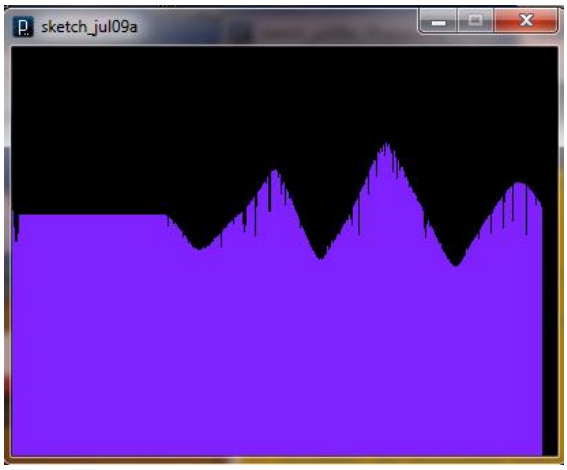


Figure 25: Graph

The flat or constant reading of the graph is when the variable resistor was not varied. When the variable resistor was varied it produced a fluctuate graph as shown in the picture above.

CHAPTER 5

CONCLUSION & RECOMMENDATION

For conclusion, this project is a realistic system and can be develop to monitor the heart rate of the firemen. Because collapse due to heart failure can be avoided and reduced the risk during rescue mission. Furthermore, it is worth to develop a system to monitor and at the same time it can prevent firefighter's fatalities. The firefighter's life is also important.

For future planning, proof of concept to be up scaled for real application. Develop the system and it will be tested with BOMBA to make sure the system is comfortable for the rescue mission and satisfied with the system. The next step is to go for standardization and finally to commercialized it.

For recommendation, this system can be improved with a better transmission signal with less limitation especially in distance.

REFERENCES

[1] EPCglobal, EPCglobal Architecture Framework, , vol. Version 1.2, Oct. 2007.

[2] Siddharta Mal, "RFID-Enabled Wireless Heart Monitoring".

[3] http://www.nlm.nih.gov/medlineplus/ency/article/003399.htm.

[4] Ron Weinstein, "RFID: A Technical Overview and Its Application to the Enterprise," June 2005.

[5] Roy Want, "An Introduction to RFID Technology," 2006.

[6] (2007, March) http://www.feast.org/?articles&ID=568.

[7] and S. R. Das N. Vaidya, "RFID-Based Networks – Exploiting Diversity and Redundancy," June (2006).

[8] http://www.netrand.com.my/p_products_details03.php?proID=61.

[9] http://www.cisco.com/en/US/docs/solutions/Enterprise/Mobility/wifich6.html.

[10] Harvey Lehpamer, *RFID Design Principles*.: Artech House, 2008.

[11] Steven Shepard, *Radio Frequency Identification*. USA: McGraw-Hill.

[12] emeraldinsight.com.

[13] Stephen A. Weis, "RFID (Radio Frequency Identification): Principles and Applications".

[14] Klaus Finkenzeller, *RFID Handbook: Fundamentals and Application in Contactless Smartcard*.: John Wiley & Sons, Ltd., 2010.

[15] Barnard Riaan, "Innovative RFID Applications in the UK," Nov.2006.

[16] Motorola. RFID World. [Online]. http://www.motorola.com/staticfiles/Business/Solutions/Industry%20Solutions/RFID%20Solutions/Documents/Static%20Flies/CS_Megatrux_1007.pdf

[17] Pala. Z and Inanc. N, "Smart Parking Applications Using RFID Technology," in *RFID Eurasia*., Sept.2007.

[18] Institute of Medicine, *Crossing the Quality Chasm: A New Health System for the 21st Century*.: Institute of Medicine publication, 2001.

[19] Monaly J.E. and Yang S.C. Cangialosi A., "Leveraging RFID in hospitals: Patient life cycle and mobility perspectives," vol. 45, no. 9, September 2007.

[20] Richard N. Fogoros. (2011, October) The Cardiac Electrical System - How the Heart Beat. [Online]. http://heartdisease.about.com/od/palpitationsarrhythmias/ss/electricheart.htm

[21] Edmund R. Burke, *Precision Heart Rate Training*.: Human Kinetic , 1998.

[22] http://www.lifealert.net/.

[23] http://www.carematix.com/.

[24] http://www.cardionet.com/medical 02.htm.

[25] Everyday Health. [Online]. http://www.everydayhealth.com/heart-health/understanding-a-slow-heart-rate.aspx

[26] "Firefighters Fatalities Report," 2009-2010.

[27] Gerritt A. Blaauw and Jr., Frederick P Brooks, *Computer Architecture-Concepts and Evolution*., 1997.

APPENDIX

This is the code for the Transmitter and Receiver applications.

```
//#define TRANSMITTER
#define RECEIVER

// Arduino digital pins
#define BUTTON_PIN  2
#define LED_PIN     13

// Button hardware is setup so the button goes LOW when pressed
#define BUTTON_PRESSED LOW
#define BUTTON_NOT_PRESSED HIGH

void setup()
{
  pinMode(BUTTON_PIN, INPUT);
  pinMode(LED_PIN, OUTPUT);
  digitalWrite(LED_PIN, LOW);

  Serial.begin(1200);  // Hardware supports up to 2400, but 1200 gives
longer range
}

#ifdef TRANSMITTER
void loop()
{
  static int prev_button = BUTTON_NOT_PRESSED;  // Previous button
press value
  int        cur_button;                        // Current button press
value

  cur_button = digitalRead(BUTTON_PIN);

  if ((prev_button == BUTTON_NOT_PRESSED) && (cur_button ==
BUTTON_PRESSED))
  {
    writeUInt(271); // Put any number you want to send here (71 is just
a test)
  }

  delay(50); // Debounce button
  prev_button = cur_button;
}
#endif //TRANSMITTER

#ifdef RECEIVER
void loop()
{
  boolean light_led = false;
```

```
  if (readUInt(true) == 271) // Check to see if we got the 71 test
number
  {
    light_led = true;
  }

  if (light_led)
  {
    digitalWrite(LED_PIN, HIGH);
    delay(1000);
    digitalWrite(LED_PIN, LOW);
  }
}
#endif //RECEIVER
```