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Myocardial Infraction Alert System using RFID Technology

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Abstract:- Deaths caused due to myocardial infraction have become a major concern. Most of such deaths are caused due to the non-availability of medical assistance in time of need. This paper describes a technology that explores a solution to such problems using wireless communications which includes aenabled RFID (Radio Frequency Identification) frontier in which the victim's actual location is tracked for providing the necessary medical services. The paper describes the interworking wireless communications systems and miniature sensors such as RFID passive Tags , whose function is to capture the signals and wirelessly transmit all the data such as person's vital body-function data, such as body temperature and pulse to an integrated nearest ground station. The antenna also receives information simultaneously regarding the location of individual from the GPS System. Thus, both the sets of data and the medical status and the location of the patient will then be wirelessly transmitted to the ground station from where patient's medical conditions are remotely monitored, thus providing emergency rescue units with the person's exact location. The Algorithm for the conversion of the Analog pulse to Binary data in the RFID tag is written and the Algorithm for Alerting the Location & Tracking the Mobile Station is also being discussed. The exact details of the various stages involved in tracking the location of the Victim using GPS is discussed over here.

Keywords:- *RFID Reader, RFID Tag, Mobile Rescue Unit, GPS, Mobile Station.*

I. INTRODUCTION

A. Human Heart and its failure

It is rather easy to say tat "Heart" is one of the mostvital organ of our body, functioning like a smoothly embedded machine within the pericardium pumping litres blood in each cardiac cycle to various parts of our body. It beats about 72 beats per minute and a trillion times in ones lifetime. Myocardial infarction (MI), commonly called as Heart Attack results due to the interrupted blood supply to any part of the heart, resulting in thedeath of the heart cells. This is most commonly due to coronary artery blockage followed by the rupture of a vulnerable atherosclerotic plaque, which is an unstable collection of lipids such as cholesterol and fatty acids and especially macrophages in the wall of an artery. No such mechanism or machine is present which can monitor the regular health or medical condition of heart as such which gives him immediate medical aid at the time of emergency. The primary focus of this paper is to provide anemergency first aid during the victim's medical need of Heart Attack.

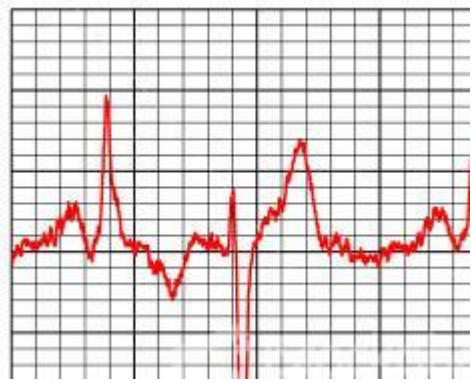

Fig 1:- Ecg of the normal working of the human heart.

The graph below shows the deaths caused over the world due to various reasons.

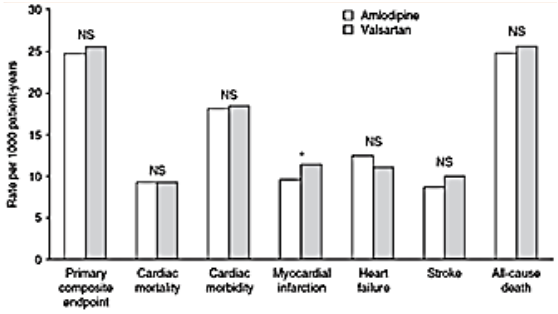

Fig 2:- Death Rate all over the world

B. RFID (Radio Frequency Identification):

Radio-frequency Identification (RFID) is the usage of a wireless system that makes use of radio-frequency electromagnetic fields to transfer data from a tag attached to the reader, for the purposes of tracking and automatic identification. Some tags are battery-less, i.e. they are powered by the electro-magnetic fields used to read them whereas others use a local power source and emit radio waves. The tag contains electronically stored information which can be read from smaller ranges up-to several metres away. The tag does not need to be within line of sight of the reader due to the work of electromagnetic waves and can be embedded in the tracked object. In social media, RFID is being used to tie the virtual world with the physical world. RFID (Radio Frequency Identification) first came to light in the year 2010 with Facebook's annual conference. FID can be used in a variety of applications such as:

- In Library - Access management
- In Logistics - Tracking of goods
- In Real time Tracking - Tracking of persons and animals

C. RFID Discovery and Operation:

Early 1970's, a group of scientists were working at the Lawrence Livermore Laboratory (LLL) on Radio Frequencies when they realized that a handheld receiver stimulated by RF power could send back a coded radio signal which gave an excellent opportunity of being connected to a simple control access which could lead to a secure facility which inturn became a system having the first building entry for the commercial use of RFID (Radio Frequency Identification).A radio-frequency identification system composes of labels or tagsattached to the objects to be tracked or identified. Two-way radio transceivers also, sometimes called as interrogators or readers send a signal to the tag and read its response in bits that are in the encoded form. The readers, most of the times transmit their observations and analysis to a computer system running RFID software. The tag's information is stored electronically in a non-volatile memory such as its not erasable. FID tags can be either battery assisted passive tag, passive or active. An active tag has an on-board battery that periodically transmits its ID signal and which provides the source of power to the tag. The technology consists of three key pieces:

- Radio Freq IDentification tags.
- Radio Freq IDentification readers.
- A data collection and management system.

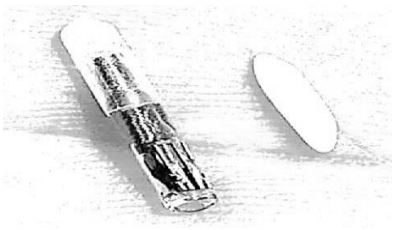

Fig 3:- Comparability among RFID Tag and a grain of rice

D. Radio Frequency Identification tags:

RFID tags are extremely small or miniaturized computer chips which are programmed with the information about aobject/product which is embedded with a number that corresponds to information stored into a database. The RFID tags can be either located inside or on the external surface of the object/product, item, or packing material. RFID tags contain a minimum of two parts: an integrated circuit for processing and storing information, modulating and demodulating a radio-frequency (RF) signal, collecting the DC power from the incident Radio Frequency Identification reader signal, and other specialized functions; and anantenna for transmitting and receiving the signal. The Radio Frequency tags are divided in two major groups:

- *Active Group*: Here, the tag itself has an internal power source, i.e. a battery that can be replaced. In some cases, this feature limits the lifetime of the RFID tag, but for some of the other applications, the tag is designed to live more than the typical time needed.
- *Passive Group:* Here the power to energize the tag's circuitry is drawn from the reader's Electromagnetic generated field.

E. Radio Frequency Identification readers:

Radio Frequency Identification readers and Systems are querying systems that send interrogation signals to the RFID tags and retrieve the responses given by them. These responses are stored within the RFID reader for a later transfer to a data collection and acquisition system. The captured data can be also instantaneously transferred to the data acquisition system. Similar to tags, Radio Frequency ID readers come in different sizes. RFID readers are usually continuously on and are continually transmitting radio energy and waiting for any tags that enter their field of operation. Thus, an RFID reader can be configured so that it sends the radio pulse only in response to an external event occurred. The RFID scanners used in veterinarian's offices are frequently equipped with triggers and power up the only when the trigger is pulled. The largest RFID readers consist of a desktop personal computer with a special card and multiple antennas connected to the card through shielded cable. Such a reader requires a network connection so that it could report tags that it readable to other computers. The smallest readers are of the size of postage stamp embedded in mobile telephones.

Band (Freq)	Range	Data Speed	Applications
120-150 kHz	10 cm	Low	Animal Identification
13.56 MHz	1m	Moderate	Smart cards
433 MHz	1-100m	Moderate	Defence
0.8-0.9 MHz	1-2 m	High	EAN
2.4-5.8 MHz	1-2 m	High	WLAN, Bluetooth
3.1-10 GHz	2-200m	High	Active Tags

Table 1. Radio Frequencies along with their specifications

F. Pulse Amplitude Modulation (PAM):

Pulse Amplitude Modulation abbreviated as PAM is a modulation technique wherein the amplitude of the baseband signal is varied with respect to the message signal. The baseband or the message signal here is a square wave (binary stream of input) and the carrier signal is a sinusoidal wave of a particular frequency nearly 10times greater than frequency of the message signal.

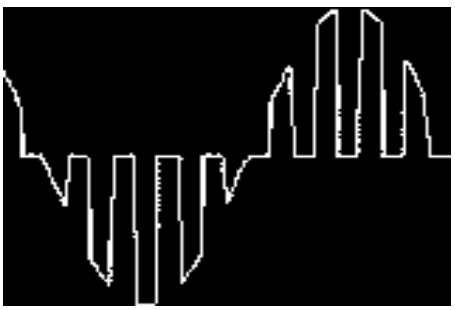

Fig 4:- Pulse Amplitude Modulated Signal

II. MYOCARDIAL INFRACTION ALERT UNIT

The Myocardial Infraction Alert Unit consists of the

following five components:

- RFID Tag implanted into the human body.
- RFID Reader placed in any tracking object/cellular/mobile phone.
- Global Positioning Satellite System (GPS) for tracking purpose.
- Location & Tracking Base Station Unit.
- Ambulances / Mobile Rescue Units.

Fig 5 below depicts the complete system being implemented.

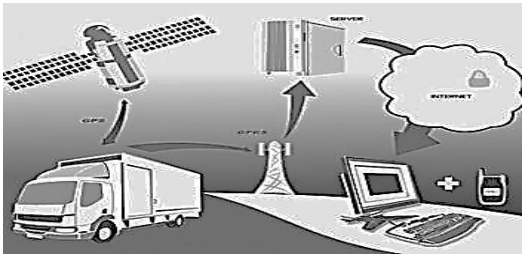

Fig 5:- Heart Failure Alert System

III. GENERAL WORKING OVERVIEW OF RFID

RFID tag implanted in the human body stores the data and transmits the heart rate pulse data in the form of voltage levels. The RFID reader placed in the cellular/mobile phone sends the command signals to RFID tag requesting the current medical status of the victim and the RFID tag in response sends the stored voltagelevel data in the form of pulses (binary stream) which are converted from analog to digital form using the embedded software in the tag and is a continuous process.The corresponding software is loaded in the cellular phone with a suitable software program related to the inputs and checks for the condition of a heart failure. If the failure has occurred, an ALERT is generated/triggered as the RFID readers will auto-dial to the base tracking station using the GPS. The locating and tracking station also simultaneously alerts the rescue units.

IV. WORKING OF IMPLEMENTED RFID TAGS

Passive RFID systems couple the transmitter to the receiver with either backscatter or modulation depending on whether the tags are operating in the near or far field of the RFID reader, respectively. In the near field communication, a RFID tag couples with the RFID reader via EM inductance. The antennas of both the RFID reader as well as the RFID tag are basically coils, using many turns of small gauge wire. The reader communicates with the tag by modulating a carrier wave with the message, which it does by either varying the amplitude or the phase or the frequency of the carrier, depending on the design of the RFID system in question. The RFID tag communicates with the RFID reader by varying the loads on its antenna used for communication. This in turn affects the voltage across the reader's antenna. Switching the load on and off rapidly enables the tag to establish its own carrier frequency/ a subcarrier so that the tag can in-turn modulate the carrier to communicate its reply back to the transmitter. FID Tags are very much smaller than a grain of rice and is equipped with a tiny antenna that will capture and wirelessly transmit a person's vital body-function medical data, such as pulse and blood pressure. These RFID tags are capable of identifying the Heart pulses in the form of Voltage levels and convert into a bit sequence for communication. The first step in Analog to Digital Conversion is Pulse Amplitude Modulation. This takes an Analog signal as the input, samples it and generates a sequence of pulses based on the results of the Sampling quantizes PAM Pulses.i.e. the method of assigning integral values in a specific range to sampled instances. The binary encoding of assigning these integral values is done based on the Algorithm mentioned below which depends on the Average Heart pulse voltage of the Victim.

V. ALGORITHM FOR RFID SIGNAL CONVERSION FROM ANALOG TO DIGITAL DOMAIN.

The following algorithm is implemented within the RFID tag for the conversion of the Analog signals to Digital.
Step 1:Acquire the analog signals from the pulses originated from the human heart.
Step 2: Generate a series of samples from the analog signals acquired with respect to the RFID Tag frequency.
Step 3: Assign integral values to the samples generated.
Step 4: Compare each and every sample value with the average voltage level of the human heart.
Step 5: If the compared value lies within the range of the averaged voltage level value of the heart, assign value as BIT=LOW else assign BIT=HIGH.
Step 6: Generate the bit sequence by comparing each and every individual pulse to the average value.

The algorithm above can be represented in a piece of code in C Language as mentioned below:

```
int main()
{Intanalog_value = 0, a1,b1,c1=0;
a1 = Int adc (int analog_value);
b1 = Int avg (int a1);
c1 = int bit_assign (b1,a1);}

Int avg (int a)
{Intprev_avg, n;
prev_avg = ((prev_avg + a) / n);
n++;
return (prev_avg);}

Int adc (int b)
{int Temp=0;
b = (b&0xFFFFFF00);
b|=(1 << 24);
while((b&0x80000000)==0)
{Temp = b;
Temp = (Temp>>8) & 0x00FF;
Return(Temp);
}}

Int bit_assign (int b1, int a1)
{Int BIT=0;
BOOL LOW=0,HIGH=1;
```

if (a1 < = b1) : BIT = LOW ? BIT = HIGH;
return (BIT); }

Fig 6 below depicts the complete process of conversion of analog signal to digital domain.

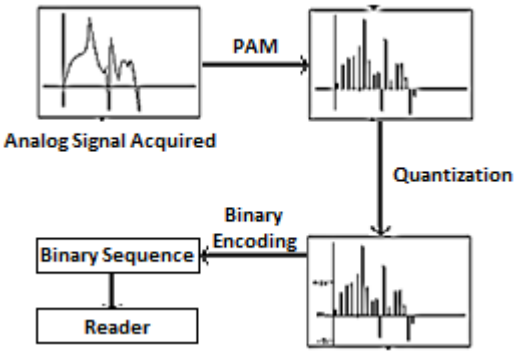

Fig 6:- Process of Analog to Digital Conversion

The analog signal is initially captured from the person who is assumed to be the victim. The signal is then sampled at a frequency that is supported by the Passive RFID Tag. The samples generated are then quantized by assigning the integral values and rounded off. The quantized digital values are then encoded and the binary sequence are generated. This binary sequence generated is then sent to the reader.

VI. WORKING OF RFID READER WITHIN THE CELLPHONE

The Radio Frequency ID entification reader initially sends a pulse of radio energy to the RFID tag and waits/listens for the Tag's response. The RFID tag detects this energy pulse and acknowledges the RFID reader back with a response that contains the RFID tag's serial number and other information as well. In simple RFID systems, the reader's pulse of energy functioned as an on-off switch. In advanced RFID systems, the RFID reader's RF signalmay contain commands to retrieve the data from the tag, instructions to read or write memory that the tag contains. The RFID reader within the cellphone or laptop is as shown in the fig 7.

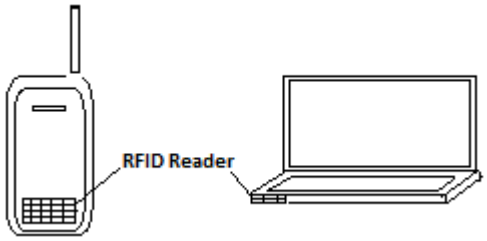

Fig 7:- Presence of RFID Reader within Cellphone and Laptop

The RFID reader continuously sends the commands to the RFID tags and in turn receives the Heart Rate in the form of Voltage levels encoded in the form of bit sequence as Response from the RFID tags with the help of the algorithm mentioned above. The embed edreader inturn sends the received Bit Sequence to a software in the cellular phone. In case a heart pulse is detected, the software automatically alerts the Tracking & Location station. The RFID Tag – Reader communication is as depicted in the fig 8 as shown.

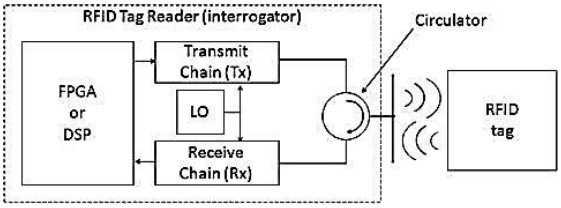

Fig 8:- shows the working of the RFID Tag reader

The algorithm in the software at the RFID reader side is as follows:

Step 1:The bit sequence of the Heart Rate obtained from the reader is read which was in-turn received as the sequence from the RFID tag.
Step 2: A Counter is set to count for the number of zeros in the sequence.
Step 3: If a bit 1 occurs within the sequence, reset the counter to 0 and restart from Step 1.
Step 4: If the counter is equals to five consecutive 1's, then goto Step 5.
Step 5: Transmit the alert message to the nearest Location and Base Tracking station.

VII. VARIOUS STAGES IN MYOCARDIAL INFRACTION ALERT SYSTEM:

A. Capturing the pulses and their conversion

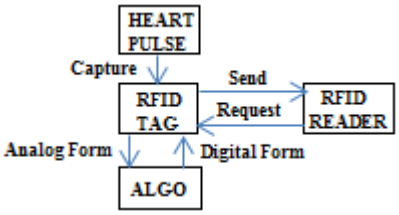

Fig 8:- Stage 1: Acquire & Convert Cycle.

The RFID tag continuously senses the body for determining the Heart Pulses. After sensing the pulses, it is converted into a digital pulse format by using the algorithm that converts analog signals into quantized digital signals and stores in it self. Upon receiving the "send" command from the RFID reader, the tag sends all the data stored within itself to the reader for further processing. A piece of code that depicts the analog to binary conversion is as depicted below:

/*Piece of Code for the A – D Conversion*/

Int bit_assign (int b1, int a1)
{ Int BIT=0;
BOOL LOW=0,HIGH=1;
if (a1 < = b1) : BIT = LOW ? BIT = HIGH;
return (BIT); }

B. Comparing the tag data for monitoring the health:

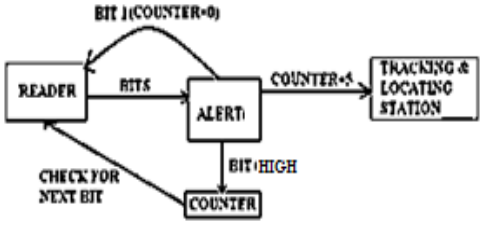

Fig 9:- Comparing the bit sequence.

The bits obtained from the tag are compared everytime to check whether a BIT=LOW or a BIT=HIGH has occurred. If consecutive five BIT=LOW is observed in the sequence, the tracking and locating base station is alerted. Else the counter is reset to 0.

```
/*Piece of Code fordetecting a Weak Pulse */
ALERT ()
{ if (bit==LOW)
{ counter++; }
else
{counter=0 ;}
if(counter==5)
{ Alert Locating &Tracking System");
counter=0; } }
```

C. Victim's Exact Location Determination and Rescue

Location and Tracking receives a special RFID ALERT message via Cellular Phone by features like Autodialling, Auto-Redialling and Auto Messaging. These services are provided by the Cellular Network Service Provider. In turn, Then the Locating & Tracking Station immediately transmits an ALERT message back to the Mobile Rescue Unit and sends a request to Global Positioning System for the exact location of the Radio Frequency Identification Reader embedded within the CellularPhone. The Locating &Tracking Station transmitsan ALERT message simultaneously to both the GPS System & Mobile Rescue Unit to alert the Doctors/Rescue team in the Mobile Rescue Unit indicating a possible Heart Failure. The Global Positioning System mean-while locates the exact location of the Victim and guides the Mobile Rescue Unit to the destination in time and provides immediate medical assistance to the Victim.

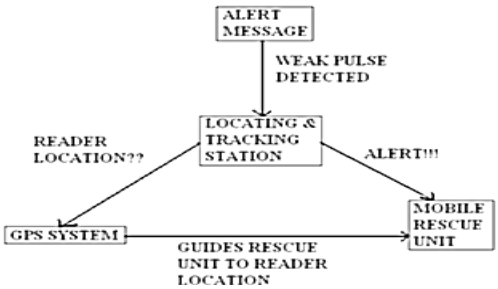

Fig 10:- Location Alert and Rescue

VIII. MERITS AND DEMERITS

A. Merits of the implementation

Advantages of the implementation are as follows:

- Can save a life when in need.
- Less time consumption in implantation
- The RFID tag device goes undetected by the metal detectors and hand scanners at the security scanning places.
- Convenient to enhance consumer experience
- Revolutionize inventories by tracking bodies in real time

B. De-Merits of the implementation

Some disadvantages of this implant process is that

- Implantation is expensive. Each and every individual cannot afford it.
- RFID can cause problems to patients undergoing MRI (Magnetic Resonance Imagery) Scan.
- Causes tissue infection or adverse effects sometimes.

IX. CONCLUSION

The above explained process of the paper is well worth of establishing a new modernised era in the field of Medical as well as in the field of Electronics and Wireless Communication. The disadvantage of this above process is it cant guarantee to save each and every victim pertaining to Heart Diseases and Heart Failures. This facility would like to be extended to each and every individual who has been undergoing implant of an RFID tag as to save their life in need.

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