Design and Implementation of Healthcare Patient based General Packet Radio Service

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Abstract

In recent years the health monitor systems for patients was developed by using wireless technologies such as Internet of Things (IoT), Wireless Sensor Network (WSN), or Websites. In this research a patient's position in Google map, heartbeat rate, and temperature were measured and transmitted to the family or doctor based GPRS technology via the smartphone and microcontroller. This system has advantages of low cost design, Early warning of patient status through SMS message or email, position recognize based on GPS and fast of treatment patient.

Keywords

Healthcare, GPRS, Microcontroller, Heart Rate, LM35.

Introduction

The health care monitor become common now a days not enclosed used in hospitals for patients only. Heart beat rate, temperature, or any parameters related to health were monitored by humans interested their health [1]. The health monitor system provides early disease detection and treatment [2]. Healthcare is a service provided to the patients need continuous monitoring and peoples live far away from hospitals [3]. Healthcare can be delivered by using phones or smart devices via messages, or internet depending on new telecommunication technologies such as WSN where the sensors read the health parameter and transmitted it over networks to the desired receiver [4] as shown in fig.1, IoT where the patient connected to the internet and sent information to the health center based cloud applications as shown in fig.2 [5][6], or GSM where the sensors sent parameters via SMS to indicate the patient status for his family or doctor [7] as shown in fig.3.

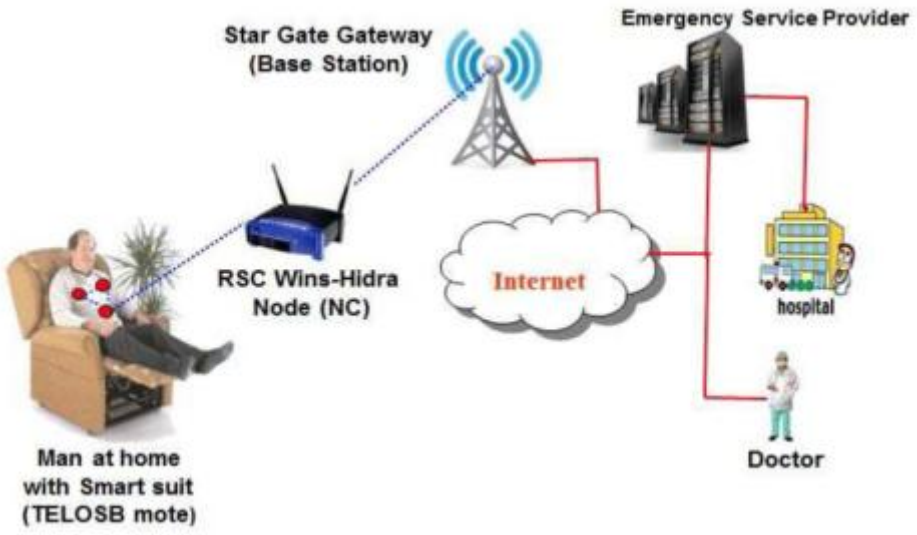


Figure 1 Healthcare based Wireless Sensor Network (WSN)

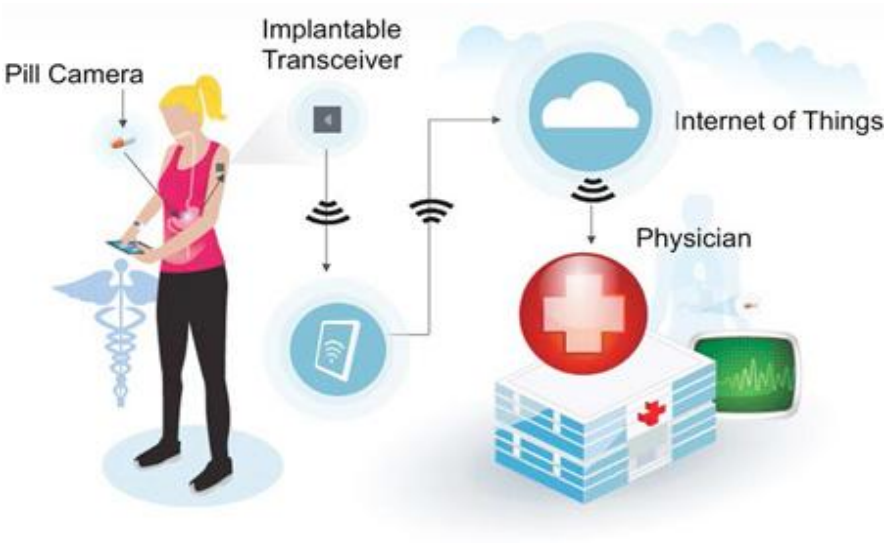


Figure 2 Healthcare based Internet of Things (IoT)

Figure 3 Healthcare based GSM technology via SMS

One of the most problems Confrontation the patient location who needs succor the Global Position System (GPS) technology can solve the problem, but GPS can provide the patient position tracker only without health data, therefore GPRS technology has been used in this research. GPRS it is a service operated with 2G and 3G mobile communication system's GSM, it operated data rate 56-to-114 kbit/second. GPRS provides Reasonable speed data transmission, by using Time Division Multiple Access (TDMA). It can offer multiple services such as SMS, internet access, multimedia messaging service (MMS), internet protocols (WAP), point to point based (IP) address, and point to multi point connections. GPRS technology can utilize many GPS tracker devices and provides update real time location object as shown in fig.4 [8].

Figure 4 GPRS Tracking Network Diagram

Related Works

Alfio Costanzo, et al [9] proposed an embedded system can monitor the patient from any distance by using mobiles and sent his data to family or doctor, the patient data can diagnose based fuzzy controller for first aid treatment.

Dipika Vasava, et al [10] proposed a low cost portable health care system can measure the heart rate, body temperature, and human pressure by using the Raspberry Pi microcontroller board.

Kajal Singh, et al [11] designed accurate, and reliable real time smart health care monitor system based Artificial Neural Fuzzy Inference Systems by using specific sensors and send patient data over wifi.

Afef Ben Jemmaa, et al [12] designed distributed system of an inelegant remote health care monitor system of vital sign and decision help system for multiple agent coordinates.

Human Body Physiological Fundamentals

The heart is responsible for blood pumping throughout the human body. The heart is consisting of four parts; two atriums and two ventricles. The heart is composed of four chambers; two atriums and two ventricles. The blood returning from entire body goes to the right atrium and passed to the right ventricle, which pumped to the lungs to oxygenate it, this blood back to the heart via left atrium and passed to left ventricle then pumped to whole body again as shown in fig.5 [13]. The heart generates electrical signal depending on the polarization of myocardial cells with each beat.

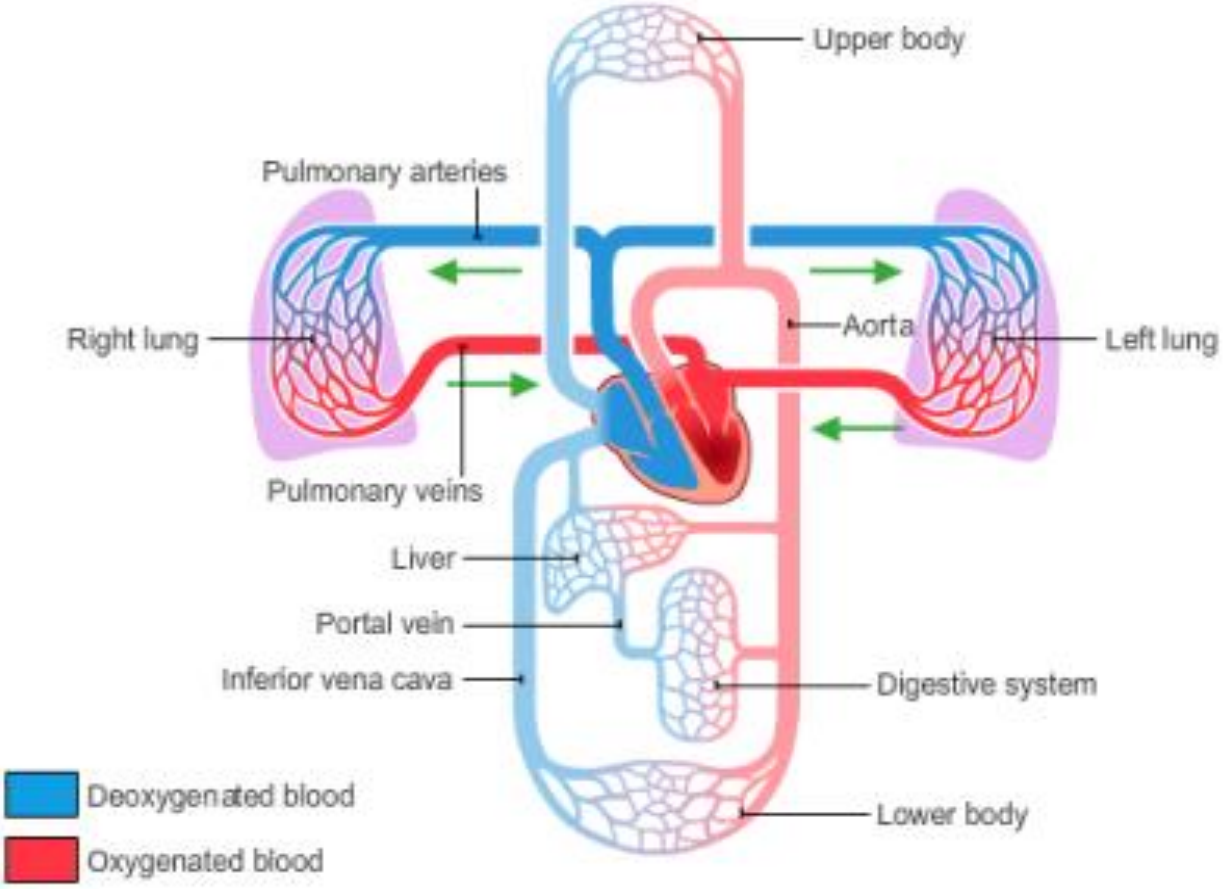


Figure 5 Blood circulation scheme

The electrical signal generated by the heart can be visualized by using the electrocardiogram (ECG), it is trace the electrical signal generated by heart with each beat. The heart can generate voltage signal approximate 1mV among human body points which can be measuring via electrode contacts the human body as shown in fig.6 [14].

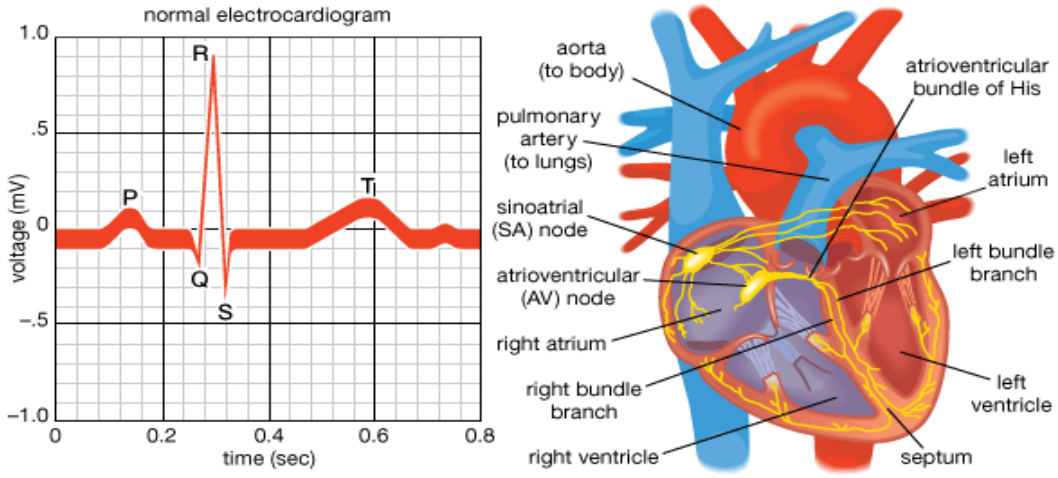


Figure 6 Typical ECG Waveform and heart Cardiac conduction system

The list of heart beats events shown in fig.7 which explain the generated heart signal parts that known as QRS complex: Atrium begins to depolarize, Atrium depolarizes, Ventricles begin to depolarize at apex Atrium repolarizes, Ventricles depolarize, Ventricles begins to repolarize at apex, and Ventricles repolarize.

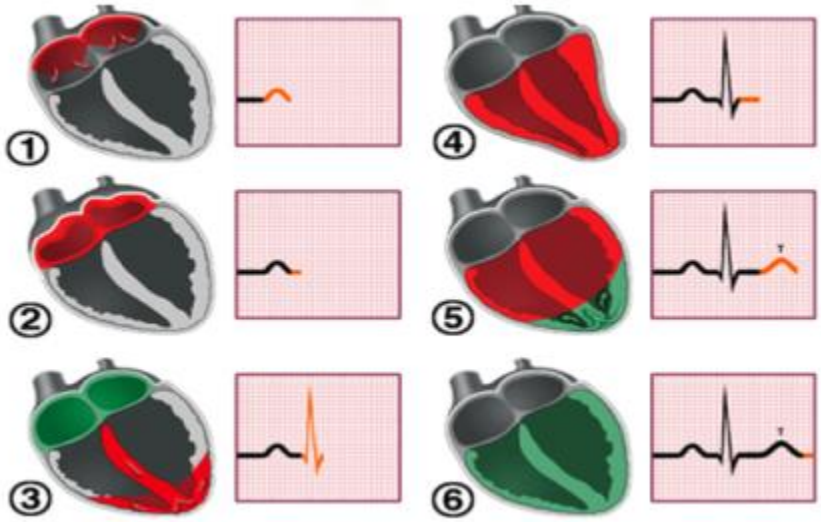


Figure 7 Myocardium electrical activity

Heart beat rate measured by calculated the pulse of the body. The pulse rate measured at any point on the human body where the artery pulsation is transmitted to the human surface by pressuring it with the index and middle fingers [15]. The heart rate based ECG is accurate method, but it is expensive the method can be used for heart rate measurement is an optical transmitter receiver method. Each heart beat the blood density will increase in the finger cause a decreasing power of light received by the IR sensor. The fig.8 shows

the tissues diagram that will participate to the received signal. The IR sensor will pick up AC signal and DC components received from other non- pulsing tissues and surrounding light levels therefor filter circuit will be needed. The variance in receiving light levels will be causes varying resistance of the IR sensor. The varying in resistance causes varying voltage output [16].

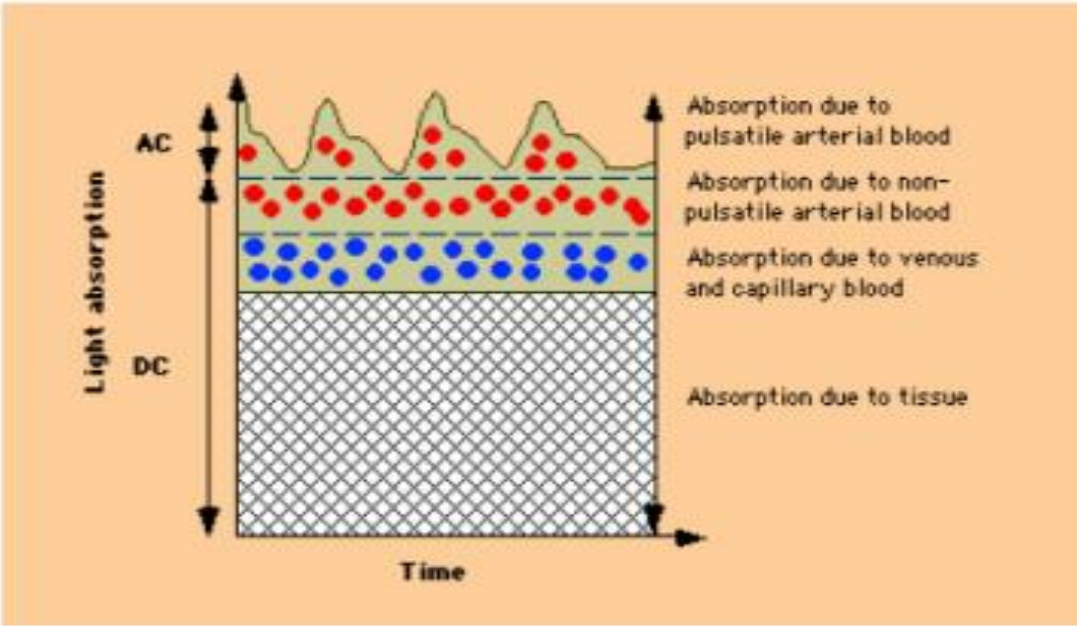


Figure 8 Pulsatile index finger tissues

Human Body Temperature Measurement

The human body temperature different from one person to another because it depends on human age, exertion, infection, sex, and time of day, the typical temperature of human is 37°C, there are various methods for body temperature measurement such as in the anus, under arm (axillary), or in the mouth [17][18]. Axillary temperature measurement is the simple and safe method for measure the temperature of human body.

Proposed Health System Design

The proposed health care system in this research consist of heart beat rate sensor and temperature sensor used for measuring the patient status based microcontroller board which can display the patient data on LCD screen and sent it to the patient's smart phone via Bluetooth. An Android application on the patient's smart phone read data from microcontroller and sent it to the patient relation person (family or doctor) as SMS, E-mail, and its location on a Google map.

1) Heartbeat Rate Sensor

The infrared optical sensor has been used measure the variation of blood volume in finger with each heartbeat, which depends on oxyhemoglobin molecules that can absorb the IR signal. The detector consists of IR transceiver and filter amplifiers the finger position on the sensor shown in fig.9. The intensity of IR reflected depends on blood volume in finger with each beat the alternating of reflected signal can produce pulses. The detector consists of two stage band pass filter with (0.5HZ-2.34HZ) cut off frequency where can be measure from (30bpm) to (140bpm) as shown in eq.1 and the output signal amplitude at the millivolt level therefore amplifier gain (101) used as shown in eq.2. The output level from filters altered between (0v, and 0.35v) therefore a zero cross detector used to convert levels between (0v, and 5v). The active filters used operational amplifier LM324 as shown in fig.10, and the component details shown in Table.1.The output signal of detector for patient on oscilloscope shown in fig.11 (a and b).

$$cut\ off\ frequency = \frac{1}{2\pi RC} \qquad (1)$$

$$gain\ of\ each\ stage = 1 + \frac{Rf}{Ri} \qquad (2)$$

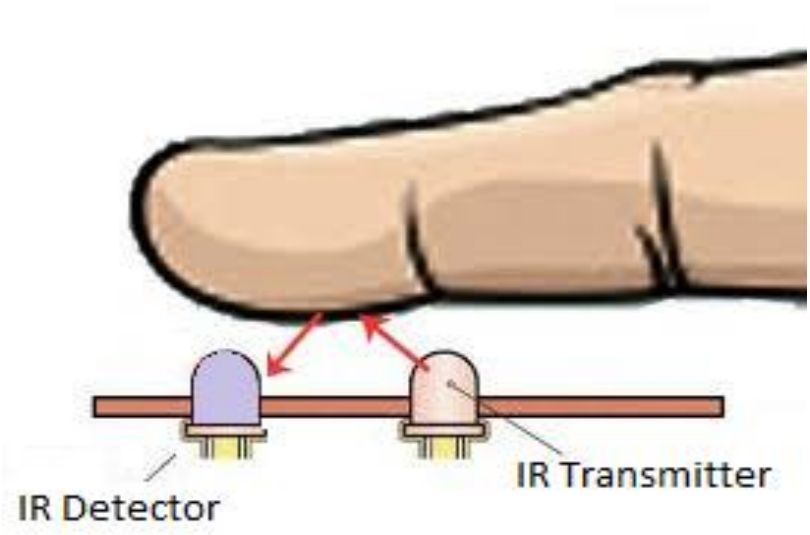


Figure 9 Finger position on IR sensor

2) Temperature Sensor

Human body temperature measured by using LM35 transducer, it is an analog sensor produce an analog output voltage signal related to centigrade with resolution (±10mv/°C) and range (-50°C to +150°C) the output from sensor connected to 10 bits ADC of microcontroller.

3) System Hardware

The hardware circuit of the healthcare system consists of microcontroller PIC16F877A, temperature analog sensor (LM35), infrared heartbeat sensor, 16X2 liquid crystal display, and HC-06 Bluetooth, the circuit diagram of proposed health care system shown in fig.12. This circuit connected to smart phone via Bluetooth then transfer patient data over GPRS to the destination (doctor or family).

4) System Software

There are three software used in proposed healthcare system one for microcontroller by using microC programming language and the two other android application programs one for the patient and the another for doctor or family by using the Android SDK and Java (JDK) as shown in fig.13(a, b, and c). The flow chart of each application shown in fig.14, and fig.15.

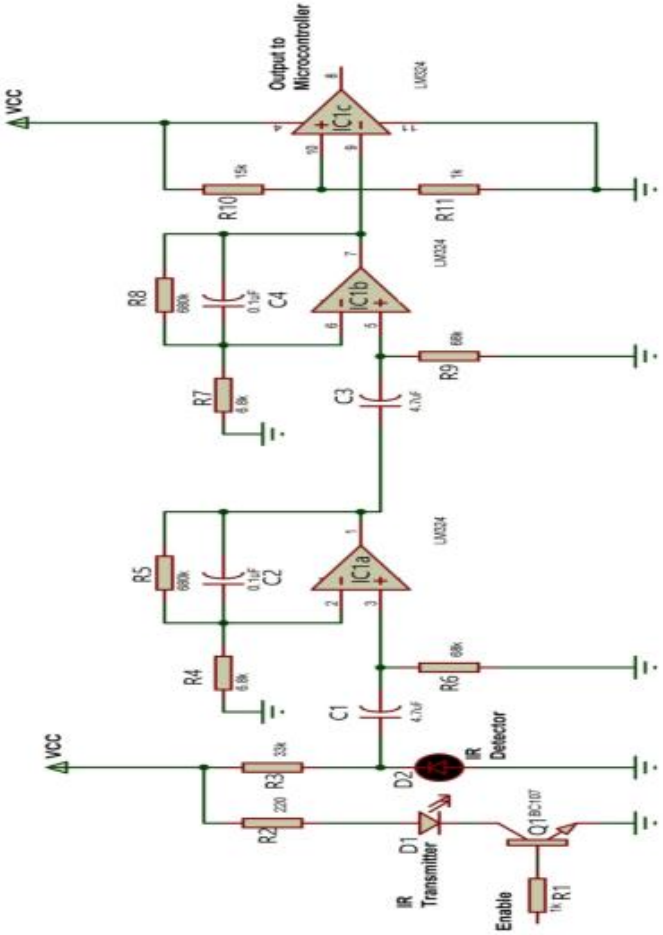
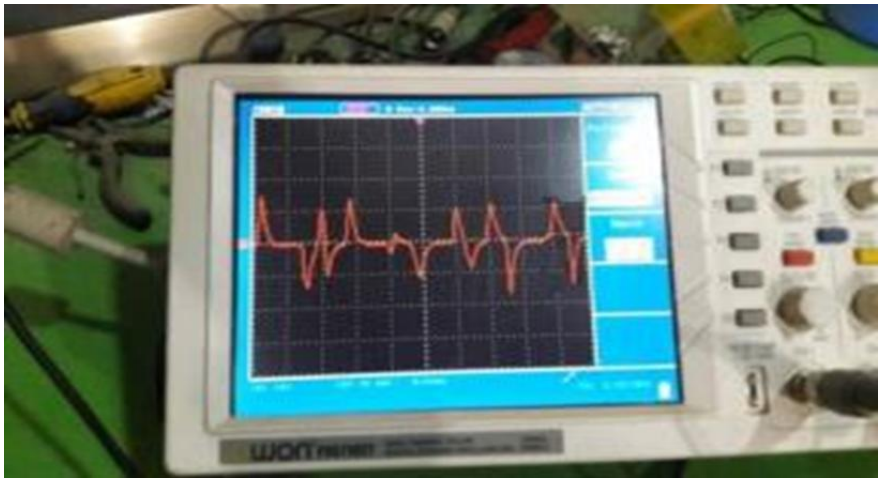


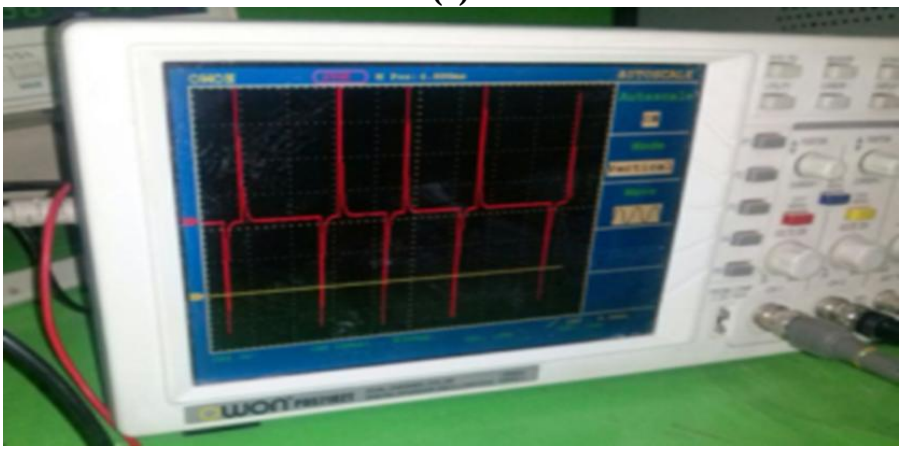
Figure 10 IR pulse sensor circuit diagram

Table 1 IR pulse rate sensor components

Component	Value
R1, R11	1KΩ
R2	220Ω
R3	33KΩ
R4, R7	6.8KΩ
R5, R8	680KΩ
R6, R9	68KΩ
R10	15KΩ
C1, C3	4.7µF
C2, C4	0.1µF
D1	IR transmitter
D2	IR receiver
IC1	LM324
Q1	BC107



(a)



(b)

Figure 11 IR pulse sensor output on oscilloscope for patien (a) without zero cross detector (b) with zero cross detector

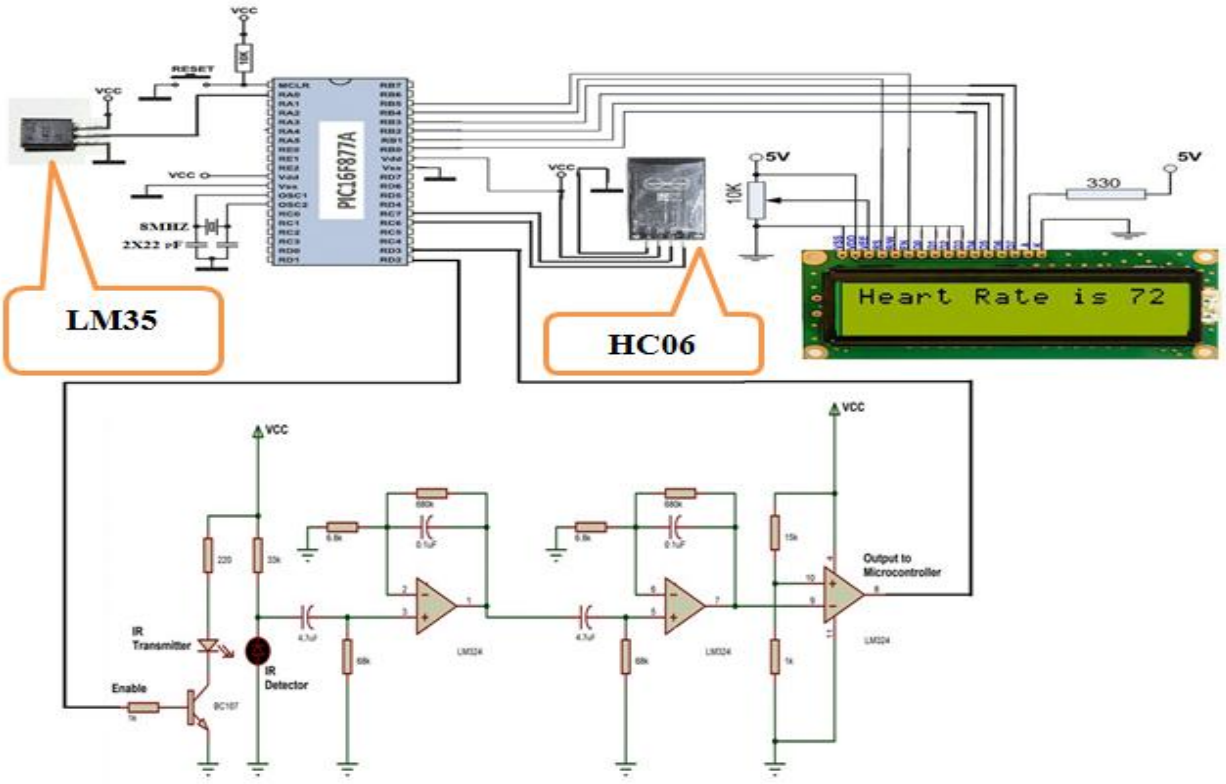


Figure 12 Proposed health care circuit diagram

Figure 13(a): The android application of patient

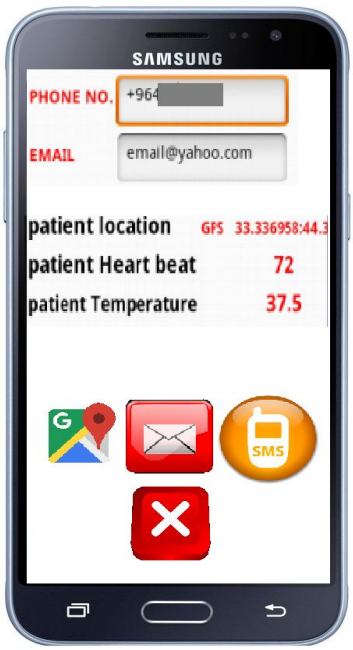


Figure 13(b): The android application of family or doctor

Figure 13(c): The google map location of patient

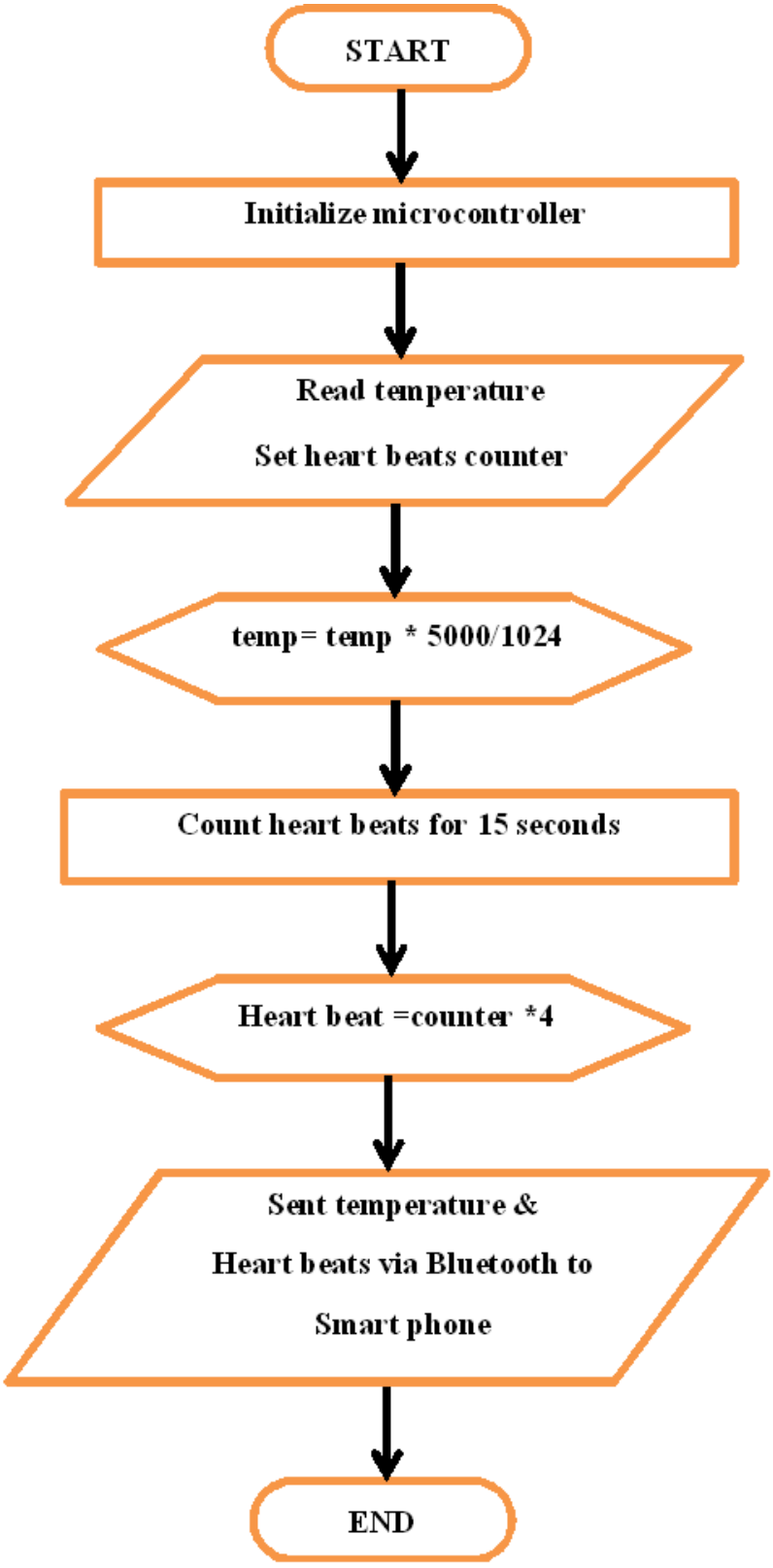


Figure 14 The microcontroller flowchart of health care system

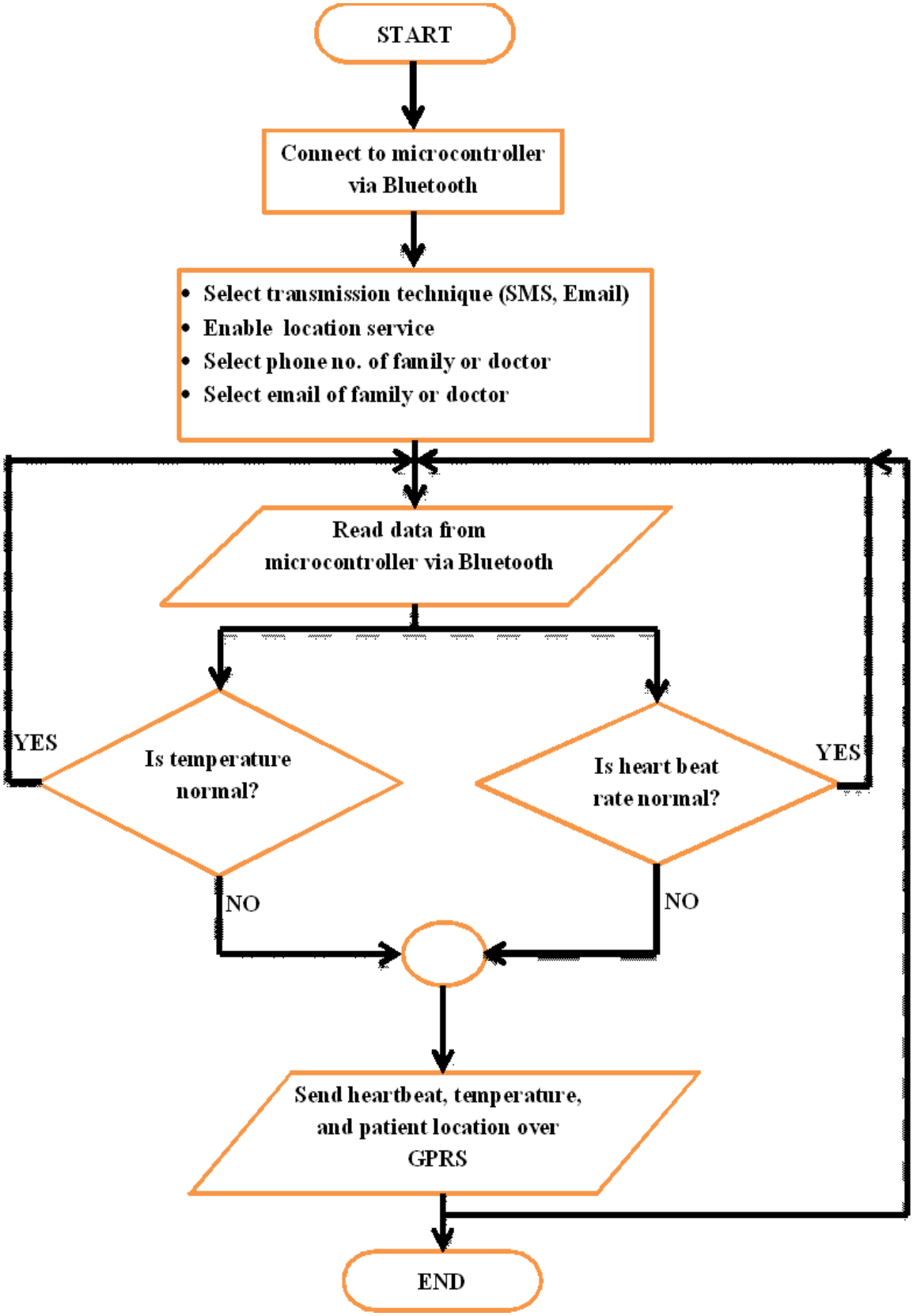


Figure 15 The patient android appliction flowchart of health care system

Conclusions

The proposed health care system has been designed and implemented with low cost can transmit the patient information based on GPRS technology by using smart phone and microcontroller PIC16F877A, if any abnormal signal from patient the health care system send SMS message or Email with GPS position to the doctor or family.

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