System design

3.1 Overview:

In this chapter discusses the basic design of the three measuring sensors heart rate, blood pressure and temperature of the patient. The complete system design will be highlighted.

3.2 System block diagram:

The system is used for measuring continuously automatically the values of the patient's important physiological parameters such as body temperature and pulse rate. The design of Wireless patient monitoring system is divided into two parts: Hardware & Software. The hardware is consisting of two sub units - Transmitter & Receiver. The Transmitter unit is consisting of Microcontroller, blood pressure, heart rate, temperature lm35, Power Supply, LCD, GSM modem and ASK. The Receiver unit is consisting of computer and ASK.

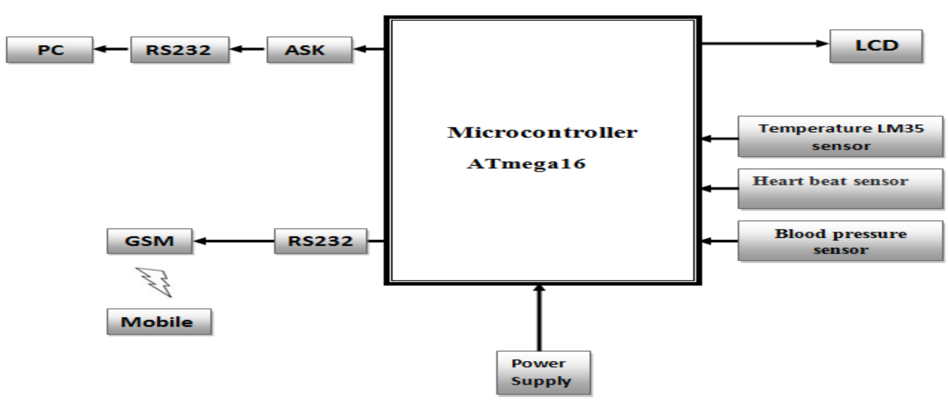


Figure (3-1): Block Diagram for System

The Microcontroller AT mega 16 Unit: The inbuilt ADC receives analog data from sensors and converts it to digital data then passes it to the microcontroller. The sensors continuously sends data from the distant site.

3.3 Temperature measurement of the patient:

Temperature senses at a rate 10 ml volts per degree Celsius, where the is activated ADC in range of 0-5V, thus the temperature value appears on LCD and send to the mobile through SMS, also send to the computer by wireless technique (ASK) , The message contain temperature of the patient in a normal or in abnormal status .

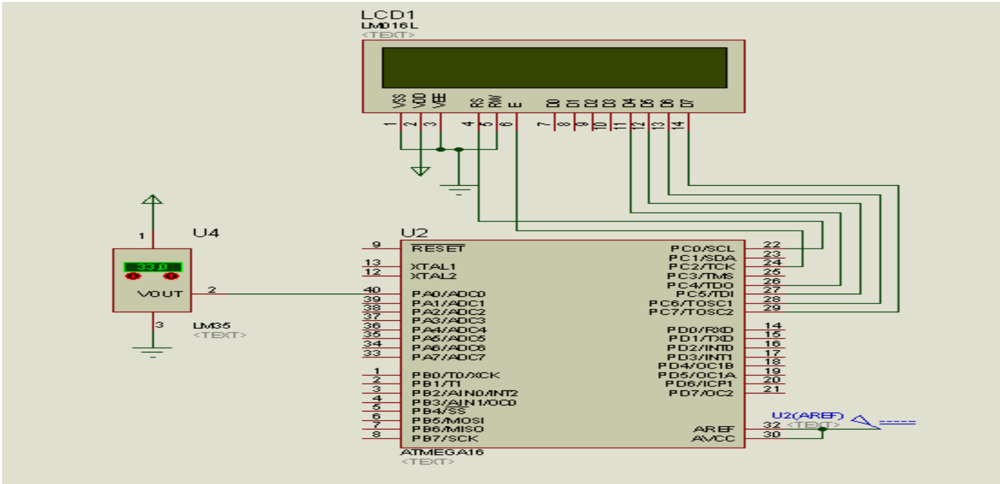


Figure (3-2): Lm35 measurement

The normal temperature of the human body between 25-37 °C.

Equalization of the voltage conversion to ° C:

If one ml volts gives one degrees Celsius.

If x volts gives y ° C.

Beat and reverse the equation get the following:

(1 * x V) / 10 ml volts = y temperature centenary.

After the abbreviation value equation becomes the following:

100 * x volts = y ° C.

3.4 Measuring heart rate:

This circuit describes a microcontroller based heart rate measurement system that uses optical sensors to measure the alteration in blood volume at fingertip with each heart beat. The sensor unit consists of an infrared light-emitting-diode (IR LED) and a photodiode, placed side by side as shown below (3-3). The IR diode transmits an infrared light into the fingertip (placed over the sensor unit), and the photodiode senses the portion of the light that is reflected back. The intensity of reflected light depends upon the blood volume inside the fingertip. So, each heart beat slightly alters. The amount of reflected infrared light that can be detected by the photodiode. With a proper signal conditioning, this little change in the amplitude of the reflected light can be converted into a pulse. The pulses can be later counted by the microcontroller to determine the heart rate. The signal conditioning circuit consists of two identical active low pass filters with a cut-off frequency of about 2.5 Hz. This means that the maximum measurable heart rate is about 150 bpm. The operational amplifier used in this circuit is MCP602, a dual OpAmplifier chip. It operates at a single power supply and provides rail-to-rail output swing. The filtering is necessary to block any higher frequency noises present in the signal. The gain of each filter stage is set to 101, giving the total amplification of about 10000. A 1 uF capacitor at the input of each stage is required to block the DC component in the signal. The equations for calculating gain and cut-off frequency of the active low pass filter are shown in the circuit diagram. Figure (3.4) shows the two stage amplifiers/filters provide sufficient gain to boost the weak signal coming from the photo sensor unit and convert it into a pulse.

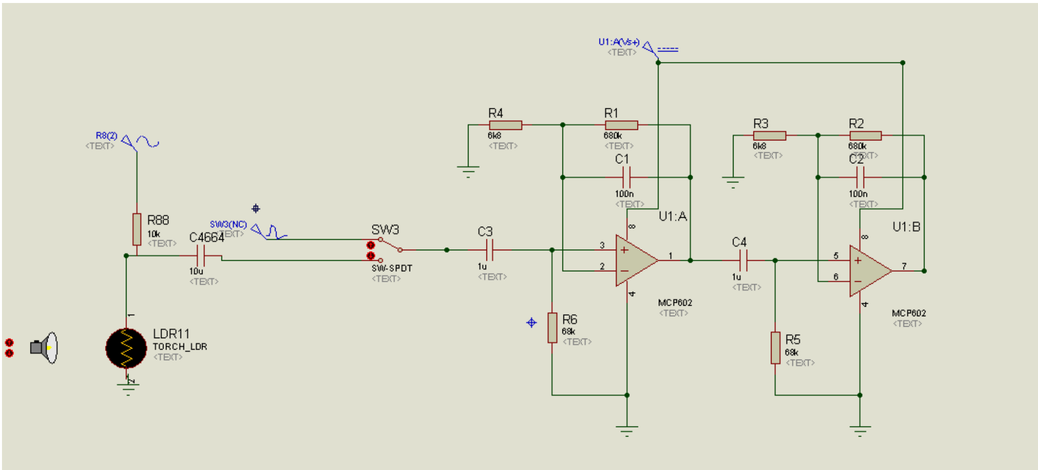


Figure (3-3): circuit measuring heart rate

The equations of circuit: Gain of stage one = 1 + R1 / R2, This means that 101 times magnification and that compensation in the values of the resistors. The same magnification factor in the second magnifier, a 101 times.

Gain of stage second = 1 + R1 / R2

Cutoff frequency of this circuit:

Cutoff frequency = 1 / (RF * CF * 2 * pi).

This equation compensation in intensive c1, c2, R1, R2 each speaker separately, we find that the frequency is 2.5 Hz, for C3, C4 band pass filter.

In this circuit the device calculates the time between two pulses consecutively and find out the time of the impulse first to the second, where this time is the difference between the pulses time and know the number of pulses per unit of seconds have is inverted time of the two pulses are the pulses hit in 60 to give readers per unit time. The maximum amount of time between the two pulses is 2 seconds where the microcontroller to wait two seconds to ensure that the period may be the biggest in what could be a 2 second.

The following figure (3.4) shows the Clock generator inside to microcontroller so that the microcontroller calculates the time between pulses within a period of a maximum of 2 seconds and calculate the pulses / sec where inverted time and hit that rate in the 60 to give the rate per unit time in Minutes and so on are display this value on the LCD and send through SMS and and GUI (by ASK). See the figure (3-4).

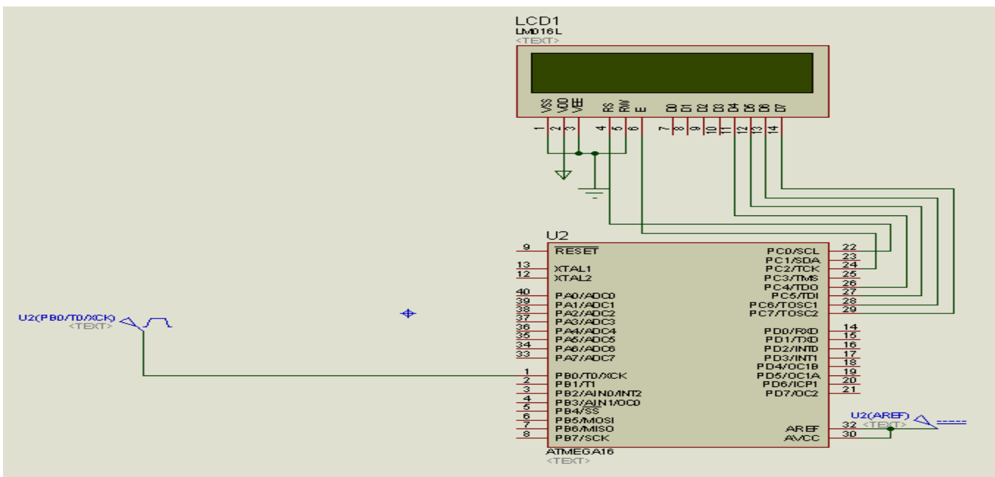


Figure (3-4): Clock generator inside to Microcontroller

3.5 Measurement the blood pressure of the patient:

Contraction and relaxation of the ventricles in the heart lead to maximum (systolic) and minimum (diastolic) blood pressure values in the aorta as well as other arteries. Typical systolic and diastolic pressure values of 120/80 mm Hg. The mean arterial pressure is approximately 93 mm Hg.

Mean arterial pressure equation:

Mean Arterial Pressure = diastolic pressure + [1/3* Pulse Pressure]

Pulse Pressure = systolic Pressure - diastolic pressure

The Microcontroller is the largest value measured where it represents systolic and also lower value measure which diastolic and are bringing this great and minimum values to how much pressure as it depends on the proportion of the magnification-in amplifier and sensitivity of sensor .and approximately the 5-volt corresponds to a pressure of 240, 0 volts corresponds to a pressure of 0, thus become a value calculated pressure is then displayed on the LCD then sent through SMS and GUI (by ASK).

3.6 Blood Pressure Sensor circuit:

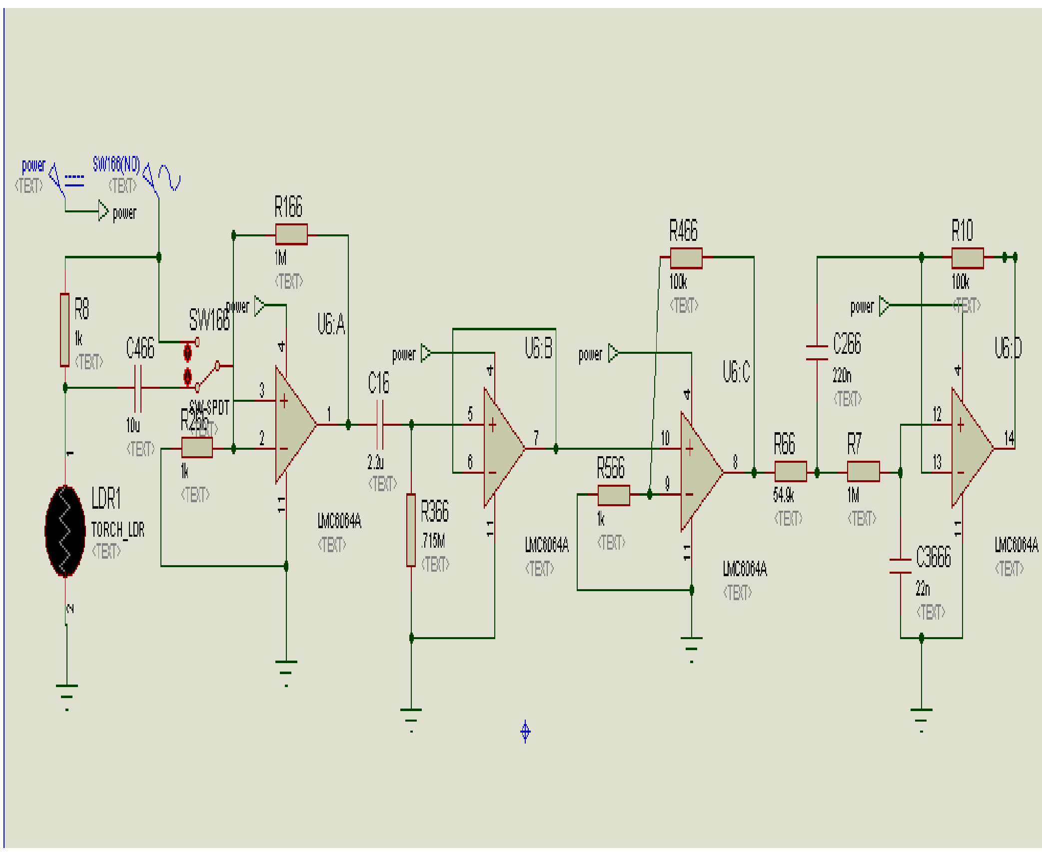


Figure (3-5): Blood Pressure Sensor circuit

The blood pressure circuit can be divided by the four stages, at any stage there is operational amplifier. The switch is used to switch between photo resister and sine wave signal, which it is input to the first stage: the amplifier is added to the system to increase the gain of the signal further.

The gain here is set to 1000. First Order High Pass Filter at the next stage in the simulation circuit is a first order high pass filter that filters out DC components of the signal and rejects frequencies below 0.1 Hz as equation $\text{gain} = -(\text{RF}/\text{RIN})$ which is set as its cut-off frequency.

Second Stage: the amplification added to the system to increase the gain of the signal further, the gain here is set to 100.

Second Order Low Pass Filter is a four stage which is a low pass filter added at the last stage of the circuit. It is a second order Butterworth filter with a cut-off frequency at 10 Hz. Therefore, it rejects unwanted frequenciesabove10Hz as equation $\text{Fc}(1/2 * \text{pi} * \text{R2} * \text{c2})$ reducing noise. After any end stage the output is shows on the oscilloscope , show the variation of the signal.

3.7 The main unit in the circuit:

The main unit in this circuit is Microcontroller, where the processes necessary to calculate the three values of the temperature, the heart rate and the blood pressure.

* The division of the time between them about 2 seconds to in order read on the arrangement, and then will be displayed on the LCD and to be sent to SMS & GUI (by ASK) , see figure (3-6).

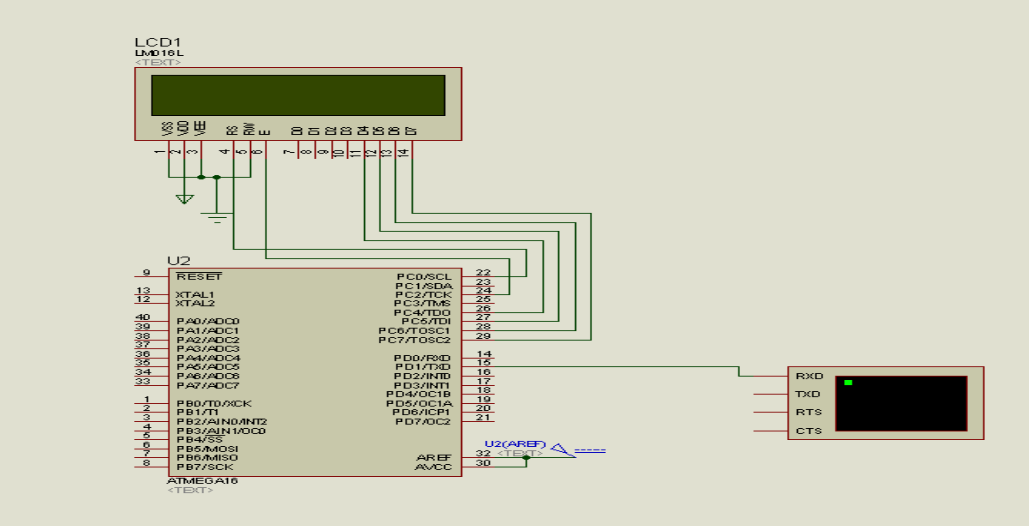


Figure (3-6): The Main unit in the circuit

3.8 Graphical user interface:

Finally, the data will be displayed on the (GUI) in a computer doctor and also on the mobile phone, the following figure (3- 7) illustrates the (GUI) receiving data from Microcontroller and the data will be in table as part of the database, see figure (3-7).

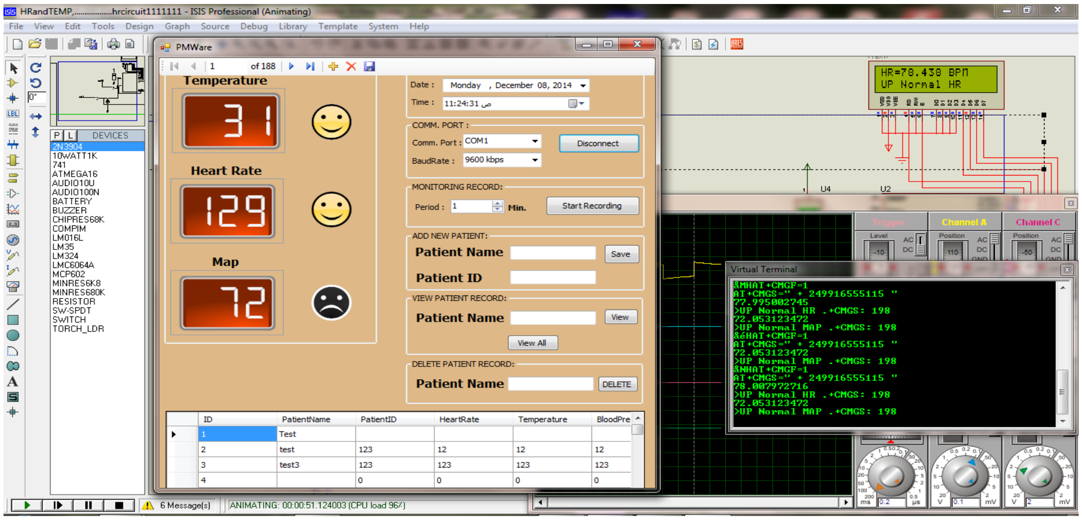


Figure (3-7): Graphical user interface

3.9 Flow Chart:

First Step: both values will be reset (Calc = 1 and Timer = 0).

Second Step: The unit test of the time is two seconds, If the time has become two seconds (calc=calc +1), and in this case will bet will depend on the measurement values of Calc:

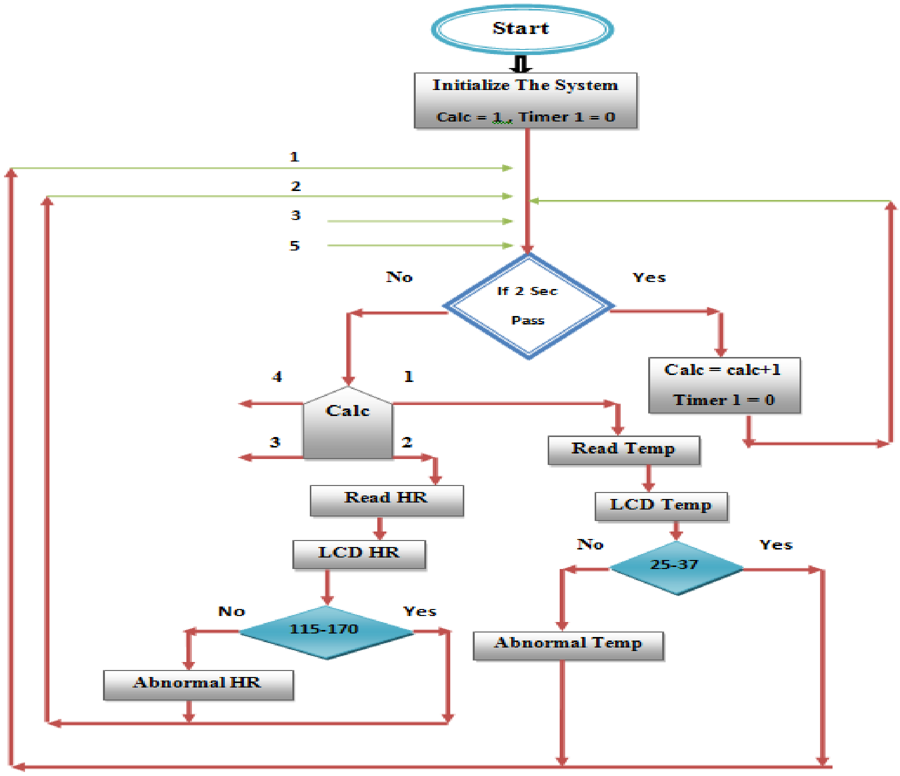
Case one (Calc = 1): Senses the temperature and displayed the value on the LCD, if the temperature is out of the range, then will be displayed the situation as abnormal status.

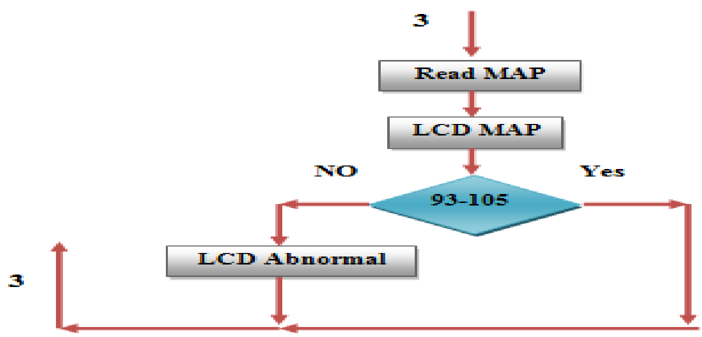
Case Two (Calc = 2): Senses the heart rate and displayed the value on the LCD, if the heart rate is out of the range , then will be displayed the situation as abnormal status.

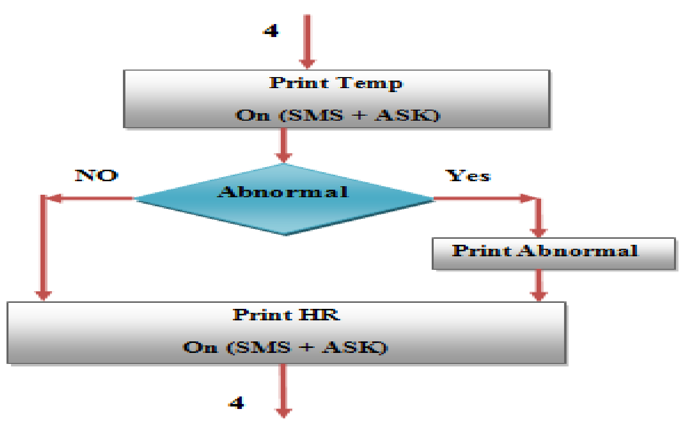
Case Three (Calc =3): Senses the blood pressure and displayed the value on the LCD, if the blood pressure is out of the range, then will be displayed the situation as abnormal status.

Case Four (Calc = 4): the Temperature value will be printed on the (SMS) and GUI (by ASK), if it is the out of the range, then will be displayed the situation as abnormal status.

The value of the heart rate printed on the (SMS) and GUI (by ASK), if the out of the range, then will be displayed the situation as abnormal status, then the value of blood printed on the (SMS) and GUI (by ASK), if the out of the range, then will be displayed the situation as abnormal status. Then it will return to the starting point.


Start
Initialize The System
Calc = 1, Timer 1 = 0
1
2
3
5
No
If 2 Sec
Pass
Yes
Calc = calc+1
Timer 1 = 0
4
1
Calc
3
2
Read Temp
Read HR
LCD Temp
LCD HR
No
25-37
Yes
No
115-170
Yes
Abnormal Temp
Abnormal HR


3
Read MAP
LCD MAP
NO
93-105
Yes
LCD Abnormal
3


4
Print Temp
On (SMS + ASK)
NO
Abnormal
Yes
Print Abnormal
Print HR
On (SMS + ASK)
4

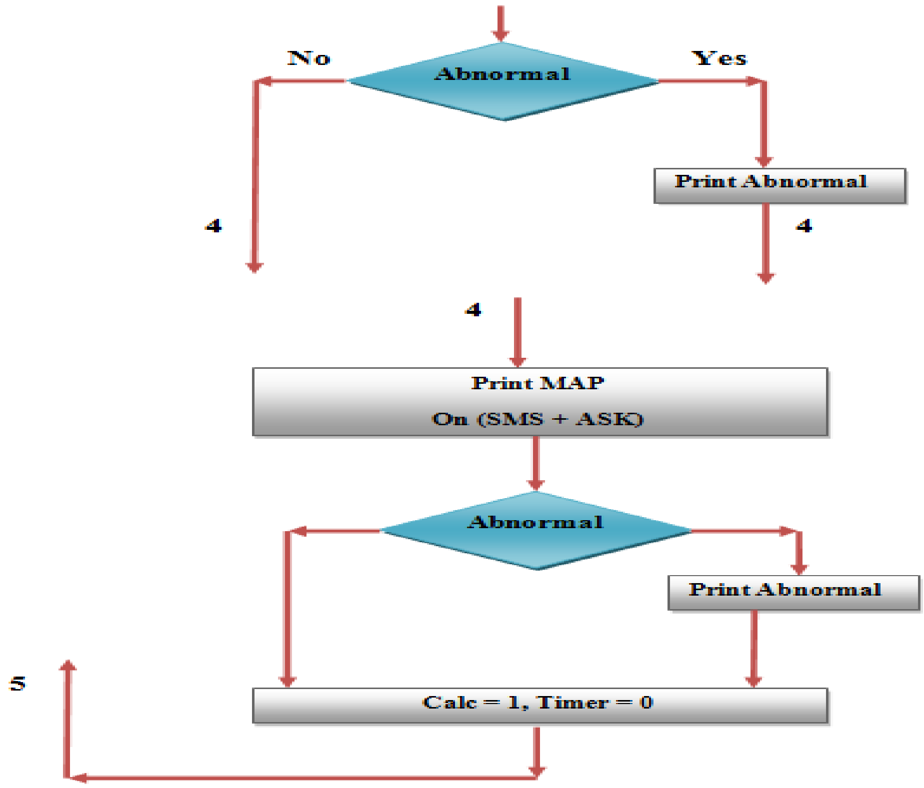


Figure (3-8): Flow Chart