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Instantaneous ECG And Heartbeat Counter With Audio/Video Indication

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Abstract: Hybrid is the catch these days and the interdisciplinary field has taken a new leap. As innovation continues to prevail in this world. So is the field of medical care, as it has also shown significant innovations to overcome the primitive methodology. Science and Technology plays a significant role in this. The confluence of two major disciplines viz. Medical and engineering has revolutionized the delivery of healthcare and medical procedures for diagnostic therapy, treatment and surgery. Especially in the field of cardiology. When referring to cardiology an ECG is the first thing that runs into our minds. The Electrocardiogram is a linear graph of the voltage fluctuations produced by the myocardium. The heart muscle possesses the property of automatic rhythmic contraction and relaxation. The impulses that arise in the conducting system spread throughout the myocardium- resulting in the excitation of the muscle fiber. This results in weak electric currents which spread throughout the entire body. These can be recorded by placing electrodes at various positions on the body and connecting them to an electrocardiographic apparatus. This paper aims at providing a method through which one can get an instant heartbeat rate within a couple of seconds rather than waiting for 60 seconds. It is a user-friendly device, hence can be easily handled by anyone.

Keywords: Heartbeat monitor, instantaneous Heartbeat monitor, Microcontroller 89c2051, LCD display, Clamp type sensor, Ultrasonic Gel. ECG signal. Heartbeat Rate

..

I. INTRODUCTION

The ECG machine has been one of the important tools made available by the engineers and scientists to the cardiologists. The electrocardiogram was introduced into clinical medicine at the turn of the century as a method of studying arrhythmias. As the time passed the machine became more reliable and portable.

In the 1930`s and 1940`s multitude of new electrocardiography leads were introduced. The standard 12 lead paper record, the leads being taken in sequence, was established in the 1950`s. A parallel science of vector cardiography grew up in specialist centers, in which cardiac currents were studied on oscilloscopes in more than one dimension at a time and with leads and electrodes appropriate to the three orthogonal or right angled axes. Unfortunately, because the human body does not behave electrically like a regular three dimensional solid, the vector – cardiographers could not agree on the best method that could be applied to the orthogonal electrocardiogram. The advent of minicomputers in the early 1970`s, provided additional incentives for computerized ECG monitoring. The last decade has witnessed considerable progress in this field would be sufficient to validate the above statement.

Present day ECG systems have become more complex. They are designed to provide ease of operation to the cardiologists and to give higher accuracy. In order to meet these requirements a personal computer (PC) is playing a major role in these systems. Because of the use of PC in ECG systems, it has become possible to obtain a good quality of ECG waveform and also to carry out its analysis for diagnostic purposes. A lot of further work is going on in this area because of the number of possibilities which are opened due to the use of PC's

Cardiac Cycle: Cardiac cycle for ECG is shown in figure. It is basic ECG waveform .the P Q R S T waves reflect the rhythmic electrical depolarization and repolarization of the myocardium
The heart of the project is micro controller 89c2051. The project is divided into different block. The heart beat is sensed by the clamp type sensor. Where the signal is achieved from clip type sensor is very low will be in micro volt. The maximum differential signal from the sensor at R wave is up to 1.2mv. Hence the signal should be applied to the instrumentation amplifier for the faithful amplification and S/N level improvement. The resistance of the circuit is decided by the gain of amplifier

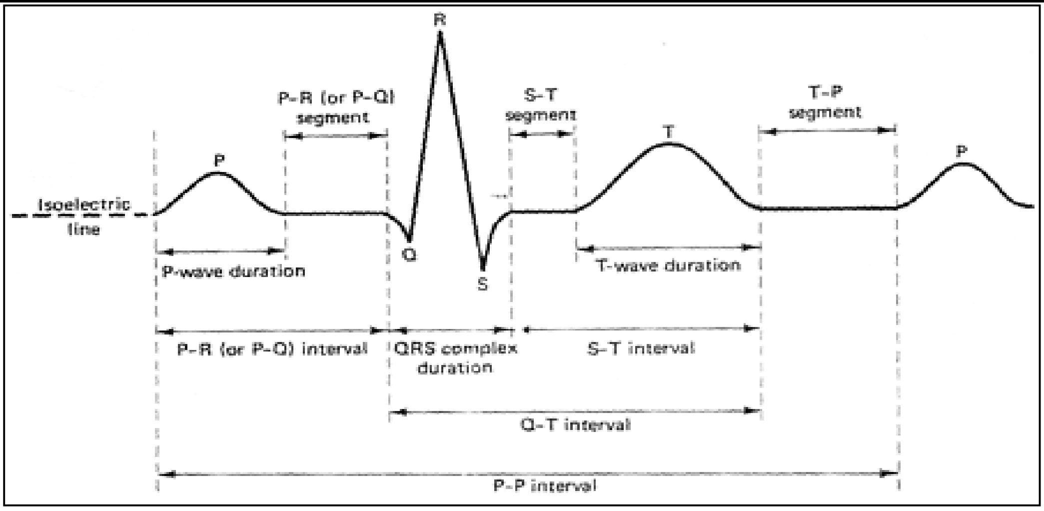

Figure 1

LITERATURE SURVEY

Heartbeat monitors have been undergoing innovation and development from many years. Many authors have developed and implemented distinct heart beatt monitors in different ways using microcontroller.

1. **Microcontroller Based Heart Rate Monitor, The International Arab Journal of Information Technology, October,2008**

Authors developed heart rate monitor using microcontroller PIC 16F8760 for collecting and store the data in a serial EPROM. This system has been tested on simulated ECG signals for distinct heart diseases. In this method, total memory size by storing three bytes for each heart rate variation was minimized by logical approach. Therefore, system's overall diagnosis time and amount of data is also minimized. So, final goal of an author is minimized hospitalisation and assistance costs.

2. **A Microcontroller Based Automatic Heart rate counting system from fingertip, Journal of Theoretical and Applied Information Technology, April, 2014**

A device designed by the authors is a durable, portable and flexible. Authors developed this handy, easy-to-use device which proven to be a good heart rate counting system but it has some improvements. They used ATmega8 microcontroller for the system.

3. **Heart Rate Measurement from the finger using low-cost microcontroller, IEEE Paper**

The system explains a design of an easy, low-cost microcontroller based heart rate measuring device. The output shown on LCD with video indication. The heart rate is measured using finger by optical sensors. This device has one advantage that it can be used by non-professional people at home and measure the heart rate easily and safely. In addition, this system also has improvements in certain areas such as a graphical LCD can use, sound can be added to the device

4. **Microcontroller Based Wireless Temperature and Heart Rate Read- Out, IOSR Journal of Engineering (IOSRJEN), Jan 2013**

Author developed an instrument has stable operation, simple structure and low power consumption. This instrument has been developed using transceiver module. It is helpful for finding signs of disease of patients earlier, because of this we can avoid the sudden death of patients. In addition, this technology is available for short distance communication and this distance is limited for 10 metres.

II. PPROPOSED METHOD

A spy robot with detection robot is needed to be designed to employ in peace support, operations and in the clearance of contaminated areas. For the safety of the operator, the robot is controlled with help of controller using the RF module.

The robot has an metal detector and smoke sensor fixed to it in order to locate the mines as well as to detect the smoke. After the detection of mine robot produces warning alert to the personnel nearby with help of a buzzer that is mounted on the robot. Therobot actuation is done with high powered DC motor supported by h bridge circuit that allows robot to move in any direction

BLOCK DIAGRAM

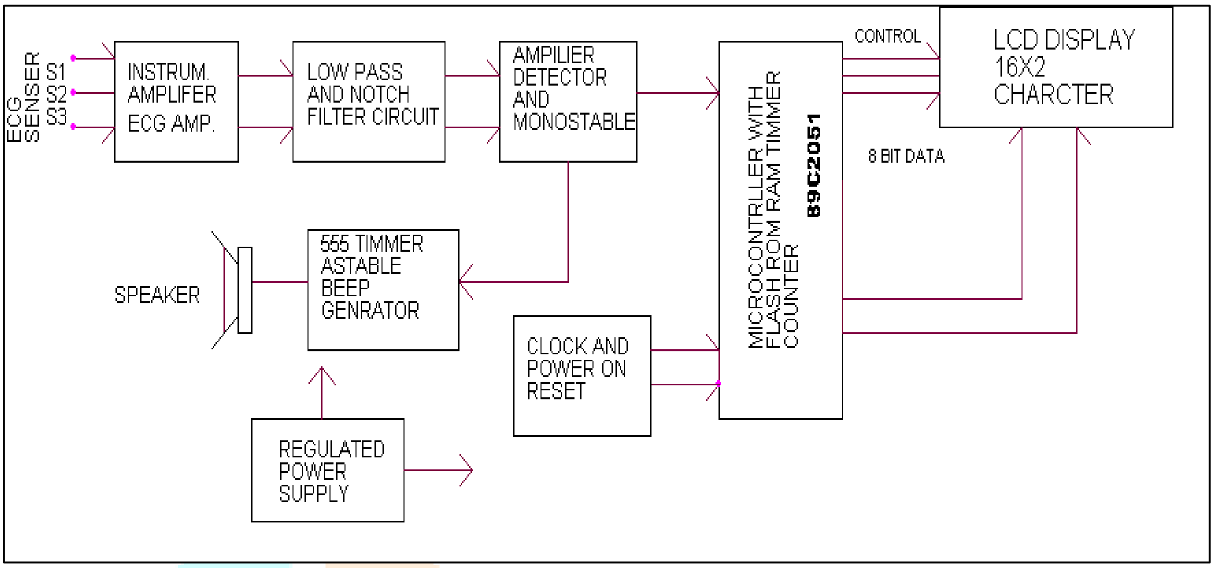

Figure 2

1) Low pass filter: : The signal from the clamp type sensor is initially applied to the RC low pass filter to the signal at low frequency only the signal at high frequency is highly attenuated.

2) **Instrumentation amplifier**: The signal from the sensor part is having very low magnitude. The faithful amplification of the signal is done with instrumentation amplifier by providing the gain up to 1000.

3) **Low pass filter:** The maximum frequency component of the ECG signal is having highest frequency up to 150 Hz. It is under the band of low frequency hence an active low pass filter having cutoff frequency up to 150 Hz is designed which attenuate the component of higher frequency.

4) **Notch filter.** The frequency component involved in the ECG signal having 50 HZ frequency of mains or source available. To avoid the noise interference of 50 Hz the active notch filter is designed.

5) **Amplifier:** The ECG signal is passed from the number of active block but till it is having low amplitude level and detection of the r wave will be typical. Hence to have additional amplification one inverting amplifier having gain up to 5 is added at last.

6) **Comparator & Beep generator**: This block detects the r wave signal from the spectrum of ECG signal it will compare ECG SIGNAL WITH FIOX dc REFERNEC. The reference May be varied as per our requirement to adjust the perfect detection of the R wave. The detected pulse of R wave is applied to the beep generator circuit to have an audio and visual indication.

7) **Micro controller:** The heart of the system is micro controller is 89C2051 which having flash Rom 2K and two I/O port. The LCD display is interfaced with the controller to observe the heart beat rate of a patient to be monitored

8) **Regulated power supply**. The analog hardware of the system requires dual 12V power supply and digital hardware requires the +5V power supply.

Software design:

LOGIC FOR THE PROGRAMMING:

Heart Beat Rate BPM is inversely proportional to the time duration between two R waves (T).
Heart Rate BPM = K/T;
Let Heart Rate = 70 beats/min Beats/sec = 70/60
Time period between two Heart Beats (T) = 60/70 sec
70 = K/ (60/70)
K = 60
Let the timer is generating the pulses of 1 kHz frequency then:
1 sec = 1000 pulses

K = 60*1000 = 60000

Heart Beat Rate BPM = K/T = K/N = 60000/N, Where N is counter value

Heart Beat Rate is inversely proportional to the counter value N.

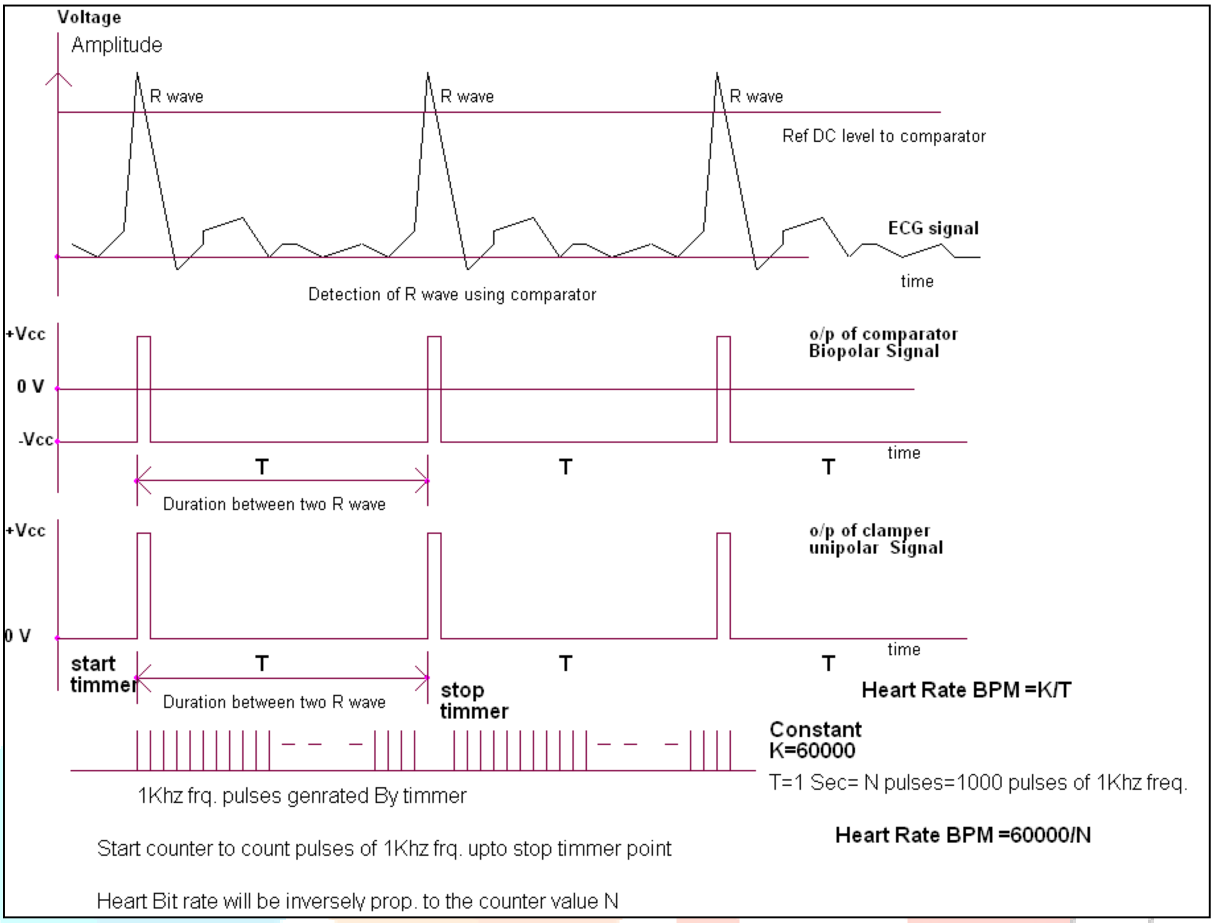

Figure 3

PROGRAM:

```
/*------------------Port Pins definitions------------------*/

#define    ENLCD      P3.0
#define    RSLCD      P3.2
#define    RWLCD      P3.1
#define    LCD_PORT   P1
/*******************************************/

bit UpdateSecFlag,UpdateMinFlag,pollstart;
unsigned char SecCount,TimerCount,heartrate;
unsigned int count,Runcount;
void LcdData(unsigned char);
void LcdCmd(unsigned char);
void InitLcd(void);
void LcdFunc(unsigned char lcdf_no,unsigned char val);
void DispMsg(char *m);
void delay(unsigned int );
void DispVal2(unsigned char Val2);
void DispVal3(unsigned int Val3);
void Initialise(void);
void RunActions(void);

/*******************************************/
#include "io51.h"
#include "biomed1.h"
#include "biomed2.h"
void main(void)
{
unsigned char tmp;
PS = 1;
delay(250);
delay(250);
Initialise();
delay(250);
delay(250);
InitLcd();
delay(255);
DispMsg(" HEART BIT     ");
delay(255);
LcdFunc(8,0xc0);
delay(255);
DispMsg("  MONITOR      ");
delay(255);
delay(255);
delay(255);
LcdFunc(1,0);          /* clear lcd screen */
while(1)
{
delay(255);
RunActions();
delay(255);
}
}        /* end of main*/

void Initialise(void)
{
unsigned char i;
SecCount = 3;    /*3c*/
RWLCD = 1;
```

```
AUXR = 0x00;
PCON = 0x00;
TMOD = 0x21;          /* Timer  1 autoreload (8bit)
*/
ET0 = 1;
TH0 = 0xfc;
TL0 = 0x20;
TCON = 0x00;
pollstart = 0;
count = 0;
EX1 = 1;
IT1 = 1;
EA = 1;
TR0 = 1;

i = 100;          /*load i with value 100*/
while((i--)>0); /*count down till i=0*/
}
}
void InitLcd()  /*function to initialize lcd*/
{
delay(150);        /* delay 24 ms > 15 ms */
LcdFunc(6,0x38);   /* set DL i.e 8 bits,N=1 i.e 2
lines,F=0 i.e 5*7 dots*/
delay(30);         /* delay  6 ms > 4.1 ms */
LcdFunc(6,0x38);   /* set DL i.e 8 bits,N=1 i.e 2
lines,F=0 i.e 5*7 dots*/
delay(5);          /* delay 600  us > 100 us */
LcdFunc(6,0x39);   /* set DL i.e 8 bits,N=1 i.e 2
lines,F=0 i.e 5*7 dots*/
delay(40);
LcdFunc(6,0x39);   /* set no. of lines , no. of bits ,
no. of dots */
delay(10);
LcdFunc(5,0x14);   /* set cursor display shift */
delay(10);
LcdFunc(4,0x0e);   /* set display on /off control
Setting ON,Cursor On,BlinkOff*/
delay(10);
LcdFunc(3,0x06);   /* set entry mode */
delay(10);
LcdFunc(1,0);      /* clear the display */
delay(12);
}


void LcdFunc(unsigned char lcdf_no,unsigned char val)
{
unsigned char dummy;
ENLCD = 1;        /* rs=0 r/w=0 en=0*/
RSLCD = 1;
//          RWLCD = 0;
LCD_PORT = 0x00;

switch(lcdf_no)
{ case(1):LcdCmd(0x01);     /* Clear Display */
break;
case(2):LcdCmd(0x03);     /* Return Home  */
break;
case(3):LcdCmd(val);     /* Entry Mode Set */
break;


void DispVal2(unsigned char Val2)
{
data unsigned char dsi;
dsi = Val2/10;
LcdFunc(9,dsi+0x30);
dsi = Val2%10;
```

```
LCD_PORT=0;
UpdateSecFlag=1;
Runcount = 0;
}

void delay(unsigned int lp_index)
{
unsigned char i;
for(;lp_index>0;lp_index--)    /*for the parameter passed
to the function*/
{


case(4):LcdCmd(val);      /* Display On/Off Control */
break;
case(5):val&=0x1c;        /*  Cursor or Display
Shift */
LcdCmd(val);
break;
case(6):val&=0x3c;        /*  Function Set */
LcdCmd(val);
break;
case(7):val&=0x7f;        /* Set CG RAM
Address */
LcdCmd(val);
break;
case(8):LcdCmd(val);     /* Set DD RAM
Address */
break;
case(9):
LcdData(val);
break;
}
ENLCD = 0;        /* en=0*/
return;
}


void LcdCmd(unsigned char cmd)
{
unsigned char tmp,dummy;
tmp = cmd;
LCD_PORT = tmp;
ENLCD = 0;
dummy++;
ENLCD = 1;
}

void LcdData(unsigned char ldata)
{
unsigned char tmp,dummy;
tmp = ldata;
LCD_PORT = tmp;
RSLCD = 1;
ENLCD = 1;
dummy++;
dummy++;
ENLCD = 0;
RSLCD = 0;
}

void DispMsg(char *m)
{
for(;*m;LcdFunc(9,*m++));       /*display the
contents of location pointed by m*/
}
interrupt [0x13] void PedDemandInterrupt (void)
{
EX1 = 0;
```

```
LcdFunc(9,dsi+0x30);
}

void DispVal3(unsigned int Val3)
{
data unsigned char dsi,dsj;
dsi = Val3/100;                /*hundreds value*/
LcdFunc(9,0x30+dsi);
dsi=dsj = Val3%100;
dsi = dsi/10;
LcdFunc(9,0x30+dsi);
dsi = dsj%10;                  /*units value*/
LcdFunc(9,0x30+dsi);           /*display units value*/
}

interrupt [0x0B] void T0_int (void)     /* Timer 0 Overflow
*/
{
unsigned char i;
TR0 = 0;
P3.4 = ~P3.4;
count = count + 1;
TH0 = 0xf0;
TL0 = 0x08;
TR0 = 1;
}
```

```
P3.5 = ~P3.5;
EX1 = 1;
if(P3.5)
{
TH0 = 0xf0;
TL0 = 0x08;
TR0 = 1;
}
else
{
TR0 = 0;
Runcount = count ;
count = 0;
}
}

void RunActions(void)
{
heartrate = 60000/Runcount ;
LcdFunc(8,0x80);
DispMsg("HEART BT MONITOR");
delay(255);
LcdFunc(8,0xc0);
delay(255);
if((heartrate>30)&&(heartrate<150))
{
DispVal3(heartrate);
DispMsg("      BPM ");
}
else
DispMsg("PULSE NOT DETECT");
}
```

III. WORKING

The ECG signal is achieved by applying it to the low pass filter . 150 Hz is the cutoff frequency of the LPF. The noise line of 50Hz is been deducted with the help of a not. The R pulses is detected through this notch filter. One more stage of amplifier is inserted and finally signal is applied to the comparator for the detection of R wave.. After detection of the R pulses the signal is applied to monostable multivibrator. The output of monostable is the sharp spike having very low on time with respect to off time. Via the sensor these signal are transmitted . The duration between two-conjugative pulses is inversely proportional to the heart beat rate. As the duration is long the heart beat rate will be low. And if the duration is low then the heart beat rate will be very high. The normal heart beat rate is varying from 70-120 bpm.

The conjugative pulses are applied to 89C2051. The LCD display is interfaced with 89c2051. Where the count of N is directly proportional to the duration between two pulses. This count N is used to divide the fix no. The ratio of this division is adjusted to be a heart beat rate. The counter, timer and division of two numbers are adjusted by software only. Heart beat rate is directly displayed on LCD display. The beep circuit is developed using 555 timer. The 555 timer is working in astable multivibrator mode. It is enabled or disabled by the output of the pulses coming from comparator.

LCD is used to display the data. LCD we have used is 16x2 that is 16 character 1 line, total 2 lines are there .We could have used a better resolution LCD but due to limitation of money and for project requirement 16x2 LCD is sufficient .This LCD has8-beat parallel interface. It is possible to use all 8 beats plus 3 control signals or 4beats plus the control signal it requires +5 volts

Figure 4

In the above figure 4 we are using a clamp type sensor which will help get the input which is the ECG signal. And ultrasonic transparent gel act as a agent to get better result.

IV. RESULTS AND SIMULATION

<u>Instrumentation Amplifier:</u>

The differential gain given by sensors is in mv. So for first stage differential amplifier we have to convert mv signal into volt level.So required total gain is 1000. According to the calculation of differential amplifier for fig. given below :-

Total gain of ckt is given by:-

Av = [1+2R1/R2]*R3/R4

Now for our ckt Av = 1000=100*10, Av1 = 100 & Av2 = 10

Av1 = 1+ [2R1/R2], Assume R2 = 1K.

100 = 1 + 2R1/1K hence R1 = 49.5K

Approximate available value in market is 51K.

Hence R1 = 51K ,R2 = 1KFor Av2 = 10 Let R3 = 4.7 K , Av2 = R4/R3 , 10 = R4/4.7 K ,hence R4 = 47 K , R3 = 4.7 K

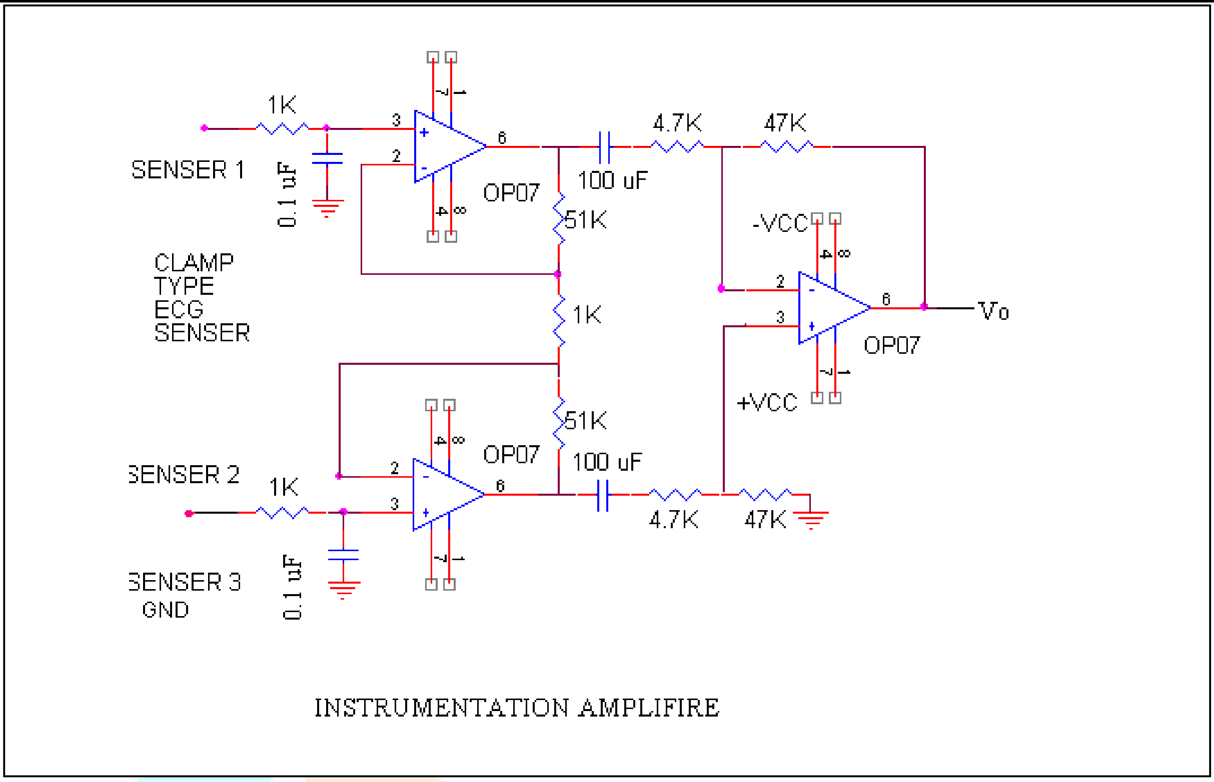

Figure 5

Low pass filter:-

We know that highest frequency component in ecg signal is 150 Hz.
Let us assume Fc=150 Hz.
Cut –off frequency = 1/2pi*RC
Now, we want Fc = 150 Hz,
Let C = 0.1 uF
So, 150 = 10^6/2pi*R*0.1
R = 10 K

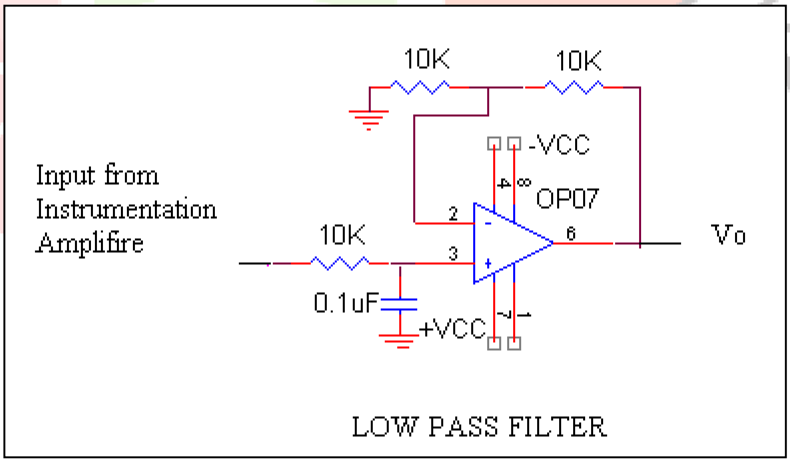

Figure 6

Notch Filter:

We have to remove the noise of 50 Hz which may appear due to the mains supply.
So, we have to design Notch Filter with cut off frequency of 50 Hz.
According to ckt of Notch Filter,
Fc = 1/2pi*RC,
assume C = 0.1 uF
50 = 10^6/2pi*R*0.1
R = 0.031*10^6
R = 31 Kohl,
nearer value is 33 Kohm
Hence R = 33 Kohm

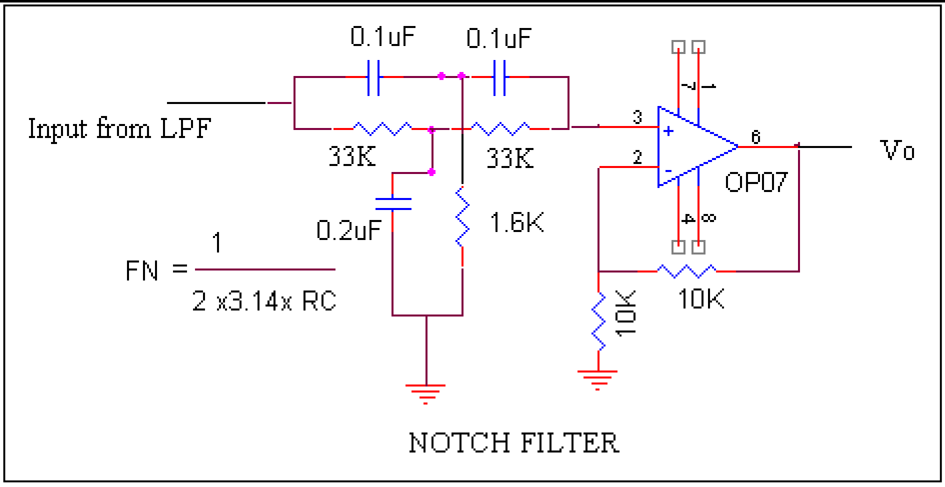

Figure 7

FINAL CIRCUIT DIAGRAM:

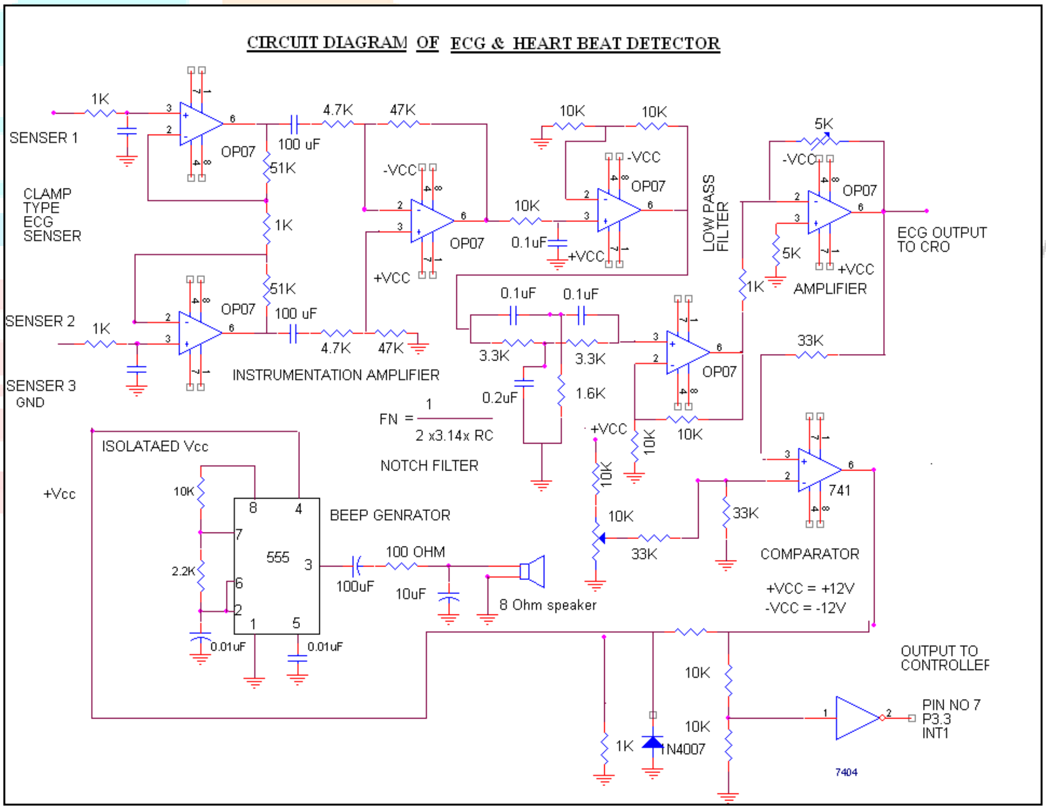

Figure 8

Result:

AGE	Time taken to Display Result on LCD	Heartbeat Rate
5	2.22 sec	103 Bpm
12	2.10 sec	94 Bpm
20	1.90 sec	74 Bpm
35	2.54 sec	89 Bmp
53	2.90 sec	69 Bpm
79	3.16 sec	95 Bmp

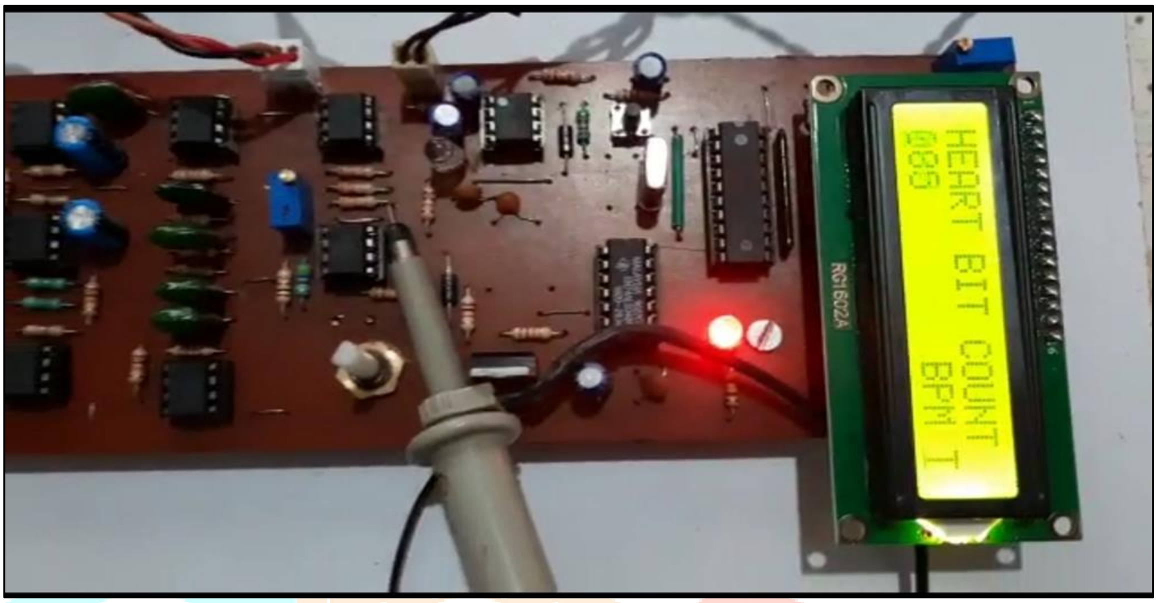

Figure 9

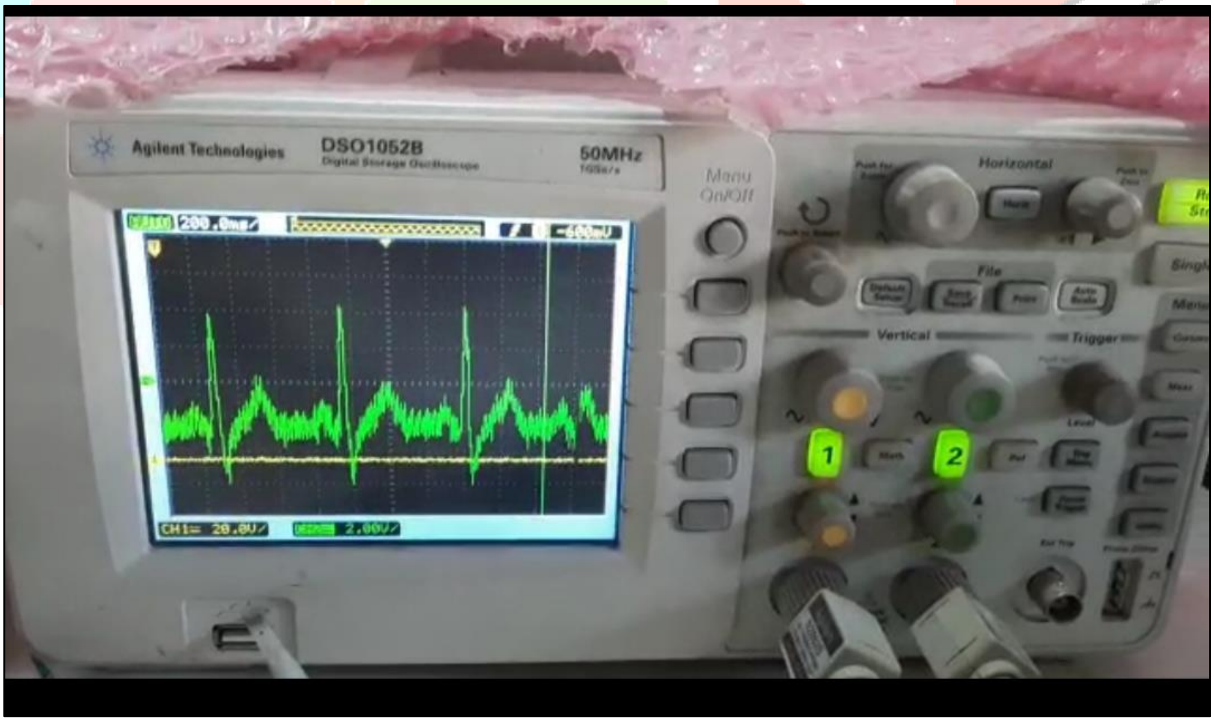

Figure 10

The table mentioned above has three columns. The first columns has a set of different ages, the second column is the time taken to display the result on the LCD screen. And the last column shows the heartbeat rate.

The fig 9 is the overlook of how the result will be displayed by the module.\

The fig 10 is the ECG signal with is been displayed on the LCD. And the signal shown is the replica of an ECG signal.

V. CONCLUSION AND FUTURE SCOPE

Conclusion:

The paper successfully provides a convenient, time saving and user friendly approach toward developing an instantaneous heartbeat monitor. The instantaneous factor is highly beneficial in a longer run as it saves a lot of time. And also the user friendly aspect also makes it readily convenient and easy to use, due to this, chances are that the market rate of the product will be profitable. Apart from this the goal of the paper was to put forward an instantaneous and user friendly approach, as this will be extremely crucial for an individual to keep track of the heartbeat rate, and hence this paper also promotes a healthy lifestyle by helping us to keep track of our hearts health .

Future Scope:

1. The interferences and noise include in the main sensed ECG signal can be minimized by the advanced signal conditioning technique like filters using AGC can be implemented.

2. Diagnosis of patient can be display with prediction of heartbeat rate i.e. Low blood pressure, High blood pressure by implementing the logic for the program of microcontroller.

3. The record of ECG signal, Heart bit rate can be stored using E-PROM IC's.

4. PC interfacing can be done for displaying the ECG signal of patient on monitor screen.

5. Selecting the proper sensors, the movement of cardiac valves (LUB-DUB and MURMUR sounds) can be amplified.

6. The whole Biomedical monitoring can be done i.e. Different parameters like body temperature; blood pressure can be collectively measured and displayed.

VI. REFERENCE

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