Embedded Systems Project (EE3401)

HEARTBEAT MEASUREMENT USING 8051 MICRO CONTROLLER

Electrical Engineering Project submitted to the

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in

Electrical Engineering

By

NARA RAMU NAIDU (121EE0906)

NARA LAKSHMAN NAIDU (121EE0907)

BANOTHU SWARUP (121EE0833)

Under the supervision of

Dr. Supratim Gupta

Department of Electrical Engineering

National Institute of Technology Rourkela

TOPIC: HEARTBEAT MEASUREMENT USING 8051 MICRO CONTROLLER

OBJECTIVE OF THE PROJECT:

The objective of the Heartbeat Sensor Project with the 8051 microcontroller is to create a simple yet effective system for monitoring and displaying heart rate. Using an analog heart rate sensor, the 8051 microcontroller reads the analog signal, converts it to a digital value, and displays the heart rate on an output device. This project aims to showcase the integration of sensor interfacing, analog-to-digital conversion, and basic display functionalities within an embedded system. It provides a foundation for understanding how microcontrollers can be employed in health monitoring applications.

COMPONENTS:

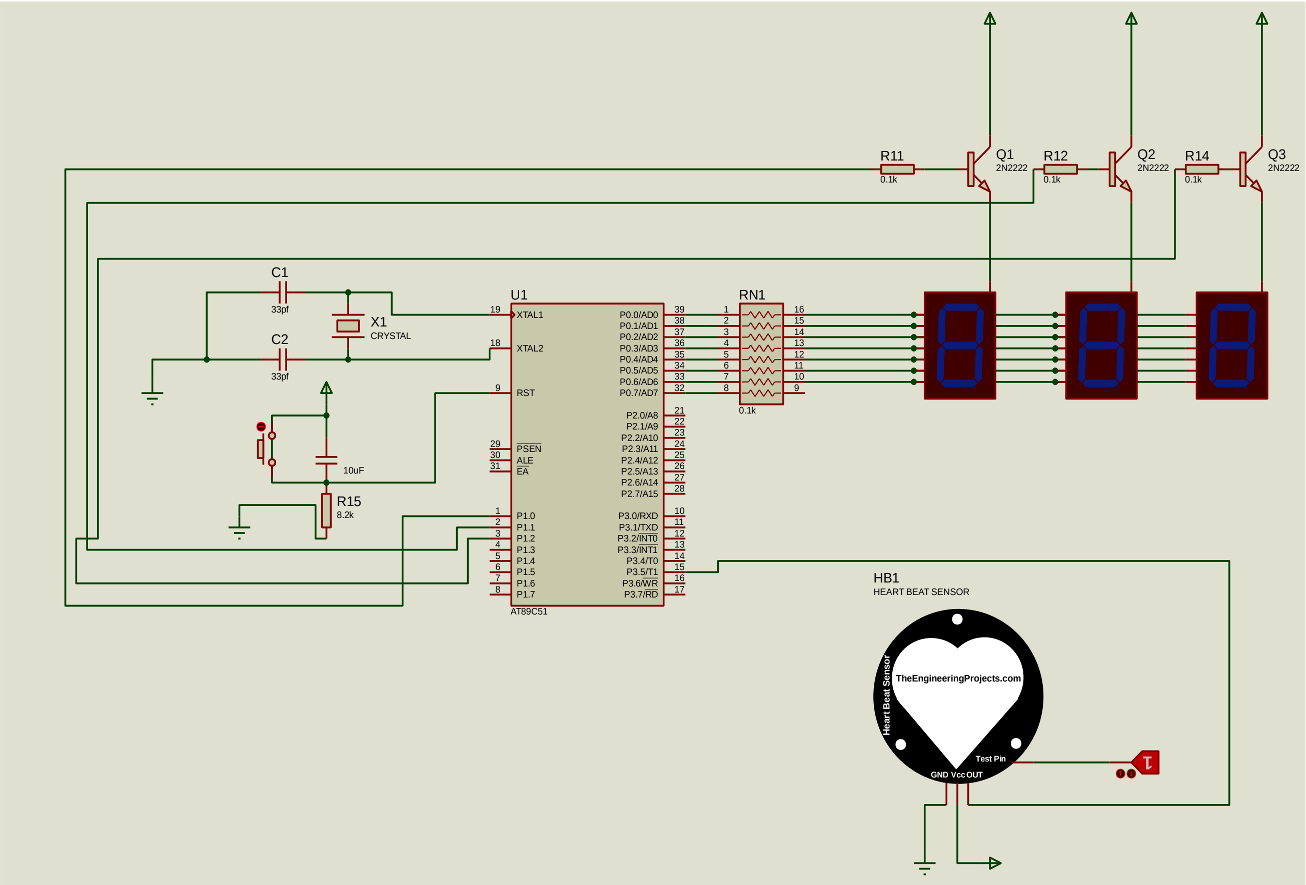
- 8051(AT89S51) MICRO CONTROLLER
- 8051 MC(AT89S51) DEVELOPMENT KIT
- HEARTBEAT SENSOR
- 7-SEGMENT DISPLAY (COMMON ANODE) - 3
- TRANSISTORS(2N2222) - 3
- RESISTORS - 0.1Kohm (10)
- BREADBOARD
- JUMP WIRES

CIRCUIT DISCRIPTION:

- Initially person will place their finger on heartbeat sensor, then this will sense the beat in the form of voltage variations and converts to the digital form. Need to give the test input as 1 and ground is given to the sensor.
- Output from heartbeat sensor is send to the 8051 micro-controller as input through p3.5 port.
- From p0.0 to p0.2 the outputs are connected to the 3 transistors for base terminals.
- Collector terminals is connected to the 5V supply and emitter terminals are connected to 7-segment display.

- Transistors take input from micro controller and accordingly these will turn ON/OFF to display the digits in 7 segment displays.
- 3 7-segment displays are connected in series and to the micro controller through p0.0 to p0.7(output signal from micro controller)
- COM of 7-segment display is connected to transistors which allows to blink on/off.
- Resistors are used between 7-segment display and micro controller of value 100ohms to decrease the voltage.
- So, finally the signal came from heartbeat sensor goes to micro controller then goes to transistors and 3 7-segment displays which displays the heart rate (beats per minute) with 15 second's delay.
- When power is switched ON, the indicator LED D4 will glow and continues in that state. Now place your fingertip over the sensor and adjust preset R14 so that the LED D4 starts blinking. After you get the LED blinking, reset the power and wait for 15 seconds. The display will show your heart rate in beats per minute.

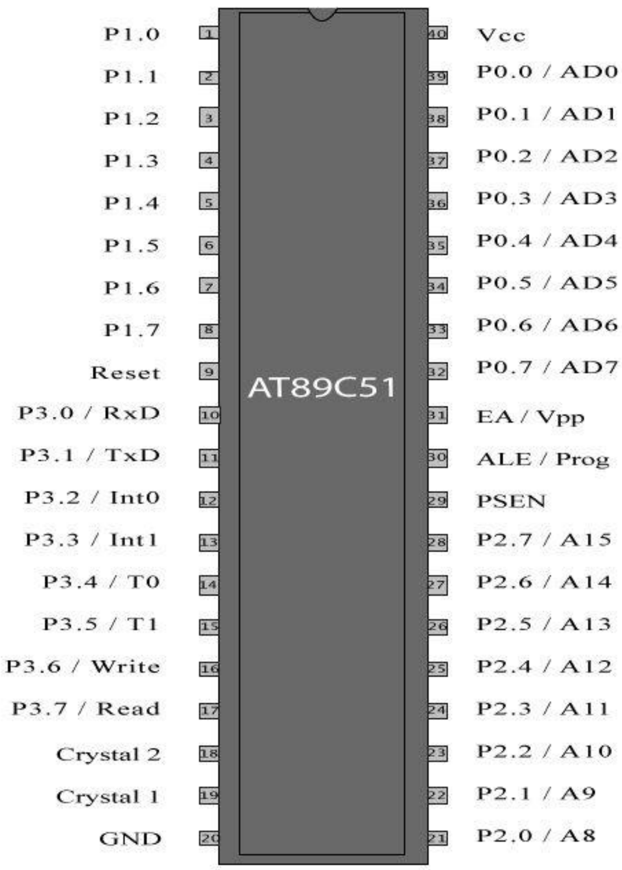
SCHEMATIC CAPTURE:



COMPONENTS DISCRIPTION:

1)8051–Micro controller:

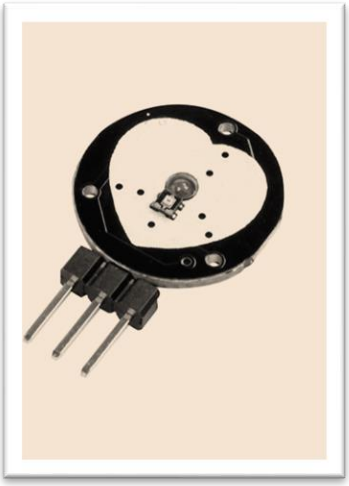
- The 8051 microcontroller was designed by Intel in 1981. It is an 8-bit microcontroller. It is built with 40 pins DIP (dual inline package), 4kb of ROM storage and 128 bytes of RAM storage, and 2 16-bit timers.
- The 8051 Assembly language programming is based on the memory registers. If we want to manipulate data to a processor or controller by performing subtraction, addition, etc., we cannot do that directly in the memory, but it needs registers to process and store the data.



2)Heartbeat Sensor:

- Photoplethysmography is the process of optically estimating the volumetric measurement of an organ. Pulse oximetry, cardiovascular monitoring, respiration detection, heart rate monitoring etc. are a few common applications of photoplethysmography.

- Let's see how photoplethysmography is used to measure heart rate from the fingertip. The volume of blood inside the fingertip rises during diastole, or expansion of the heart, and falls during systole, or contraction of the heart. If you could somehow count the number of pulses in a minute, it would be the heart rate in beats per minute (bpm). The resulting pulsing of blood volume inside the fingertip is precisely proportional to the heart rate.

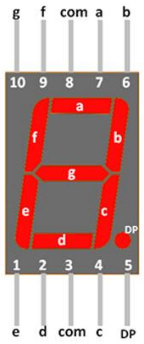


Working of Heartbeat Sensor:

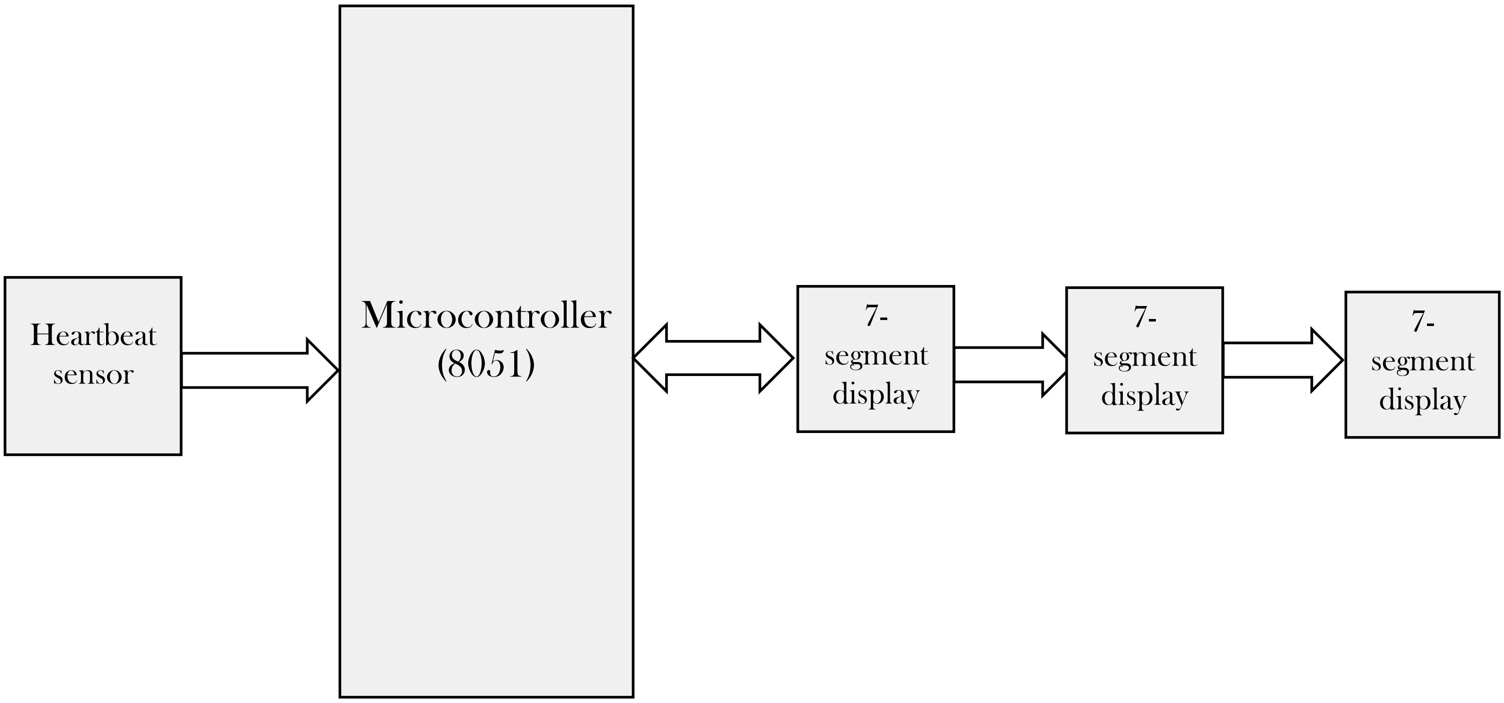
- An IR transmitter /receiver pair is placed in close contact to the fingertip. When the heart beats, the volume of blood cells under the sensor increases and this reflects more IR waves to sensor and when there is no beat the intensity of the reflected beam decreases. The pulsating reflection is converted to a suitable current or voltage pulse by the sensor. The sensor output is processed by suitable electronic circuits to obtain a visible indication (digital display or graph).
- LTH1550-01 photo interrupter forms the photoplethysmography sensor here. LTH1550-01 is simply an IR diode – photo transistor pair in single package.

3)7-Segment Display (CA):

- This display has nothing more than 8 LED inside it. These 8 LEDs are separated into each segments which can be named as a,b,c,d,e,f,g,DP.These entire 8 segment LEDs have one end of their pins pulled out of the module and the other ends are connected together and pulled out as the Common pin. So, to make an LED of a particular segment glow we just must power common pin along with the segment pin. This way we can power more than one segment at a time to represent the numeric number 0-9.



BLOCK DIAGRAM:



ALGORITHM USED:

- First initialized the look up table (LUT), then moved starting address of LUT to DPTR.
- Initialized the output ports p0 and p1 and sets P3.5 as input port (from heartbeat sensor).
- We used timer 0 and timer 1 as counters and loads TL1(load lower byte) and TH1(load higher byte) with initial value.

  1)For the counting purpose both the timers of 8051 (Timer0 and Timer1) are used. Timer 1 is configured as an 8 bit auto reload counter for registering the number of incoming zero going pulses and Timer0 is configured as a 16-bit timer which generate the necessary 1 second time span for the Timer1 to count.

  2)For counting the number of beats Timer0 and Timer1 are used. Timer1 is set as an 8 bit auto reload counter for counting the number of pulses (indicating the heartbeat) and Timer0 is set as a 16-bit timer which generates a 65536uS delay.

  3)When looped 230 times it will produce a 15 second time span (230 x 65536uS =15S) for the Timer 1 to count. The number of counts obtained in 15 seconds is multiplied by 4 to obtain the heart rate in beats per minute.

  4)The Timer 0 which generates the 1 second time span is configured in Mode 1 (16-bit timer). So, the maximum it can count is 2^16 and it is 65536. In 8051 the crystal frequency is divided by 12 using an internal frequency divider network before applying it as a clock for the timer.

  5)That means the timer will increment by one for every 1/12th of the crystal frequency. For an 8051 based system clocked by a 12MHz crystal, the time taken for one timer increment will be 1µS (i.e., 1/12MHz).
- Then we separated the digits to display on 3 7-segment display by dividing with 100 for 100's place, with 10 for 10's place and with 1 for unit's place.
- Above step can be done with load registers A, B with DIV operator.
- Now, to display the digits transistors are used (Q1, Q2, Q3). These are connected to p1.0 to p1.2 ports.
- Accordingly, we turn on/off the transistors to get display of digits.
- 3 7-segment displays are connected in series and connected to p0.0 to p0.7 ports.
- Repeats the subroutine DLOOP 100 times.
- We gets 7seg digit drive pattern for current value in A (DISPLAY: MOVC A,@A+DPTR),MOV DPTR,#LUT.

ASSEMBLY CODE:

```
ORG 000H                        ; origin
MOV DPTR,#LUT                   ; moves starting address of LUT to DPTR
MOV P1,#00000000B               ; sets P1 as output port
MOV P0,#00000000B               ; sets P0 as output port
MAIN: MOV R6,#230D              ; loads register R6 with 230D
      SETB P3.5                 ; sets P3.5 as input port
      MOV TMOD,#01100001B   ; Sets Timer1 as Mode2 counter & Timer0
as Mode1 timer
      MOV TL1,#00000000B        ; loads TL1 with initial value
      MOV TH1,#00000000B        ; loads TH1 with initial value
      SETB TR1                  ; starts timer(counter) 1
BACK: MOV TH0,#00000000B        ; loads initial value to TH0
      MOV TL0,#00000000B        ; loads initial value to TL0
      SETB TR0                  ; starts timer 0
HERE:  JNB TF0,HERE             ; checks for Timer 0 roll over
      CLR TR0                   ; stops Timer0
   CLR TF0                      ; clears Timer Flag 0
   DJNZ R6,BACK
   CLR TR1                      ; stops Timer(counter)1
   CLR TF0                      ; clears Timer Flag 0
   CLR TF1                      ; clears Timer Flag 1
   ACALL DLOOP                  ; Calls subroutine DLOOP for displaying the count
   SJMP MAIN                    ; jumps back to the main loop
DLOOP: MOV R5,#252D
BACK1: MOV A,TL1                ; loads the current count to the accumulator
    MOV B,#4D                   ; loads register B with 4D
    MUL AB                      ; Multiplies the TL1 count with 4
```

```
MOV B,#100D              ; loads register B with 100D
DIV AB                   ; isolates first digit of the count
SETB P1.0                ; display driver transistor Q1 ON
ACALL DISPLAY            ; converts 1st digit to 7seg pattern
MOV P0,A                 ; puts the pattern to port 0
ACALL DELAY
ACALL DELAY
MOV A,B
MOV B,#10D
DIV AB                   ; isolates the second digit of the count
CLR P1.0                 ; display driver transistor Q1 OFF
SETB P1.1                ; display driver transistor Q2 ON
ACALL DISPLAY            ; converts the 2nd digit to 7seg pattern
MOV P0,A
ACALL DELAY
ACALL DELAY
MOV A,B                  ; moves the last digit of the count to
accumulator
CLR P1.1                 ; display driver transistor Q2 OFF
SETB P1.2                ; display driver transistor Q3 ON
ACALL DISPLAY            ; converts 3rd digit to 7seg pattern
MOV P0,A                 ; puts the pattern to port 0
ACALL DELAY              ; calls 1ms delay
ACALL DELAY
CLR P1.2
DJNZ R5,BACK1            ; repeats the subroutine DLOOP 100 times
MOV P0,#11111111B
RET
```

```
DELAY: MOV R7,#250D            ; 1ms delay
 DEL1: DJNZ R7,DEL1
        RET
DISPLAY: MOVC A,@A+DPTR      ; gets 7seg digit drive pattern for current value in A
        CPL A
        RET
LUT: DB 3FH                    ; LUT starts here
     DB 06H
     DB 5BH
     DB 4FH
     DB 66H
     DB 6DH
     DB 7DH
     DB 07H
     DB 7FH
     DB 6FH
END
```

ADVANTAGES:

- ✓ 1.PORTABLE:

  The equipment is designed to be carried easily carried and used when required.

- ✓ 2.LOW POWER CONSUMPTION:

  The components used in the circuit accept input voltage of 5V, so we can conclude that the equipment consumes less power.

- ✓ 3.ACCURATE MEASURMENT:

  The circuit is equipped with RC components which reduce the disturbances in the circuitry.

✓ 4.FLEXIBILITY:

The microcontroller used in this equipment is ISP programmable. Also, the opamp used does not depend on the quantity of the blood that flows.

CONCLUSION:

This heartbeat sensor project using the 8051 microcontroller aims to measure and monitor a person's heart rate. By interfacing the sensor with the 8051, we can analyze the analog signal representing heartbeats and convert it into a digital format for further processing. The microcontroller facilitates real-time monitoring, allowing healthcare professionals or individuals to track heart rate variations. This project not only demonstrates the integration of sensor technology with a microcontroller but also highlights its potential applications in healthcare and fitness monitoring.