An Embedded Platform for Patient Monitoring and Care System

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Abstract - *This paper proposed a prototype that analyses various Bio-medical parameters like temperature and heartbeat obtained from the sensors used &with the help of a microcontroller, all the parameters obtained are displayed on an LCD screen. Based on the parameters obtained the patient is continuously monitored and if in case of any critical mishap when the parameters go out of a particular range then it is prevented by the care system attached to the Patient Monitoring System. The primary function of this system is to sense the temperature and heartbeat of the patient and sensed data is sent to the embedded processor port. The processor is programmed to continue monitor the data and send the actuation signals to patient care system.*

Keywords*:* sensors, microcontroller, bio signals, medicine injection system

1 Introduction

It has been long recognized in the health care industry that long-term, continuous monitoring is a key element in preventive care for people with chronic conditions such as cardiovascular disease. A typical example of patient monitoring is a home care device, such as an electronic blood pressure or glucose meter. An ambulatory system that allows long-term monitoring of mobile patients is also desirable. The ambulatory electrocardiogram (ECG) Holter device, used since the 1960s, provides a reliable measurement of the wearer's heartbeat but is heavy and cumbersome to wear over an extended period of time. In addition, its substantial power consumption forbids continuous operation using low-capacity batteries. In recent years, lightweight devices have emerged as a viable technology for continuous measurement of vital biomedical parameters [7]. Wearable, biosensors connected to self-organizing allows physicians to continuously monitor vital signs, and helps in preventing any critical mishap and also helps physicians to record long-term trends and patterns that provide invaluable information about a patient's ongoing condition, ease of Use [1]. The availability of advanced

Fig.1. Patient Monitoring and Care Systems

sensing devices combined with sophisticated; self-organizing care system will enable new applications and represents a significant opportunity for remote health monitoring. This system will serve 3 requirements

1) The first is a portability factor so that these health monitoring devices can fit or attach easily to a wrist or arm band, ring sensor or other wearable or implantable device.
2) The second requirement is extremely low power so that small batteries can be used for an extended period of time.
3) The third requirement is a highly sophisticated protocol for low latency, high scalability and high responsiveness.

The organization of paper is as follows:
Section II describes the block diagram. Section III gives the detail of component used in proposed system. Section IV and V overviews the software and hardware parts of this proposed work. Finally some conclusion and future scopes are drown from the work done in section VI.

2 Description

Various biometric signals are sensed by the sensors and sensed signals are conditioned through signal conditioning circuits. After getting the appropriate shape and value these bio signals are converted in to digital signals for processing. Embedded processor continues monitors these bio signals and display their values on LCD times to time. Any variation in these signals makes processor to send the actuating signals to patient caring system as shown in Fig. 2.

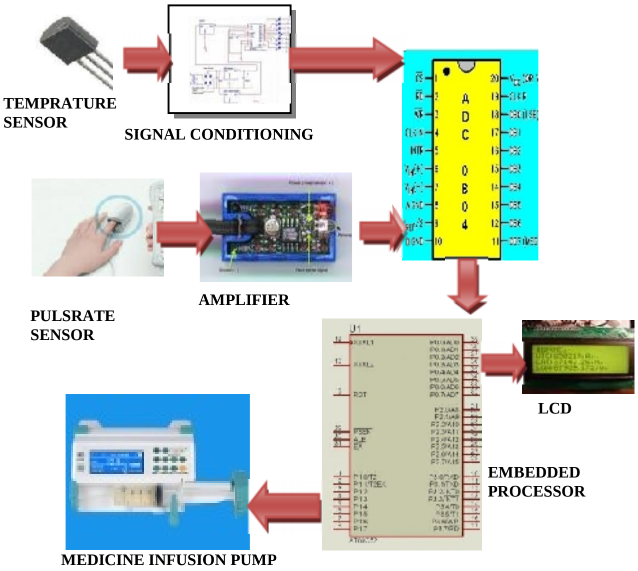

Fig.2. Block Diagram

3 Components Used

The whole system is composed of three components sensing, processing and actuating. Apart from these components, the signal conditioning circuit, local display system and programmed algorithm are also integrated part of this application specific embedded system. A few components are discussed below

3.1 Microcontroller

89c52 from ATMEL is being used. The AT89C52 is a low-power, high-performance CMOS 8-bit microcomputer with 8K bytes of Flash programmable and erasable read only memory (EPROM). The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. We use this because it reduces the amount of external hardware or internal software necessary to process the sensory data. Functions of micro controller in this prototype are:

1) Used to display Biomedical Parameters on LCD.
2) It is also used to interface the temperature sensor, the heartbeat sensor, the LCD and the Infusion Pump.

3.2 Liquid Crystal Display

Display used here is the LCD display. It is an intelligent LCD. It is a 16*2 LCD, which displays 32 characters at a time 16 will be on the 1st line and 16 will be on the 2nd line. There are two lines on the LCD and it works on extended ASCII code i.e. when ASCII code is send it display it on the screen. On the LCD total no of pins are 16 out of which 14 pins are used by the LCD and 2 are used for backlight. LCD is an edge trigger device i.e. from high to low. The data can also be monitored on mobile devices using DTMF [4].

3.3 Temperature Sensor

In this a precision centigrade temperature sensor LM35 is used. It is a precision integrated-circuit temperature sensor, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature [2]. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. For every ^{0}C change in temperature, it shows a variation of 10mV in the output [3].

3.4 Heart Beat Sensor

A Heart Beat Sensor is implemented with a pair of LED and LDR. (Fig.3). This transducer works with the principle of light reflection, in this case the light is infrared.

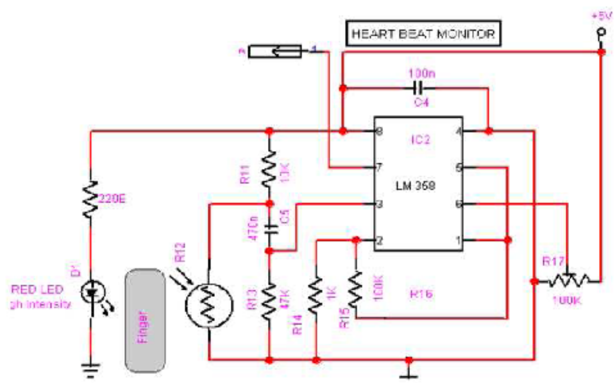

Fig.3. Heart Beat Sensor

3.5 Medicine Injection System

In this part we have implemented syringe to a DC motor with help of a screw such that, when the relay is switched on, the DC motor starts, which in turn moves the screw n the screw changes the rotatory motion of the motor into linear motion which moves the piston of the syringe back & forth.

4 Software Implementation

The software design is a key element in the development of a project. For visualization of the different parameter on the LCD display, the microcontroller is burnt in assembly level language. The microcontroller chosen for the development of the system is Atmel89c52. The Atmel89c52 has 8K bytes of Flash programmable and erasable read only memory (EPROM) and has the capability to write to its own memory. The use of a FLASH device for development also provides the option to use FLASH microcontrollers in the final design making the system fully upgradable. This allows modification of the microcontroller software to expand.

Software Code.

```
;-TEMP LOGER..--- -
;LCD at PORT1
;ADC at PORT0
; ------------BELOW 20 DEGREE------COLD
; ------------UPTO 35 DEGREE------WARM
; ------------ABOVE 35 DEGREE------HOT
org 0000h
mov a,#38h ;initialise two line 5x7 matrix
35
acall command ;sub routine
mov a,#38h ;initialise two line 5x7 matrix
acall command ;sub routine
mov a,#0ch ;display on,cursor blinking
acall command ;sub routine
mov a,#01h ;clear lcd
acall command ;sub routine
mov a,#80h ;shift cursor TO 1st line
acall command ;
---Temperature----
mov a,#'P'
acall data1
mov a,#'a'
acall data1
mov a,#'t'
acall data1
mov a,#'i'
acall data1
mov a,#'e'
acall data1
mov a,#'n'
acall data1
mov a,#'t'
acall data1
mov a,#0c0h ;shift cursor TO 1st line
acall command ;
mov a,#'M'
acall data1
mov a,#'o'
acall data1
mov a,#'n'
acall data1
mov a,#'i'
acall data1
mov a,#'t'
acall data1
mov a,#'o'
acall data1
mov a,#'r'
acall data1
mov a,#'i'
acall data1
mov a,#'n'
acall data1
mov a,#'g'
acall data1
acall delay2
acall delay2
acall delay2
acall delay2
--Temp--
mov a,#01h
acall command
mov a,#80h
acall command
mov a,#'T'
acall data1
mov a,#'e'
acall data1
mov a,#'m'
acall data1
mov a,#'p'
acall data1
mov a,#'.'
acall data1
mov a,#20h
acall data1
mov a,#'i'
acall data1
mov a,#'s'
acall data1
mov a,#0c0h ;shift cursor TO 1st line
acall command ;
mov a,#'H'
acall data1
mov a,#'/'
acall data1
mov a,#'R'
acall data1
mov a,#'='
acall data1
acall delay2
acall delay2
acall delay2
acall delay2
-----ADC-----
mov p0,#0ffh
go:
setb p2.5
clr p2.5 ; INTR=p2.6 ; start conversion
setb p2.7 ; WR = p2.7
; RD = p2.5 active low
hee:jb p2.6,hee
acall delay2
clr p2.5
mov a,p0 ; a contain temp in hex
MOV 40H,A
-----HEX to BCD conversion-
lop: cjne a,#35d,next ; if a is smaller carry=1
sjmp next
next: jnc gom
setb p3.7 ; below 30 led on
40
sjmp hoi
gom:
MOV A,40H
cjne a,#45d,next2 ; if a is smaller than 35 c=1
sjmp next2
next2: jnc gom2
clr p3.7
SJMP HOI
gom2:
setb p3.7 ; above 40 led off
hoi:
MOV A,40H
mov b,#10d
div ab
mov r6,b ; 0ne
mov b,#10d
div ab
mov r7,b ; tens
mov r2,a ;hundred
mov a,#89h ;shift cursor TO 1st line
acall command ;command subroutine
mov a, r2
orl a,#30h
acall data1
mov a, r7
orl a,#30h
acall data1
mov a, r6
orl a,#30h
acall data1
mov a,#20h
acall data1
mov a,#27h
acall data1
mov a,#'C'
acall data1
setb p2.0
jb p2.0,kou
mov a,#0c4h ;shift cursor TO 1st line
acall command ;
42
mov a,#'7'
acall data1
mov a,#'5'
acall data1
acall delay2
acall delay2
acall delay2
acall delay2
acall delay2
acall delay2
acall delay2
mov a,#0c4h ;shift cursor TO 1st line
acall command ;
mov a,#'7'
acall data1
mov a,#'3'
acall data1
acall delay2
acall delay2
acall delay2
acall delay2
acall delay2
acall delay2
acall delay2
mov a,#0c4h ;shift cursor TO 1st line
acall command ;
mov a,#20h
acall data1
mov a,#20h
acall data1
;---- -
kou:
Ljmp go
;------
delay1:
mov r3,#150d
h130: mov r4,#150d
h230: djnz r4,h230
djnz r3,h130
ret
delay2:
mov r3,#255d
h1300: mov r4,#255d
h2300: djnz r4,h2300
djnz r3,h1300
ret
delay:
mov r3,#60d
h13: mov r4,#40d
h23: djnz r4,h23
djnz r3,h13
ret
command:
mov p1,a
clr p3.2
clr p3.1
setb p3.0
clr p3.0
acall delay1
ret
data1:
mov p1,a
setb p3.2
clr p3.1
setb p3.0
clr p3.0
acall delay1
ret
END
```

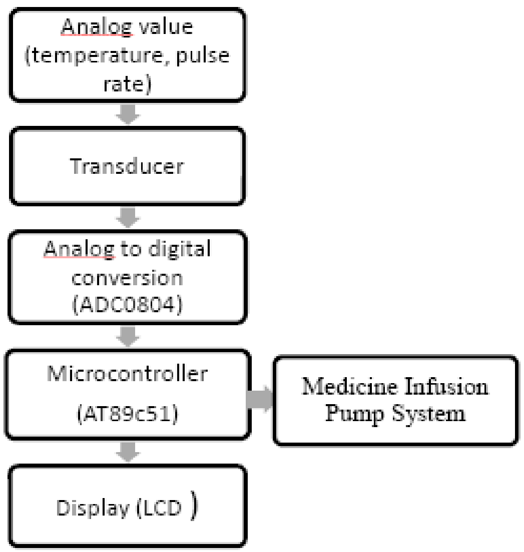

Fig.4. Flow Diagram

The proposed work is focused on the body temperature measurement device and heart rate measurement monitor, taking up the analog values using the sensor LM35 and LDR and LED; these signals were fed into an ADC (Analog to Digital Convertor) ADC0804. The digital value of the temperature measurement and heart rate measurement from the ADC is then fed to the microcontroller (AT89c52). The LCD (Liquid Crystal Display), is interfaced with the microcontroller which displays the value of the temperature sensed and the heart beat. In case the values of the temperature and the heart beat goes out of a particular range prescribed by the doctor the relay gets triggered and hence the Care System responds accordingly as shown in Fig.4.

4.1 Software Code

The microcontroller along with its various interfaces requires software to work on. The logic involved in achieving the desired operation has been carefully prepared and is noted down in form of software code. The Software Code is in the form of assembly language.

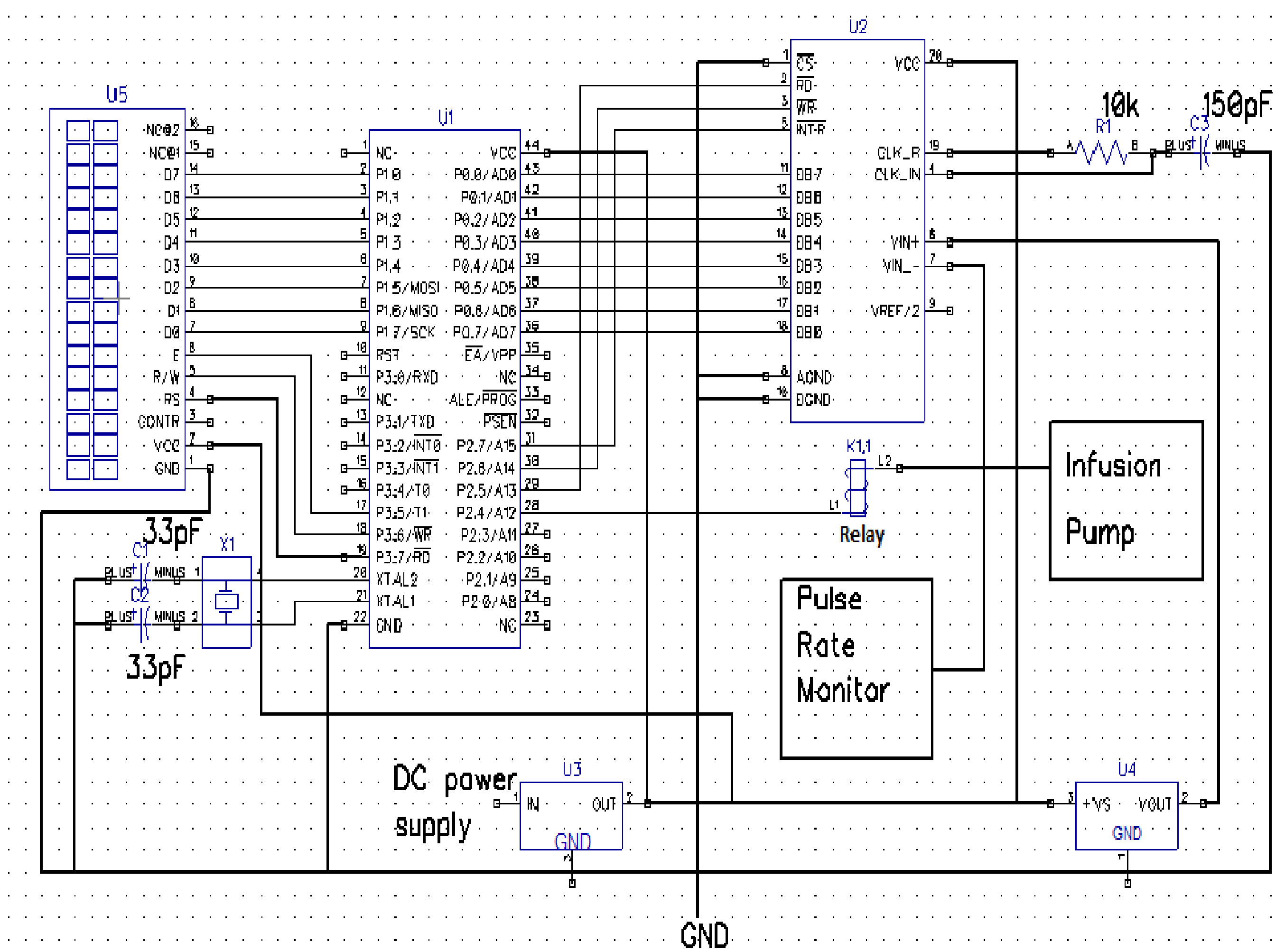

Fig.5. Schematic Diagram

5 Hardware implementation

By using various electrical circuits the bio-medical like temperature and heart beat parameters can be found. The output of the circuits is amplified by means of an amplifier and fed into an A/D converter. The digitized signal is then fed into the input port of the microcontroller. The microcontroller displays the parameters in digital value in the display device. And the injector connected to the prototype works accordingly as shown in Fig. 5. Hardware implementation of proposed work is shown in Fig.6.

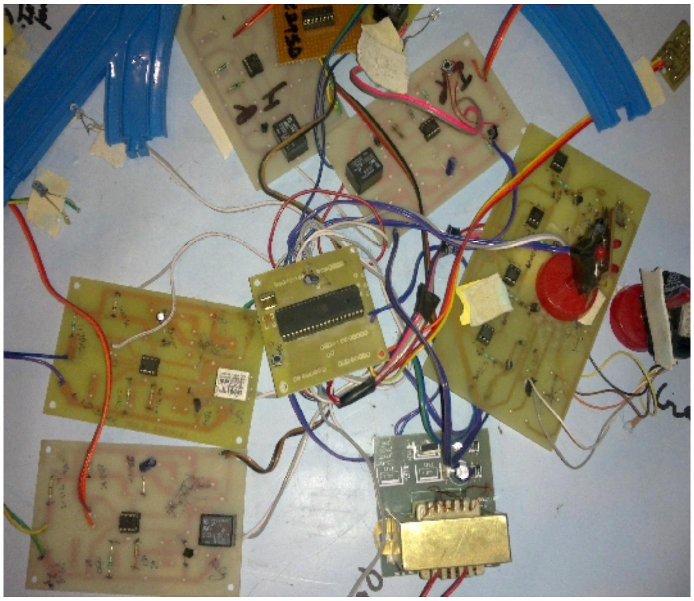

Fig.6. Hardware Implementation

6 Conclusion and Future Scopes

The project has been successfully completed within the stipulated time frame with the prototype displaying bio-medical parameter and the Care System i.e. the Infusion Pump working accordingly. We have achieved the desired outputs of the body temperature and the heartbeat of the patient on the LCD displays and according to which the Care System i.e. the Medicine Infusion Pump performs if these parameters go out of a particular set range. Despite lots of research in this field of Monitoring and Care of patient, there has been very little effort in actual implementation of the concept which provides ample scope for the further developments of this project. Over the past few decades, technology has touched lives, literally. While use of technology in healthcare has been made in a hospital environment, a larger scope lies for technology to become simple. The complete system can be condensed in to a SoC by using on-chip network [5][6].

Patient Monitoring and Care today is fast becoming a common reality. From Cardiac Monitoring to Diabetes Management and more, healthcare services that were once restrained within doctors being around the patient 24 hours are now finding their spot under technologically sound and improved healthcare. That's a win-win for both doctors/caregivers and patients. Patient Monitoring and Care makes objective, pertinent information available to caregivers in a timely manner, or as and when the need arises, prevent any kind of critical disaster to occur. This way, the patients are taken care of and the doctors are able to perform their job effectively too. Also, this addresses the issue of ever-less-available resources like healthcare staff and physical presence of the doctor. Additionally, it helps improve patient health, thanks to early diagnosis and preventive care.

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