Abstract— In spite of the improvement of communication link and despite all progress in advanced communication technologies, there are still very few functioning commercial wireless monitoring systems, which are most off-line, and there are still a number of issues to deal with. Therefore, there is a strong need for investigating the possibility of design and implementation of an interactive real-time wireless communication system.

In this paper, a generic real-time wireless communication system was designed and developed for short and long term remote patient-monitoring applying wireless protocol. The primary function of this system is to monitor the temperature and Heart Beat of the Patient and the Data collected by the sensors are sent to the Microcontroller. The Microcontroller transmits the data over the air. At the receiving end a receiver is used to receive the data and it is decoded and fed to Microcontroller, which is then displayed over the LCD display. If there is a dangerous change in patient's status an alarm is also sounded. The paper deals with the design and development of hardware and software for temperature and heartbeat measurement of a patient over LCD.

Keywords: Bluetooth Modem, microcontroller, operational block diagram, software tool, results

I. INTRODUCTION

The main objective of this project is to design a system that continuously monitors the heartbeat of the patient and if they are likely to exceed the normal values, the system immediately sends a message to the doctor’s LCD. This project is a device that collects data from the sensors, codes the data into a format that can be understood by the controlling section. This system also collects information from the master device and implements commands that are directed by the master.

The data which are recorded continuously are Heartbeat of the patient. The digital value read is sent to the microcontroller. The microcontroller temporarily stores this value. The heartbeat pulses can be seen by the doctor at regular intervals in LCD to know the patient condition. The software application and the hardware implementation help the microcontroller read the output of the sensors and send these values to the doctor’s mobile whenever he sends a request to the controlling unit. The performance of the design is maintained by controlling unit.

Fig. 1: Block diagram for Heartbeat Monitoring System

A. Microcontroller

1) (AT89S52)

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel’s high-density non-volatile memory technology and is compatible with the Industry standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer [1][2]. By
combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel's AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

1. Features
   1. Compatible with MCS-51 Products
   2. 8K Bytes of In-System Programmable (ISP) Flash Memory – Endurance: 1000 write/Erase Cycles
   3. 4.0V to 5.5V Operating Range , Fully Static Operation: 0 Hz to 33 MHz
   4. 256 x 8-bit Internal RAM
   5. 32 Programmable I/O Lines
   6. Three 16-bit Timer/Counters
   7. Eight Interrupt Sources ,Three-level Program Memory Lock
   8. Full Duplex UART (Universal Asynchronous Receiver Transmitter) Serial Channel
   9. Low-power Idle and Power-down Modes

10. Interrupt Recovery from Power-down Mode
11. Dual Data Pointer
12. Power-off Flag
13. Fast Programming Time
14. Flexible In System Programming (Byte and Page Mode)

4. Data Memory
   The AT89S52 implements 256 bytes of on-chip RAM. The upper 128 bytes occupy a parallel address space to the Special Function Registers. This means that the upper 128 bytes have the same addresses as the SFR space but are physically separate from SFR space.

   When an instruction accesses an internal location above address 7FH, the address mode used in the instruction specifies whether the CPU accesses the upper 128 bytes of RAM or the SFR space. Instructions which use direct addressing access the SFR space.

   For example, the following direct addressing instruction accesses the SFR at location 0A0H (which is P2).

   MOV 0A0H, #data
   Instructions that use indirect addressing access the upper 128 bytes of RAM. For example, the following indirect addressing instruction, where R0 contains 0A0H, accesses the data byte at address 0A0H, rather than P2 (whose address is 0A0H).

   MOV @R0, #data
   Note that stack operations are examples of indirect addressing, so the upper 128 bytes of data RAM are available as stack space.

B. 8051

In 1981, Intel Corporation introduced an 8-bit microcontroller called the 8051. This microcontroller had 128 bytes of RAM,4K bytes of on-chip ROM, two timers, one serial port, and four ports(each 8-bit wide) all on a single chip. At the time it is also referred to as a “system on chip.” This is an 8-bit processor, meaning that the CPU can work on only 8 bits of data at a time. Data larger than 8 bits has to be broken into 8 bit pieces to be processed by the CPU. The 8051 has a total of four I/O ports, each 8-bit wide. There are many versions of the 8051 with different speeds and amounts of on-chip ROM marketed by more than half a dozen manufacturers. It is important to note that although there are different flavors of the 8051 in terms of speed and amount of on-chip ROM, they are all compatible with the original 8051 as far as the instructions are concerned. This means that if you write your program for one, it will run on any of them regardless of the manufacturer.

1. Features
   1. Compatible with MCS-51 Products
   2. 8K Bytes of In-System Reprogrammable Flash Memory
   3. Fully Static Operation: 0 Hz to 33 MHz
   4. Three-level Program Memory Lock
   5. 256 x 8-bit Internal RAM
   6. 32 Programmable I/O Lines
   7. Three 16-bit Timer/Counters
   8. Eight Interrupt Sources
   9. Programmable Serial Channel
   10. Low-power Idle and Power-down Modes
   11. 4.0V to 5.5V Operating Range
   12. Full Duplex UART Serial Channel
   13. Interrupt Recovery from Power-down Mode
   14. Watchdog Timer
   15. Dual Data Pointer
   16. Power-off Flag
   17. Fast Programming Time
   18. Flexible ISP Programming (Byte and Page Mode)
II. BLUETOOTH PROFILE AND ITS COMMUNICATION

Bluetooth is low cost, low power short-range radio technology originally developed as a cable replacement to connect devices such as mobile phone handsets, headsets and portable computers. No longer do people need to connect, plug into, install, enable or configure anything to anything else.

The Bluetooth specification is an open, global specification defining the complete system from the radio up to the application level. Version 1.0 of the Bluetooth came into existence in 1994 when Ericsson Mobile Communication began its study for alternatives to replace the cable and this technology hit the market in 1999. This study concluded with radio link as a better option than the optical communication like infrared because of its line of sight limitation.

Then they formed Bluetooth Special Interest Group(SIG) to define and promote Bluetooth specification with five key promoters:
1. Ericsson Mobile Communications
2. Intel Corp.
3. IBM Corp.
4. Toshiba Corp.
5. Nokia Mobile Phones

Bluetooth devices operate at 2.4 GHz globally available license free band. This band is reserved for general purpose usage of Industrial, Scientific and Medical applications. Thus Bluetooth has to be very robust because many users, polluters of this shared spectrum.

The operating band is divided into 1MHz spaced channels signalling data at 1 mega signals per second for the sake of obtaining maximum available bandwidth. Its modulation scheme is Frequency Shift Keying (FSK). Technical robustness is not possible if the Bluetooth devices operate on the constant frequency, Bluetooth devices has to jump to another frequency continuously within the available bandwidth. After sending a packet both devices has to jump another radio channel effectively which is called Frequency Hopping Spread Spectrum (FHSS). Each Bluetooth timeslot lasts for 625 micro seconds. Generally Bluetooth devices hop for every packet or every 2 packet or every 5 packets. Bluetooth is mainly designed for low power radio frequency link available in the range of 10m, 20m and 100m. Bluetooth specification allows three different powers they be connected from other devices. A Bluetooth connection tries to connect itself to other devices and slave is waiting to be connected from other devices. A Bluetooth connection can always be made from pair of master and slave devices. A slave can be in two modes, Inquiry scan or Page scan mode. Inquiry scan mode is waiting for a packet of Inquiry from other Bluetooth device and Page scan mode is waiting for the packet of connection from other Bluetooth device. Every Bluetooth device has its unique address, called BD (Bluetooth Device) address, which is composed of twelve hexadecimal digits which is used frequently while establishing the link among the Bluetooth devices.

The supported channel configurations are as follows:

<table>
<thead>
<tr>
<th>Configuration Rate Downstream</th>
<th>Max. Data Rate</th>
<th>Max. Data Upstream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simultaneous Voice Channels</td>
<td>64 kb/sec X3 channels</td>
<td>64 kb/sec X3 channels</td>
</tr>
<tr>
<td>Symmetric Data</td>
<td>433.9 kb/sec</td>
<td>-433.9 kb/sec</td>
</tr>
<tr>
<td>Asymmetric Data</td>
<td>723.2 kb/sec or 57.6 kb/sec</td>
<td>57.6 kb/sec or 723.2 kb/sec</td>
</tr>
</tbody>
</table>

Table 1: supported channel configurations

The synchronous voice channels are provided using circuit switching with a slot reservation at fixed intervals. A synchronous link is referred to as an SCO (synchronous connection-oriented) link. The asynchronous data channels are provided using packet switching utilizing a polling access scheme. An asynchronous link is referred to as an ACL (asynchronous connection-less) link. A combined data-voice SCO packet is also defined. This can provide 64 kb/sec voice and 64 kb/sec data in each direction.

Bluetooth devices can interact with one or more other Bluetooth devices in several different ways. The simplest scheme is when only two devices are involved. This is referred to as point-to-point. One of the devices acts as the master and the other as a slave. This ad-hoc network is referred to as a piconet.

B. Bluetooth Modem – Blue SMiRF Gold

sku: WRL-00582

Description: The Blue SMiRF is the latest Bluetooth® wireless serial cable replacement from Spark Fun Electronics! These modems work as a serial (RX/TX) pipe. Any serial stream from 9600 to 115200bps can be passed seamlessly from your computer to your target. We've tested these units successfully over open air at 350ft (106m)!

The remote unit can be powered from 3.3V up to 6V for
easy battery attachment. All signal pins on the remote unit are 3V-6V tolerant. No level shifting is required. Do not attach this device directly to a serial port. You will need an RS232 to TTL converter circuit if you need to attach this to a computer.

1) Specifications:
1. FCC Approved Class 1 Bluetooth® Radio Modem
2. Extremely small radio - 0.15x0.6x1.9"
3. Very robust link both in integrity and transmission distance (100m) - no more buffer overruns!
4. Low power consumption : 25mA avg
5. Hardy frequency hopping scheme - operates in harsh RF environments like WiFi, 802.11g, and Zigbee
6. Encrypted connection
7. Frequency: 2.4–2.524 GHz
8. Operating Voltage: 3.3V-6V
9. Serial communications: 2400-115200bps
10. Operating Temperature: -40 ~ +70°C

C. Serial communication using RS232
RS 232 stands for Recommend Standard number. Most new PC’s are equipped with male D type connectors having only 9 pins. Since RS232 is not compatible with microcontrollers we need a voltage converter to convert the RS232’s signals to TTL voltage levels[7]. These are acceptable to the microcontroller’s TxD and RxD pins. The MAX 232 converts the RS232 voltage levels to TTL voltage levels and vice versa.

The chip uses +5v power source which is the same as the power source for the microcontroller. It provides 2-channel RS232C [7] port and requires external 10uF capacitors.

D. LIQUID CRYSTAL DISPLAY (16X2)
LCD screen consists of two lines with 16 characters each. Each character consists of 5x7 dot-matrixes. Contrast on display depends on the power supply voltage and whether messages are displayed in one or two lines [10]. For that reason, variable voltage 0-Vdd is applied on pin marked as Vee. Trimmer potentiometer is usually used for that purpose. Some versions of displays have built in backlight (blue or green diodes). When used during operating, a resistor for current limitation should be used (like with any LE diode).

E. ADC (0804)
Analog-to-digital converters are among the most widely used devices for data acquisition. Digital systems use binary values, but in the physical world everything is continuous i.e., analog values. Temperature, pressure (wind or liquid), humidity and velocity are the physical analog quantities. These physical quantities are to be converted into digital values for further processing [4]. One such device to convert these physical quantities into electrical signals is sensor. Sensors for temperature, pressure, humidity, light and many
other natural quantities produce an output that is voltage or current. Thus, an analog-to-digital converter is needed to convert these electrical signals into digital values so that the microcontroller can read and process them. An ADC has an n-bit resolution where n can be 8, 10, 12, 16 or even 24 bits. The higher resolution ADC provides a smaller step size, where step size is the smallest change that can be detected by an ADC. In addition to resolution, conversion time is another major factor in judging an ADC. Conversion time is defined as the time it takes the ADC to convert the analog input to a digital number.

The ADC0804 IC is an 8-bit parallel ADC in the family of the ADC0800 series from National Semiconductor. It works with +5 volts and has a resolution of 8 bits. In the ADC0804, the conversion time varies depending on the clocking signals applied to the CLK IN pin, but it cannot be faster than 110µs.

**F. SENSORS**

The sensors used in here are Heartbeat and Temperature sensor. The output of temperature sensor is given to the ADC so as to convert the analog value into digital data and then give it to the microcontroller. The Heartbeat sensor used is basically a LED and LDR arrangement.

**1) LED and LDR arrangement**

The Heartbeat sensor used in this project is basically a LED and LDR arrangement. The LED used in this arrangement is a high intensity LED.

Heart beat is sensed by using a high intensity type LED and LDR. The finger is placed between the LED and LDR. As sensor, a photo diode or a photo transistor can be used. The skin may be illuminated with visible (red) using transmitted or reflected light for detection. The very small changes in reflectivity or in transmittance caused by the varying blood content of human tissue are almost invisible. Various noise sources may produce disturbance signals with amplitudes equal or even higher than the amplitude of the pulse signal. Valid pulse measurement therefore requires extensive preprocessing of the raw signal.

The setup described here uses a red LED for transmitted light illumination and a LDR as detector. With only slight changes in the preamplifier circuit the same hardware and software could be used with other illumination and detection concepts. These values are sent to the ADC for conversion of analog to digital and then sent to the microcontroller.

**2) LM35 TEMPERATURE SENSOR**

LM35 converts temperature value into electrical signals. LM35 series sensors are precision integrated-circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature[6]. The LM35 requires no external calibration since it is internally calibrated. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1/4°C at room temperature and ±3/4°C over a full −55 to +150°C temperature range.

The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 μA from its supply, it has very low self-heating, less than 0.1°C in still air.

**G. Regulated Power Supply**

The circuit needs two different voltages, +5V & +12V to work. These dual voltages are supplied by this specially designed power supply[5]. The main object of this power supply is to deliver the required amount of stabilized and pure power to the circuit.

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**Fig. 7: ADC 0804 interfaced with 8051**

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**Fig. 8: Heart beat sensor depiction**

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**Fig. 9: circuit diagram of full wave regulated power supply using IC’s**
III. WORKING PRINCIPAL
The working goes like this: The temperature and heartbeat of the patient will be monitored continuously and the status of the patient will be monitored and sent to the doctor wherever he may be.
Thus, the two values, the temperature and the heartbeat pulse will be sent to the doctor who knows the entire health conditions of the patient. Thus, to send this data, we are using the wireless technology, Bluetooth. When the monitoring system sends a message to the doctor’s, even this system should have a device which can send or receive the messages from/to the doctor. The device we are using is the Bluetooth modem. The Bluetooth modem will be interfaced with the microcontroller through serial interface.
The data which are monitored continuously in this project are Temperature and Heartbeat of the patient. The analog quantities are taken and converted into corresponding digital values using a single channel ADC. This converted digital value is sent to the microcontroller. The microcontroller temporarily stores this value.
The doctor can read the temperature and heartbeat value whenever he wishes to. The doctor can take care of the patient’s condition wherever he may be. The doctor has to send predefined messages to the modem to retrieve the data. The modem receives the predefined messages and intimates the same to the microcontroller. Now, it is the job of the microcontroller to read the value, process it and send the requested value to the doctor’s mobile. The user can read the updated data whenever he reads the predefined messages to the modem. These values can also be displayed on the LCD.

IV. CIRCUIT DIAGRAM

![Circuit Diagram](image)

Fig. 10: Circuit diagram of entire process

V. SOFTWARE TOOLS

A. KEIL COMPILER
Keil compiler is software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. Keil compiler also supports C language code.

B. PROLOAD
Proload is software which accepts only hex files. Once the machine code is converted into hex code, that hex code has to be dumped into the microcontroller and this is done by the Proload. Proload is a programmer which itself contains a microcontroller in it other than the one which is to be programmed. This microcontroller has a program in it written in such a way that it accepts the hex file from the Keil compiler and dumps this hex file into the microcontroller which is to be programmed.

![Proload Programmer](image)

As the Proload programmer kit requires power supply to be operated, this power supply is given from the power supply circuit designed above. It should be noted that this programmer kit contains a power supply section in the board itself but in order to switch on that power supply, a source is required. Thus this is accomplished from the power supply board with an output of 12volts.

VI. RESULTS AND CONCLUSION

A. Results
Assemble the circuit on the PCB as shown in Fig 5.1. After assembling the circuit on the PCB, check it for proper connections before switching on the power supply.

B. Conclusion
The implementation of Heartbeat Monitoring System using GSM is done successfully. The communication is properly done without any interference between different modules in the design. Design is done to meet all the specifications and requirements. Software tools like Keil Uvision Simulator, Proload to dump the source code into the microcontroller, Orcad Lite for the schematic diagram have been used to develop the software code before realizing the hardware.
The performance of the system is more efficient. Continuously reading the output from the sensors and pass the data to the doctor’s mobile whenever the read values exceed the normal values or whenever the doctor sends a request to the controlling unit is the main job carried out by the microcontroller. The mechanism is controlled by the microcontroller.
The circuit is implemented in Orcad and implemented on the microcontroller board. The performance has been verified both in software simulator and hardware design. The total circuit is completely verified functionally and is following the application software.
It can be concluded that the design implemented in the
Present work provides portability, flexibility and the data transmission is also done with low power consumption.

VII. APPLICATIONS & ADVANTAGES

A. ADVANTAGES
1. This system gives very accurate heart beat rate than the existing equipment.
2. Efficient and low cost design.
3. Low power consumption.
4. Easy to install the system.
5. Fast response.

B. APPLICATIONS
1. Old age people Heart Rate remote monitoring continuously.
2. Central diagnostic system implementation in hospitals.
3. Consistent health monitoring for personal health care without any cable contact interface.

VIII. FUTURE ENHANCEMENTS
In spite of the improvement of communication link and despite all progress in advanced communication technologies, there is still very few functioning commercial Wireless Monitoring Systems, which are most off-line, and there are still a number of issues to deal with. Therefore, there is a strong need for investigating the possibility of design and implementation of an interactive real-time wireless communication system. In our project, a generic real-time wireless communication system was designed and developed for short and long term remote patient-monitoring applying wireless protocol.

REFERENCES