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Patient Monitoring System using CAN and Android

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Abstract— ***This work presents a monitoring system that has the capability to monitor physiological parameters like human body temperature, blood pressure (BP), heartbeat and the oxygen level from multiple patient bodies. In the proposed system, a coordinator node in patient site has attached to the patient's body to collect all the signals from sensors and sends them to the central base station at doctor site. Both the units comprise of 8051 series of (AT89S8252) microcontroller and communicated with each other by Controlled Area Network (CAN) protocol. The different sensors attached to the patient's body observe the required physiological parameters and are displayed in the LCD on the patient unit. Then the acquired data are transmitted to the central node on doctor site. This system can also detect the abnormal conditions, issue an alarm to the patient and send an SMS/E-mail to the doctor. Also, the monitoring signals are finally obtained in an Android mobile device. Finally, an android app is developed to display the recorded biomedical information graphically to both the doctor and patient in real time.***

Keywords— ***Patient Monitoring, Sensor, CAN, Android App, Web Server***

I. INTRODUCTION

During the last quarter of the century, there has been a magnificent improvement in the use of electronic equipment in the medical field of clinical and medical exploration purpose. In the most promising field of health care [1] [2] to detect the existence of some physical quantity is very useful for diagnostic purposes. Therefore, many types of electronic devices are used in hospitals and testing center. The primary purpose of the electronic instrument for medical application is to measure the physical quantity present in the human body which assists the medical personnel in advance investigation and hence, many types of electronic instrumentation systems are presently used in modern hospital and other dispensaries.

The common features of most medical instrument systems satisfy the common features available in the other instrumentation system. The most common constituents are measure and, sensing unit, signal processing unit and display unit.

To monitor the patient vital physiological parameters continuously, many hospitals are now adopting electronic sensors connected nearby to patient, monitors or PC placed at bedside and also some alarm system with the constant supervision of a para medical assistant with a notebook containing the full history of the patient. But this method of monitoring is not also free from error and it may lead to any disaster due to human error. In this work, a smart monitoring system is purposed with an automatic android base app where a doctor can watch the patient condition in real time. Most importantly, it uses CAN protocol, which is a very secure communication protocol and can accommodate many users without any data loss.

II. PATIENT PHYSIOLOGICAL PARAMETERS

A. *Blood Pressure*

It is expressed as the pressure of the blood in the arteries as it is pumped by the heart around the body (Sunrom datasheet [3]). The blood is pushed into the whole body when the heart contracts through the artery, which creates pressure on the arteries. Blood pressure is the prime symptoms of human health condition and usually measured in the upper arm of a person. It is usually demonstrated by the utmost pressure over bottom pressure (in medical terminology systolic pressure over diastolic) and the normal range is 120/80 mm Hg (millimeters of mercury). It is regulated by the nervous system of a person which varies according to human physical condition like walking, running, sitting, etc.

B. *Pulse Rate*

It is the other way to know the overall condition of the heart. The trained people can recognize one's pulse which represents the heartbeat palpation.

C. Temperature

Body temperature is the ability of the human body to generate as well as to eliminate the heat. Despite of a large-scale variation of temperature in the environment, the human body can cool itself within its limiting range. In medical terminology, the body temperature is called euthermia (DS18B20 Datasheet [4]) usually depends the place, time and activity of the person. The body temperature varies depending upon the different part of the body and also temperature measured inside the body is slightly higher than the measurement taken on the skin of the body. The normal human body temperature is 98.6 F taken internally. The DS18B20 is a digital thermometer by Dallas Semiconductor which provides 9 to 12-bit (configurable) temperature readings indicating the temperature of the device. It incorporates only one wire (beside ground) to communicate with microcontroller. The data line itself provides the power for different activities for sending the information.

D. Pulse Oximetry

It is a non-invasive method to measure the oxygen saturation level (Sunrom datasheet [5]). A SPO2 sensor is used for the pulse oximetry. It generally placed on the finger tip of a human body which measures the hemoglobin saturated with oxygen.

III. PROPOSED ARCHITECTURAL DIAGRAM

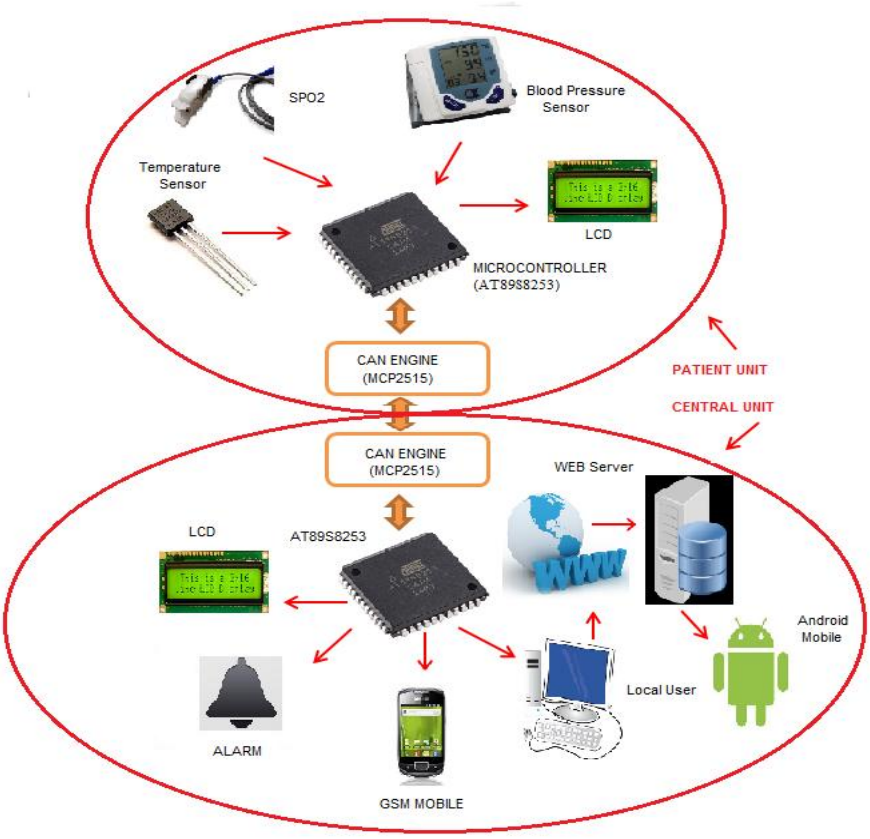

Fig. 1 Architectural Block diagram of smart & secure multi patient monitoring system)

A. Materials and methods

Hardware Used

- AT89S8253 MCU
- Temperature sensor (DS18B20)
- Blood Pressure Sensor (SUNROM Model 4118)
- SPO2 Sensor (SUNROM Model 4017)
- Liquid crystal display (LCD)
- SM Module-SIM 300
- Serial interface-MAX 232,
- System PC.
- Android Mobile Device.
- MCP2515 (CAN engine**)**

Software Used

- Operating system - Windows XP, 7,8.
- Operating system (mobile) - Android OS
- Coding of Microcontroller- Assembly language
- Simulation: KEIL
- Software for Android Development: JAVA
- Database: MySQL

Protocols Used

- RS232 protocol: It is implemented for the communication between microcontroller and GSM module and also between microcontroller and PC.
- One wire protocol: It is used for the communication between microcontroller and a temperature sensor.
- SPI protocol: It is implemented for the communication between CAN engine and microcontroller.
- Controller Area Network (CAN): It is used for the system communication, i.e., between patient nodes to the central node.

B. Patient Unit

In this work, all the sensors (i.e. Blood pressure sensor, temperature sensor and the SPO2 sensor) are connected with the patient's body. All the sensors observe the reading of the vital parameters in every 10 minutes and those data also displayed on the LCD. To receive the data read by the blood pressure sensor, RS232 protocol is used. So blood pressure sensor is connected with the pin P3.0 (R_XD) and the P3.1 (T_XD). Again through the blood pressure sensor, the heartbeat reading can also be found. The DS18B20 is the temperature sensor and communicated through the one wire protocol. The one wire protocol is used to give the maximum accuracy, i.e. ±0.25˚C. It uses only one port pin of the microcontroller to interface. The SPO2 sensor is used for the detection of oxygen level in the blood. This sensor uses only one port pin of the MCU. But to receive the sensor's reading MCU doesn't use any protocol. It also measures the heartbeat.

After receiving those sense data, microcontroller transmits these data to the MCP2515 (CAN ENGINE). The MCP2515 uses two protocols to communicate; Controller Area Network (CAN) and Serial Peripheral Interface (SPI). MCP2515 is connected to the microcontroller on port 1 and to interface with MCP2515 with MCU, SPI protocol is used. The microcontroller AT89S8253 has inbuilt SPI protocol architecture. The MCP2515 of the patient unit will send those data to the control unit.

C. Central Unit

The central unit is otherwise called a server unit. A GSM modem and a PC are used in this unit. In addition to these two, a MCP2515 (CAN engine) is also present and a bulb along with a buzzer are also implemented to indicate the critical condition. In the central unit, the MCP2515 is also connected with the AT89S8253. The MCP2515 of control unit will receive the data sent by the MCP2515 of patient unit and then will send those data to the microcontroller. The microcontroller will compare those data with the primary data. If it found any mismatch, then it will trigger the buzzer and also switched on the bulb, E.g. if the sensed temperature is 38˚C degree centigrade. But the primary data which has been stored in the microcontroller is 37˚C. When the microcontroller will compare this data, it will find a mismatch. Then the microcontroller will trigger the buzzer and also the bulb. After that, the microcontroller will send those data to the PC through HyperTerminal. The HyperTerminal is nothing but RS232 protocol. The buzzer will produce a sound until, someone will press the enter key on the PC. It is the indication to the microcontroller that someone has seen these critical data.

When someone will press the ENTER key in the PC, the ASCII code of ENTER key (0DH) will be transmitted to the microcontroller through RS232 protocol. After receiving the ASCII code of the ENTER key, the microcontroller will trigger off the buzzer and sent a message to the doctor's mobile. As the doctor's mobile number is stored in the microcontroller. For sending a message, a SIM900 GSM modem is used.

IV. IMPLEMENTATION

Figure 2 shows the total experimental set up for this work, where both patient node and central node are connected along with laptop for sending the data through hyper terminal.

Fig. 2 Total Experimental Setup

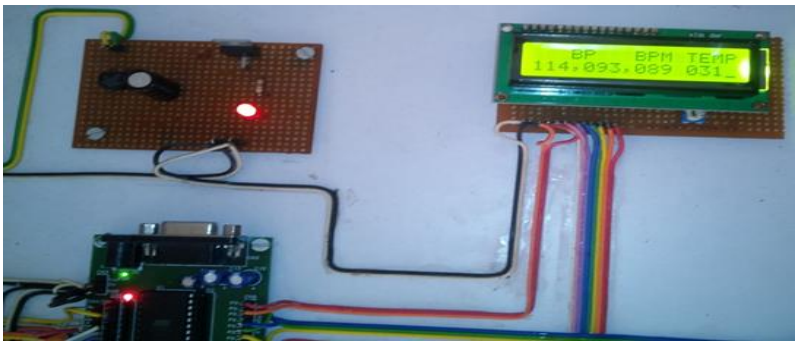

Fig. 3 Data transmitted to the LCD

Fig. 3 shows the output of blood pressure measuring unit which is also displayed on the LCD at patient node, so that the attendants of patients can aware of the condition of the patient.

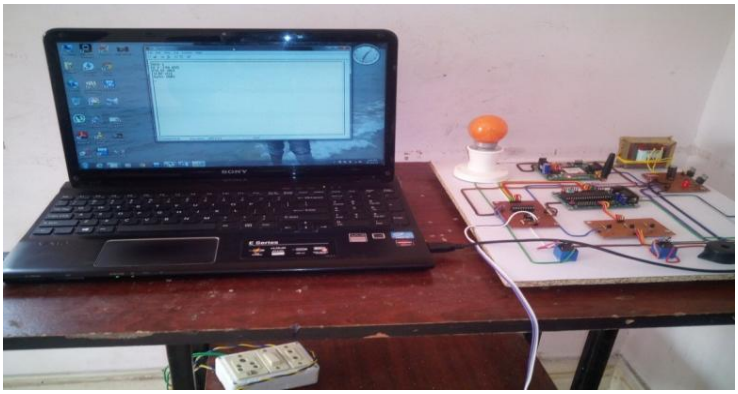

Fig. 4 Data transmitted through hyper terminal

Fig. 4. Shows the data received by central node which are also available on the PC through hyper terminal whereas Fig. 5. Shows the data accessed through online from the server database.

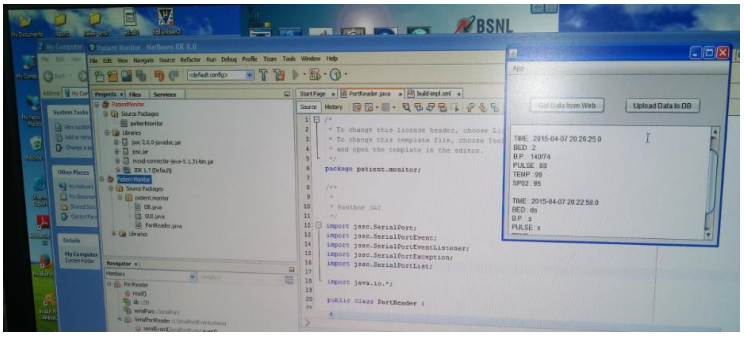

Fig. 5 Data transmitted through hyper terminal

The software package consists of a database and an Android app [6] [7]. The data are first extracted from the hardware setup and sends the data from the hardware to the database hosted online. The database used here is a MySQL database [8] [9]. A pair of programs is used in the software package which is custom written for this purpose. The data from the hardware are communicated to the computer through serial port using a serial cable.

The communication is performed first between the hardware and computer. The software running on the computer fetches the data from the hardware and sends it to the online database running SQL queries remotely, with a single click of a button in the interface provided. Now the data are ready to be seen on any Android device which has the "Patient Monitor" app installed as shown in Fig.6.a and the device is needed to be connected to the internet to fetch online data. The android app user Interface is given with a button which triggers the code to fetch data online and shows the user the data recorded online as shown in Fig. 6.b.

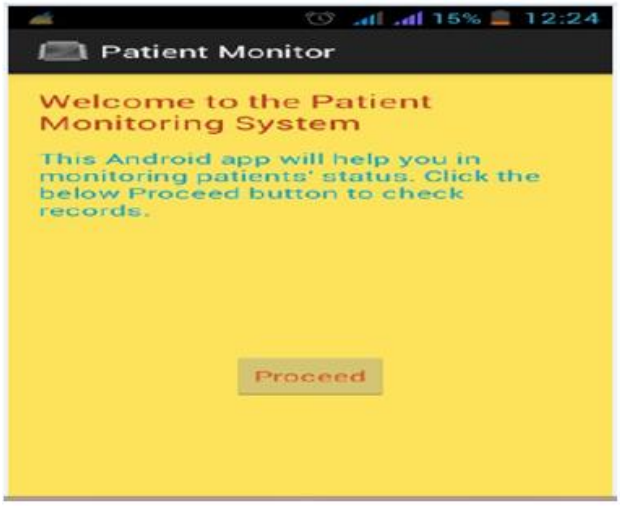

Fig. 6a Installed Android App start up screen

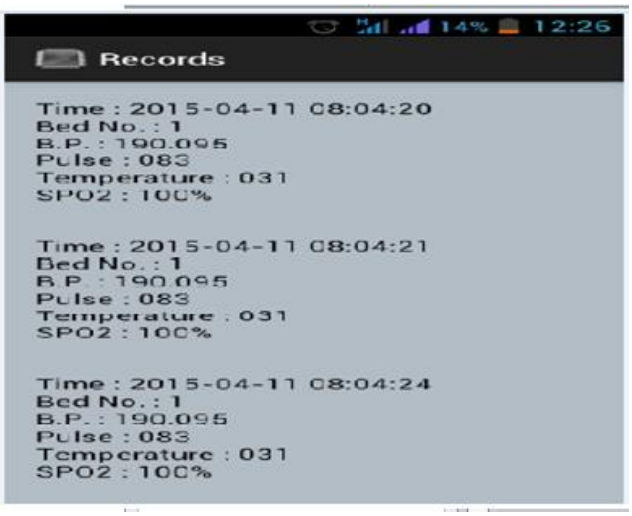

Fig. 6b Records on the Android Device

V. CONCLUSION

In this paper, prototype for Smart and Secure Multi-Patient Monitoring System is thoroughly discussed. In this work, the prototype contains AT89S8253 microcontroller, temperature sensor (DS18B20), blood pressure sensor, SpO2 sensor, MCP2515 (CAN engine), LCD, GSM modem, PC and other hardware circuit, so that patient's vital parameters can be tracked in regular interval. Those tracked data can be transferred to the corresponding doctor's mobile phone for taking necessary precautions to take care about the patient in a given fixed time interval. The auto alarm facility in this system works for the abnormal conditions, when the reading of vital signs exceeds from fixed level. By using GSM network continuous monitoring record can be sent to the doctor's mobile phone. Most importantly, the developed Android App makes the doctor more active in distant places also.

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