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Patient Monitoring and Record Management using Sensors and Zigbee

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ABSTRACT

The medical domain is improving day by day at an exponential rate. Thus constant monitoring of the patient's vital body parameters will add to the advancement in the Medical Facilities available today. Currently, patient monitoring in most hospitals requires the doctor to personally examine each patient and keep a record of his health. This paper presents a method, Hospital Management System that can be used for examining the patients and maintaining their health records. It is based on a communication network with a Central Controller Unit. This Central Controller Unit wirelessly communicates with its Terminal Units. The system may comprise of multiple Terminal Units. The terminal units are used for data acquisition for a patient's health information either by a user or automatically by some sensors. The Terminal Unit wirelessly sends this data to the Central Unit. The Central Unit receives this data and saves it in a database for all the patients. It also determines whether a patient is in extreme condition and in such an emergency case it calls the assigned doctor by sending a message through GSM. This system reduces manual data record management, thereby reducing the possibility of human error. It is user friendly without compromising on the efficiency of the system. Moreover, centralization of control leads to security of data thus, maintaining its accuracy.

Keywords *– ATMEGA644P communication, GSM, management, RFID, sensors.*

1. INTRODUCTION

In India, health care and management is considered as of significant concern due to growing population and constantly improving standard of living. Many health care plans have been devised in the past on various levels to control the cost, the quality and to improve the management capabilities of hospitals [1].

These plans have led to better and efficient information systems. Such systems include a detailed record of hospital financial accounts, patient database and medical inventory management [1]. However, most hospitals focus on cost- cutting strategies and financial management. Along with, it is also necessary to restore the health parameters of in-house patients on a regular check-up basis. This provides a timely graph of body parameter Vs time and a pathway to confirm certain results based on initial diagnosis. It also helps to confirm certain hypotheses in the medical research field [2].

Constant monitoring of the patient's vital body parameters is very important. It adds to advancement in the medical facilities already existing. Currently, patient monitoring in most hospitals requires the doctor to personally examine each patient and keep a detailed record of his health. This process is done manually and is thus, time consuming.

The presence of wired monitoring system restricts the mobility and flexibility of the doctor [3]. Hence, an organized portable system is required to minimize these drawbacks. With a vision to eliminate these, the paper describes an application based system which can be used for effective and efficient database management of the hospital. Such systems and applications improve the quality of care and reduce costs.

The use of sensors and RFID technologies for medical purposes improve the clinical test accuracy, database security, real time logistics analysis and data optimization [3]. Also, the use of GSM technology for medical emergency reduces the fatal risk of patients and ensures appropriate precautions and timely treatment. Thus, the communication gap among hospital staff and patient is bridged in a "healthy" manner.

2. MATERIALS AND METHODS

2.1 Materials

An appropriate design of the power supply largely regulates the working and efficiency of any system. We require +5V fixed DC supply. Thus we

select the 7805 voltage regulator IC. The input to the IC is 9V (DC).

There are various temperature sensors locally available in the market. We use LM35 in our designed system because it is a precision integrated circuit temperature sensor. It has linear output range, high accuracy and wide range of operation. LM35 is a temperature sensor which gives output proportional to 10mV/°C [4].

The pulse rate is calculated by measuring the variation in blood volume in tissues using a light source and a detector such as IR sensors. This technique is selected since the change in blood volume is synchronous to the heart beat and thus, the pulse rate. The circuit consists of two stages of signal conditioning. The first stage consists of a combination of high pass filter and low pass filter which compresses the large DC component and boosts the weak pulsatile AC component, which carries the required information. The output of the first signal conditioning stage goes to a similar combination for further filtering and amplification.

To enter the static data of the patient or retrieve the formerly entered data, we need a keyboard. We use a 5x11 virtual keyboard for our system. It is an alphanumeric keyboard. It does not have distinct keys that are visible, but virtual path intersections. The doctor does not need to actually touch the keypad to enter the desired data through the keyboard. If the finger is taken in the proximity of the intersection, the key gets detected automatically and data gets entered. The virtual keypad consists of IR transmitter- receiver pairs. The transmitters and receivers are alternately placed. It assures that the transmitted IR rays are not received by multiple receivers and wrong keys do not get pressed. The IR transmitter- receiver pairs are conducting normally when any key is not pressed. We interface the virtual keypad to the port D of the ATMEGA644P microcontroller via an amplifier circuit which consists of IC LM324 along with resisters and potentiometers. The advantage of virtual keyboard over normal keyboard is that the key bouncing effect is eliminated completely and provides security.

The LM324 series are low−cost, quad operational amplifiers with true differential inputs. It has Short Circuited protected outputs and the quad amplifier can operate at supply voltages as low as 3.0 V or as high as 32 V. LM 324 has four amplifiers per package and are internally compensated.

We have used 20X4 LCD to view a considerable amount of data at a time.

Criteria for selection of microcontroller:

- It should be able to work on low power to be compatible with Zigbee.
- It should have an inbuilt ADC.
- It should support serial communication.
- It should have a well defined interrupt structure.
- It should have 2 USART's ports.
- It must be low cost and easy to handle.
- It must be fast in operation.

Thus we selected Atmega 644P

ATMEGA644P is an 8 bit microcontroller using the RISC architecture. 10,000 read/erase cycles are possible by the IC. It has 64K bytes of in system programmable memory, 512 bytes EEPROM and 1Kbyte RAM along with read-while-write capabilities [5]. This CMOS IC has a throughput of 1 MIPS per MHz It has three timers, 32x8 general purpose working registers, two USART ports and an 8-channel 10-bit ADC. This microcontroller has 32 I/O lines, of which, Port A (PA7 to PA0) can be used as analog inputs to the Analog to digital converter [5]. It also supports 16 differential input voltage combinations. The USART in ATMEGA644P supports full duplex operation and can operate in synchronous or asynchronous mode [5]. Full duplex operation implies separate transmit and receive registers and data transfer is done serially. It has two USART's – USART0 and USART1. The IC can be operated efficiently over a voltage range of 2.7V -5.5V. The ideal operating voltage for ATMEGA644P is -40°C to +125°C [5].

In this system we also use modern electronic equipments like Zigbee, RFID and GSM to improve the health care facilities.

Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication [6]. We use GSM in our system to contact the hospital authorities in case of emergency. GSM network is divided into three major systems: the switching system (SS), the base station system (BSS), and the operation and support system (OSS). The switching system (SS) is responsible for performing call processing and subscriber-related functions [6].

All radio-related functions are performed in the BSS, which consists of base station controllers (BSCs) and the base transceiver stations (BTSs). The operations and maintenance center (OMC) is connected to all equipment in the switching system and to the BSC. The

implementation of OMC is called the operation and support system (OSS) [6]. There are two basic types of services offered through GSM: telephony (also referred to as tele-services) and data (also referred to as bearer services). Telephony services are mainly voice services that provide subscribers with the complete capability (including necessary terminal equipment) to communicate with other subscribers. Data services provide the capacity necessary to transmit appropriate data signals between two access points creating an interface to the network [7].

RFID enables wireless data collection by readers from electronic tags attached to or embedded in objects, for identification and other purposes. RFID systems involve software, network and database components that enable information to flow from tags to the organization's information infrastructure where it is processed and stored [8]. Systems are application-specific. RFID uses Automated Data Collection (ADC) technology that uses radio-frequency waves to transfer data between a reader and a movable item to identify, categorize and track [8].

It is fast and does not require physical sight or contact between reader/scanner and the tagged item thus performs the operation using low cost components. RFID attempts to provide unique identification and backend integration that allows for wide range of applications[9]. RFID tags are classified in 2 types, active and passive. Active tags are battery powered with long range and higher storage capacity where as Passive tags do not require external power, shorter range and low storage capacity [9].

Zigbee is a specification for a suite of high level communication protocols used to create personal area networks [10]. It is a wireless technology based on the IEEE 802.15.4 standard [11]. This modern module uses mesh technology for communication. It is easy to implement with low complexity. It operates on low power. Zigbee module uses a radio frequency of 2.4GHz to operate [10]. It improves the efficiency, safety, security, mobility and reliability of communication from one point to another [11]. Zigbee uses a common standard to communicate irrespective of product type or product specification. It supports low data rate, long battery life and networking security. Data transfer is achieved at a rate of 250 Kbits/s [10]. It has myriad applications in home management, health care and fitness, telecommunications, consumer electronics and many more.

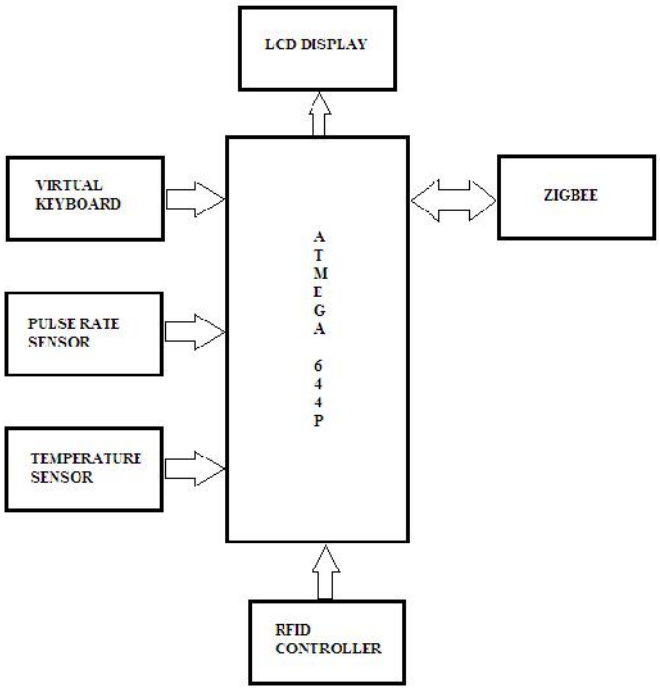

Fig 1: Block Diagram of Patient Monitoring and Record Management System.

2.2 Methodology

Our system is used for health care and management in hospitals using modern electronic equipments. We have divided our system in 2 units i.e. the central unit and the terminal units. As shown in Fig.1, the terminal unit consists of all the sensors required to measure/monitor the various parameters of the patients. It also consists of Zigbee, virtual keypad and RFID modules for data transmission and security purpose. The central unit also consists of Zigbee and virtual keypad for data management of terminal units, whereas GSM module is used for contacting the management of hospital in case of emergency.

The system works as follows, when a patient is admitted to the hospital the nurse enters the patient's details in the terminal unit.

The virtual keypad is used to enter the personal details of the patient. The pulse rate sensor and the temperature sensor are used to directly measure the pulse rate and temperature of the patient at that moment. Any other parameter can also be stored directly into the database via keypad.

Zigbee will transfer the information from the terminal unit to the central unit [11], where this data is stored to be used later.

The central unit stores and manages all the patient information which can be later retrieved when necessary. The information can be retrieved from the central unit as well as the terminal unit. However, the data cannot be altered from the terminal unit for security purpose n to avoid adulteration of information.

RFID is installed on the central as well as the terminal units to provide security in such a way that only authorized person such as doctors or nurses can access the information. Thus an RFID tag is required to access or alter the patient's information from central unit or terminal units [9]. This provides secured record management.

The central unit continuously monitors the changes in the various patient's parameters and in case of emergency such as alarming rise or fall in any of the parameters, the concerned doctor is informed via the GSM that is installed on the central unit [6].

3. RESULTS AND DISCUSSIONS

Thus, by using materials and methods mentioned above, a system can be successfully implemented which measures the patient's temperature and pulse rate directly by using the sensors on the Terminal Unit. These parameters along with other static information are then transmitted to the Central Unit where this data is stored in the patient's database.

Currently, patient monitoring in most hospitals requires the doctor to personally examine each patient and keep a detailed record of his health. This process is done manually and is thus, time consuming, whereas, by using Patient Monitoring and Record Management system using Sensors and Zigbee, the patient's database is automatically updated in the patient's health record. Bharati hospital in Katraj, Pune has a software-based information system installed called 'Lifeline' that provides access to patient database and their lab test reports at any place in the hospital premises [12]. However, in this system the data is manually entered into the computers at each lab and all the computers are connected via LAN. In the system described in this paper, the data can be entered in the Terminal Unit which is compact and wireless, thus making it more efficient.

4. CONCLUSION

This system can be successfully installed in Hospitals for effective record management. If modified, it can be used for various other organizations where record management is an important task for the smooth functioning of the organization. There are several advantages of this system as it provides security due to RFID implementation and accuracy of data. Manual data entry is minimized due to which human errors are also reduced and time delay is avoided. The system is user friendly and interactive; the administrator controls the entire system via the central unit.

However, there are a few precautions that need to be taken to use the system efficiently. As the Central unit contains all the information, a backup should be maintained in case the central unit crashes. The hospital authorities using the system should be trained to use the equipment and software before it can be put to practice and the equipment should be handled with care so as to not damage the sensors or other modules present on it.

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