Technical Report on Data Acquisition of Patient's Health Status using GSM and WSN

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Abstract-*This paper, presents a Wireless Sensor Network (WSN) for monitoring patient's physiological conditions continuously using Zigbee. Here the physiological conditions of the patient's are monitored by sensors and the output of these sensors is transmitted via Zigbee and the same has to be sent to the remote wireless monitor for acquiring the observed patient's physiological signal. The remote wireless monitor is constructed of Zigbee and Personal Computer (PC). The measured signal has to be sent to the PC, which can be data collection. Although Bluetooth is better than Zigbee for transmission rate, Zigbee has lower power consumption. The first procedure of the system is that the wireless sensors are used to measure Heart rate, temperature and fall monitoring from human body using Zigbee. Next procedure of the system is to measure saline level in bottle using Zigbee. The measured signal is sent to the PC via the RS-232 serial port communication interface. In particular, when measured signals cross the standard value, the personal computer will send a message to the caretaker's mobile phone.*

Keyword: *Sensors, Data Acquisition, GSM and monitoring*

I. INTRODUCTION

Health care and management is considered 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 versus 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, this 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 healthcare and reduce costs.

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.GSM Data Acquisition System is based on GSM Cellular Network.It is widely used in industry, building, petroleum, rail-way, school...etc.

Data acquisition is the process of sampling signals that measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer.

Data acquisition systems (DAQ) typically convert analog waveforms into digital values for processing. Sensors convert physical parameters to electrical signals. Signal conditioning circuitry to convert sensor signals into a form that can be converted to digital values. Analog-to-digital converters convert conditioned sensor signals to digital values.

The user can know the exact data (e.g. input voltage is AC 220 V) via SMS; also user can set the voltage alarm point. When the input voltage is higher or lower this point, the system will alarm. It will send SMS, as well as phone call to inform user immediately.

1. AC Voltage input monitoring (Range: 0-500V).

2. Frequency input monitoring for AC signals (50Hz).

3. Temperature Monitoring (Range: -10 to +60).

II. Transmission by GSM Modem/GPRS

The following is a description of information transfer from a data logger to a GSM Modem. Nowadays the use of mobile phones, especially GSM/GPRS, is being successfully implemented in the field of data transmission. The figure 1.1 presents the general scheme of field data transmission through a GSM Modem/GPRS. The information from the sensors goes to the data logger where it is processed and it is passed by an RS 232 or USB interface to the GSM Modem (SIM card), and later sent to a connected PC by another modem. In the case of the data transmission failure caused by a problem with the circuit or the GSM Modem, it remains stored in the memory. Its main advantages are the flexibility and unlimited reach, although the latter is restricted somewhat by the cellular phone penetration rate. Another advantage is the low cost per amount of transmitted data, as well as the option of remote control of the equipment and simple power requirements.

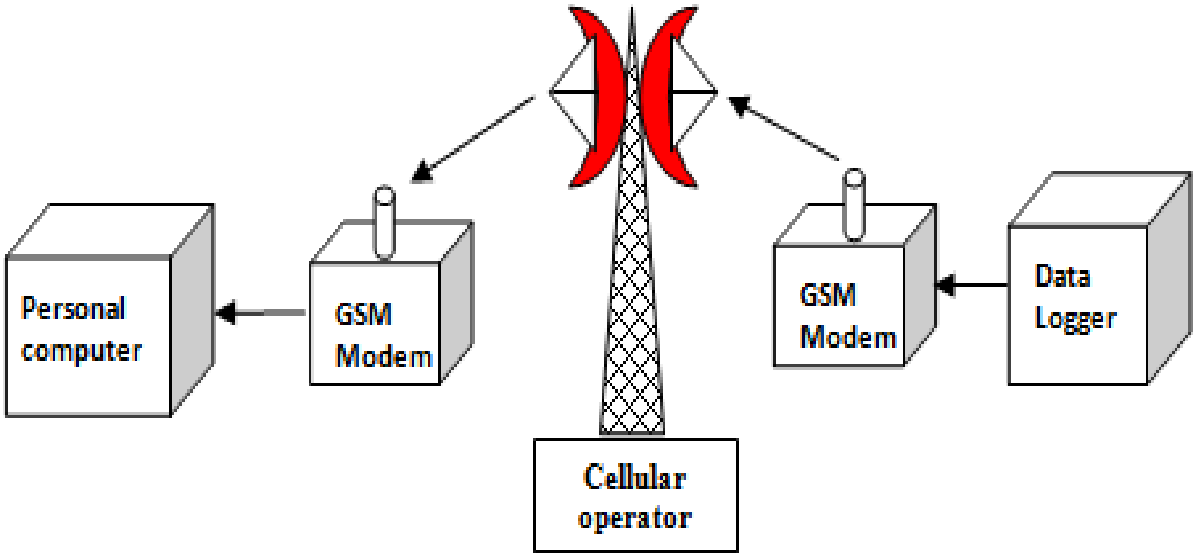

FIGURE 1: FIELD DATA TRANSMISSION THROUGH GSM MODEM

III. 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). 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, 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 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 resistors 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. LM324 has four amplifiers per package and are internally compensated.

In this work, 20X4 LCD is used 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 compatiblewith 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

- 8 bit microcontroller using the RISC architecture.
- It has 64K bytes of in system programmable memory, 512 bytes EEPROM and1Kbyte RAM along with read-while-write capabilities.
- It has three timers, 32x8 general purpose working registers, two USART ports and an 8-channel 10-bit ADC.
- 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].
- Full duplex operation implies separate transmit and receive registers and data transfer is done serially.
- 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.

A. GSM

Global System for Mobile Communication (GSM) is the world's most popular standard for mobile telephony systems. The GSM Association estimates that 80% of the global mobile market uses the standard. GSM is used by over 1.5 billion people across more than 212 countries and territories. This ubiquity means that subscribers can use their phones throughout the world, enabled by international roaming arrangements between mobile network operators. GSM differs from its predecessor technologies in that both signaling and speech channels are digital, and thus GSM is considered a second generation(2G) mobile phone system. This also facilitates the wide-spread implementation of data communication applications into the system. The GSM standard has been an advantage to both consumers, who may benefit from the ability to roam and switch carriers without replacing phones, and also to network operators, who can choose equipment from many GSM equipment vendors. GSM also pioneered low-cost implementation of the short message service (SMS), also called text messaging, which has since been supported on other mobile phone standards as well.

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). Theswitching system (SS) is responsible for performing callprocessing and subscriber-related functions[6].All radio-related functions are performed in theBSS, which consists of base station controllers (BSCs)and the base transceiver stations (BTSs). The operationsand maintenance center (OMC) is connected to allequipment in the switching system and to the BSC. Theimplementation of OMC is called the operation andsupport system (OSS)[6]. There are two basic types ofservices offered through GSM: telephony (also referredto as tele-services) and data (also referred to as bearerservices). Telephony services are mainly voice servicesthat provide subscribers with the complete capability(including necessary terminal equipment) tocommunicate with other subscribers. Data servicesprovide the capacity necessary to transmit appropriatedata signals between two access points creating an interface to the network[7].

B. RFID

RFID (radio frequency identification) is a technology that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency (RF) portion of the electromagnetic spectrum to uniquely identify an object, animal, or person. RFID is coming into increasing use in industry as an alternative to the bar code. The advantage of RFID is that it does not require direct contact or line-of-sight scanning. An RFID system consists of three components: an antenna and transceiver (often combined into one reader) and a transponder (the tag). [8]The antenna uses radio frequency waves to transmit a signal that activates the transponder. When activated, the tag transmits data back to the antenna. The data is used to notify a programmable logic controller that an action should occur. The action could be as simple as raising an access gate or as complicated as interfacing with a database to carry out a monetary transaction. Low-frequency RFID systems (30 KHz to 500 KHz) have short transmission ranges (generally less than six feet). High-frequency RFID systems (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) offer longer transmission ranges (more than 90 feet). In general, the higher the frequency, the more expensive the system[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.

B. ZIGBEE

Zigbee is a specification for a suite of high level communication protocols using small, low-power digital radios or Low-Rate Wireless Personal Area Networks (LR-WPANs), such as wireless light switches with lamps, electrical

meters with in-home-displays, consumer electronics equipment via short-range radio. The technology defined by the Zigbee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. Zigbee is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking. Zigbee is a low-cost, low-power, wireless mesh networking standard. First, the low cost allows the technology to be widely deployed in wireless control and monitoring applications. Second, the low power-usage allows longer life with smaller batteries[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.

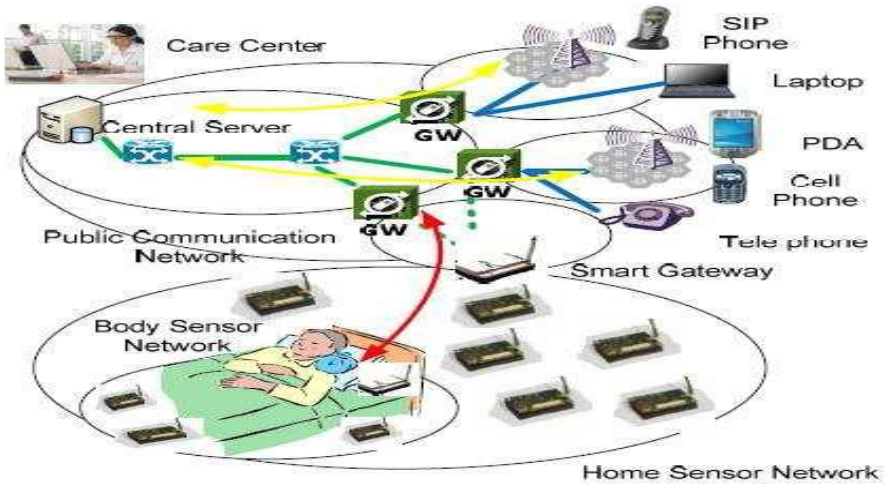

Figure 2: Block Diagram of Patient Monitoring and Record Management System.

IV. METHODOLOGY

This 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 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 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 isstored to be used later.

The central unit stores and manages all the patientinformation which can be later retrieved when necessary.The information can be retrieved from the central unit aswell as the terminal unit. However, the data cannot bealtered from the terminal unit for security purpose and toavoid adulteration of information.

RFID is installed on the central as well as theterminal units to provide security in such a way that onlyauthorized person such as doctors or nurses can accessthe information. Thus an RFID tag is required to accessor alter the patient's information from central unit or terminal units[9]. This provides secured recordmanagement.The central unit continuously monitors thechanges in the various patient's parameters and in caseof emergency such as alarming rise or fall in any of theparameters, the concerned doctor is informed via theGSM that is installed on the central unit[6].

CONCLUSION

A low cost patient monitoring system based on GSM system has been proposed. A temperature sensor LM35 and RFID module communicate to

the mobile via GSM technology. This telemetry system allow the doctor to observe the data and temperature of the patient via messages on mobile phone whenever required. After successful completions of this project it can conclude that the microcontroller based system can be effectively used as communication medium in conjunction with GSM.

REFERENCES

[1] Jonathan E. Helm, Marcial Lapp, and BrendanD. See, "*Characterizing An Effective HospitalAdmissions Scheduling And ControlManagement System: A Genetic AlgorithmApproach*", in Proceedings of the 2010 WinterSimulation Conference, pp. 2387-2394, 2010.

[2] Martin Smits and Gert van der Pijl,"*Developments in Hospital Management andInformation Systems*", in Proceedings of the32nd Hawaii International Conference onSystem Sciences, pp. 1-5, 1999.

[3] Ali Asghar Nazari Shirehjini, Abdulsalam Yassine, and Shervin Shirmohammadi, "*Equipment Location in Hospitals using RFIDBased Positioning System*", Karlsruhe Instituteof Technology (KIT), Karlsruhe, Germany,Technical Report.

[4]*"LM35 Precision Centigrade Temperature Sensors Datasheet"*, National SemiconductorsCorporation, November 2000.

[5]*"ATmega164P/324P/644P datasheet",* ATMELCorporation.

[6]Marc Kahabka, *GSM Pocket Guide*, Wandel &Goltermann GmbH & Co, Volume 2.

[7]"Global System for Mobile Communication(GSM)", Web ProForum Tutorials,*http://www.iec.org.*

[8] *"RFID: Radio-frequency Identification"*, OCEDMinisterial Meeting Paper, pp. 94-101, Seoul,Korea, June 2008.

[9] Elisabeth Ilie-Zudor, Zsolt Kemény, Péter Egri, and László Monostori, "*The RFID Technologyand its current applications",* In Proceedings ofThe Modern Information Technology in theInnovation Processes of the IndustrialEnterprises,pp.1-8, 2006.

[10] Johan Lönn and Jonas Olsson, "*Zigbee forWireless Networking",* Linköping University,Department of Science and Technology (ITN),*March 2005.*

[11] "Zigbee alliance", Available [online]: *http://www.Zigbee.org/About/UnderstandingZi gbee.aspx*

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