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Raspberry PI based Data Sensing and Logging System using Wireless Sensor Nodes (WSN) and Local Area Network (LAN)

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Abstract– In these days automation using wireless communication has made the systems more smart and automated. The use of wireless communication has made the monitoring remote parameters easy. In medical domain, monitoring the patients parameters play an important role in diagnosing and giving appropriate treatment. In the existing system patient is monitored using bedside monitoring station with wired sensors, which makes the patients to be periodically monitored by the doctors/ nurses. This paper describes system which uses sensors to measure various parameters of the patient like temperature, Blood pressure wirelessly using Wireless Sensor Nodes (WSN) and update the status to Raspberry PI based server. The server updates the information using Local Area Network (LAN), so that the doctor can monitor the patient's status anywhere within the Local Area Network and also sends an alerting SMS to a predefined mobile number if a parameter crosses the threshold.

Keywords— Local Area Network (LAN), Automation, Wireless Sensor Nodes (WSN), Blood Pressure (BP).

I. INTRODUCTION

Nowadays, wireless communication is more popular and powerful communication technique over the wired communication. In medical science, wireless application rapidly increased with number of advantages over the wired connection such as, its ease to use, its reduced risk of infection, failure and patient discomfort, to enhance mobility. The low cost portable devices like heart rate monitors, temperature monitoring and Blood Pressure(BP) monitors are essential instruments in intensive care.It is difficult to monitor the patients continuously so normally, this kind of patients attached with relevant sensors to the body and the patient become sequentially bed bound with sensors. Earlier the patient is monitored from ICU and sends the patient condition to the bed side PC through wired communication. Whenever patient needs to be moved from bed, all patient monitoring device has to be disconnected and then need to be reconnected it later. The use of Wireless Sensor Nodes (WSN) will make patients monitoring systems more effective. The WSN can be mode more effective by using zigbee S2 and GSM. Here Raspberry Pi is used to continuously update patient's data to the LAN server. WBAN is the base concept to develop the patient monitoring system.

Wireless Sensor Network (WSN) to monitor the patient's physiological conditions continuously using Zigbee technology. The ZigBee based sensor network makes the transmission of patient's data to a remote central station. The use of zigbee makes it a low power device [1,2]. A patient monitoring system during the critical situation plays a vital role in every house. Point-of-care (POC) patient monitoring refers to near patient testing, usually outside the central hospital or primary care facility [3]. The remote monitoring of patients health using Wireless Sensor Networks (WSNs) makes the system more centralized and makes the sensing wireless. AARM embedded web server based on Raspberry Pi makes the system to update the data acquired using WSN to the server using which a central monitoring of patients is done[10].

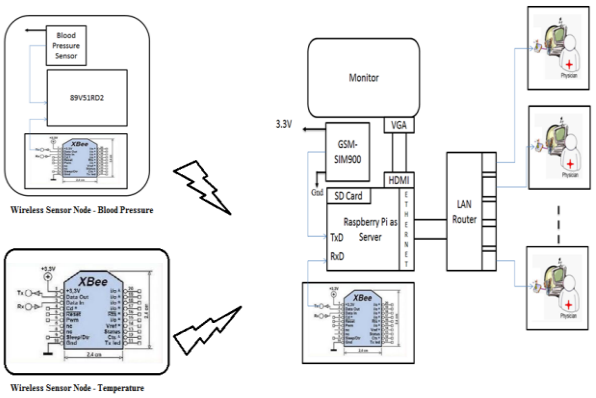
In the proposed system, the patient's physiological conditions are acquired by the wireless sensors nodes attached on the patient body, and are then transmitted to the remote base-station. The base station is designed using a Raspberry Pi. The Raspberry Pi is basically ARM 11 processor with features like serial communication and Ethernet and so on. These features are explored to communicate with the WSN designed to acquire data and update the status to doctor's chamber using LAN.

This paper is organized as follows. The section 2 gives overview of the proposed system, section 3 introduces the System Architecture and the hardware design. The section 5 deals with software implementation of the architecture, section 6 covers results and discussions and section 7 deals with conclusions.

II. DESIGN & IMPLEMENTATION

A.Block diagram:

Wireless Sensor Nodes: The wireless sensor nodes are basically designed using ZigBee technology, The ZigBee modules are reconfigurable devices which can be configured to operate as router, coordinator or end devices. The patient nodes are configured are Routers in API mode which configures the ZigBee module to read analog or digital sensor status and convert them in digital form using ZigBee and transmit it as a frame. The frame basically comprises the information like Node number and the converted data. System block diagram is shown in figure 1.



Transmitter section Server section

Fig 1. Block diagram

Raspberry Pi as Server: The Raspberry Pi server section basically has a ZigBee configured as coordinator to receive the data coming from different nodes. The frames coming from different nodes is received and stored, from the received data the required information is extracted and display in the server which acts as Central Monitoring station. The Raspberry pi unit does the additional function of updating the status using a Local Area Network, this helps the doctors to monitor the patient status sitting at their chamber and also has the feature of sending SMS using GSM SIM900 when the parameter under monitoring condition are above the threshold value defined.

B. Hardware Requirements:

- **Temperature Sensor**: We will use the LM35 Temperature sensor and which is most accurate with an accuracy of +/-0.4C.and working based on the principal of thermocouple. LM35 temperature sensor is shown in figure 2.

Advantages of LM 35 sensor

- It measures temperature more accurately than thermistors.
- It is sealed and does not undergo oxidation.
- It does not require output voltage to be amplified.

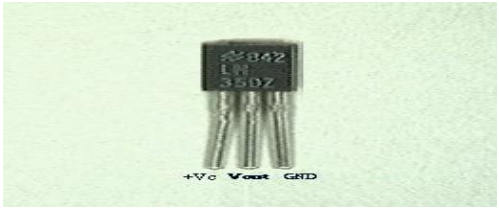


Fig 2. LM35 Temperature Sensor

The output voltage of LM35 sensor is proportional to Celsius temperature.

BP sensor: Sphygmomanometer- Blood pressure is the force of blood against the walls of arteries. Blood pressure is recorded as two numbers—the systolic pressure (as the heart beats) over the diastolic pressure (as the heart relaxes between beats). The measurement is written one above or before the other, with the systolic number on top and the diastolic number on the bottom. For example, a blood pressure measurement of 120/80 mmHg (millimeters of mercury) is expressed verbally as 120/80. The Sphygmomanometer is shown in figure 3.

In this System we are not using Full Sphygmomanometer, Half part only, Remaining Electronics parts which creates analog O/p As per Increasing the AIR.

Fig 3. Sphygmomanometer

- **XBEE S2 modules:** It is a Technological Standard Created for Control and Sensor Networks, based on the IEEE 802.15.4 Standard. In particular we are using series 2 over series 1. The reason behind this is that we can implement star topology only in series 2.operating at 2.4 GHz and range up to 100 meter. Here using mesh topology. There are two types of communication modes API mode and AT mode. Zigbee router is AT mode and zigbee coordinator as API mode.
- Created by the ZigBee Alliance.
- Low power consumption because it has inbuilt ARM7 core.
- Small packet devices.

X- CTU software used for zigbee configuration .shown in figure 4.

- **Raspberry Pi:** Its credit card sized computer board operating in LINUX operating system with 700 MHz. This is miniaturized processor which is capable of handling a number of applications just like CPU of a desktop computer. It has a Rasbian OS and it is introduced by Raspberry Pi foundations UK in 2012. It can be configured to develop games, web server etc. and available 3000 to 4000 thousands. It's running on Python programming language. Raspberry Pi Board Module B+ is shown in figure 5.

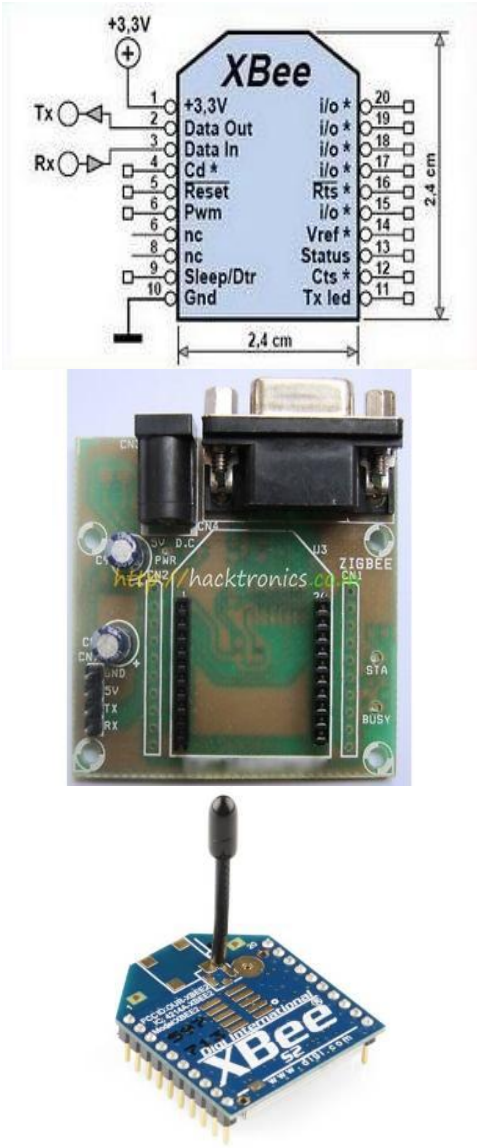


Fig 4. Zigbee pin structure and module

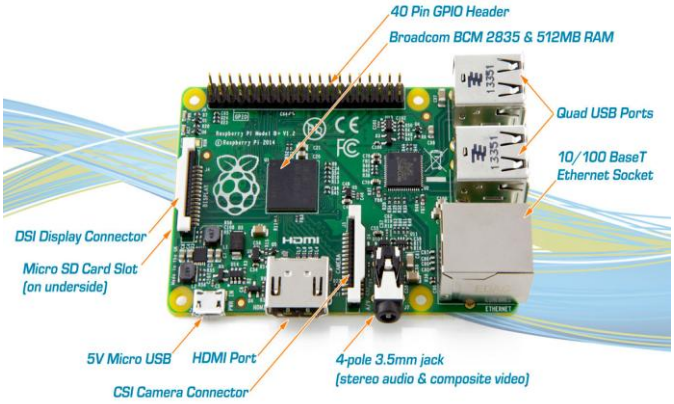


Fig 5. Raspberry Pi Board Module B+

- **GSM modem:** This is used to send SMS to doctor if the health parameter exceeds normal value.
-

C. Software Requirements:

X-CTU tool: This is a software utility tool given by DIGI internationals for configuring XBEE chips.

Python Programming: Python is an interpreted language which is very easy to read and write. It has a vast Libraries and it is platforms independent. Hence this programming is used in the project.

HTML scripting: This scripting is used to design web page.

III. Algorithm for the Model

1) The proposed system first collects the patient's data through sensors.
2) The collected data may be in analog form so they are converted to digital form using ADCs present in ZigBee modules. This makes the ZigBee to be used efficiently and act as sensor node.
3) The sensed data using WSN is transmitted to the coordinator node zigbee.
4) At the doctor site the data are received by receiving module and it feeds the data to processor at the doctor site.
5) The processor is pre-programmed to
   - Update the received data to the server and update the status to Local Area Network.
   - It compared the data received with base values the vital parameters. If any of the parameter or parameters exceeds the normal value then an alerting SMS is sent to doctor.

IV. Results & Discussion

The figure shows intermediate values between zigbee router and zigbee co-coordinator. Pointer value shows input pin select and transmitted values. Temperature sensor Result is shown in figure 6.

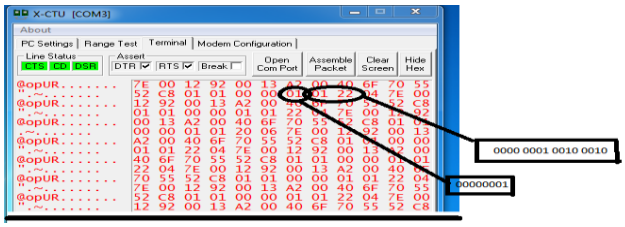


Fig 6.Temperature sensor Result

The above figure shows the sample digital values obtained from temperature sensor. The output is in HEX format which consists of frame of data involving handshaking signals along with the actual temperature sampled values. Later these sampled values are averaged

and is converted into temperature in Celsius format. . Actual Temperature sensor results from Raspberry pi shown in figure 7.

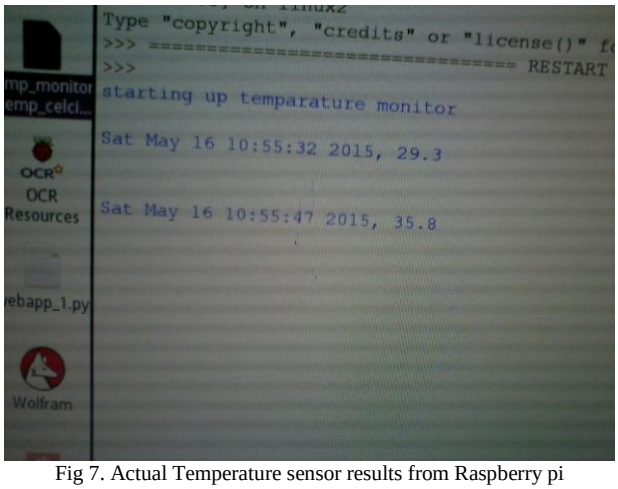


Fig 7. Actual Temperature sensor results from Raspberry pi

The above screen shot show exact value of LM35 temperature sensor and it's obtain from run Python programming language for temperature sensor. The below graph shows varied temperature and Blood pressure obtained from LAN network. The same data obtain within LAN network in any PC. The Temperature & B.P display at doctor's desktop is shown in figure 8.

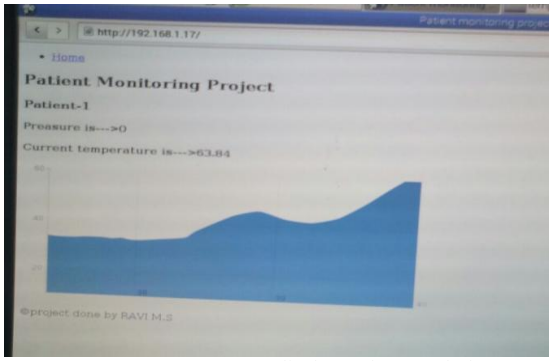


Fig 8. Temperature & B.P display at doctor's desktop

V. Conclusion

Wireless Sensor Nodes designed using ZigBee is emerging as a significant element of next generation healthcare services. In this paper we proposed a mobile physiological monitoring system, which is able to continuously monitor the patient's heart beat, blood pressure and other critical parameters in the hospital. The entire system consists of a router node to acquire the patient's physiological data. The transmitted data from the router node is received by the coordinator node. The coordinator node connected to the server. The server nodes designed to update the data using LAN which helps is easy way to monitor the patient at their chamber and helps doctors to take immediate actions. The GSM technology helps the server to update the critical conditions directly to the doctor mobile to avoid further damages.

VI. Future Scope

We use the temperature sensor and BP sensors to obtain patient conditions instead of those possible to use heart beat sensor, pressure sensor and here we use medical application only instead of this field use industrial, irrigation and electronic display applications. We done only LAN network to see the patient condition continuously, we buy the web site it's possible to see patient condition in world wide. We use LAN only because of cost estimation.

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