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# Centralized Heart Rate Monitoring and Automated Message Alert System using WBAN

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***Abstract-*** A vision commonly found in the research arena is to provide sensing and wireless communication for assisted living facilities, to improve lifestyle, to improve health care, and to support long term medical studies. Nowadays, Wireless Sensor Network research is being performed to address medical applications. WSN has put an enormous impact on medical healthcare in terms of reducing the patient's risks of severity in emergency situations. This paper presents a centralized heart rate monitoring and an automated message alert system that employs a wireless body area sensor network (WBAN), which is an enabling technology for medical applications in this type of environment.

***Index Terms***- Wireless Body Area Sensor Networks (WBAN), Wireless Sensor Network (WSN), Wi-Fi

## I. INTRODUCTION

A wireless sensor network (WSN) consists of spatially dispersed and dedicated sensors (motes) that can gather, monitor, process and record the physical or environmental conditions such as temperature, sound, humidity, pollution levels, pressure etc, and collaboratively pass their data through the network to a central location. Nowadays, WSN can be found in various healthcare applications like monitoring precarious diseases, Glucose level monitoring, Infant Monitoring etc as studied in [9].

One of the subsets of the medical WSN applications is Wireless Body Area Sensor Networks (WBAN). A WBAN is a special purpose sensor network that acts as an interface between various sensors in and around the human body and the computer system. They consist of several physiological sensors attached to the human body or implanted in the body, that will record and process the physiological changes and measurements, sending these measurements to an external processing unit, which could be then transmitted to other external servers [1][6]. Similar kind of examples include the prevention of ulcers[2], support of rehabilitation[3], or informing doctors at remote locations of the state of patients residing at home[4]. Various health care applications that use wearable sensors and implantable sensors in WBAN are studied in [7][10]. All the applications mentioned use wireless sensor nodes that measure physiological changes, perform some processing and send data to some Gateway (personal devices) like mobile phones, a personal computer or personal digital assistants (PDA) that acts as a sink [5].

The WBAN is capable of connecting to the communication network and transmit data. The sensors communicate with local control devices which are either on patient's body or at accessible distance. The local control devices then communicate with remote destination or a monitoring server to exchange data for diagnostic and therapeutic purposes. In emergency case, such as abnormal readings received by ECG, an alert is sent to the caring group of people. An appropriate action is then taken according to the severity of the alert. WBAN system must also meet a number of security requirements like confidentiality, data integrity etc as mentioned in [7][8].

In this project, the data obtained from multiple heartbeats, temperature and dust sensor is stored and processed using Atmel microcontroller, which is then transmitted to a centralized unit, where the information for multiple sensors will be displayed simultaneously. The efficiency of data transmission is monitored and verified. Wireless networking for the sensors had been successfully designed to show the active pulse sensor. Besides, the data transmitted and received by the receiving system is accurate and it has been proved through several observations.

Heartbeat sensors are used to get the heart rate data of the patients. The principle of this sensor is based on the red and infrared light absorption characteristics of oxygenated and deoxygenated hemoglobin. Oxygenated hemoglobin absorbs more infrared light and allows more red light to pass through it. Deoxygenated (or reduced) hemoglobin absorbs fewer red lights and allows less infrared light to pass through it. Red light is in the 600-750 nm wavelength light band and infrared light is in the 850-1000 nm wavelength light band. After the transmitted red (R) and infrared (IR) signals pass through the measuring site and are received at the photo detector, the R/IR ratio is calculated. The R/IR is compared to a "look-up" table. Dust sensor is used to measure the dust percentage inside the ward of the hospital and the temperature sensor is used to measure the temperature of the ward.

Once the data is received by these sensors and processed by the microcontroller, this data is sent to a main location with the help of Wi-fi. Wi-fi implements a high level communication protocol using low power digital radios. It is mostly used to send periodic data signals over long range with the help of mesh networks. It provides a secure way of networking. The low cost allows its wide usage and due to low power it can operate longer on batteries. Most importantly if the data sent by the sensors to the microcontroller is abnormal, then

an automatic message is sent to the doctor so that the patient can be attended. Each patient is authenticated with a unique ID (identification) number, so that there is no confusion in attending the suffering patient.

## II. METHODOLOGY

The working principle for this project is the easy measurement of a patient's vital parameter through a new sensor based device and the communication network provided by the gateway and Wi-fi technology. These two technologies combine to build a fast monitoring system for hospitals and healthcare centers and are very practical.

An optical sensor based device called heartbeat sensor is used to measure both pulse rate and hemoglobin level. It passes the light waves through a thin body part such as finger and a photo-detector at the other end measures the intensity of both. More oxygenated hemoglobin absorbs more infrared light and passes the red light. Deoxygenated (or reduced) hemoglobin absorbs few red lights and allows less infrared light to pass through it. This information or data is sent to the microcontroller which analyzes this information. Then this information is sent to the monitoring system (computer in the ward) which collects the data from the patients and then transmits it to the main location. Each such set consist of Microcontroller AT89S52, temperature sensor, dust sensor and heartbeat sensor. The dust sensor which is present in the ward itself detects the percentage of dust in the surroundings (ward) and helps in the precaution of the patients. The temperature sensor detects the temperature of the ward. This combination set of Microcontroller AT89S52, temperature sensor, dust sensor and heartbeat sensor acts as the transmitter part. The data obtained from these sensors are stored in the host computer. The data in the host computer can be Wi-fied anywhere in the network. Here it is wi-fied to a main location (monitoring server). This whole setup constitutes the receiver part. The data transmission is started as soon as all the connections are done. Each node (patient) has different ID number which has been assigned using AT89S51 controller. This ID number is important to differentiate the data, once it is received at the receiver end. Thus, overlapping of data can be avoided. Multiple data will be identified at the receiver end and will be shown on a single monitor. Thus, it could be easier for the medical practitioner to monitor a number of patients simultaneously. This monitoring will also view the active heartbeat and temperature sensor. Therefore, any idle or inactive sensor will be neglected.

The monitoring application is designed with the help of .Net and C#. These tools are system design software that provides engineers and scientists the required tools needed to create and deploy measurement and control systems through unprecedented hardware integration.

The data obtained from the sensors are real time data. If the data obtained from the heartbeat sensors shows any abnormality, automatic message alert is sent to the doctor's mobile also. The other sensors may also show abnormalities, in that case, the staffs or the nurses who are intimidated from the monitoring server, would take care of the scenario.

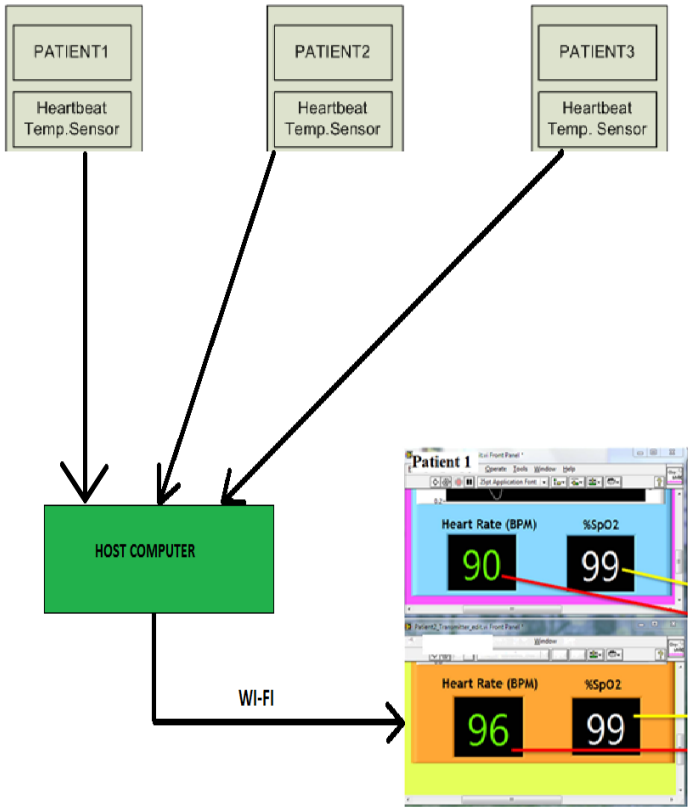


Figure 1: Block diagram for the Centralized Heart Rate Monitoring system

## III. RESULTS

The proposed system provides a web application for the observer to monitor the patients simultaneously using internet connections.

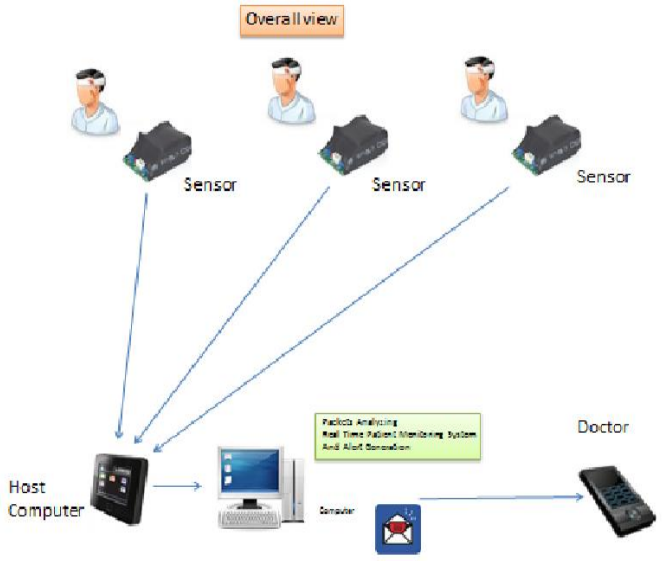


Figure 2: Proposed system diagram

As shown in the above proposed system diagram the observer opens the web application through the web browser. The operations are then selected by the observer. The observer collects the data of the patients from the host computer. The host computer sends the appropriate data through Wi-Fi. The observer then collects the information for the references. If the data received shows any abnormalities like abnormal heartbeat rate, abnormal temperature of the ward or the abnormal dust density of the ward, then an automatic message is sent to the doctor through the application to show the deteriorating condition of the patient or the ward.

Whenever the system collects the data from the patients, i.e. the host computer, the data can be stored in it and then be transmitted anywhere, where there is an appropriate Wi-Fi connection. It is transmitted to a main location where it is viewed continuously. The doctors and the nurses far away from the patients can simultaneously monitor the patients.

Various test cases were generated and the results were inferred from the test cases. The normal range for the heart rate of a patient was taken as 65bpm to 100bpm. The normal range for the dust percentage in the ward was taken as 005% to 020%.

The reading from patient 1 is taken from the host computer and then wi-fied to the main computer. Figure 3 demonstrates the condition of the patient to be normal.


Figure 3: Normal Heart rate and temperature reading from patient 1

The reading from patient 1 is again taken from the host computer and then wi-fied to the main computer. Figure 4 below demonstrates the condition of the patient 1 to be abnormal. If there is any abnormal reading in the real time data from the sensors, an automatic message alert is sent to the mobile phone of the doctor or the health care professional.


Figure 4: Abnormal Heart rate and temperature reading from patient 1

Here, a single microcontroller is used for a single patient. Similarly more number of microcontrollers can be used to obtain the results from multiple patients. Figure 5 demonstrates the reading from multiple patients.


Figure 5: Reading from different patients

## IV. CONCLUSION

The recent advances in the WBAN has the ability to integrate technology with existing applications or medical support platforms and deploy large scale systems that operate in unsupervised environments. The main objective of this project is to establish a wireless body area sensor network for handling real time data from different sensors and forwarding the data received by the host computer in the TTL format to the USB format on the receiving computer. The data that is transmitted and received is real time data and accurate. These features allow this system to be deployable in the hospitals or any institution that provides medical and nursing care. Further improvements on the paper includes expanding the system to mobile and remote patients, who are connected to a centralized monitoring system and doctors, using wireless body area network.

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