# WSN Based Health Monitoring System for Cardiac Patients

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## ABSTRACT

*A Wireless Sensor Network (WSN) based on health monitoring system for cardiac patients have been proposed. The main parameters such as heart rate, blood pressure, oxygen saturation rate and temperature are transmitted and monitored using WSN. This data is then recorded in the server PC and communicated to the near-by doctor in case of emergency. To monitor these parameters several sensors are used The main objective of this system is to reduce the stress levels of the doctor by informing them about the patients even when patients are in unconscious state. It also maintains the record of each and every patient as the changes occurs in their healthsuch as heart rate sensor, pressure sensor, SPO2 sensor and temperature sensor. Various technologies such as ZigBee, WI-FI and Android Application will be used to transmit the data to other ends (nodes within WSN, server and doctor). The proposed method consist of sensors, a WSN which transmits data using ZigBee, an Android Application which informs the doctor if the values of sensor cross the saturation level and WI-FI technology to store the measured sensor data into main server.*

**Keywords -** Wireless Sensor Network, ZigBee, WI-FI, Android Application, Heart Rate sensor, Pressure sensor, SPO2 sensor and temperature sensor.

## 1.INTRODUCTION

The following section consists of the basic architecture of the proposed system and its description. The components used in the proposed architecture consist of WSN, sensors that have been used, technologies used for transmission of data that are collected from sensors and protocol used in WSN.

In the proposed architecture each sensor node sends the values of all the sensors to the coordinator sensor node via ZigBee. Coordinator node sends all the values to server via WI-FI to store them in data base. If any emergency occurs that is if any of the sensor value exceeds its saturation value immediately alert will be given to the doctor on their respective Android Application.
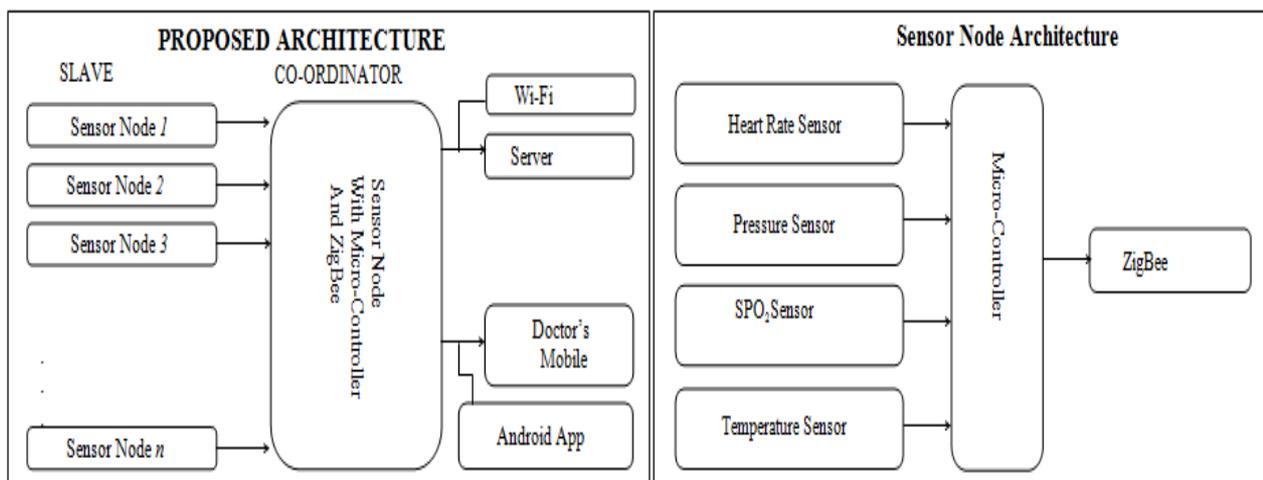


### A.Wireless Sensor Network

A WSN consists of independent wireless sensor nodes which contain one or more sensors, depending on the application, microcontroller for signal processing, memory for program and data storage, wireless communication unit and a power source [4]. In the proposed system, ZigBee is used as wireless communication unit.  It transmits the data that is collected from the sensors between sensors nodes using mesh protocol.

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## B. Sensors
There are several sensors used to monitor cardiac patients in the hospital.

### a. Heart Rate Sensor
The heart rate sensor works on the principle of photo phlethysmography. It measures the change in volume of blood through an organ of the body which causes a change in the light intensity through that organ (a vascular region). The flow of blood volume is decided by the rate of heart pulses, therefore since light is absorbed by blood, the signal pulses produced are equivalent to the required heart beat pulses [1].

### b. Pressure Sensor
A pressure sensor is a device which senses pressure of blood and converts it into an analog electric signal whose magnitude depends upon the pressure applied [1]. Since they convert pressure into an electrical signal, they are also termed as pressure transducers. By using this sensor patient's blood pressure can be measured.

### c. SPO2  Sensor
Pulse oximeters measures hemoglobin content in oxygen (oxygen saturation) [1]. Oxygenated hemoglobin absorbs infrared light and allows more red light to pass through. Whereas deoxygenated hemoglobin absorbs red light and allow more infrared light to pass through.  By comparing the amounts of red and infrared light received at the receiver, the instrument calculates the SpO2 reading.

### d. Temperature Sensor
A temperature sensor is a device, typically, a thermocouple or RTD which provides for temperature measurement through an electrical signal. [1] It  measure the amount of heat energy or even coldness of the body, allowing us to sense any physical change to that temperature producing either an analog or digital equivalent output.

## C. Technologies
In the proposed system we have used three technologies. ZigBee is used within WSN to share data between different sensor nodes. WI-FI is used to send the data measured from different sensors to server. Android Application is used to help doctors to get the updates of their patients.

### a. Zig Bee
ZigBee is a RF standard that has been specifically designed and developed for low power, low data rate wireless monitoring and control applications present across a large number of distributed nodes [5]. RF stands for Radio Frequency. It refers to a frequency or a band of frequency lying in the range of 10 kilohertz to 300,000 megahertz. These rays are suitable for radio communications and broadcasting.

ZigBee is a specification for a set of wireless protocols that have been designed for data transfer by low power devices. It is based on an IEEE 802.15 standard. The protocols of ZigBee are extensively used for producing personal area networks using small and low powered digital radios.

### b. WI-FI
Wi-Fi is a technology used for wireless area network devices based on the IEEE 802.11 standards. Wi-Fi compatible devices can connect to the Internet via a WLAN and a wireless access point. Such an access point (or hotspot) has a range of about 20 meters (66 feet) indoors and a greater range outdoors. This range is helpful to send the data from one end (patient's ward) to another end (server).  Wi-Fi most commonly uses the 2.4 GHz (12 cm) UHF and 5 GHz (6 cm) SHF ISM radio bands.

### c. Android Application
Android is an open source and Linux-based operating system for mobile devices such as smartphones and tablet computers. It offers a unified approach to develop application for mobile devices which can be accessed anytime anywhere [7]. Their applications can run on different devices powered by Android. Such an application is developed for doctors so that they can get the notification on time if any negative changes occur in their patient's health.

## D.Protocol
A mesh network is a network topology in which each node is connected to every other node. With routing, the message is propagated along a path by hopping from node to node until it reaches to the coordinator node.

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Zig Bee is best suited with the mesh topology as a large network is formed using this topology has many advantages over the other topologies.

## 2.DATA FRAMING STRUCTURE

Data frame consists of sequence of data that will be transmitted between the sensor nodes. It is of 20 Bytes.

| Header | Unique-ID | Time | Heart Rate Sensor | De-Limiter | Pressure Sensor | De-Limiter | Temperature Sensor | De-Limiter | SPO$_2$Sensor | De-Limiter | CRC-16 | Footer |
|--------|-----------|------|-------------------|------------|-----------------|------------|--------------------|------------|---------------|------------|--------|--------|

**Header -** Header refers to supplemental data placed at the beginning of a block of data being stored or transmitted. It is of 2 Bytes.

**Unique-ID –** It contains patients ID whose data is sent from the respective sensor node. It is of 2 bytes.

**Time** – It specifies the time at which values are taken. It is of 1 Byte.

**Sensor Data** - It provides data from Heart Rate Sensor (2 Bytes) Temperature sensor (2 Bytes), Pressure Sensor (2 Bytes) and SPO$_2$ sensor (2 Bytes).

**Delimiter** – This is used to separate the data between different sensors. It is of 1 Byte.

**Correction key** – This is used as error correction key to detect the error if occurred in the received value. It is of 2 Bytes.

**Footer** – Footer refers to supplemental data placed at the end of a block of data being stored or transmitted, which may contain information for the handling of the data block, or just mark its end. It is of 1 Byte.

## 3.RESULTS

**Table 1.** Reports of Patient stored in the server

| Time | Heart Rate (per min) | Blood Pressure | Temperature | SPO$_2$ (%) |
|------|----------------------|----------------|-------------|-------------|
| 3:00PM | 155 | 160/140 | 96 | 88 |
| 3    3:10 PM | 140 | 150/130 | 96 | 90 |
| 3:20 PM | 130 | 140/120 | 96 | 90 |
| 3:30 PM | 115 | 140/100 | 96 | 92 |
| 3:40 PM | 105 | 135/100 | 96 | 92 |
| 3:50 PM | 95 | 135/90 | 96 | 93 |
| 4:00 PM | 95 | 130/90 | 96 | 94 |
| 4:10 PM | 95 | 130/90 | 96 | 94 |

**Figure 1** Android Application

Above figure shows Android Application that can be used by doctors for knowing the status of their patients. All the data coming from the sensor nodes are sent to server and stored in data base in MS Access file – each for respective patients as shown in the table below.

## 4.CONCLUSION

This work describes the operation and application of a WSN Based Health Monitoring System for Cardiac Patients considering a high connectivity range and computational capacity. Each sensor node is employed with a 16-bit microcontroller, sensors and a ZigBee module. Further these sensor nodes send the data to coordinator and from coordinator to server and to doctor. Thus the resulting network monitors Heart rate, Temperature, Blood Pressure and SPO2 dataof all the patientsfor 24 x 7 hours. The research also considers the development of network connectivity, based on controller and different technologies which are able to operate in emergency conditions.

## 5.ACKNOWLEDGEMENT

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