Real Time Green Corridor Health IoT Monitoring System

Asha S R, Aditi Patil, G Narendra Kumar
Department of Electronics and Communication Engineering
University Visveswaraya College of Engineering
Bangalore Karnataka,India
asha.sr003@gamil.com, aditipatil787@gamil.com, gnarenk@yahoo.com

***Abstract*—The information and communication technologies have led to the development of Internet of Thing (IoT) allowing many devices to collect, transmit data through the internet providing more data interoperability methods. Iot helps in monitoring, recording, storing and displaying of information through the inter-connection of many wireless sensor networks. The vital health parameters are captured and transmitted through wireless communication to the server providing quality of service in health care. In this paper we are proposing the system that helps patient in monitoring health parameters and the information can be accessed by the physician, caretakers with an unique identifier. During an emergency, the patient has to be taken to the hospital faster and safer through the online monitoring of patient's health condition and provides traffic free path to the nearest hospital. The earliest possibility of reaching the hospital is achieved by using the real-time smart traffic system providing a green corridor to the vehicle equipped with Zigbee Transmitter and Zigbee Receiver at the traffic signal. Real-time health monitoring system is built with required sensors that helps in capturing and storing of data in the remote server that is accessed through a mobile application. A smart traffic system is developed to provide a green corridor that helps patient to reach the hospital to the earliest.**

***Index Terms*—IOT; Health Monitoring System; Smart Traffic Control; Wireless Communication; Zigbee.**

I. Introduction

Health is one of the basic needs for a better life, there are several global health issues such as lack of health care services, unavailability of doctors during the emergency, transportation facility and adequate traffic on the roads *etc,*. World Health Organization (WHO) defines the health as "a state of complete physical, mental and social well being". A modern healthcare system [1] as shown in Figure 1 provides better healthcare services to people at any time from anywhere that is economical and user-friendly. Nowadays the healthcare system is growing rapidly. In the traditional approach, the physicians had to visit the patients for proper diagnosis and advice.The basic health parameters are monitored at remote location and when the situation becomes critical the patient has to be taken to hospital. To resolve such issues the patients are equipped with knowledge and information on the current situation, disease diagnosis and providing quicker treatment remotely. This healthcare service is provided by acquiring, recording, displaying and transmitting the data from the patient to a remote server at any time. This provides an alarm to the caretakers when the parameters exceeds the defined threshold and is centrally monitored. With the required firmware and software, the server will be connected to an open communication network via TCP/IP protocol. Thus, a patient can be monitored from any location. The patients can reduce unnecessary back-and-forth travel to the far located hospitals as the data is already delivered via SMS or Email.

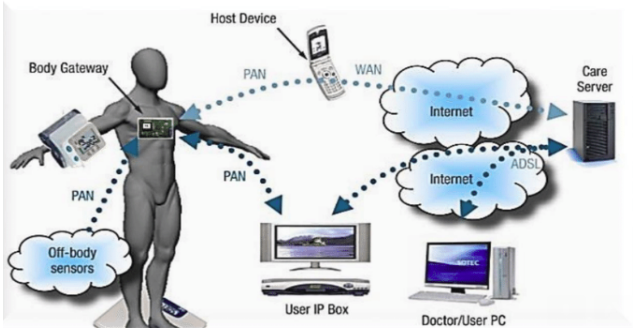

Fig. 1. Health Monitoring System

Internet of Things (IoT) [2] is connecting devices to the internet with sensors and compatible platforms. These IoT sensors are placed on the patient; health information will be collected and updated to server continuously via the WiFi module that is the fastest, most flexible, interoperable method for monitoring any issues related to the health, its treatment and responsiveness. This information needs to be secured with the authentication and authorization mechanism to avoid misuse of data. We propose a solution to address all these challenges of the smart healthcare system.

During an emergency, the patient needs to be monitored continuously on the way to the hospital and to reach the hospital using the shortest and earliest path; however, traffic imposes delays and makes it difficult to achieve this. The difficulties faced by emergency vehicles can be avoided using this smart traffic system [3] with ZigBee technology. As shown in Figure 2 as the emergency vehicle approaches the traffic intersection, the serial communication takes place when the vehicle is in the range of 100m and the signal is tapped to green. The signal remains green until the emergency vehicle passes and then followed by a normal sequence. In this paper we propose a smart traffic solution to address all the above-listed issues.

The paper is organized as follows: In Section **II**, we list related works, in section **III** we explain our proposed system, in section **IV** we provide the implementation details, section **V** covers the experimentation results and observations finally we conclude our work in section **VI**.

II. Related Work

Wireless monitoring of health has drawn attention from the research and industry in the last decade. Research and

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Fig. 2. Smart Traffic System

development efforts have been published in the literature. We have constrained this effort to consider some of the very recent associated works.

A smartphone-based wireless healthcare monitoring system (WHMS) is presented in [4]. The paper proposes a system with online real-time tracking of the health of the patient. In addition to that, it provides the alarm and message on the received information. Heart rate monitoring and data transmission via Bluetooth is presented in [5]. The paper describes a simple heart rate monitor system with data on the LCD and simultaneously sends the information to a smart device via Bluetooth. The system considers the input from the pulse sensor by keeping the patients finger over the sensor and is processed by Arduino to count the number of pulses and displaying the output.

Wireless sensor-based health monitoring system is presented in [6]. The system monitors the parameters of multiple patients. A coordinator node in contact with the patient captures the data and transmits it to the base station. This forms a wireless body sensor network (WBSN) able to sense the heart rate, temperature and so on. During abnormal conditions, this issue an alarm to the patient and the physician receives an SMS/E-mail. This minimizes the consumption of energy to improve the lifetime of the network, gear up and extend the communication coverage for better quality.

A smart ambulance system is presented in paper [3], this system provides traffic clearance to the ambulance. The patient parameters along with the coordinates from the ambulance are sent to control center. The control center sends the nearby hospital details to the ambulance, then the ambulance will choose the path to the hospital and the traffic signals from this path will turn green; this route will be considered as a green bay.

III. Proposed System Module

In the proposed system we monitor the basic health parameters like temperature, heart rate, ECG, Blood pressure. These parameters are monitored 24X7 and updated to the server.The block diagram of our proposed system is shown in Figure 3; data from different sensors are collected and updated in the server with a Wi-Fi module. The data is analyzed with the standard thresholds if the range is within the standard threshold its just displayed on the LCD and updated to the server. The Physicians and the caretakers can access the data stored at the server through the TCP/UDP application. The data is secured as each patient is provided with a unique identifier.

In case the range of parameters exceeds the threshold and its detected as an emergency or the physician suggests the caretakers that the patient needs to be hospitalized then we

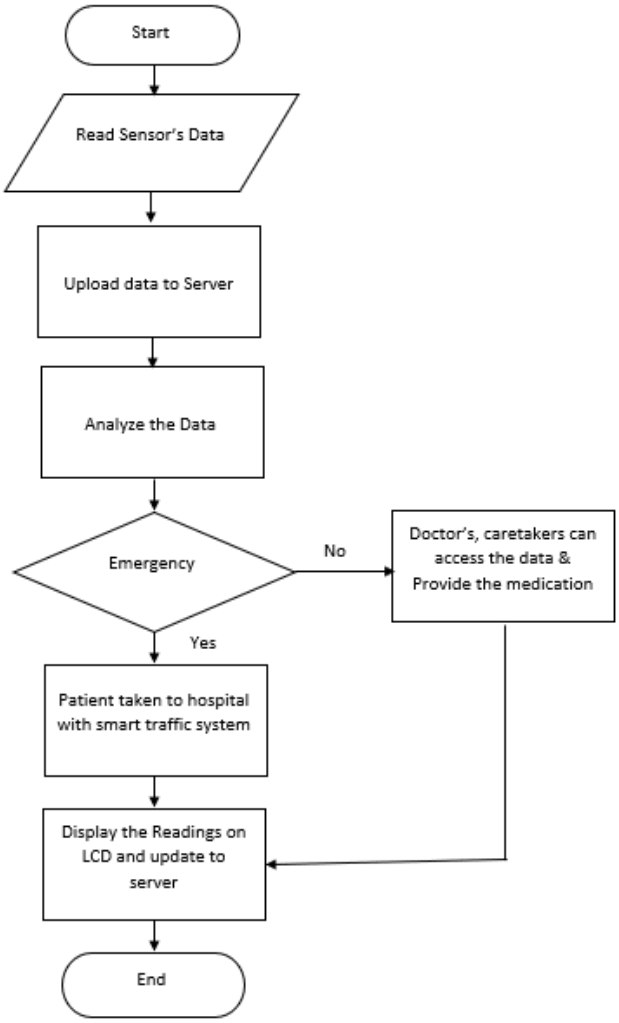

Fig. 3. Flow Chart

use the smart traffic system with Zigbee technology to reach the hospital as early as possible.

In this smart traffic system, we have equipped the Zigbee transmitter at the emergency vehicle and a Zigbee receiver at the signal intersection. The Zigbee transmitter and Zigbee receiver operate with a baud rate of 9600. This uses UART protocol and through the serial communication the signal gets tapped to green. As the emergency vehicle approaches the signal intersection and is within a range of 100m the signal gets tapped to green. The signal remains green until the emergency vehicle passes the intersection and it remains red on all the other paths. Here the paths are indicated with four switches each switch interfaced with each path. While the patient is taken to the hospital the parameters are monitored continuously and updated to the server, so that when the patient reaches the hospital the next procedure is carried out and the life of the patient is saved in critical situations. Figure 5 indicates the Zigbee transmitter module and Figure 6 indicates the Zigbee receiver module.

IV. Implementation

Step by step implementation of the smart health monitoring system is shown in Figure 4, information from different sensors is collected and updated to the server via the wireless communication channel, Wi-Fi Module 24X7. This Wi-Fi module can be used as the client as well as the server, here

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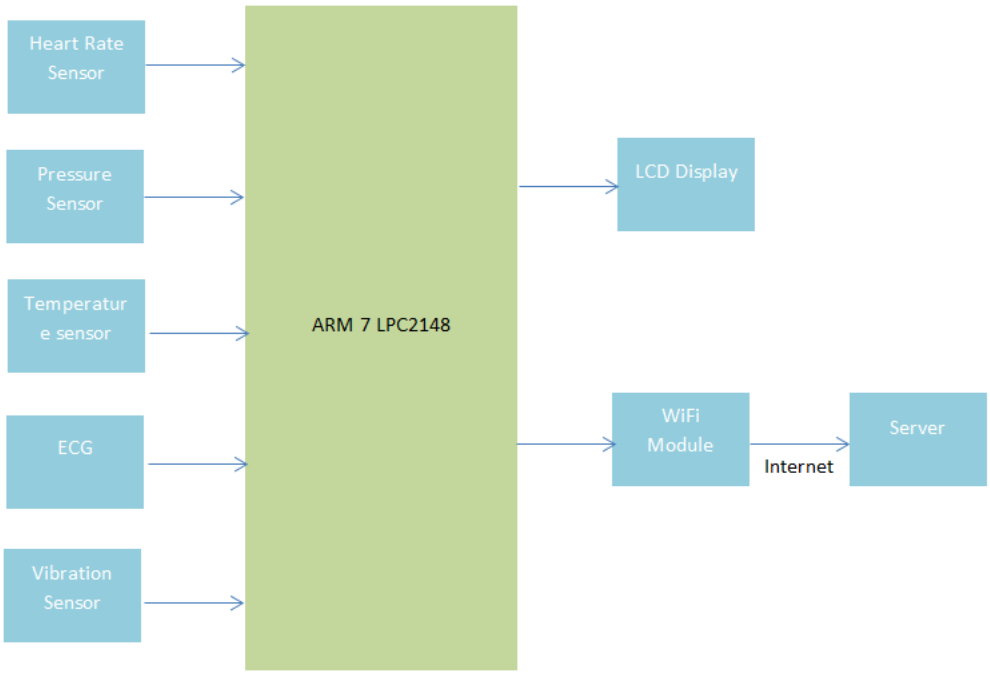

Fig. 4. Block Diagram

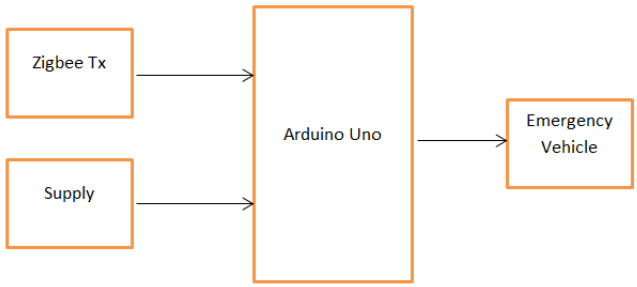

Fig. 5. Zigbee Transmitter at Emergency Vehicle

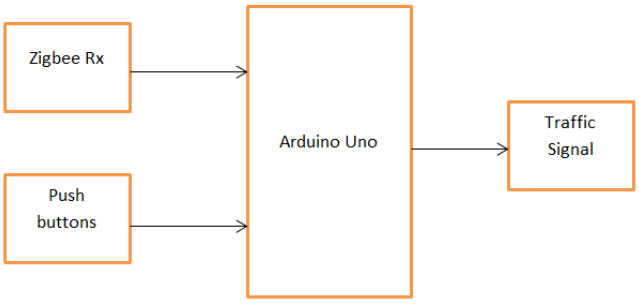

Fig. 6. Zigbee Receiver at Traffic Signal

it acts as a server that helps in fetching and storing of the information. The data can be accessed by the physicians or the caretakers through a user-friendly application based on TCP/UDP protocol. The data is secured as each patient is provided with a unique identifier and is updated to the server every 5 seconds. The doctors and the caretakers can access the physical parameters of the patient anytime and provide a required solution.

During emergency, on the way to the hospital traffic is another issue. This is taken care by the smart traffic system, providing a green signal on the path of an emergency vehicle approach then followed by a normal sequence. The technology used here is ZigBee, transmitter placed at emergency vehicle and receiver at the traffic signal intersection. When the vehicle approaches the intersection point, the serial communication takes place and taps the signal to green on the path of emergency vehicle. The signal continues to be green on the path of an emergency vehicle and red on the other paths. Once the emergency vehicle passes the signal intersection, the normal sequence is continued. In this way, the chances of accidents at the intersection are reduced and the life of a patient is saved.

The basic Parameters to be monitored with the following sensors namely: Heart Rate Sensor, Blood Pressure, Temperature, ECG. The vibration sensor is used to demonstrate the occurrence of the accident.

A. *Heart Rate Sensor*

Infrared light is transmitted through IR diode into the fingertip and the reflected light is captured by the photodiode. Depending on the volume of blood at fingertip the intensity of reflected light varies.

Fig. 7. Heart Rate Sensor

The thresholds of the heart rate are mentioned in Table II.

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B. Blood Pressure Sensor

As the blood gets pumped by the heart in the body the pressure of blood at arteries is measured. As the heartbeats, it contracts and pushes blood through the arteries to the rest of the body. This creates pressure on the arteries.

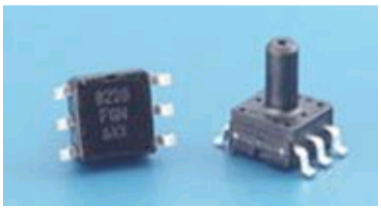

Fig. 8. Pressure Sensor

The thresholds of the blood pressure are mentioned in Table III.

C. Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors, the output voltage is linearly proportional to the Celsius (Centigrade) temperature. This is more advantageous over linear temperature sensors calibrated in Kelvin as we get both values.

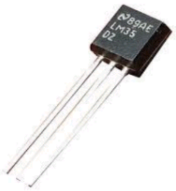

Fig. 9. Temperature Sensor

The thresholds of temperature sensor are mentioned in Table IV.

D. ECG Sensor

The electrical impulses generated in every heartbeat is captured. The electricity detected by an electrode is transmitted via this wire to a machine, which translates the electricity into wavy lines recorded on instruments present at the hospital. The ECG records in detail and are used to diagnose a broad range of heart conditions.

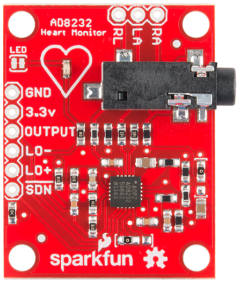

Fig. 10. ECG Sensor

E. LCD Display (16*2)

The most useful device in an embedded system. Mainly to display the required information. Pixels are used for most flexible ones.

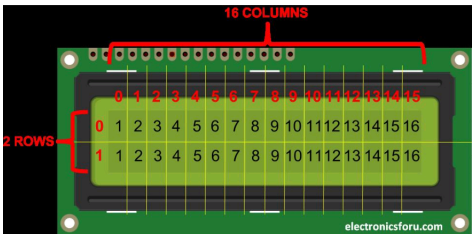

Fig. 11. LCD Display

F. Wifi Module

The patient is tracked continuously with the Wireless module, that can connect the computer to the internet. The Arduino Uno WiFi module can be used as a WiFi modem. This can be used as a server and transmit the data to the webpage automatically.

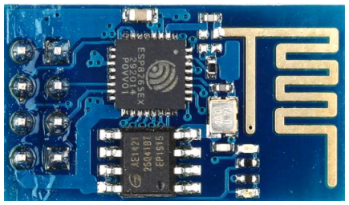

Fig. 12. Wifi Module

G. Zigbee

The available wireless Zigbee technology is cost and power-efficient. Its characteristics make this communication best suited for several embedded applicationslike industrial control, home automation when compared to other wireless technologies like Bluetooth, IEEE802.11b, IEEE802.11g, and UWB.

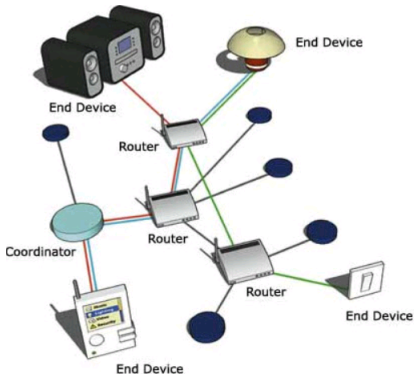

Fig. 13. Zigbee

The Table 1 shows the comparative study of wireless technology with different parameters.

H. LED

The LEDs are small, individual electronic lights created using applied voltage to a semiconductor chip and reflector inside a small colored lens or outer casing.

I. ARDUINO UNO

Arduino Uno is an 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists of other components like crystal oscillator, serial communication, voltage regulator, etc. They are inexpensive, can run on cross-platform,

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TABLE I
COMPARISON OF WIRELESS TECHNOLOGY

Parameter	Zigbee	Bluetooth	802.11b	802.11g	UWB
Throughput (Mbps)	0.03	1-3	11	54	200
Max. Range(ft)	100	30	200	200	30
Bandwidth (MhHz)	0.6	1	22	20	500
Price (USD)	2.0	3.0	5.0	12	7

opensource and extensible hardware and software compared to another microcontroller.

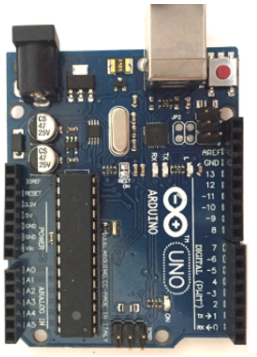

Fig. 14. Arduino UNO

J. LPC2148 ARM 7

LPC2148 Pro Development Board is based on an LPC2148 ARM7TDMI microcontroller with 512K on-chip memory. This board is powered by the USB port and does not require any external power supply. It is ideal for developing embedded applications with high-speed wireless communication (Zigbee / Bluetooth / WiFi), USB based data logging, real-time data monitoring and control, interactive control panels, *etc.*

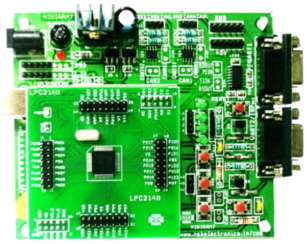

Fig. 15. LPC2148

V. RESULTS AND OBSERVATIONS

The patient is monitored with different sensors and the information is updated to the server every 5secs using IoT. This data can be accessed by the physicians and the caretakers anytime with a unique identifier. To monitor the criticality of health parameters we used the standards defined by healthcare system regulators and are tabulated. The observation of different sensors and threshold are accessed by a mobile application that captures the data stored at the dedicated server through the Wi-Fi module.

As the system is turned on, different health parameters are displayed on the LCD. The heart rate is measured by placing a finger on the sensor, it measures the heartbeat and blood level at the fingertip. The pressure sensor monitors the pressure, this device has a projection where we can apply the pressure on the projection, based on the applied pressure it determines the pressure along with high BP or low BP. The temperature sensors monitor the temperature of the patients body and determine whether the patient has a fever or is normal based on the medical standards.ECG helps in monitoring the different heart rate parameters. The signal is observed and the value changes based on different parameters.

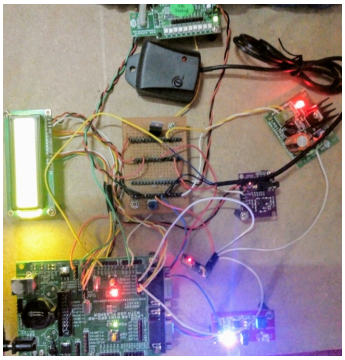

Fig. 16. Health Monitoring System

TABLE II
HEART RATE VALVES

Target Zone	Training Recommended
Normal (72 BPM)	Normal Rate
Low (60-70 BMP)	Low Heart Rate
Hign (>72 BPM)	Abnormal Heart Rate

TABLE III
BLOOD PRESSURE VALUES

Pressure Level	Systolic(mmHg)	Diastolic(mmHg)
Normal	90-130	60-80
Low	<90	<60
High	>140	>90

TABLE IV
TEMPERATURE VALUES

Type	Celsius	Farienheat
Hypothermia	<35.0	95
Normal	36.5-37.5	97.7-99.5
Fever	>37.5	>99.5
Hyper Pyrexia	>40	>104.0

During the emergency, the patient is taken to the hospital with continuous tracking of health parameters. The traffic on the way to the hospital is avoided with the smart traffic system implemented with ZigBee technology to save the life of the patient. The four paths are provided with four switches in the demonstration, when the switch is pressed the respective signal interfaced to that path turns green. The switch is also interfaced to display the availability of the metro facility on the respective path where the emergency vehicle is approaching. In future, the GPS will be integrated

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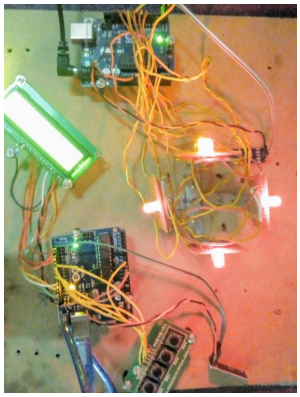

Fig. 17. Smart Traffic System

to know the availability of metro and distance of it from the emergency vehicle, so that the patient is taken to the hospital to the earliest.

The health parameters displayed on the LCD are shown in Figure 18.

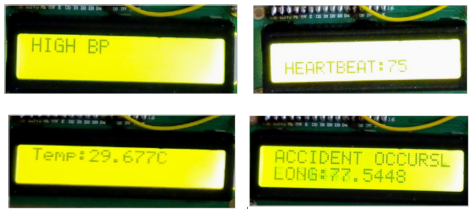

Fig. 18. Display of Parameters

The android application interface is shown in Figure 19.

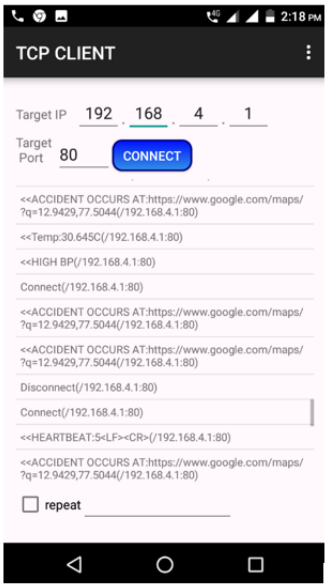

Fig. 19. Android Application Interface

VI. Conclusions

The Health monitoring system proposed in this paper keeps track of the patient health. It minimizes the time by providing user-friendly solution that keep track of the patient and report the same to the concerned person along with updating it to the server for future reference. The solution achieves the goal of mobility and agility of the device on human and still be very particular with the tracking of all the health parameters. Our system provides security control over the data access and is easier to operate in any environmental conditions with minimal space for storage. During an emergency, the traffic on the way to the hospital is avoided with smart traffic system with ZigBee technology. As the vehicle approaches the signal, serial communication takes place between the Zigbee transmitter and the ZigBee receiver within the range and the signal is tapped to green followed by a normal sequence. As a future enhancement, the application can be extended to include other vital health information, provide more security, monitor multiple patients simultaneously by providing an alarm to the concerned person and could be integrated with the Electronic Health Record (EHR) system to make it more useful and can be coupled with historical data. The Global Positioning System (GPS) and density-based sensor can be included as a future scope that improves the performance by using real time traffic information.

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