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Design of Wireless Medical Monitoring system

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Abstract— *Medical Monitoring Systems are essential when a country's population is quickly growing, increasing the demand for healthcare. This paper describes the architecture of a wireless sensor network using RF technology. It is mostly used in hospitals to capture and send various patient monitoring data. This application consists of a nRF24L01 Wireless Transceiver Module with External Antenna based network with three sensors attached to the transmitter component, including a heart rate sensor, a temperature sensor, and an oxygen sensor. These sensors, which are placed directly to the patient, measure the patient's condition. The same data is provided wirelessly by RF Technology to the receiver section, which is located with the medical representative, and by that receiver module, which is a web page written in Python for the backend process, HTML for the frontend process, and SQL for the database. He will receive all patient updates and will be able to view their previous patient records. Medical officers can readily prescribe treatment with the use of prior records. It's quick, dependable, and reasonably priced.*

Keywords— *RF module, Temperature Sensor, Heart rate &Oxygen rate sensor, ATmega328 microcontroller, AurdinoNano*

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I. INTRODUCTION

A. Need for Wireless System

According to WHO estimates, cardiovascular diseasesaccount for about 32 % mortality globally, as well as in India. Heart and blood vessel disease cause cardiovascular illnesses. According to current estimates, India will reach the highest number of heart disease cases in the world soon. These types of cardiovascular diseases need continuous monitoring of certain body parameters due to which long hospital stays is needed. Patients are regularly monitored by hospital staff through various devices which including bedside monitors in hospitals. These instruments are bulky and immobile and thus patients have to be stick to the bed and also their wired connections are very uncomfortable to patients and medical staff also. Due to mounting hospital costs and shortage of qualified healthcare professionals, it is very difficult to continuously monitor the essential body parameters of the patients which suffering from CVD.

To circumvent these constraints, a device that keeps track of a patient's heartbeat count, oxygen level, and temperature should be simple to monitor on software. This equipment, which includes a heartbeat sensor, temperature sensor, and oxygen rate sensor, will allow them to monitor the patient's health and detect any irregularities. Any time a change occurs, it is displayed on the software's screen. This notification will assist in taking necessary action at the appropriate moment, as well as allowing medical officers to prescribe therapy more simply using past records. Patients would be spared future health difficulties as a result of this. This would also help the patient's doctor take the required action at the appropriate time.

B. The Existing System

The existing patient monitoring system is a fixed system thatcan only be used when the patient is in bed. The available systems are typically huge and only found in intensive care units of hospitals (ICUs).Fig.1 Shows the bulky and heavy medical monitoring system of hospital which is fixed.

Fig.1 The Exiting System

C. The Proposed System

The system would constantly monitor critical physiological metrics such as temperature, heart rate, and oxygen saturation and compare them to a predetermined value set, alerting the doctor via software if these values exceeded a certain threshold.

These services may produce similar health outcomes as typical in-person physician appointments, while also being more cost-effective and providing greater patient satisfaction.

The heart rate, oxygen level, and temperature of a patient, forexample, are sent to a professional. It may happen in real time, or the data could be preserved and transferred later. So, with the aid of sensors that track these parameters and send a signal to the receiver section if there is an abnormality in these parameters, the Patient Monitoring System helps to continually monitor critical parameters of a patient like heart beat, temperature, oxygen rate, and so on. In the receiver portion, there is a python web page for the backend process,

HTML for the frontend process, and SQL for the database. The medical officer will receive all updates on their patients and will be able to view their past patient records. Using past records, medical officers can easily recommend treatment.

II. LITERATURE REVIEW

Heart rate monitoring equipment is used in most hospitals, and it uses manual methods to analyse ECG by connecting lids to the patient's chest. On a bedside monitor or other specialised monitoring equipment, the ECG graph is presented. These devices are interconnected and heavy, and they are unable to communicate across long distances. Zhang Qian [2] had developed the solution for greenhouse monitoring and control system based on Zigbee technology. Some researcher focus on heartbeat monitoring system only which are present by Warsuzarina Mat Jubadi et al. [3]. Smart phones are employed for cardiac patients' health monitoring in addition to location tracking shows by Uttara Gogate et al. [4]. Many academics presented smart phone- based approaches for detecting, storing, and analysing acquired data. Heinzelman W. [5] had developed describe application of architecture of wireless network for specific protocol .Using biosensors, these systems can be improved to become more accurate, dependable, cost-effective, and wearable. The system created by Hofmann et al.

[6] effectively monitors a patient's physiological condition, such as ECG, Temperature, Systole, Diastole, Heartbeat, Flex, and Accelerometer, and processes them in a transmitter kit attached to the patient's body. This system describes the effectiveness of data flow from the transmitter kit to the receiver, which is located on the hospital server. We're also constantly tracking the patient's location and doing emergency rescue efforts. Healthcare monitoring systems based on wireless sensor networks can be used to monitor cardiac patients in hospitals and at home. Our research focuses on continuous cardiac patient monitoring in hospitals, notably in intensive care units (ICUs), and at home, using a wireless sensor network-based healthcare monitoring system. It achieves a variety of objectives, including lower costs and shorter hospital stays, as well as continuous and remote monitoring without the need for experts' presence.

Problem Statement

In hospitals, when a patient's condition must be monitored ona frequent basis, this is normally done by a doctor or other paramedical personnel who constantly monitors several essential metrics such as body temperature, heartbeat, and oxygen saturation, which becomes boring after a while. As aresult, issues arise as a result of this. However, many researchers have attempted to solve it in a variety of ways inthe past, but the key approaches in many situations are either SMS or RF module to communicate patient's specified parameter information from sender device to receiver device.

III. SYSTEM ARCHITECTURE

The following Fig.2 shows the system architecture. It shows that Different sensors are attached or induced to the patient's body to collect vital body parameters like temperature, oxygen rate, pulse rate to be monitored. All the sensor's probes are also attached to patient's body. The sensor data is in the form of analogue impulses, which must be converted to digital using the Arduino board's inbuilt circuitry, which gather and process sensor data for communication. All the values of different body parameter are sent by a transmitter section to a receiver section through RF module (nRF24L01 module) which is in turn connected to PC. This computer hassoftware that operates a web page with a Python backend, XAMPP for serving web pages on the Internet, HTML for the frontend, and SQL for the database. All updates on their patients will be sent to the software which is monitor by medical officer, who will also have access to their previous patient information because It include database of individualpatient which stored all the current and previous data. Medical officers can simply recommend treatment based on previous records. If a parameter's value is outside of its usualrange, the software display notification alert along with the date and time.

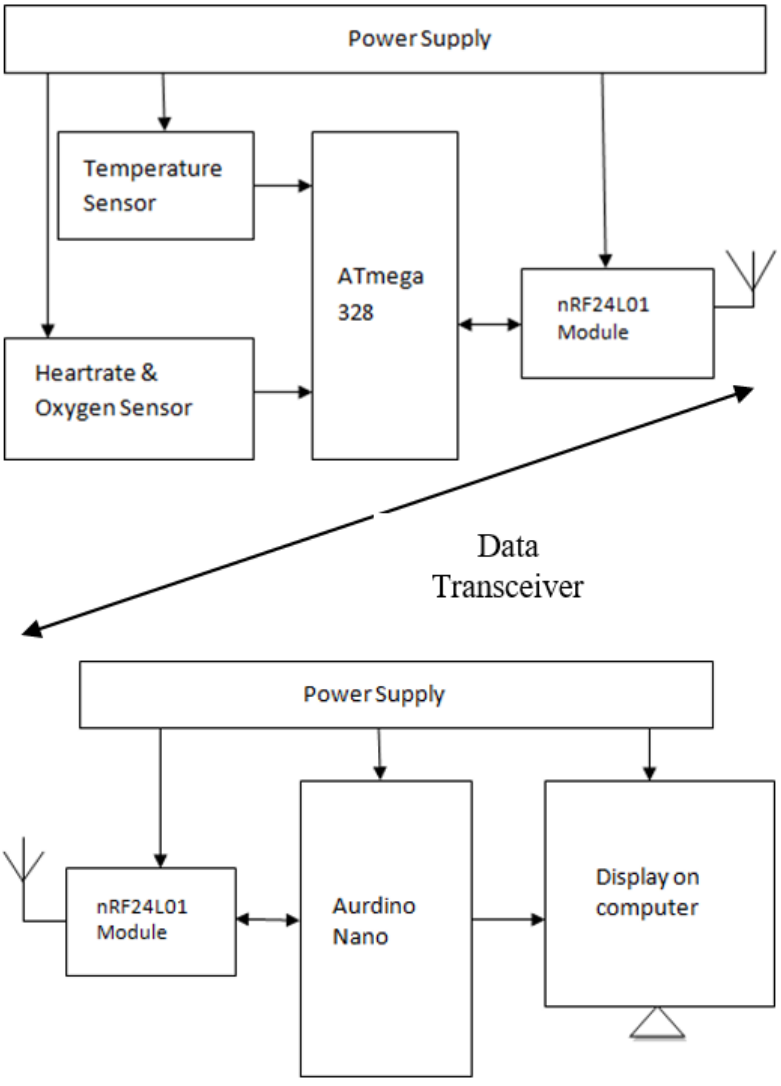

Fig.2 System Architecture

BLOCK DESCRIPTION

There are two major section in this project are Transmitter Section & Receiver Section. For communication between these two section , nrf24L01 module is used.

A. Transmitter Section

The RF Module, which is made up of sensor nodes as depicted in Fig.3, is the transmitter component of the monitoring health care system. Wireless sensors must be small and portable in order to preserve the patient's

moment with the sensors on the body. The three sensors that are utilized to monitor the patient's basic needs are temperature, pulse rate, and oxygen. A microcontroller is attached to the sensors and power supply. The RF Module sends data to the receiver circuit, which is connected to another component of the circuit. The ATmega328 microcontroller is used in this project.

The power supply for all microcontrollers and digital sensors is provided by a transformer. As we need DC power supply for atmega328 and current sensors we used rectifier after transformer which convert 5V AC into the 5V DC which is not pure DC but contains ripples for removing the ripples we use capacitor, which remove ripples from the supply and give 5V DC. The supply is given to the circuit using transformer.

A temperature sensor is connected to pin 25 of the Atmega328 microcontroller (Lm35). Pin27 and pin28 of the Atmega328 microcontroller are connected to the heart rate and oxygen rate sensor (MAX30100). The atmega328 microcontroller's pins 14, 15, 17, 18, and 19 are connected to the eight-terminal nrf24l01 module. All of the remaining pins are linked to their respective ports. To make the module run, a 3.2V supply is provided. The first and last terminals of both sensors are linked to Vcc and ground, respectively. The microcontroller receives input from all sensors, which detect the patient's physiological data. Through the nRF24L01 module, the data from the microcontroller is sent to the receiver.

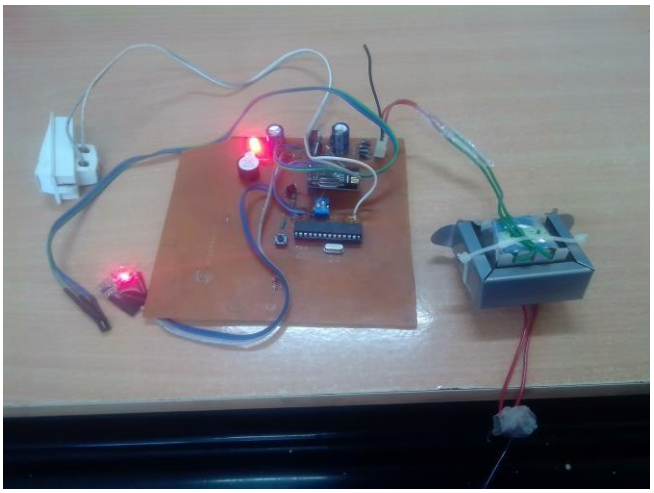

Fig.3 Transmitter section

B. Receiver Section

Fig.4 depicts the receiver section, where the data transmitted by the RF Module is wirelessly received by the other RF Module in the receivers section. The data will be sent to a control device via the RF module. According to the specs, all of the components are connected together and mounted on a PCB. The Aurdino Nano is utilised in the receiver part, which includes a USB connector for connecting to a computer. The programming of the microcontroller will correspond to the controller's limit.

We set the normal range of all parameters in which if heart rate is greater than 120bpm, if SPO2 rate is less than 90%, if Temperature rate is greater than 45℃ .of any patient exceed the limit then alert notification display on screen. If all the parameters are within the limits which mean patients are in good state of following parameters then the value of the sensed data will be displayed on PC as well as stored on PC and we can see history of patients easily in future references. If the collected data exceeds the set limit, an alarm notification is sent out. Alert notification are issued on the screen/dashboard of PC to alert the staff/medical officer taking care of the patient and to provide better cure.

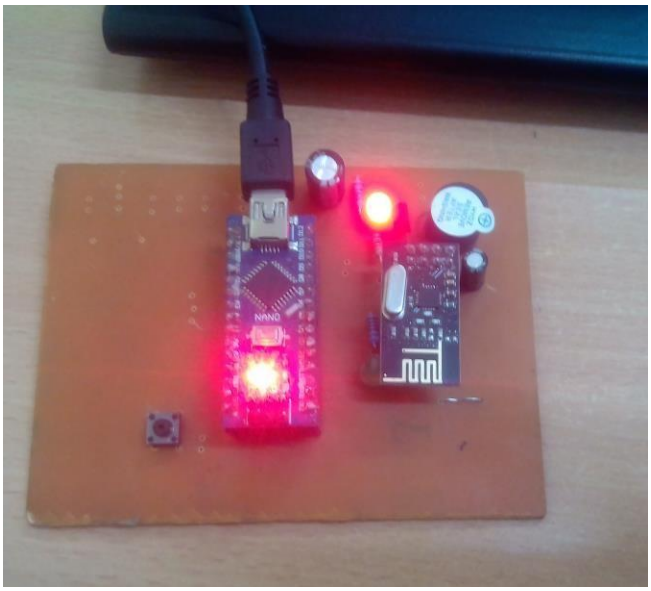

Fig.4 Receiver section

IV. TECHNOLOGY

A. Hardware Used

These systems use five hardware components as shown in Fig.5: a nRF24L01 module, a temperature sensor (LM35), a heart rate and oxygen rate sensor (MAX30100), an Atmega328 micro controller, and an Aurdino Nano.

- The NRF24L01 is an ISM-band wireless transceiverthat transmits and receives data at 2.4 to 2.5 GHz. This transceiver module is made up of just one chip.The data is sent using the SPI protocol. It transmits data at a rate of 2Mbps. When broadcasting at 0 dBm, it only uses 11.3 mA and 13.5 mA when receiving. A frequency generator, a shock burst mode controller, a power amplifier, a crystal oscillator modulator, and a demodulator are included in this transceiver module. This module is made to send data at a fast rate over vast distances. The operating voltage for this module is 3.3 volts. Because to its built-in voltage regulator, it has a superior power supply rejection ratio and range. The NRF24L01 has eight major pinouts, but there are a few more pins as well.
- The LM35(Sensor for determining temperature) is acentigrade temperature sensor with a low voltage and good accuracy. It's a chip that generates a voltage proportional to the temperature in degrees Celsius, and it's simple to use with an Arduino. TheLM35 temperature sensor is pretty precise, never fails, works in a variety of conditions, and requires no additional components to function. The LM35 sensor is also non-calibrated, with a typical accuracy of 0.5°C at ambient and 1°C throughout a temperature range of 55°C to +155°C.

- The MAX30100 is a sensor that combines pulse oximetry with heart rate monitoring. It works by integrating two LEDs with photo-detector adjusted optics and low-noise analogue signal processing to detect pulse oximetry and heart rate signals. To measure the patient's health parameters, this sensor can be used with any microcontroller, such as an Arduino, ESP8266, or an ESP32.
- The Arduino Nano is a breadboard-friendly Microcontroller board based on the ATmega328p with 30 male DIP30 I/O connections. Although the input voltage ranges from 7 to 12 volts, it operates at 5 volts. Any load connected to the Arduino Nano's pins should not exceed 40mA because the Arduino Nano's maximum current rating is 40mA. Arduino Pins are used as Input Pins when interacting with sensors, but they must be utilised asOutput Pins when driving a load. PinMode() and digitalWrite() are used to control digital pins, while analogRead() is used to control analogue pins ().
- The ATMEGA328 controller from Microchip is a high-speed, low-power microcontroller. The ATMEGA328 microcontroller is an AVR RISC- based microcontroller with an 8-bit AVR core. It's the most popular AVR controller because it's used in ARDUINO boards. C compilers, macro assemblers, programme debuggers/simulators, in- circuit emulators, and evaluation kits are among the ATmega328P's programme and system development tools. The fast PWM mode, which generates a high-frequency PWM waveform, makes it ideal for power control, rectification, and DAC applications.

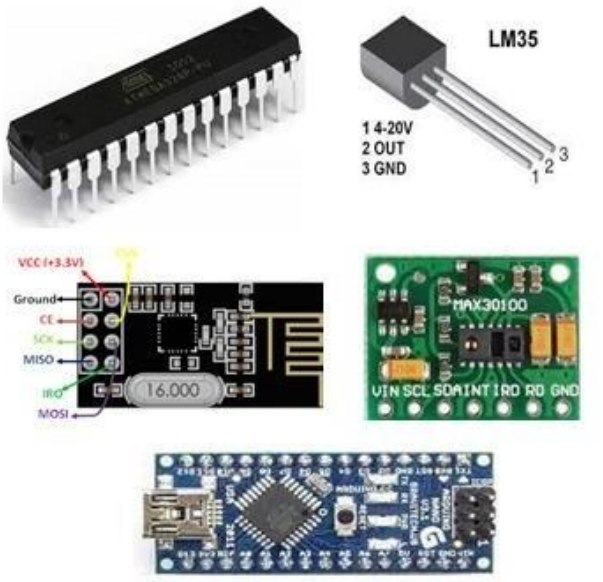

Fig.5 Hardware components

B. Software Used

This project makes use of client-side programming languages including HTML, CSS, and JavaScript, as well as server-side scripting languages like Python, PHP, and MySql. The atmega328 microcontroller is written in C++.

- HTML (Hyper Text Markup Language) is a programming language that is used to create webpages and apps. It describes a Web page's structure It describes the structure of a Web page. It is made up of a variety of parts. It is the most widely used markup language for web development.HTML elements instruct the browser on how to display the data.display the data.
- CSS is a style sheet language for specifying the appearance of a document written in a markup language such as HTML. Layout, colours, and fonts were made with CSS to separate display from text. The separation of formatting and content also allows for the presentation of the same markup page in different styles for distinct rendering techniques, such as on-screen, in print, and by voice. Separating formatting and content also allows you to deliver the same markup page in different styles for different rendering techniques, such as on-screen, in print, and via voice.
- JavaScript is an interpreted programming language that is very lightweight. It's made to make network-centric apps.It complements and works in combination with Java. Because JavaScript is interwoven with HTML, it's very simple to utilise. It's cross-platform and open source.
- Python is a high-level programming language that is dynamically semantic, interpreted, and object-oriented.Because of its high-level built-in data structures, dynamic type, and dynamic binding, it's ideal for Rapid Application Development and as a scripting or glue language for combining existing components.
- PHP is a programming language that allows web developers to create dynamic content that interacts with databases. PHP is most commonly used to create web-based software applications.
- The Structured Query Language (SQL) is a computer language that allows you to create complex queries. SQL is used to interface with a database.According to the American National Standards Institute (ANSI), it is the standard language for relational database management systems.
- C++ is a free-form programming language that supports object-oriented, procedural, and generic programming and is case-sensitive. Because it incorporates both high and low level language characteristics, C++ is classified as a middle-level language.

V. SOFTWARE CO-DESIGN

The sensor delivers data from transmitter section to the receiver section through the nrf24l01 module and transfers it to the Aurdino Nano. The Aurdino Nano's USB port is used to connect to your computer.Various programming languages are used in this project, including Python, Javascript, PHP, SQL, HTML, CSS and C++.

The computer shows a web page termed Dashboard on the screen as shown in Fig.6, which uses javascript for backend design and alert display with the patient's name, HTML & CSS for frontend design of page, and XAMPP for web server. PHP, Python, and MySql are used on the server side of this project. PHP is utilised on the server side to handle data history and generatedynamic page content. SQL is a database language (to store all the data). MQTT is a protocol that allows data to be sent between limited devices and server applications (MQ

Telemetry Transport). This project makes use of client-side scripting languages including HTML, CSS, and JavaScript, as well as server-side scripting languages like Python, PHP, and MySql. C++ programming language is used in micro controller atmega328 in both transmitter and receiver section.
All patient updates, as well as previous patient data, are sent to a computer dashboard/screen that the medical officer has access to. Medical officers may only make treatment recommendations based on past medical records. The software displays a notification alert with the patients name and the outrange parameter if a parameter's value is outside of its regular range.

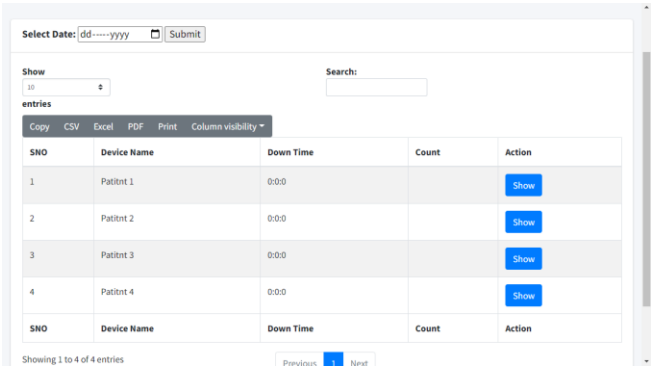

Fig.6 Dashboard

VI. RESULTS

Data collected from sensors is sent over nrf24l01 module. All data is shown on the computer's dashboard or screen. The history of all measured parameters of patient no. 3 are shown in Fig.7.The alert notification of patient no. 4 in which temperature rate is greater than 45°C which is 70.38°C is shown in Fig.8.

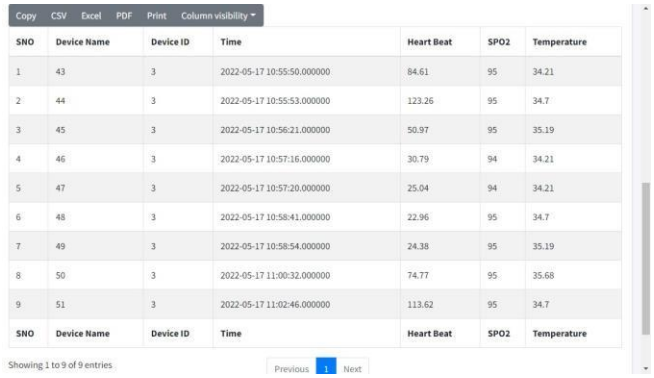

Fig.7 History of Patient 3

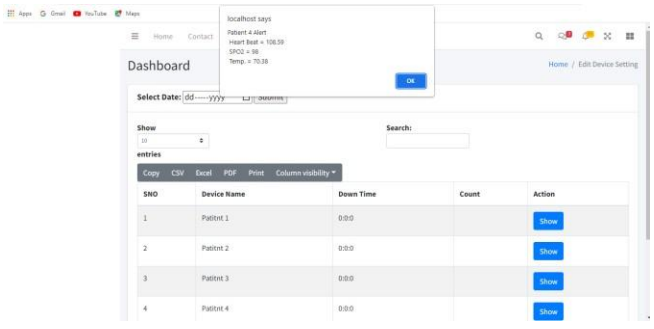

Fig.8 Alert Notification of Patient 4

VII. CONCLUSION

A cardiac patient monitoring system is proposed in this study, which measures body parameters such as heart rate, temperature, and oxygen level. It enables caregivers and hospital workers to track and save patient physical features inreal time. It notifies caregivers of any anomalies. Data can bemade available on the system

webpage screen via RF Technology, but only to approved users such as specialised doctors for particular advise. As a result, design parameters such as security, accuracy, and efficiency are successfully met. The accuracy rate is over 95% when compared to standard clinical procedures and commercial devices like FitBit. As a result, the device could be beneficial in hospital ICUs for continuous monitoring of cardiac patients. This system can be used to care for and monitor elderly people who are alone in their homes, as well as to look after babies.

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