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IOT BASED REMOTE PATIENT HEALTH MONITORING SYSTEM

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ABSTRACT:
With advances in technology and the miniaturization of sensors, new innovations are being used to improve human life. One important area benefiting from this technology is healthcare. Many people find healthcare services very expensive, especially in developing countries.
This project aims to address a healthcare problem faced by society today. The main goal was to design a remote healthcare system with three main parts: detecting a patient's vital signs using sensors, sending the data to cloud storage, and providing the data for remote viewing. This allows doctors or caregivers to monitor a patient's health progress without needing to be in the hospital.
The Internet of Things (IoT) connects medical resources to offer smart, reliable, and effective healthcare services. Health monitoring for active and assisted living can use IoT to improve patients' lives. In this project, I developed an IoT-based Remote Health Monitoring System using locally available sensors to keep it affordable for mass production.
The proposed system collects sensor data through an Arduino microcontroller and sends it to the cloud for processing and analysis. Feedback based on the analyzed data can be sent to the doctor or caregiver via email or SMS alerts in case of emergencies.

INTRODUCTION

An IoT-based remote patient health monitoring system extends hospital care by allowing a patient's vital signs to be monitored remotely. Traditionally, such systems were only available in hospitals, featuring large and complex equipment that consumed a lot of power. However, advances in semiconductor technology have led to smaller, faster, low-power, and affordable sensors and microcontrollers.
This progress has enabled the remote monitoring of patients' vital signs, especially for the elderly. Our remote health monitoring system aims to track health parameters such as:

- Body Temperature
- Pulse Rate
- Oxygen Level
- Room Temperature
- Room Humidity
- ECG
- Live Video Streaming of the Patient

Room temperature and humidity are measured to understand the patient's environment. The system uses a microcontroller, which serves as the heart of the system. Sensors send data to the microcontroller, which processes and transmits it to an IoT website accessible by doctors.

Recently, several remote health monitoring systems have emerged, featuring wireless detection systems that send sensor data to a remote server. Some require a subscription fee, which can be a barrier in developing countries due to cost and limited internet connectivity.

Many systems were initially introduced in developed countries where infrastructure is robust. However, to make these systems viable in developing countries, they need to be adapted to meet basic, minimal conditions.

A simple patient monitoring system can be designed based on the number of parameters it can detect:

Single-Parameter Monitoring System: Monitors a single parameter, such as an Electrocardiogram (ECG) reading. From an ECG, multiple readings like heart rate and oxygen saturation can be derived.

Multi-Parameter Monitoring System: Monitors multiple parameters simultaneously. Examples include systems used in High Dependency Units (HDU), Intensive Care Units (ICU), during surgery, or in post-surgery recovery units in hospitals. These systems track parameters like ECG, blood pressure, and respiration rate, proving that a patient is alive or recovering.

In developing countries, many elderly individuals move to rural areas after retiring, while in developed countries, they may move to assisted living group homes. In both cases, a remote health monitoring system can be very useful.

LITERATURESURVEY

Vishal Soni worked on IOT based Patient Health Monitoring System

In this project, they used a temperature sensor and a pulse sensor, interfacing them with an Arduino UNO connected to an ESP8266 Wi-Fi module. The data collected by these sensors is transmitted to the cloud for remote monitoring. This setup allows doctors or caregivers to monitor the patient's vital signs from anywhere.

Prajoona Valsalan worked on IOT based Patient Health Monitoring System

The core objective of this project is to design and implement a smart patient health tracking system. Sensors are placed on the patient's body to monitor their temperature and heartbeat. Additionally, two sensors are placed in the patient's home to measure the room's humidity and temperature. These sensors are connected to a control unit, which calculates the values from all four sensors. The calculated values are then transmitted through an IoT cloud to a base station. From the base station, the data can be accessed by a doctor at any location. This setup allows the doctor to make treatment decisions based on the patient's temperature, heartbeat, and room conditions.

Prachi Patil has worked on IoT based Patient Health Monitoring System

In his paper, she used ThingSpeak as an IoT platform to display sensor data. The body temperature, pulse rate, and oxygen level are monitored using an Atmega 328P microcontroller and an ESP8266 Wi-Fi module.

Yedukondalu Udara worked on health monitoring system using IOT.
He proposed to use Arduino Mega as a controller. He used ECG sensor, finger clip sensor, temperature sensor to monitor body parameter For Emergency messaging GSM issued. He proposed low-cost Health monitoring system in his research article.

C. Senthamilarasi in his article on A SMART PATIENT HEALTH MONITORING SYSTEM USING IOT proposed to use ECG, Heart beat sensor, temperature sensor to monitor the Patient.

Vedant Vitthal Bagate IOT BASED PATIENT HEALTH MONITORING SYSTEM USING VENTILATOR
In this research paper he proposed to use temperature sensor, pulse sensor, oxygen sensor, humidity sensor. This sensor data displayed in IOT platform. He also used ventilator for emergency purpose.

C.R. Srinivasan, in his paper "An IoT-Based SMART Patient Health Monitoring System," measured temperature and pulse rate. This data is displayed on an IoT platform and used to trigger messages via IFTTT.

Sathiya Girija, in the "IoT-Based Patient Health Monitoring System," used Arduino with a temperature sensor and pulse sensor to measure body parameters, displaying the data on an LCD. He proposed a simple system for monitoring patient health.

Sudh. Vhasmade survey on patient health monitoring system
He conducted a comparative study of various research works and ultimately proposed an IoT-based patient health monitoring system using Arduino. The main idea of the proposed system is to provide better and more efficient health services to patients by implementing a networked information cloud. This allows experts and doctors to access the data and provide fast and efficient solutions. The final model is designed to enable doctors to examine their patients from anywhere at any time.
In emergency scenarios, the system can send an emergency email or message to the doctor with the patient's current status and full medical information. The proposed model can also be developed as a mobile app to make it more accessible and user-friendly globally. Further improvements can be made to the system, such as adding more advanced sensors. With wireless data transmission over the internet, health-related data will be sent to the doctor's personal computer or mobile device, reducing the need for hospital visits and enabling immediate responses to health conditions.

Mohamad Hariz Hasshim in IoT Based Health Monitoring System for Elderly Patient
In his research paper, he developed a prototype system for patient health monitoring. The prototype successfully measured and displayed temperature, pulse, and respiratory readings on both an LCD and smartphone. The results indicate that the readings are accurate, as they have been validated. These innovations can help doctors monitor their patients remotely, and other users can better monitor their parents' health. This innovation has also resulted in a product that can measure three parameters simultaneously in real time. The proposed work paves the way for an elderly patient

monitoring system that is low-cost and highly efficient for long-distance monitoring.

METHODOLOGY

BLOCKDIAGRAM:

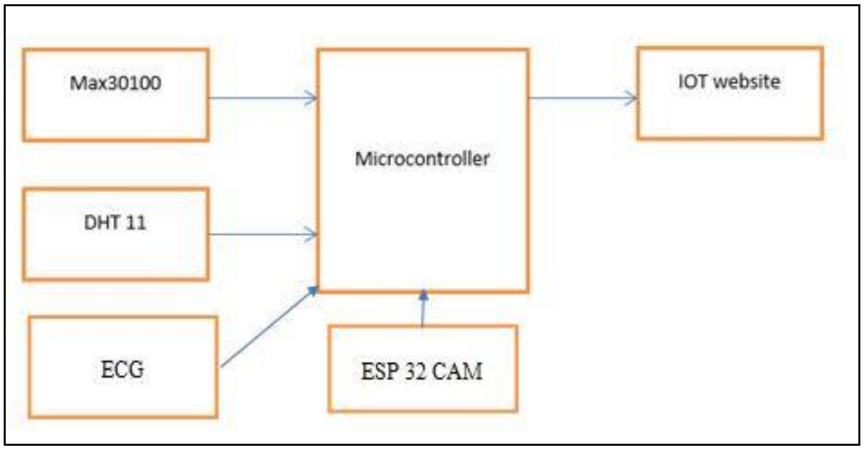


Figure1: Block Diagram for working of Health Monitoring System

In this block diagram Max30100 measures Pulse, Oxygen level and body temperature and send data to the microcontroller. This data continuously monitored and displayed on web.

MAX30100sensor

The MAX30100 is an integrated pulse oximetry and heart rate monitor sensor solution. It combines two LEDs, a photo detector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart rate signals. It operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, allowing the power supply to remain connected at all times.

The MAX30100 uses the I2C communication protocol and is designed for the demanding requirements of wearable devices. It provides a very small total solution size without sacrificing optical or electrical performance, requiring minimal external hardware components for integration.

Fully configurable through software registers, the MAX30100 stores digital output data in a 16-deep FIFO, allowing it to be connected to a microcontroller or microprocessor on a shared bus without continuous data reading from the device's registers.

The SpO2 subsystem of the MAX30100 includes ambient light cancellation (ALC), a 16-bit sigma delta ADC, and a proprietary discrete time filter. The SpO2 ADC is a continuous-time oversampling sigma delta converter with up to 16-bit resolution, and its output data rate can be programmed from 50Hz to 1kHz. It also includes a proprietary discrete time filter to reject 50Hz/60Hz interference and low-frequency residual ambient noise.

An on-chip temperature sensor allows for optional calibration of the temperature dependence of the SpO2 subsystem. While the SpO2 algorithm is relatively insensitive to the IR LED wavelength, the red LED's wavelength is crucial for correct data interpretation. The temperature sensor data can compensate for SpO2 errors caused by ambient temperature changes.

The MAX30100 integrates red and IR LED drivers for SpO2 and heart rate measurements. The LED current can be programmed from 0mA to 50mA, and the LED pulse width can be programmed from 200µs to 1.6ms, optimizing measurement accuracy and power consumption based on the use case.

Benefits and Features

- Complete Pulse Oximeter and Heart-Rate Sensor Solution Simplifies Design
- Integrated LEDs, Photo Sensor, and High-Performance Analog Front -End
- Tiny 5.6mm x 2.8mm x 1.2mm 14-Pin Optically Enhanced System-in-Package
- Ultra-Low-Power Operation Increases Battery Life for Wearable Devices
- Programmable Sample Rate and LED Current for Power Savings
- Ultra-Low Shutdown Current (0.7µA, typ)
- Advanced Functionality Improves Measurement Performance
- High SNR Provides Robust Motion Artifact Resilience
- Integrated Ambient Light Cancellation
- High Sample Rate Capability
- Fast Data Output Capability

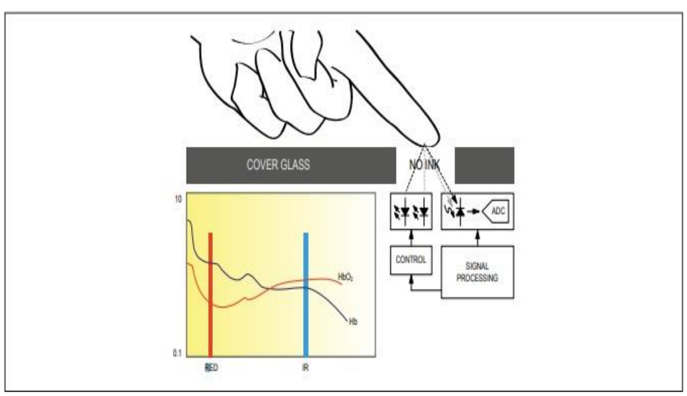


Figure2:MAX30100 sensor

DHT11Sensor

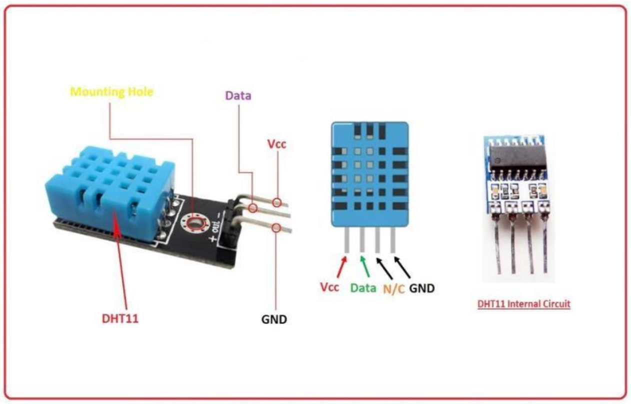


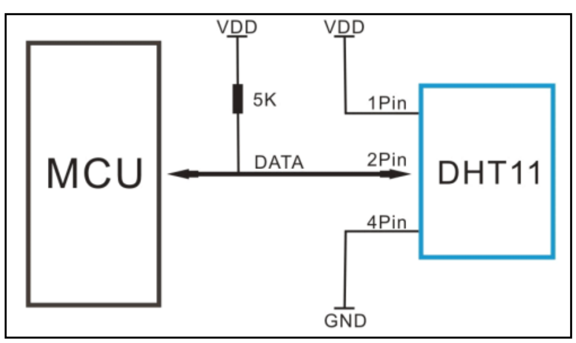
Figure3:DHT11sensor

The **DHT11** is a commonly used **Temperature and humidity sensor.** The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers.

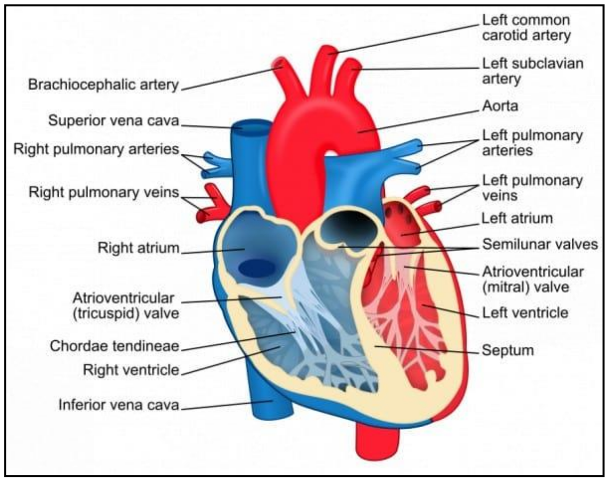
The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracyof±1°Cand ±1%. So if you are looking to measure in this range then this sensor might be the right choice for you.

DHT11 Specifications

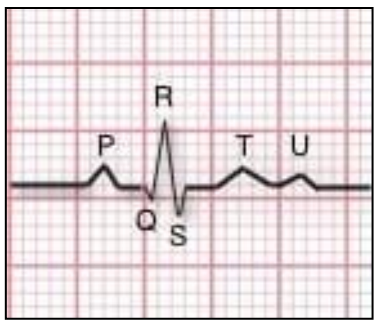
- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1°C and ±1%



ECG:-



An ECG is a paper or digital recording of the electrical signals in the heart. It is also called an electrocardiogram or an EKG. The ECG is used to determine heart rate, heart rhythm, and other information regarding the heart's condition. ECGs are used to help diagnose heart arrhythmias, heart attacks, pacemaker function, and heart failure.



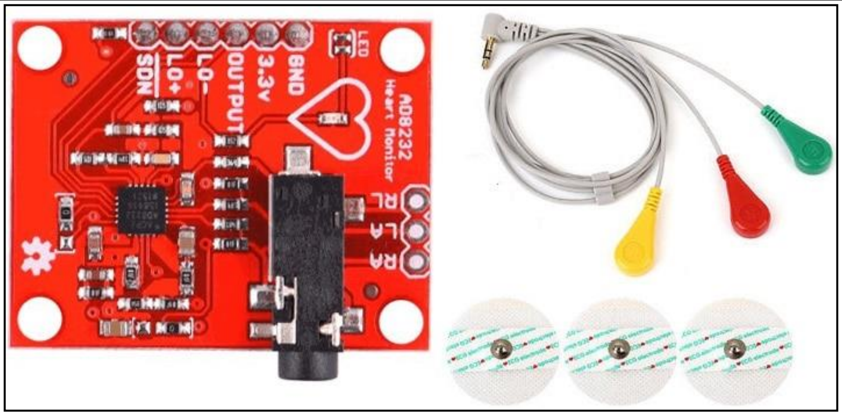
ECG can be analyzed by studying components of the waveform. These waveform components indicate cardiac electrical activity. The first upward of the ECG tracing is the P wave. It indicates atrial contraction.

The QRS complex begins with Q, a small downward deflection, followed by a larger upwards deflection, a peak (R); and then a downwards S wave. This QRS complex indicates ventricular depolarization and contraction.

Finally, the T wave, which is normally a smaller upwards waveform, representing ventricular re-polarization

AD8232 ECG Sensor

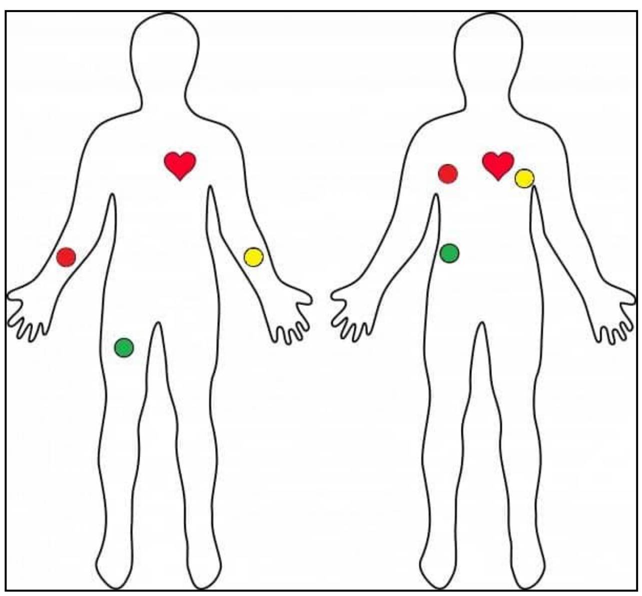
This sensor is a cost-effective board used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram and output as an analog reading. ECGs can be extremely noisy, the AD8232 Single Lead Heart Rate Monitor acts as an op-amp to help obtain a clear signal from the PR and QT Intervals easily.



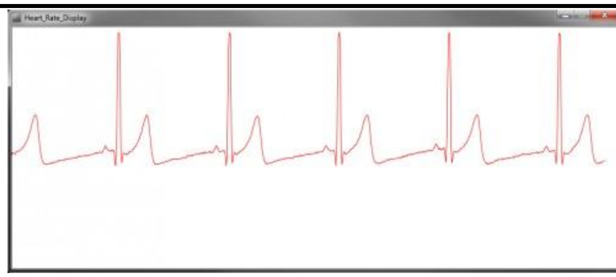
The AD8232 is an integrated signal conditioning block for ECG and other biopotential measurement applications. It is designed to extract, amplify, and filter small biopotential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement.
The AD8232 module breaks out nine connections from the IC that you can solder pins, wires, or other connectors to. SDN, LO+, LO-, OUTPUT, 3.3V, GND provide essential pins for operating this monitor with an Arduino or other development board. Also provided on this board are RA (Right Arm), LA (Left Arm), and RL (Right Leg) pins to attach and use your own custom sensors. Additionally, there is an LED indicator light that will pulsate to the rhythm of a heartbeat.

AD8232 ECG Sensor Placement on Body

It is recommended to snap the sensor pads on the leads before application to the body. The closer to the heart the pads are, the better the measurement. The cables are color-coded to help identify proper placement.



Red:RA(RightArm)
Yellow:LA(LeftArm)
Green: RL (Right Leg)



ECG Pins-

- Power Input Pins (3.3, GND)
- Electrode pad connector pins (RA, LA, RL, 3.5 mm female jack)
- Data output pin (Output)
- Leads off detection output pins(LO-, LO+)
- Shutdown control pin(~SND)
- LED

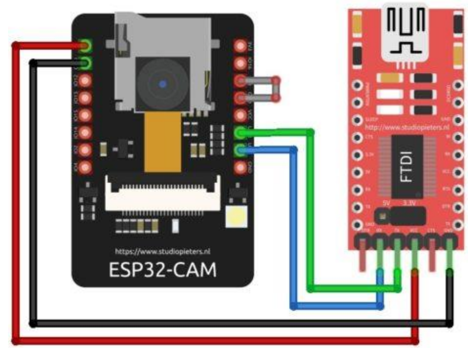
ESP 32 CAM:-

- For Video streaming of Patient

- The ESP32 Based Camera Module developed by **AI-Thinker**. The controller is based on a **32-bit CPU** & has a combined **Wi-Fi + Bluetooth/BLE** Chip. It has a built-in **520 KB SRAM** with an external **4M PSRAM.** Its GPIO Pins have support like **UART, SPI, I2C, PWM, ADC,** and **DAC**.
- The module combines with the **OV2640 Camera Module** which has the highest Camera Resolution up to **1600 × 1200.** The camera connects to the ESP32 CAM Board using a 24 pins gold plated connector. The board supports an **SD Card** of up to **4GB**. The SD Card stores capture images.

ESP32-CAM FTDI Connection

- The board doesn't have a programmer chip. So In order to program this board, you can use any type of **USB-to-TTL Module**. There are so many **FTDI Module** available based on CP2102 or CP2104 Chip or any other chip.
- Make a following **connection between FTDI Module and ESP32 CAM** module.

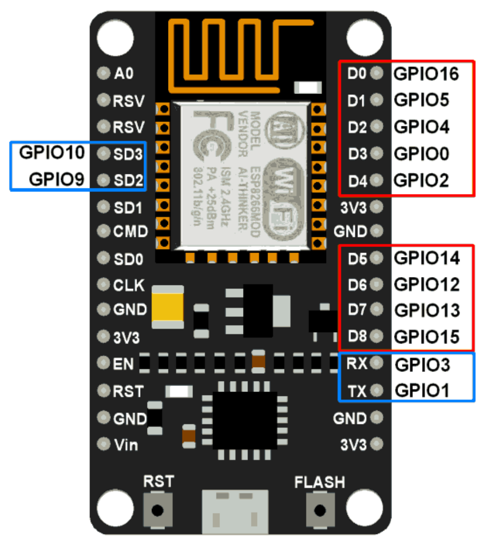


Microcontroller:-

Microcontroller is incorporated with ESP8266 Wi-Fi module.

Microcontroller is programmed by using Arduino IDE software .it reads the data of MAX30100 and DHT11 and send it to the IOT web. this web is accessed by doctors.

Microcontroller can be NodeMCU



What is NodeMCU?

The NodeMCU (***N***ode ***M***icro***c***ontroller ***U***nit) is open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espress if Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering it on or sending a keystroke to the "computer" on the chip. You also have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics. It is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.

The Arduino project created an open-source hardware design and software SDK for their versatile IoT controller. Similar to NodeMCU, the Arduino hardware is a microcontroller board with a USB connector, LED lights, and standard data pins. It also defines standard interfaces to interact with sensors or other boards. But unlike NodeMCU, the Arduino board can have different types of CPU chips (typically an ARM or Intel x86 chip) with memory chips, and a variety of programming environments. There is an Arduino reference design for the ESP8266 chip as well. However, the flexibility of Arduino also means significant variations across different vendors. For example, most Arduino boards do not have WiFi capabilities, and some even have a serial data port instead of a USB port.

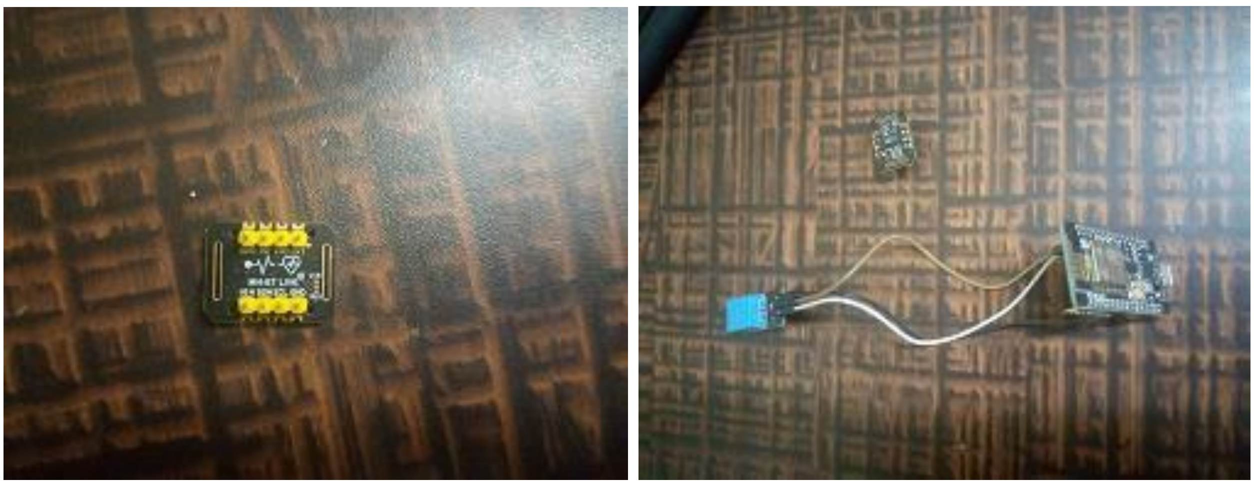
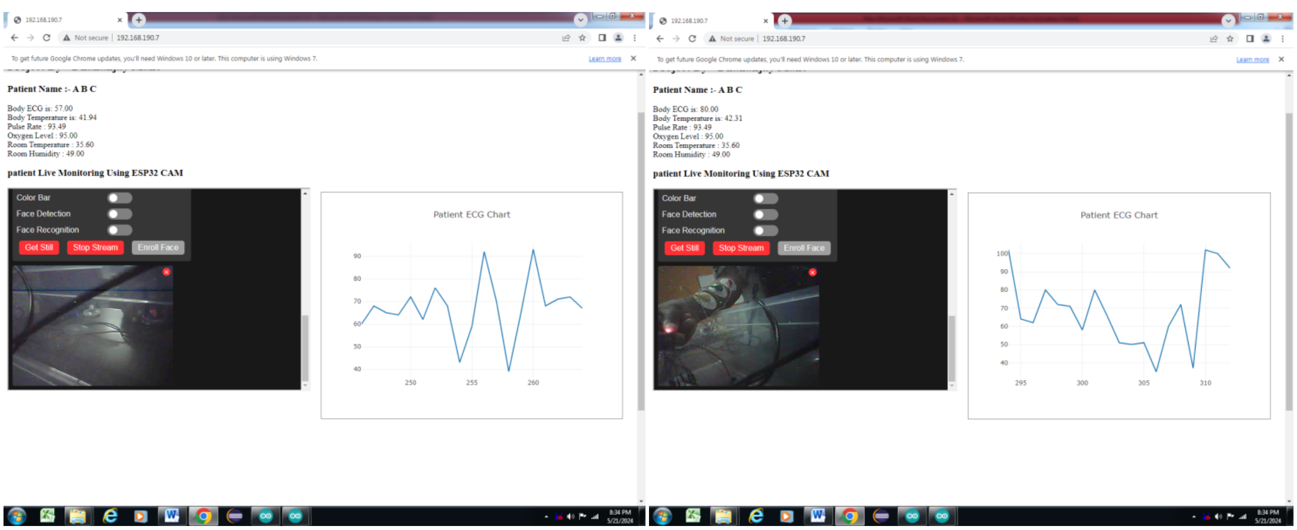
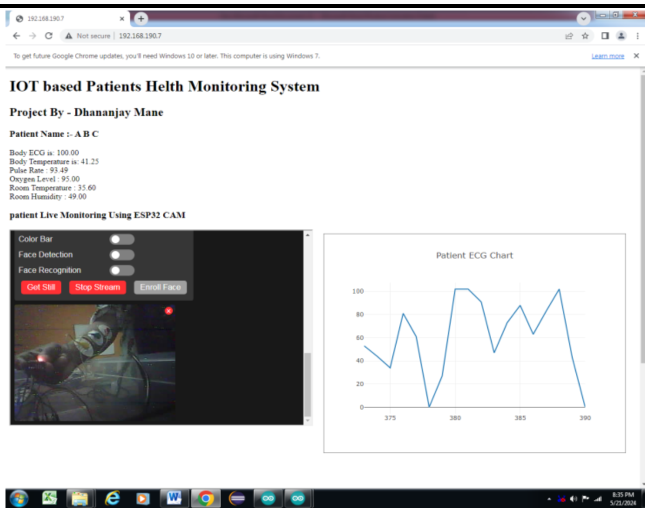
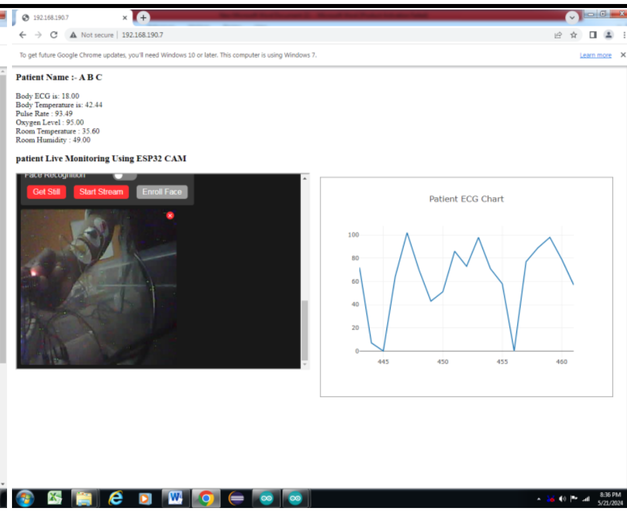


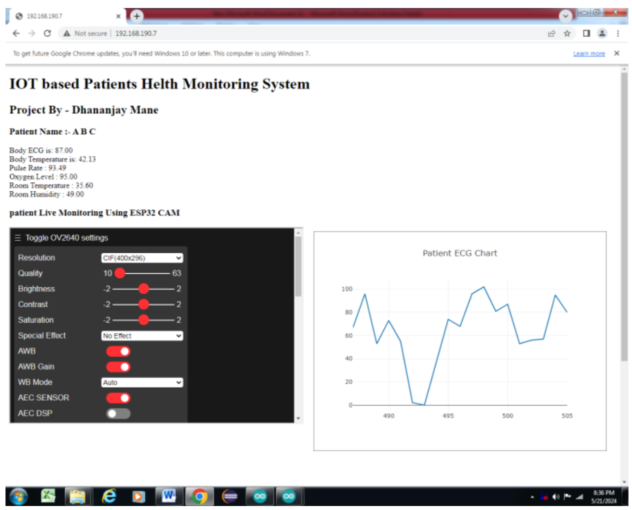
Figure: Developed Modul

RESULTS AND DISCUSSIONS:









ADVANTAGESAND DISADVANTAGES

ADVANTAGES:

- Fast and Live monitoring of patient health.
- High accuracy
- Reference consulting with other doctor for suggestion is possible.

DISADVANTAGES:

- Consumes Large Data So that it increases cost to monitor.
- Failure in internet can affect the system

FUTURESCOPE

This project offers extensive data on a patient's health, enabling data analysis and prediction of potential problems along with their solutions. The utilization of IoT in the medical field can enhance the quality of treatment, potentially saving many lives. Considering the significant practical importance of IoT-based live monitoring systems for patients at risk of heart attacks, accidents, and emergencies, this system can be easily installed in ambulances. The substantial data collected can be stored in a database, reducing the workload for doctors while providing accurate results.

CONCLUSION

The integration of IoT in the medical field holds immense benefits for enhancing treatment quality and potentially saving lives. Considering the critical practical significance of IoT-based live monitoring systems for patients vulnerable to heart attacks, accidents, and emergencies, it's clear that such a system could be readily deployed in all ambulances. The extensive data collected can be efficiently stored in a database, significantly reducing doctors' workload while ensuring accurate results.

REFERENCES

1. VishalDineshkumarSoniAnIoTBasedPatient HealthMonitoringSystem InternationalJournal on IntegratedDecember 2018
2. Ms. Prachi Patil . IoT based Patient Health Monitoring System International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 www.ijert.org NTASU - 2020 Conference Proceedings.
3. Prajoona Valsalan1 IOT BASED HEALTH MONITORING SYSTEM Journal of Critical ReviewsVol7, Issue 4, 20
4. SnehaN.Malokar, Samadhan D. Mali.“AIoT BasedHealthCareMonitoringSystem”,Int. J.ofAdvanced Researchin Electrical,ElectronicsandInstrumentation Engineering,6(1), June 2017, pp.4661-4667.
5. Raghavendra K K, Sharanya P S, ShailaPatil.“An IoT Based Smart Healthcare SystemUsing RaspberryPi”,Int.J.ofResearchandScientificInnovation(IJRSI),5(6),June2018,pp.103-106.
6. CristinaElenaTurcua,CornelOctavianTurcu.“InternetofThingsasKeyEnablerfor Sustainable Healthcare Delivery”, Int. e-Journal For Technology and Research-2017 , 1, pp.1-5.
7. R.Rubasri,D.Aravind,M.ValanRajkumar.“SimulationofHealthCareMonitoringSystemin InternetofThingsByUsingRFID”,Int.J.ofEngineeringandComputerScience,7(6),June2018, pp.23952-23970.
8. Thirumurugan,S. Surendhar, R. Sathesh Raaj, N. Ezhilmathi Hemalatha Rallapalli, Pavani Bethelli “IOT Based Patient Monitoring System”, Int. J. of Computing, Communications and Instrumentation Engg. (IJCCIE), 4(1), 2017, pp.115-118.
9. Vivek Pardeshi, Saurabh Sagar, Swapnil Murmurwar, Pankaj Hage “Health Monitoring Systems using IoT and Raspberry Pi”, Int. Conference on Innovative Mechanisms for Industry Applications(ICIMIA 2017), pp.134- 137.
10. Ashlesha A. Patil, Dr. S. R. Suralkar“Review on IOT Based Smart Healthcare System”,Int.J. of Adv. Research inEngineering and Technology (IJARET), 8(3), May - June2017, pp. 37–42.
11. Esrat Jahan, Tilottoma Barua, Umme Salma, ”An Overview on Heart rate Monitoring and Pulse Oximeter System”, Int. J. of Latest Research in Science and Technology , 3(5), September October 2014, pp. 148-152.
12. DoganIbrahim, KadriBuruncuk “Heart rate Measurement Fromthe Finger using a Lowcost

Microcontroller", Int'l Journal of Computing, Communications & Instrumentation Engg. (IJCCIE), 4(1), 2017, pp. 25-29.

13. Nikunj Patel,Princekumar Patel,Nehal Patel "Heart Attack Detection And Heart Rate Monitoring Using IOT", Int. J. ofInnovations and Advancement inComputer Science IJIACS , 7(4), April 2018, pp.611-615.