Heaven's Light is our Guide

Course No. : ETE 3200

Course Name : Project Design Based on Communication System

A Project Report on

IOT Based Patient Health Monitoring System with Blood Group Detection Using Image Processing

Submitted By

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I take this opportunity to thank all teachers who contributed their valuable advice and helped to complete this project successfully.

Heaven's Light is Our Guide

RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Electronics & Telecommunication Engineering

CERTIFICATE

This is to certify that the project entitled "**IOT Based Patient Health Monitoring System with Blood Group Detection Using Image Processing**" is carried out by Md. Habibur Rahman, roll no. 1504040 under my supervision in the Department of Electronics & Telecommunication Engineering of Rajshahi University of Engineering & Technology.

Signature of the Supervisor

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ABSTRACT

IOT Based Patient Health Monitoring System with Blood Group Detection Using Image Processing is an invaluable technological advancement that can lead to higher standard of living. It acts as an aid to solve many issues of the traditional health care system like need for manpower, accuracy, delayed work etc. This work presents a novel method for the design of a smart patient monitoring framework. This framework involves the integration of Raspberry Pi, Arduino and NodeMCU along with heartbeat sensor, temperature sensor and a high definition camera for image processing purpose that carrying out the automatic functions that are predefined. The NodeMCU provides an interface with the server for data upload and download for the documentation purposes and for future references. The system even facilitates the doctor to monitor the patient's previous history from the data in memory inbuilt in the monitoring device.

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Chapter 1

Introduction

INTRODUCTION

The technical brilliance and development in different fields has led to a drastic change in our lives, one among them is embedded systems and telecommunications. Telecommunications has the potential to provide a solution to medical services to improve quality and access to health care regardless of geography.

Internet of Things (IOT) is an advanced area which includes embedded technology, wireless sensor network, artificial intelligence and machine learning etc. to intercommunicate things. IOT improves user convenience and also enhances data collection. It optimizes various technologies in single area called IOT. IOT has applications across different fields like industries, engineering and medical. To improve existing medical systems, IOT is applicable.

The advances in information and communication technologies enable technically, the continuous monitoring of health related parameters with wireless sensors, wherever the user happens to be. They provide valuable real time information enabling the physicians to monitor and analyze a patient's current and previous state of health. Now-a-days there are several efforts towards the development of systems that carry out remote monitoring of patients.

Although many wireless standards can be used, there are important considerations such as range, throughput, security, ease of implementation and cost. The patient monitoring involves handling of sensitive data. These data should be transmitted securely without any disturbance.

A health monitoring system is a device that measures the heartrate and temperature then upload these data to the server for the real time monitoring and future usage of these data. This device can also detect the blood group using image processing algorithm.

❖ Drawbacks of conventional patient monitoring system:

There are many flaws in the conventional monitoring system. Some human errors may also occur in manual monitoring system.

Analyzing the conventional monitoring system some of the common errors are:

- Time consuming procedure.
- Chance of human error while taking the manual reading.
- Extra man power required.
- Non-availability of nurse at the time of critical condition.

Our proposed system consists of a microcontroller (Arduino), a NodeMCU, a Raspberry Pi, a heartbeat sensor, a temperature sensor and a high definition camera for blood group detection purpose. In our proposed framework, the heartrate and body temperature are automatically sensed, the readings are recorded continuously. Finally, after processing the collected data, these data are sent to the server through the existing Local Area Network. The doctors can check the health condition parameter through a web application. This framework can also detect the blood group from the blood sample by using the image processing algorithm.

Chapter 2

Functional Block Diagram with explanation of Each Block

2.1 Introduction

In this section the operation of this project with a block diagram is described. Here a brief description is given about each of the block of the block diagram. The block diagram has Arduino, NodeMCU, Heartbeat Sensor, Temperature Sensor, Raspberry Pi, Camera, LAN, Router and Server. A brief description is given below.

2.2 Block Diagram

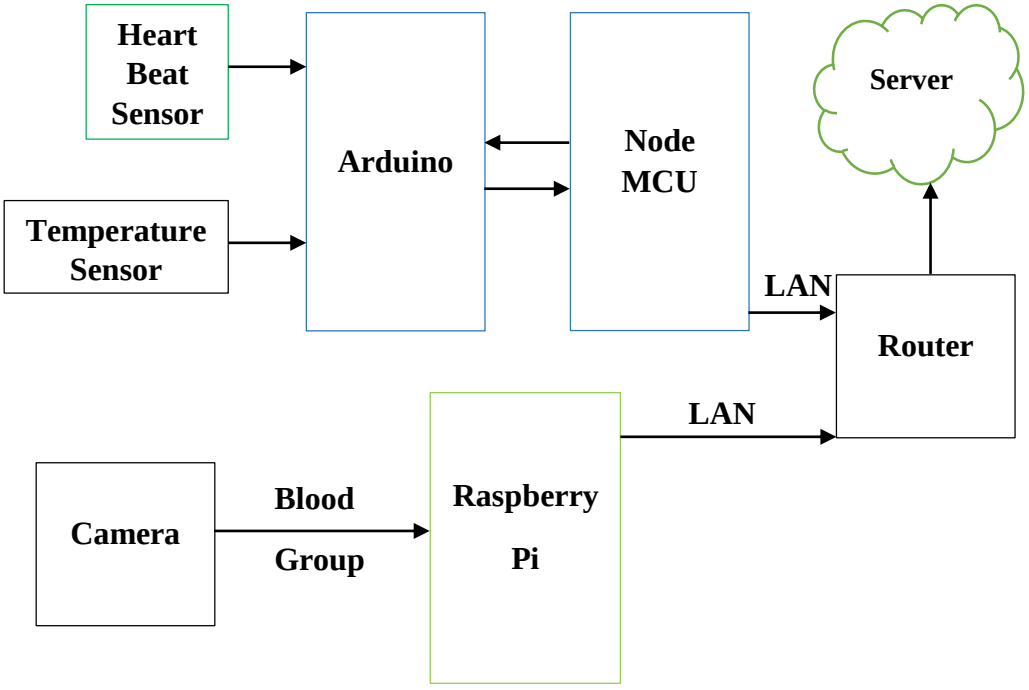

Fig. 2.1: Block Diagram

2.3 Explanation of Each block

Arduino: Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers.

NodeMCU: NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the development

kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson and SPIFFS.

Heartbeat Sensor: The heartbeat sensor is based on the principle of photo plethysmography. It measures the change in volume of blood through any organ of the body which causes a change in the light intensity through that organ (a vascular region). In case of applications where heart pulse rate is to be monitored, the timing of the pulses is more important. The flow of blood volume is decided by the rate of heart pulses and since light is absorbed by blood, the signal pulses are equivalent to the heart beat pulses.

Temperature Sensor: Temperature Sensors measure the amount of heat energy or even coldness that is generated by an object or system, that allows to "sense" or detect any physical change to that temperature producing either an analogue or digital output.

Raspberry Pi: The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside its target market for uses such as robotics. It does not include peripherals (such as keyboards and mice) and cases. However, some accessories have been included in several official and unofficial bundles.

LAN: A local area network (LAN) is a computer network that interconnects computers within a limited area such as a residence, school, laboratory, university campus or office building. By contrast, a wide area network (WAN) not only covers a larger geographic distance, but also generally involves leased telecommunication circuits. Ethernet and Wi-Fi are the two most common technologies in use for local area networks

Router: A router is a networking device that forwards data packets between computer networks. Routers perform the traffic directing functions on the Internet. Data sent through the internet, such as a web page or email, is in the form of data packets. A packet is typically forwarded from one router to another router through the networks that constitute an internetwork until it reaches its destination node. A router is connected to two or more data lines from different networks. When a data packet comes in on one of the lines, the router reads the network address information in the packet to determine the ultimate destination. Then, using information in its routing table or routing policy, it directs the packet to the next network on its journey.

Server: In computing, a server is a computer program or a device that provides functionality for other programs or devices, called "clients". This architecture is called the client–server model, and a single overall computation is distributed across multiple processes or devices.

Camera: A camera is an optical instrument to capture still images or to record moving images, which are stored in a physical medium such as in a digital system or on photographic film. A camera consists of a lens which focuses light from the scene, and a camera body which holds the image capture mechanism. Here the camera uses to take the picture of blood sample and process it to determine the blood group using image processing algorithm.

Chapter 3

Circuit Diagram & Specification of Circuit Elements

3.1 Introduction

In this section the operation of circuit diagram is described. Here a brief description is given about each component of the circuit diagram. The circuit diagram has Heartbeat Sensor, Arduino Nano, ESP 12, Raspberry Pi, Push Button, LED and Resistors. We will discuss about these components briefly.

3.2 Circuit Diagram

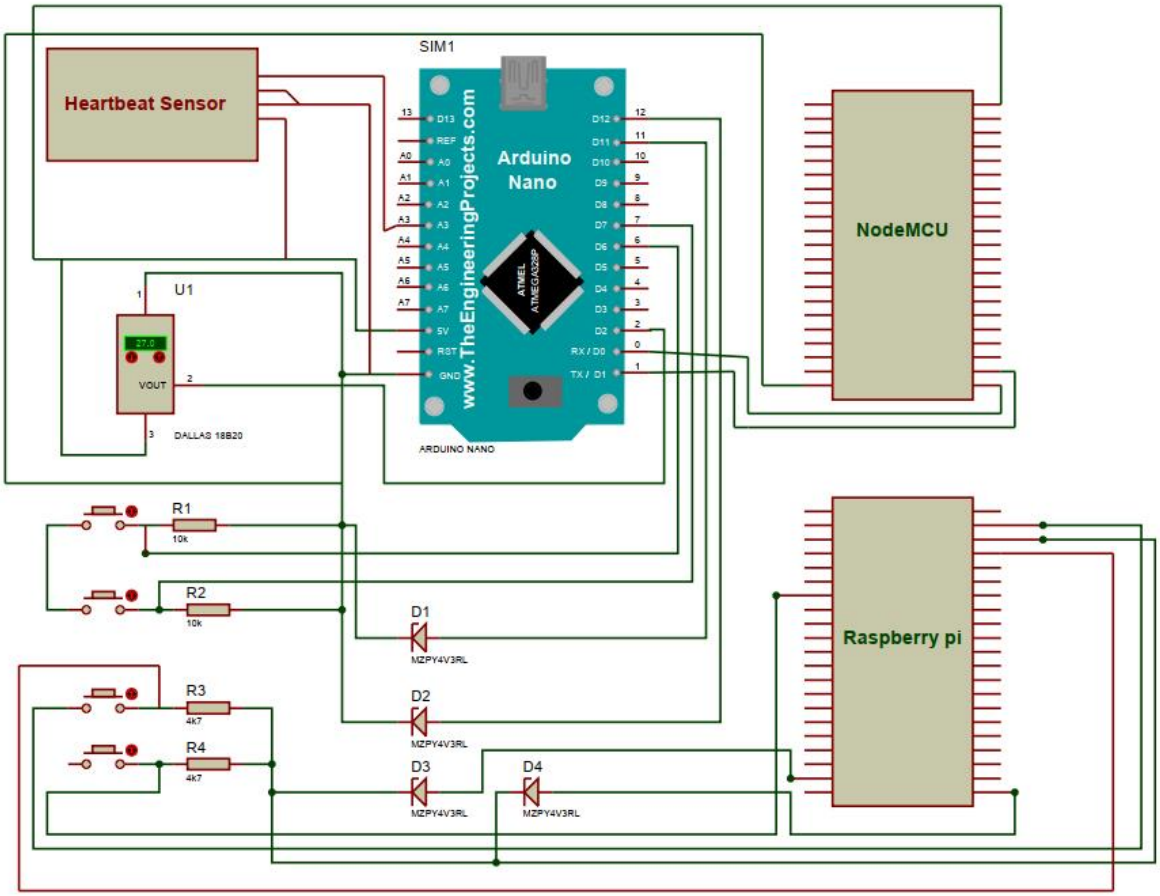

Fig. 3.1: Circuit Diagram

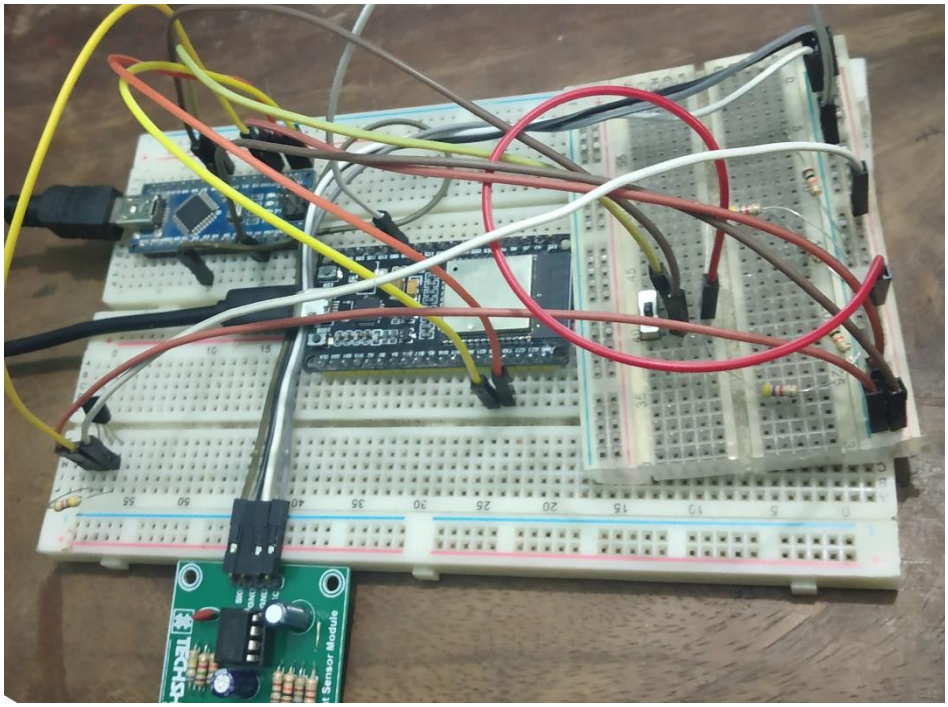

Fig. 3.2: Circuit Connection in Breadboard

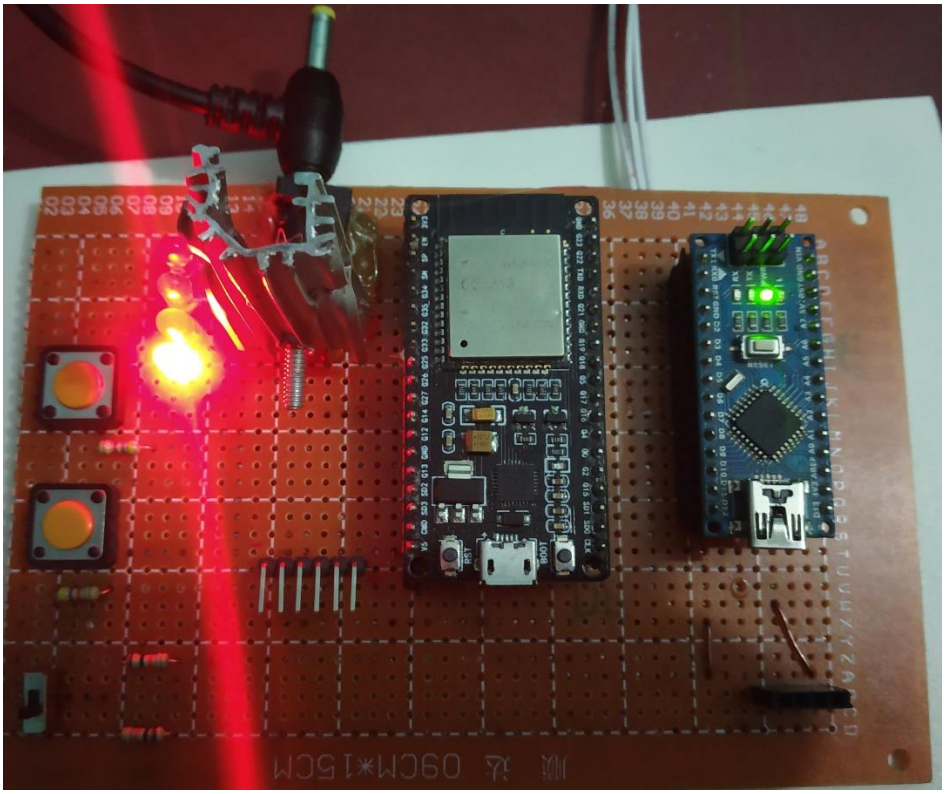

Fig. 3.3: Final Circuitry

3.3 Specification of Circuit Components

Heartbeat Sensor: The basic heartbeat sensor consists of a light emitting diode and a detector like a light detecting resistor or a photodiode. The heart beat pulses causes a variation in the flow of blood to different regions of the body. When a tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in form of electrical signal and is proportional to the heart beat rate.

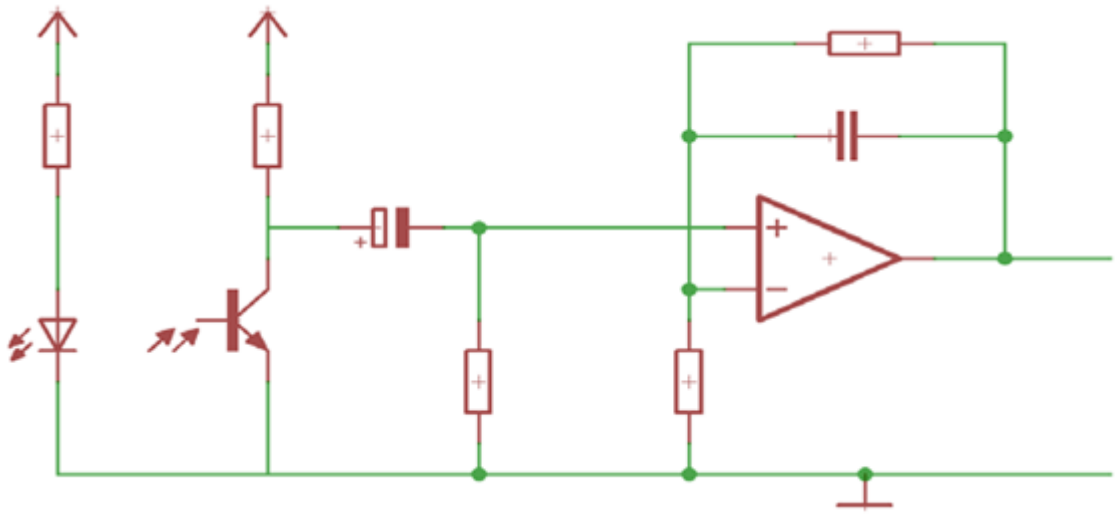

Fig. 3.4: Basic Principle of Heart Beat Sensor

Table 3.1: Specifications of Heart Beat Sensor

Operating Voltage	5V DC
Operating Current	30mA
Output	Both (Digital and Analog)

Temperature Sensor (DS18B20): The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. It has an operating temperature range of -55°C to +125°C and is accurate to ±0.5°C over the range of -10°C to +85°C. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems.

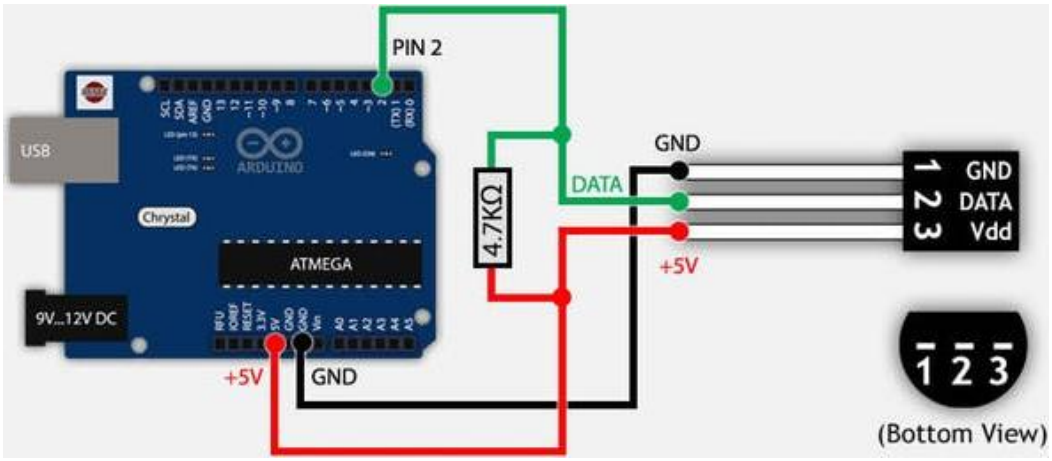

Fig. 3.5: Connect DS18B20 to Arduino

Arduino Nano: The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

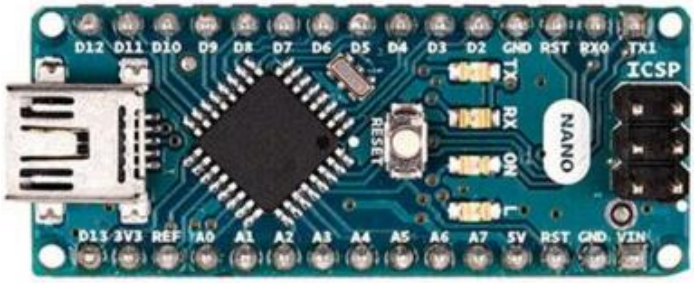

Fig. 3.6: Arduino Nano

Table 3.2: Specifications of Arduino Nano

Microcontroller	ATmega328
Architecture	AVR
Operating Voltage	5 V
Flash Memory	32 KB of which 2 KB used by bootloader
SRAM	2 KB
Clock Speed	16 MHz
Analog IN Pins	8
DC Current per I/O Pins	40 mA (I/O Pins)
Input Voltage	7-12 V
Digital I/O Pins	22 (6 of which are PWM)
PWM Output	6
Power Consumption	19 mA
PCB Size	18 x 45 mm

ESP32 WROOM: ESP32 is a series of low-cost, low-power system on a chip microcontroller with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations and includes in-built antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.

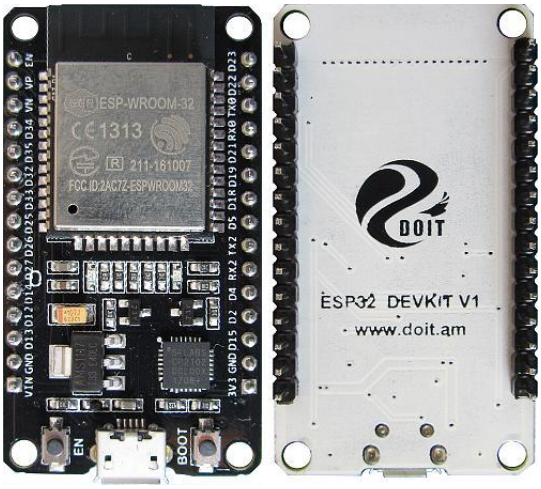

Fig. 3.7: ESP32 WROOM

Table 3.3: Specification of ESP32

Processors:	CPU: Xtensa dual-core (or single-core) 32-bit LX6 microprocessor, operating at 160 or 240 MHz and performing at up to 600 DMIPS
Memory	520 KiB SRAM
Wireless connectivity	Wi-Fi: 802.11 b/g/n
Peripheral interfaces:	12-bit SAR ADC up to 18 channels 2 × 8-bit DACs 10 × touch sensors (capacitive sensing GPIOs) 4 × SPI 2 × I²S interfaces 2 × I²C interfaces 3 × UART

Router: TL-MR3420 router is used as router in Local Area Network. The router used to create a Local Area Network between the microcontroller & server. The microcontroller communicates with server through this router.

Fig. 3.8: TL-MR3420 Router

Table 3.4: Specification of TL-MR342

Model No.	TL-MR3420
Power	12V-1A
Default IP	192.168.0.1
Username	admin
Password	admin
Serial No.	214C752006292
MAC Address	30B5C29423BC
SSID Name	alpha
Password	12345678

Raspberry Pi 3B: The Raspberry Pi 3 Model B is the earliest model of the third-generation Raspberry Pi. It replaced the Raspberry Pi 2 Model B in February 2016.

Fig. 3.9: Raspberry Pi 3B

Features:

- ✓ Quad Core 1.2GHz Broadcom BCM2837 64bit CPU
- ✓ 1GB RAM
- ✓ BCM43438 wireless LAN and Bluetooth Low Energy (BLE) on board
- ✓ 100 Base Ethernet
- ✓ 40-pin extended GPIO
- ✓ 4 USB 2 ports
- ✓ 4 Pole stereo output and composite video port
- ✓ Full size HDMI
- ✓ CSI camera port for connecting a Raspberry Pi camera
- ✓ DSI display port for connecting a Raspberry Pi touchscreen display
- ✓ Micro SD port for loading your operating system and storing data
- ✓ Upgraded switched Micro USB power source up to 2.5A

Chapter 4

Operations

4.1 Introduction

In this section the operation of this system is described. Here a brief description is given about how the system is worked. The system has 4 main features.

- Blood Group Detection
- Heart Rate Measurement
- Temperature Measurement
- Data Upload and Download (Server)

4.2 Blood Group Detection

The ABO blood group system is found and identified as the first human blood group system by Austria Rand Steiner in early nineteenth Century, according to the surface of red blood cells have no the distribution of specific antigen (agglutinogen) AlB, blood is divided into four types: A, B, AB and o. The blood type A, the red blood cells only contain agglutinogen A, the serum have anti B lectin; the blood type B, the red blood cells only contain agglutinogen , the serum have anti A lectin; blood type AB, the red blood cells contain A, B two kinds of agglutinogen , have no anti A and anti B lectin hormone in serum; the blood type 0, the red blood cells contain A, B two kinds of agglutinogen , the serum have anti A and anti B lectin. The red blood cell which have agglutinogen A can agglutinates with Anti A lectin; anti B lectin can agglutinate with B agglutinogen of red blood cells, based on this principle, ABO blood group identification can use red cell agglutination test, and then through the method of machine vision to determine blood type by whether the results obtained agglutination.

First of all, an image of the blood is taken by the high definition camera.

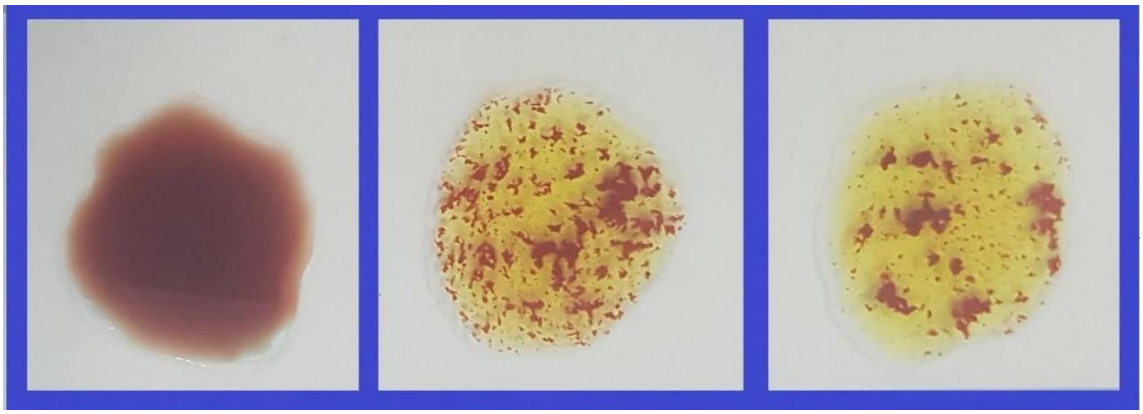

Fig. 4.1: Image Taken by Camera.

Then the picture is resized to the 280*313 pixel for the accurate result. Resize the image to a new width and height.

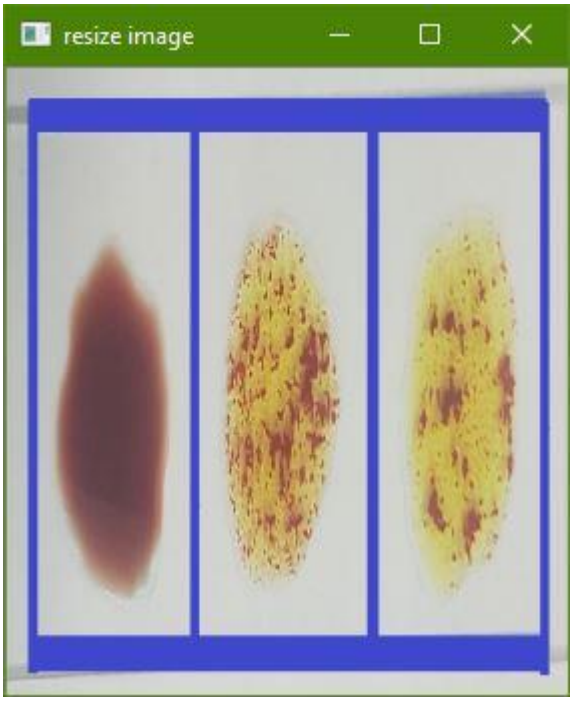

Fig. 4.2: Resized Image.

Then the image is masked to know the position of the dataset. Image masking is a process of graphics software like Photoshop to hide some portions of an image and to reveal some portions. It is a non-destructive process of image editing. Most of the time it enables you to adjust and tweak the mask later if necessary.

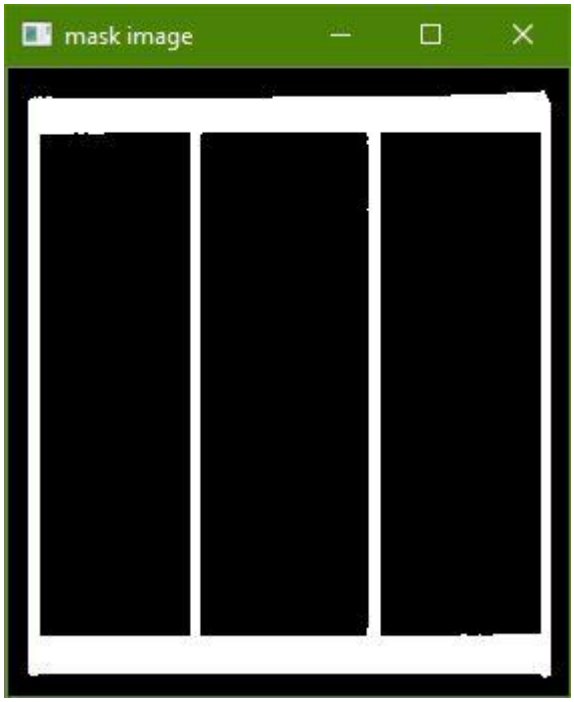

Fig. 4.3: Masking Image.

Then the image is converted to gray. The dataset has to convert to the binary data. It is not possible if it is in multiple channel. So it is converted to the binary channel. Conversion of a color image into a grayscale image inclusive of salient features is a complicated process.

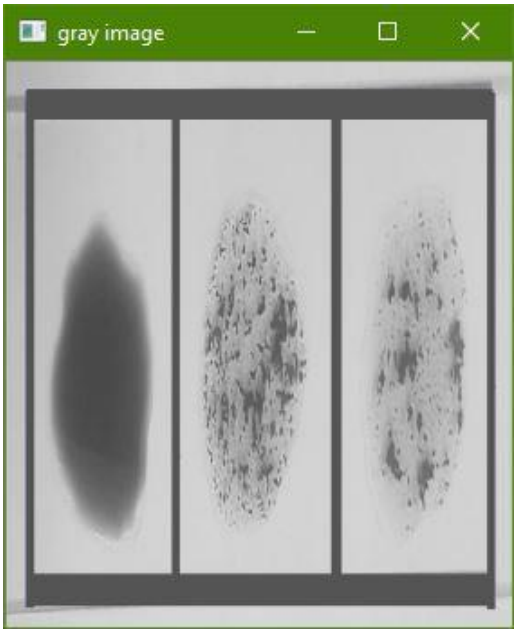

Fig. 4.4: Gray Image.

Then the gray image is converted to binary threshold. Image thresholding is a simple, yet effective, way of partitioning an image into a foreground and background. This image analysis technique is a type of image segmentation that isolates objects by converting grayscale images into binary images. Image thresholding is most effective in images with high levels of contrast.

Common image thresholding algorithms include histogram and multi-level thresholding.

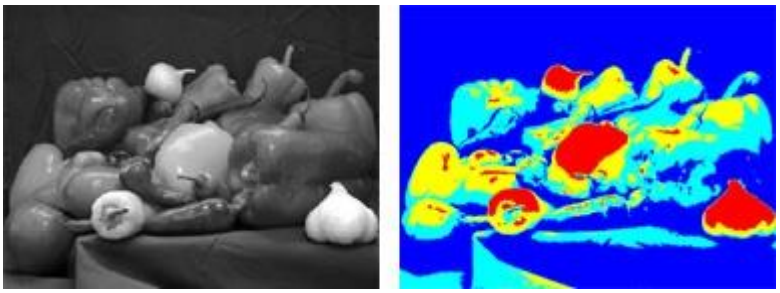

Fig. 4.5: Image thresholding using multi-level thresholding

Fig. 4.6: Image thresholding using multi-level thresholding

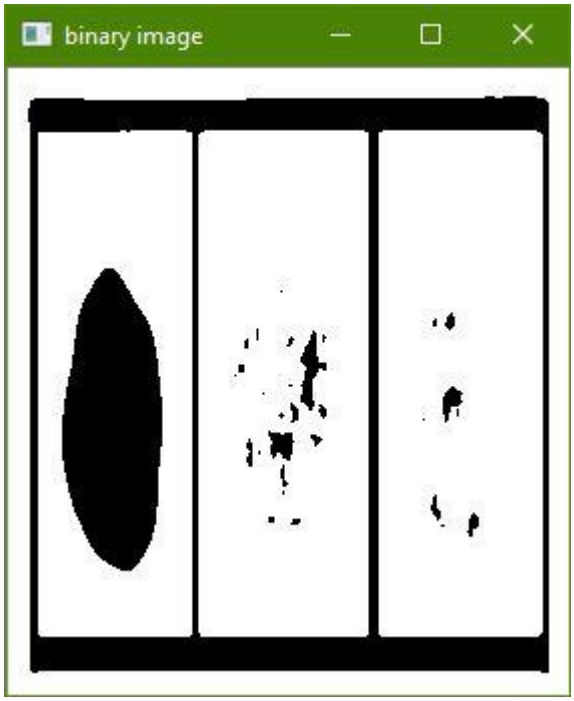

Fig. 4.7: Image after binary thresholding.

Then the image segmentation algorithm is used to get value of black region of binary threshold image. In computer vision, image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s). The data of the 3 segment after segmentation is stored into three list. By using these data, the decision that it is reacted with reagent is taken. Then the blood group is detected as follows:

Table 4.1: Blood Group Detection Logic

A	B	Rh	Blood Group
N	N	N	O-
N	N	Y	O+
N	Y	N	B-
N	Y	Y	B+
Y	N	N	A-
Y	N	Y	A+
Y	Y	N	AB-
Y	Y	Y	AB+

4.3 Heart Rate Measurement

When a tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in form of electrical signal and is proportional to the heart beat rate.

Then the output is sensed using the microcontroller and count pulse for 15 seconds. Then the count is converted into the BPM by following equation:

$$\text{BPM } = 4 * \textit{ Pulse Count}$$

4.4 Temperature Measurement

The sensor gives an analog output for a certain temperature. The voltage level indicates the temperature. For the change of 10mV, the temperature is changed 1° Celsius. The temperature is counted by the following equation:

$$Temperaure\ (C) = \frac{value}{1023 * 10} * 5000$$

Then the reading is converted to the Fahrenheit by following equation:

$$Temperaure\ (F) = \frac{9C}{5} + 32$$

4.5 Data Upload and Download (Server)

After sensing the all three data previously described, the data are uploaded to the server by using GET method. To get those data in server using PHP programming language. Then the data are processed by the predefined procedure and the server give a response to the microcontroller when the data is fully uploaded. When the microcontroller request data from server, the server first ask the patient id. Then the server query on database based on the patient id.

Chapter 5

Server Implementation

The server is running on the php apache server. The server has a dedicated database named 'medical' for this system. The database has the following tables:

- admin_table
- appointment
- appoint_number
- patient_number
- patient_table

admin_table: admin_table contains the data about admin. Here admin means the doctors. It contains the data like doctor's name, phone no, appointment time, id, password etc.

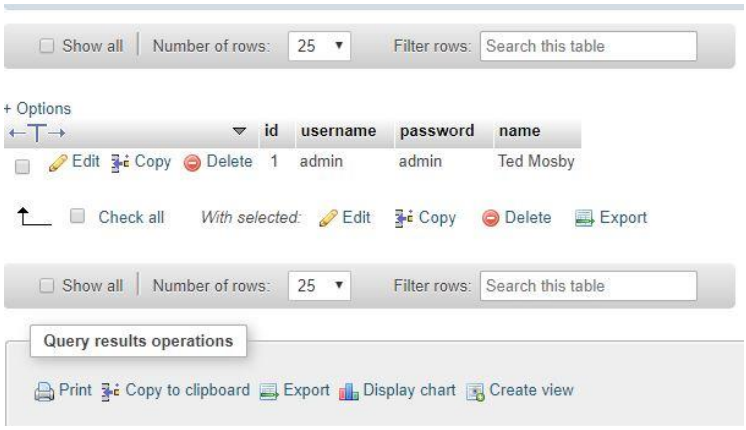

Fig. 5.1: admin table

appointment: appointment table contains the data about appointment. Here are some fields which contain the data about patient's name, serial no, previous id etc. It helps doctor to organize his appointment perfectly.

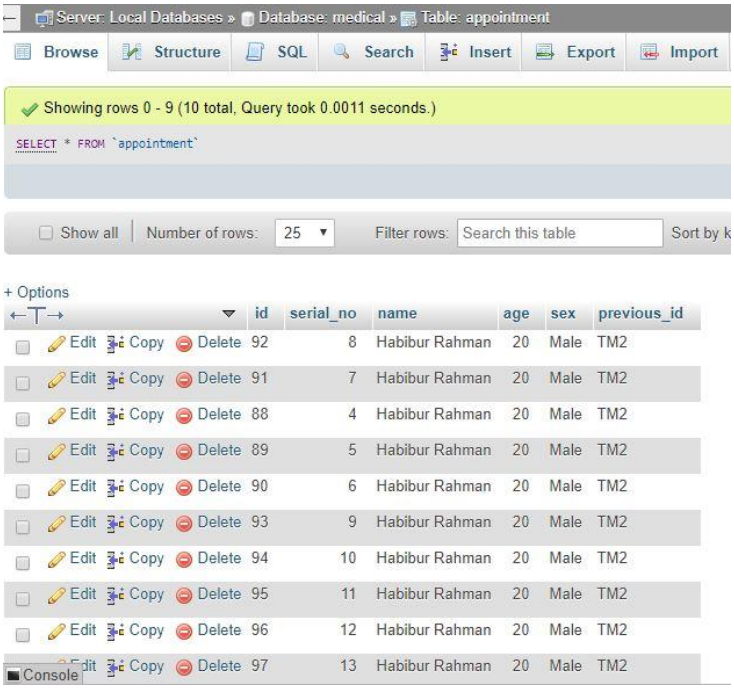

Fig. 5.2: appointment table

patient_table: patient_table contains the data about previous patient. This is the main database of this system. It contains the sensitive data like name, age, sex, id, heart rate, temperature and blood group. Data from the sensors and circuitries are saved simultaneously in this database.

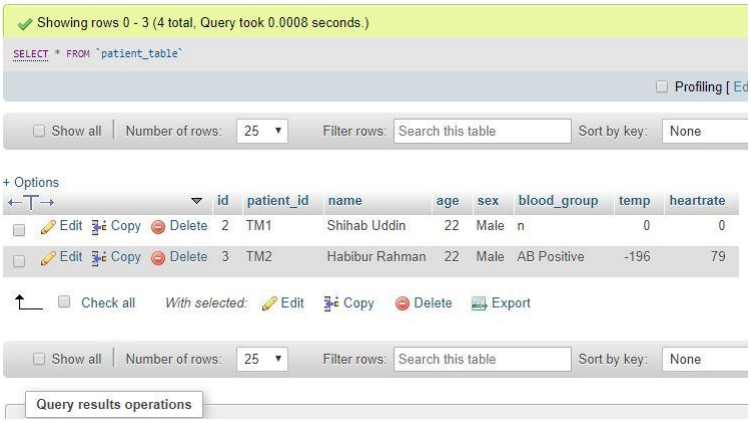

Fig. 5.3: patient table

Chapter 6

Application, Future Scope & References

6.1 Application:

This system can be implemented in the public and private medical for ensuring the better health care system. This system can be imposed to the personal health care system in home. This personal care system is very needed for the aged people. This system has a great application in ICU. The patients of ICU can be monetarized very precisely and frequently by this system. It is very tough to find a good specialist doctor in rural area. If the system is implemented in the rural area, then a doctor can prescribe medicine by monitoring the health condition of the patient. It can be done from anywhere. Doctor can monitor patient at anytime from anywhere by using the web framework of this system. The database can be used to analysis the health condition of a country. Characteristics of disease can be analyzed from the database using data science.

6.2 Advantages:

- Improved patient monitoring system.
- The proposed work eliminates the need for manpower.
- It eliminates the need for manpower but it serves to be a more accurate method as there is no human intervention.
- It can monitor every patient within every 10 seconds time interval.
- Every procedure of this system is more fast than the conventional one.
- Doctor can response very fast if there is any problem.
- Blood group can be known in a minute.
- The health data of patients are saved in an online database.
- The health data can be used for the further queries in future.
- The patient can fix an appointment with doctor easily.
- A doctor can manage his appointment precisely with this web framework.

6.3 Disadvantages:

- The heartbeat sensor and temperature sensor which are used in this system is not used for highly précised measurement.
- Unemployment problem will increase for this process.
- If there is any problem in LAN, then the server cannot get data from devices.
- Authority cannot control the devices from the server.
- Maintenance cost will be increased due to use of automation process.
- There is a huge risk of loss of privacy if the system is not enough secured.
- Greater potential for monitoring by other/unauthorized third parties.
- Increased security risks from network or remote access.

6.4 Possibility in Bangladesh

Hospital authority needs to spend extra fees or expenditure for man power in conventional patient monitoring system. If this system is implemented, then the extra expenditure can be minimized. This saved money can be spent in other valuable sector. As Bangladesh is a developing country, it's trying to improve in technology sector. Implementing this system can digitalize the Medical Health Care System and take a part in improvement of

technology sector. This framework, if implemented can be a part of Digital Bangladesh Vision 2021.

6.5 Future Plan

This project can be updated in this manner:

- Others health monitoring data will be added by upgrading hardware.
- The whole blood group detection process will be automated.
- Upgradation of website interface & data processing capability.
- Upgradation of Wi-Fi modules connecting capability.

6.6 Discussion & Conclusion

Various patient monitoring system have been developed and are still developed. The use of Wi-Fi as a communication gateway has paved way for the evolution of IoT. Previously, GSM used as a gateway has a drawback that incase of poor network coverage, the transmission becomes a problem. The proposed work eliminates the need for manpower in patient monitoring system. Not only does it eliminate the need for manpower but it serves to be a more accurate method as there is no human intervention. This system can be further improved by adding others health care sensors like blood pressure, ECG etc.

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