SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR.

ELECTRONIC WORKSHOP LAB MINI PROJECT REPORT

(6TH SEM, SESSION 2022-2023, ECP358)

"Wearable gadget automatic blood pressure, Heart rate, Oxygen Saturation monitoring system"

Submitted By

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1. Introduction:

Advancements in technology have brought about various innovations in healthcare, particularly in the field of wearable gadgets. One such innovation is the development of an automatic blood pressure, heart rate, and oxygen saturation monitoring system. This system utilizes the MAX30100 sensor and Nodemcu (ESP8266) microcontroller to measure and track vital signs accurately.

In the past, monitoring blood pressure, heart rate, and oxygen saturation levels typically required specialized medical equipment and the presence of healthcare professionals. However, with the advent of wearable technology, individuals can now conveniently monitor these vital signs in real time from the comfort of their own homes. The sensor will capture the electroencephalogram (EEG) signals of a person and send the signals to a nearby edge computing server [1].

The MAX30100 sensor is a compact and efficient device capable of measuring both heart rate and oxygen saturation levels [2] [7]. It uses a combination of light absorption and reflection principles to provide accurate readings. The Nodemcu (ESP8266) microcontroller, on the other hand, acts as the central processing unit, collecting data from the sensor and transmitting it wirelessly to a smartphone or computer [6].

By wearing the device, individuals can continuously monitor their blood pressure, heart rate, and oxygen saturation levels throughout the day. This real-time data can provide valuable insights into their overall health and help detect any abnormalities or trends that may require medical attention.

The benefits of this wearable monitoring system are numerous. Firstly, it empowers individuals to take control of their own health by providing them with accessible and easy-to-understand information about their vital signs. This promotes proactive healthcare management and early detection of potential health issues.

Secondly, the system enables remote monitoring, allowing healthcare professionals to access the data collected by the device remotely. This feature is particularly beneficial for patients with chronic conditions or those who require regular monitoring but cannot visit a medical facility frequently.

Furthermore, the integration of wearable technology into healthcare promotes a more patient-centric approach. It reduces the need for hospital visits or clinic appointments solely for monitoring purposes, freeing up valuable healthcare resources and improving overall efficiency.

In conclusion, the combination of the MAX30100 sensor and Nodemcu

(ESP8266) microcontroller offers a powerful and convenient solution for monitoring blood pressure, heart rate, and oxygen saturation levels [3]. This wearable gadget provides individuals with real-time insights into their health, promotes proactive healthcare management, and facilitates remote monitoring by healthcare professionals. With the continued advancements in wearable technology, we can expect further improvements in healthcare monitoring, leading to enhanced personalized care and improved health outcomes.

2. Impact of Project on society and the environment:

The development and implementation of a wearable gadget that provides automatic monitoring of blood pressure, heart rate, and oxygen saturation levels using the MAX30100 sensor and NodeMCU ESP8266 can have significant impacts on society and the environment.

Impact on Society:

1. Improved Healthcare Accessibility: This wearable gadget enables individuals to monitor their vital signs conveniently and continuously from the comfort of their homes. It promotes self-care and empowers individuals to take proactive steps towards maintaining their health. It also reduces the need for frequent visits to medical facilities solely for monitoring purposes, thereby freeing up healthcare resources and reducing the burden on healthcare systems.

2. Early Detection and Intervention: Continuous monitoring of blood pressure, heart rate, and oxygen saturation levels can provide valuable insights into an individual's health status. It allows for early detection of abnormalities or trends that may indicate potential health issues. This early detection can lead to timely medical interventions, helping to prevent complications and improve health outcomes.

3. Remote Healthcare Monitoring: The wearable gadget enables remote monitoring of vital signs by healthcare professionals. This is particularly beneficial for individuals with chronic conditions or those who require regular monitoring but may have difficulty visiting a healthcare facility frequently. Remote monitoring facilitates timely interventions, reduces hospital readmissions, and improves overall patient care and management.

4. Health Awareness and Education: By providing individuals with real-time data about their vital signs, the wearable gadget promotes health awareness and education. It encourages individuals to be more proactive in managing their health and fosters a better understanding of the impact of lifestyle choices on their well-being. This increased awareness can lead to healthier behaviors and improved overall health outcomes.

Impact on the Environment:

1. Reduced Medical Waste: With continuous monitoring of vital signs at home, there may be a reduced need for disposable monitoring devices and unnecessary medical visits. This can contribute to a decrease in medical waste, such as single-use blood pressure cuffs, sensors, and other disposable medical equipment.

2. Energy Efficiency: The wearable gadget utilizes low-power components such as the MAX30100 sensor and NodeMCU ESP8266, which are designed to be energy-efficient. By optimizing power consumption, the device minimizes its environmental impact and maximizes the battery life, reducing the frequency of battery replacements and electronic waste generation.

3. Sustainable Healthcare Practices: The integration of wearable technology for health monitoring aligns with the growing trend of sustainable healthcare practices. It promotes preventive care, reduces the reliance on traditional healthcare infrastructure, and encourages a more patient-centric approach to healthcare. This shift can contribute to more sustainable and efficient healthcare systems in the long run.

How it will solve the problems of society/individuals and environment.

The wearable gadget for automatic monitoring of blood pressure, heart rate, and oxygen saturation levels using the MAX30100 sensor and NodeMCU ESP8266 can address several problems faced by society/individuals and contribute to environmental solutions in the following ways:

1. Improved Health Management: The gadget provides individuals with continuous and convenient monitoring of vital signs, allowing them to take proactive steps towards managing their health. By regularly tracking blood pressure, heart rate, and oxygen saturation levels, individuals can detect potential health issues early on, enabling timely interventions and reducing the risk of complications. This empowers individuals to actively participate in their health management and promotes overall well-being.

2. Enhanced Accessibility to Healthcare: The wearable gadget enables individuals to monitor their vital signs from home, reducing the need for frequent visits to medical facilities solely for monitoring purposes. This improves accessibility to healthcare services, particularly for individuals with limited mobility, those living in remote areas, or those facing barriers to accessing healthcare. By reducing the burden on healthcare systems, it helps optimize healthcare resources and provides equitable access to monitoring and care.

3. Remote Healthcare Monitoring: The gadget facilitates remote monitoring of vital signs by healthcare professionals. This is especially beneficial for individuals with chronic conditions or those requiring regular monitoring. Remote monitoring allows healthcare providers to proactively identify any abnormalities or trends in the vital signs, enabling timely interventions and personalized care. It also reduces the need for unnecessary hospital visits, lowering healthcare costs and improving overall patient satisfaction.

4. Health Awareness and Education: By providing real-time data on vital signs, the wearable gadget promotes health awareness and education. Individuals gain a better understanding of their health status, allowing them to make informed decisions about their lifestyle and behaviors. This can lead to healthier choices, such as engaging in regular physical activity, managing stress, and adopting a balanced diet. Ultimately, improved health awareness and education contribute to disease prevention and better health outcomes.

5. Reduction of Medical Waste: Continuous monitoring at home reduces the reliance on disposable monitoring devices commonly used in medical facilities. This contributes to the reduction of medical waste, such as single-use blood pressure cuffs, sensors, and other disposable equipment. By minimizing the generation of medical waste, the wearable gadget supports sustainable healthcare practices and reduces the environmental impact associated with the healthcare sector.

6. Energy Efficiency: The wearable gadget utilizes energy-efficient components and technologies. By optimizing power consumption, it minimizes its environmental footprint and extends battery life, reducing the frequency of battery replacements and electronic waste generation. Energy-efficient design and operation contribute to a more sustainable use of resources.

Overall, the wearable gadget for automatic monitoring of vital signs addresses the challenges faced by individuals and society by promoting proactive health management, enhancing accessibility to healthcare, enabling remote monitoring, raising health awareness, and contributing to sustainable healthcare practices. Additionally, it reduces medical waste and promotes energy efficiency, aligning with environmental solutions and fostering a more sustainable approach to healthcare.

3. Block diagram and Functional description:

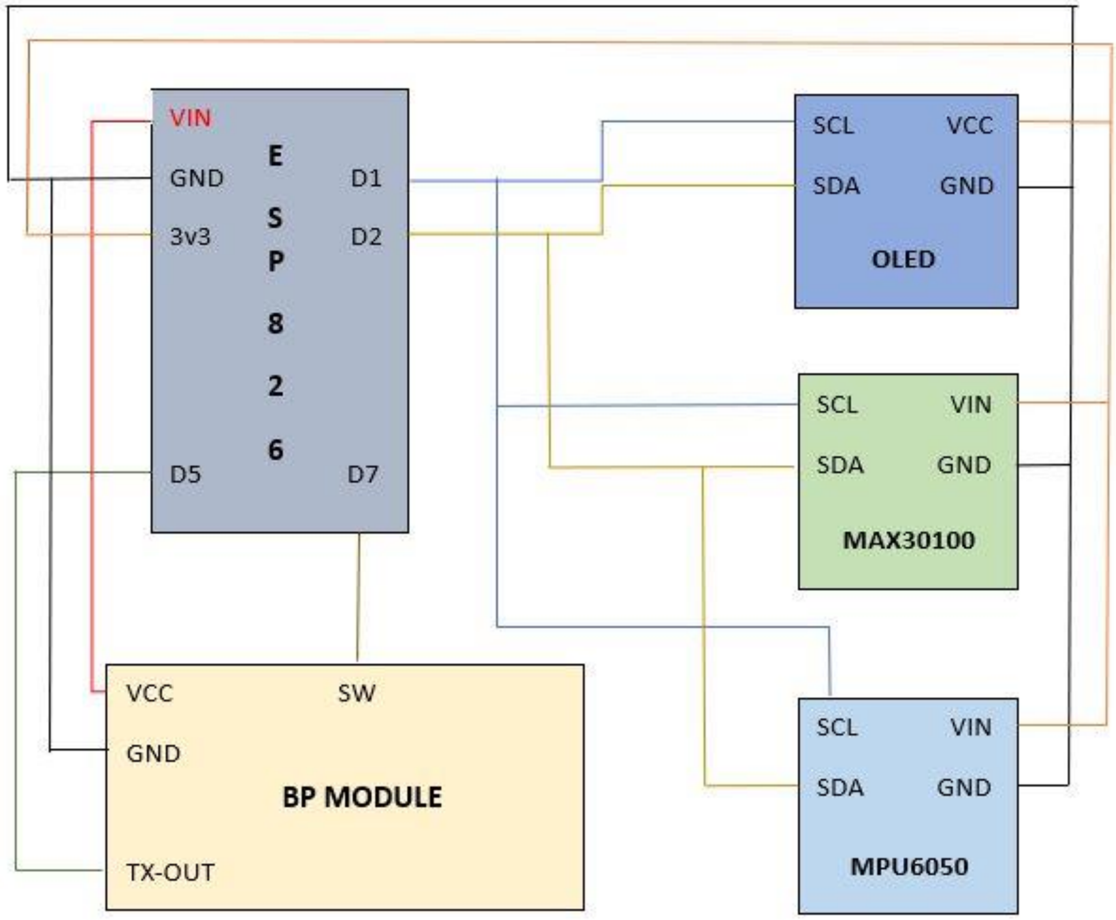


Fig no:3.1 Block diagram of proposed setup

Max30100 Sensor:

Table no:3.1 Description of MAX30100 Sensor

Sr no.	**Pin:**	**Description**
1.	VIN	This pin is used to supply power to the sensor. This sensor is powered on at 3.3V.
2.	SCL	This is the I2C serial clock pin.
3.	SDA	This is the I2C data pin.
4.	INT	This is the active low interrupt pin. It is pulled HIGH by the onboard resistor but when an interrupt occurs it goes LOW until the interrupt clears.
5.	IRD	IR LED Cathode and LED Driver connection point.
6.	RD	Red LED Cathode and LED Driver connection point.
7.	GND	This is used for supplying ground to this sensor and it is connected to the source ground pin.

Nodemcu ESP8266:

The NodeMCU ESP8266 is a widely used development board based on the ESP8266 microcontroller. It provides a convenient and affordable way to prototype and build Internet of Things (IoT) projects. Here is a functional description of the NodeMCU ESP8266:

1. **Microcontroller**: The NodeMCU ESP8266 features a powerful ESP8266 microcontroller at its core. Given its low cost, small size and adaptability with embedded devices, the ESP8266 is now used extensively across IoT devices [8].

2. **Wi-Fi Connectivity**: One of the key features of the NodeMCU ESP8266 is its built-in Wi-Fi module. The module's Wi-Fi antenna enables embedded devices to connect to routers and wireless data logging [9]. It enables the board to connect to wireless networks, allowing it to communicate and interact with other devices and the internet. This Wi-Fi connectivity is essential for IoT projects that require data exchange over a network.

3. **GPIO Pins**: The NodeMCU ESP8266 provides a number of General-Purpose Input/Output (GPIO) pins that can be used to interface with various external components and sensors. These pins allow the board to read inputs from sensors, control actuators, and communicate with other devices using protocols such as I2C, SPI, and UART.

4. **Programming and Development**: The NodeMCU ESP8266 is programmable using the Arduino IDE or other compatible development environments. It supports the Lua scripting language, making it easy to write and execute code on the board. The development process involves writing code, compiling, and uploading it to the board for execution.

5. **Power Supply**: The NodeMCU ESP8266 can be powered through a micro-USB port, allowing it to be powered by a computer or a USB power adapter. It also supports battery operation with the appropriate power management considerations.

6. **Additional Features**: The NodeMCU ESP8266 offers additional features such as analog-to-digital conversion (ADC) inputs, pulse-width modulation (PWM) outputs, and onboard memory for data storage. These features enhance its versatility and enable a wide range of IoT applications.

Overall, the NodeMCU ESP8266 provides a user-friendly and versatile platform for developing IoT projects with built-in Wi-Fi connectivity, GPIO pins for interfacing with external components, and support for programming and development.

O-LED Display:

The OLED 128x64 is a type of display module that utilizes Organic Light-Emitting Diode (OLED) technology to provide visual output. Here is a functional description of the OLED 128x64 display:

1. **Display Technology**: The OLED 128x64 display employs OLED technology, which consists of organic compounds that emit light when an electric current is applied. This technology enables the display to have self-emitting pixels, meaning each pixel generates its own light, resulting in vibrant and high-contrast visuals.

2. **Resolution and Size**: The OLED 128x64 display has a resolution of 128 pixels in width and 64 pixels in height. This pixel arrangement allows for the presentation of relatively detailed images and text. The physical size of the display can vary depending on the specific module, but it is typically compact and suitable for small-scale projects.

3. **Monochrome Display**: The OLED display is typically monochrome, meaning it can display only one color, usually white or yellow. The lack of color capability simplifies the display driver circuitry and reduces power consumption.

4. **Communication Interface**: The OLED display module is usually interfaced with a microcontroller or other devices using a standard communication protocol such as I2C (or SPI in some cases). This allows for easy integration and control of the display.

5. **Pixel Control**: The individual pixels on the OLED 128x64 display can be controlled independently. This level of control allows for drawing graphics, displaying text, and creating custom user interfaces. The display can show various fonts, icons, and images.

6. **Low Power Consumption**: OLED displays have the advantage of low power consumption since they do not require a backlight like LCD displays. Each pixel emits its own light, allowing for power-efficient operation, especially when displaying predominantly dark or black content.

7. **Wide Viewing Angle**: OLED technology offers a wide viewing angle, meaning the display can be viewed clearly from various angles without significant degradation in image quality or color accuracy. This makes the OLED 128x64 display suitable for applications where multiple viewers may be observing the display from different positions.

Overall, the OLED 128x64 display provides a compact, monochrome, and versatile visual output solution with excellent contrast, low power consumption, and wide viewing angles. It is commonly used in small-scale projects, wearable devices, IoT applications, and other scenarios where a compact and efficient display is required.

Digital BP Module :

The working of a digital blood pressure (BP) module involves several components and processes. Here is a general overview of how a digital BP module typically operates:

1. **Inflation**: The BP module includes an inflatable cuff that is placed around the upper arm. When the measurement process begins, the cuff inflates to a predetermined pressure level, temporarily cutting off blood flow to the arm.

2. **Pressure Sensing**: The module contains pressure sensors that detect the pressure within the cuff. These sensors measure the oscillations of the cuff pressure as blood flow is intermittently allowed through the compressed artery.

3. **Deflation and Measurement**: After reaching the maximum pressure, the cuff gradually deflates. As the pressure decreases, the pressure sensors continue to measure the oscillations caused by blood flow.

4. **Data Processing**: The raw pressure data obtained from the sensors is processed to extract the systolic and diastolic blood pressure values. This processing typically involves filtering, amplification, and analysis algorithms to accurately determine the blood pressure readings.

5. **Display and Output**: The calculated systolic and diastolic blood pressure values are displayed on a digital screen or outputted through a digital interface. Some digital BP modules also provide additional features such as pulse rate measurement and memory storage for storing previous measurements.

It's important to note that different digital BP modules may have variations in terms of specific components, measurement techniques, and algorithms used. Therefore, it's advisable to refer to the manufacturer's instructions and documentation for detailed information on the working of a particular digital BP module.

MPU6050 Sensor:

The MPU6050 is not primarily a temperature sensor but a combined accelerometer and gyroscope sensor. However, it does include a temperature sensor as an additional feature. Here is a brief functional description of the temperature sensor within the MPU6050:

1. **Temperature Sensing**: The MPU6050 sensor incorporates a built-in temperature sensor that measures the ambient temperature of its surroundings. the accelerometer has a measurement range of up to 16g. It also integrates a gyroscope and a 16-bit high-precision ADC [4].

2. **Analog-to-Digital Conversion**: The temperature sensor generates an analog voltage signal proportional to the temperature. The sensor's analog output is then converted into a digital value using an analog-to-digital converter (ADC) within the MPU6050.

3. **Temperature Calibration**: To ensure accuracy, the MPU6050 may require temperature calibration. Calibration involves adjusting the sensor's readings based on known temperature references to compensate for any measurement deviations or inaccuracies.

4**. Digital Output**: The temperature sensor's digital value is made available to the user through the MPU6050's registers or communication interfaces such as I2C or SPI. Users can retrieve the temperature reading by accessing the appropriate registers or utilizing the provided communication protocols.

5**. Temperature Compensation**: The temperature sensor's readings can be used to compensate for temperature-related variations in other sensor measurements. By monitoring the temperature, it is possible to adjust the readings from the accelerometer and gyroscope to account for any temperature-dependent changes, improving the overall accuracy of the MPU6050's measurements.

It's important to note that the temperature sensor within the MPU6050 is not as accurate or precise as dedicated temperature sensors. Its primary purpose is to provide a rough estimation of the ambient temperature. If precise temperature measurements are required, it is recommended to use a dedicated temperature sensor with higher accuracy and resolution.

ThingSpeak:

ThingSpeak is an IoT (Internet of Things) platform that provides a range of functionalities for collecting, analyzing, and visualizing data from IoT devices. Here is a functional description of ThingSpeak:

1. **Data Collection**: ThingSpeak allows users to collect data from various IoT devices or sensors. It provides APIs and libraries that enable developers to send data to ThingSpeak from their devices or applications. The data can be sent in real-time or in batches, depending on the specific requirements.

2. **Data Storage**: ThingSpeak provides cloud-based storage for the collected data. The data is organized into channels, which act as containers for different data streams. Each channel can have multiple fields to store different types of data. ThingSpeak ensures that the collected data is securely stored and readily accessible.

3**. Data Analysis**: ThingSpeak offers built-in analytics and visualization tools to analyze the collected data. Users can define custom analysis algorithms or use pre-built MATLAB-based functions to process and derive insights from the data. The platform supports calculations, filtering, smoothing, and other operations to manipulate and analyze the data.

4. **Visualization and Dashboards**: ThingSpeak enables users to create interactive dashboards and visualizations to represent the data. The platform provides various chart types, such as line graphs, bar charts, and gauges, to present the data in a meaningful way. Users can customize the visual appearance, layout, and behavior of the dashboards to suit their specific needs.

5**. Real-Time Monitoring**: ThingSpeak supports real-time data monitoring and alerts. Users can set up triggers or thresholds based on the data values to receive notifications or trigger actions when certain conditions are met. This allows for proactive monitoring and timely response to critical events or anomalies.

6. **Integration and APIs**: ThingSpeak offers a range of APIs and integration options to interact with the platform. Users can integrate ThingSpeak with external systems, services, or applications using RESTful APIs or MQTT (Message Queuing Telemetry Transport) protocols. This enables seamless data exchange and integration with other IoT platforms, cloud services, or analytics tools.

7. **Collaboration and Sharing**: ThingSpeak allows users to share their data, dashboards, and visualizations with others. This promotes collaboration, data sharing, and knowledge exchange within the IoT community. Users can control access permissions and share their work publicly or with specific individuals or groups.

8. **IoT Application Development**: ThingSpeak serves as a platform for developing IoT applications. It provides tools, resources, and documentation to assist developers in building applications that interact with ThingSpeak's APIs and services. This includes support for popular IoT development boards and protocols.

Overall, ThingSpeak offers a comprehensive set of features and functionalities for data collection, storage, analysis, visualization, and real-time monitoring in the context of IoT. It serves as a powerful platform to harness the potential of IoT data and derive valuable insights from it.

4. Circuit diagram and its description:

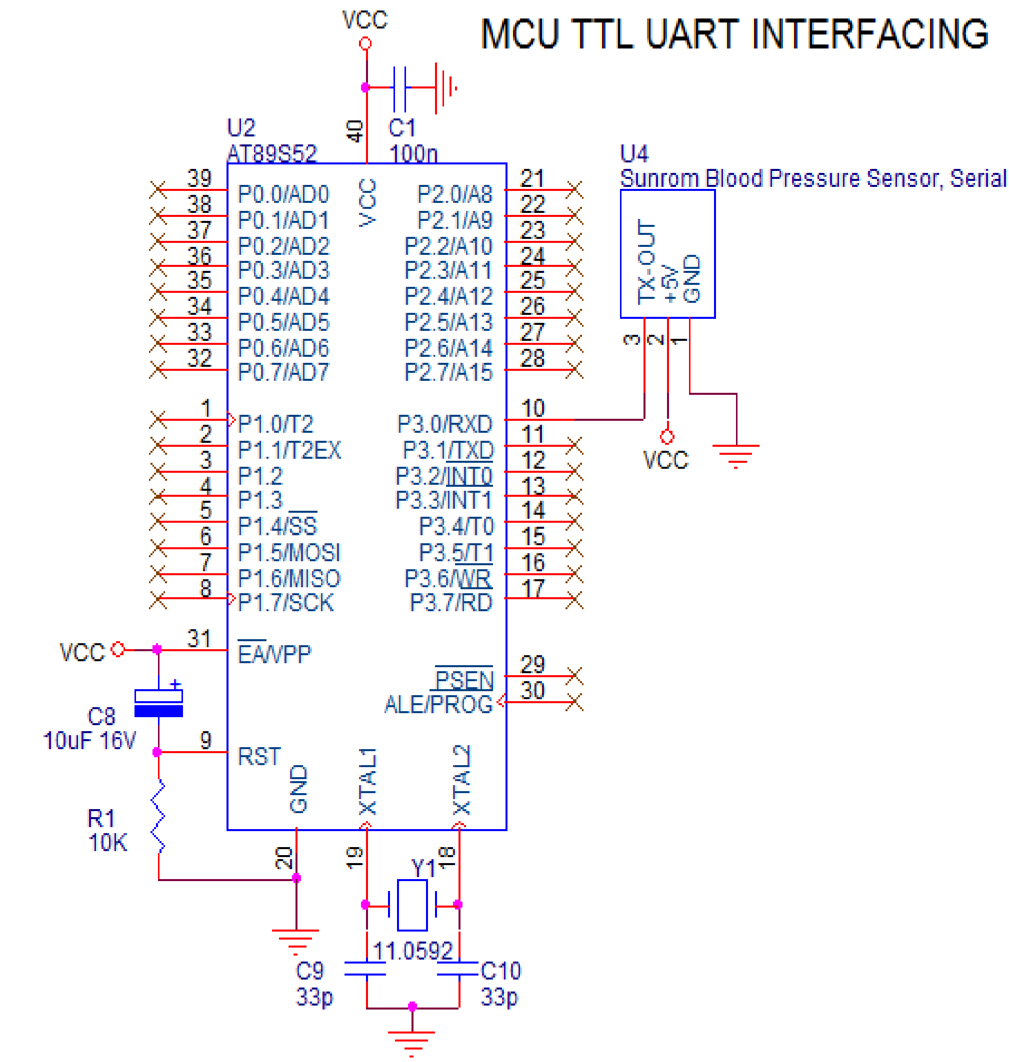


Fig no:4.1 Generalize BP module connection with Microcontroller.

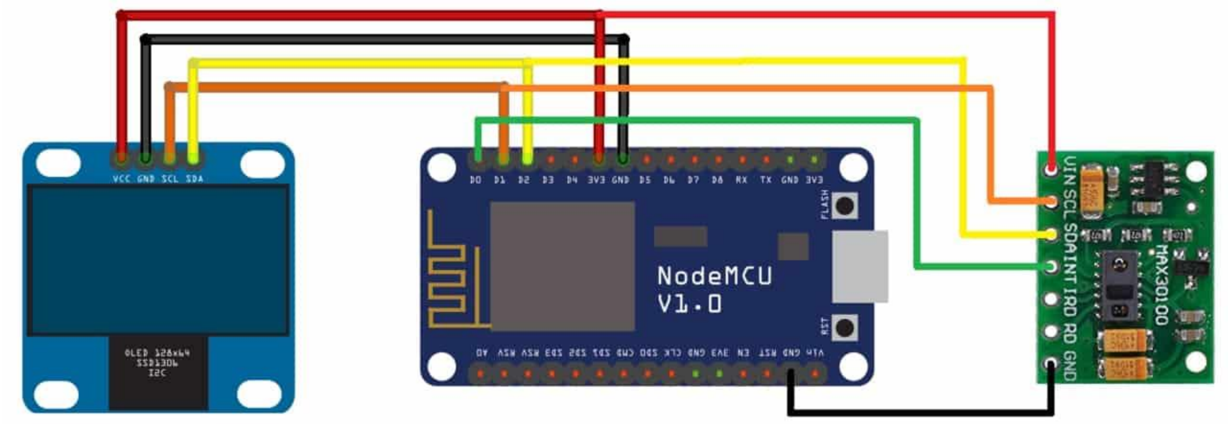


Fig no: 4.2 Connection of OLED and MAX30100 with NodeMCU

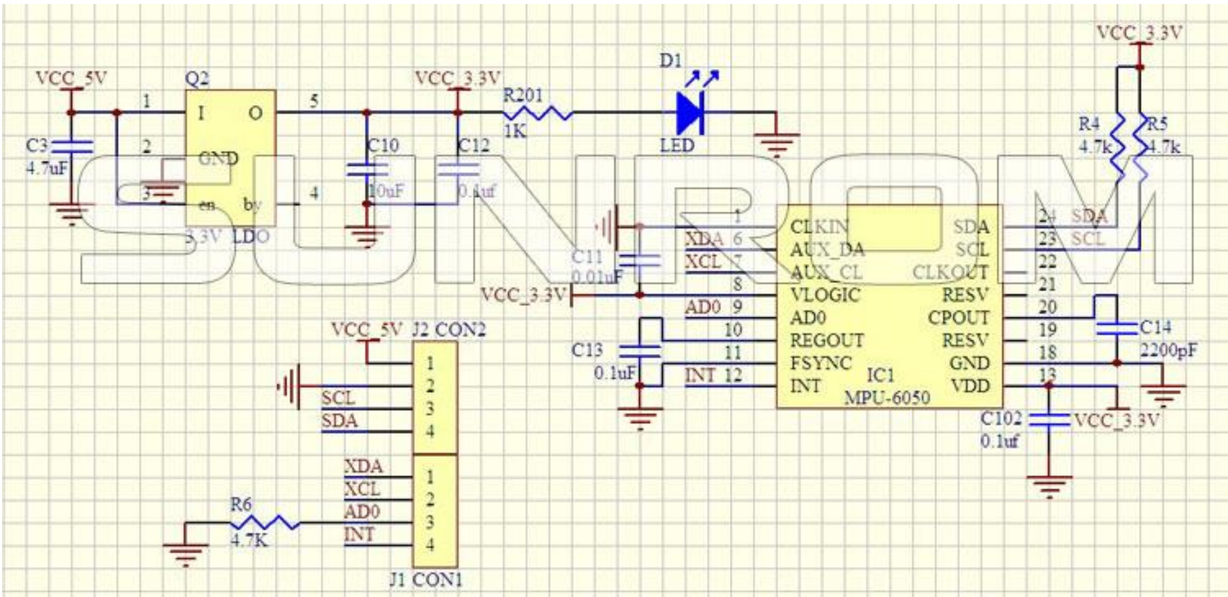


Fig no:4.3 Schematic layout of MPU6050 module

1. **MAX30100 Sensor**:
   - VCC (Power) pin of MAX30100: Connect to a 3.3V power source on the NodeMCU.
   - GND (Ground) pin of MAX30100: Connect to the GND (Ground) pin on the NodeMCU.
   - SDA (Serial Data) pin of MAX30100: Connect to the SDA pin on the NodeMCU (for I2C communication).
   - SCL (Serial Clock) pin of MAX30100: Connect to the SCL pin on the NodeMCU (for I2C communication).
2. **OLED Display**:
   - VCC (Power) pin of OLED: Connect to a 3.3V power source on the NodeMCU.
   - GND (Ground) pin of OLED: Connect to the GND (Ground) pin on the NodeMCU.
   - SDA (Serial Data) pin of OLED: Connect to the SDA pin on the NodeMCU (for I2C communication).
   - SCL (Serial Clock) pin of OLED: Connect to the SCL pin on the NodeMCU (for I2C communication).

3. **NodeMCU ESP8266**:

- VCC (Power) pin of NodeMCU: Connect to a 3.3V power source.
- GND (Ground) pin of NodeMCU: Connect to the GND (Ground) pin.
- Connect the SDA and SCL pins of NodeMCU to the corresponding SDA and SCL pins of MAX30100 and OLED.

4. **Digital Blood Pressure (BP) Module**:

Typically, it involves connecting power (VCC and GND) and communication pins (e.g., UART, I2C, SPI) to appropriate pins on the NodeMCU.

5. MPU6050 Sensor:

- VCC (Power) pin of MPU6050: Connect to a 3.3V power source on the NodeMCU.
- GND (Ground) pin of MPU6050: Connect to the GND (Ground) pin on the NodeMCU.
- SDA (Serial Data) pin of MPU6050: Connect to the SDA pin on the NodeMCU (for I2C communication).
- SCL (Serial Clock) pin of MPU6050: Connect to the SCL pin on the NodeMCU (for I2C communication).

5. PCB layout and Artwork

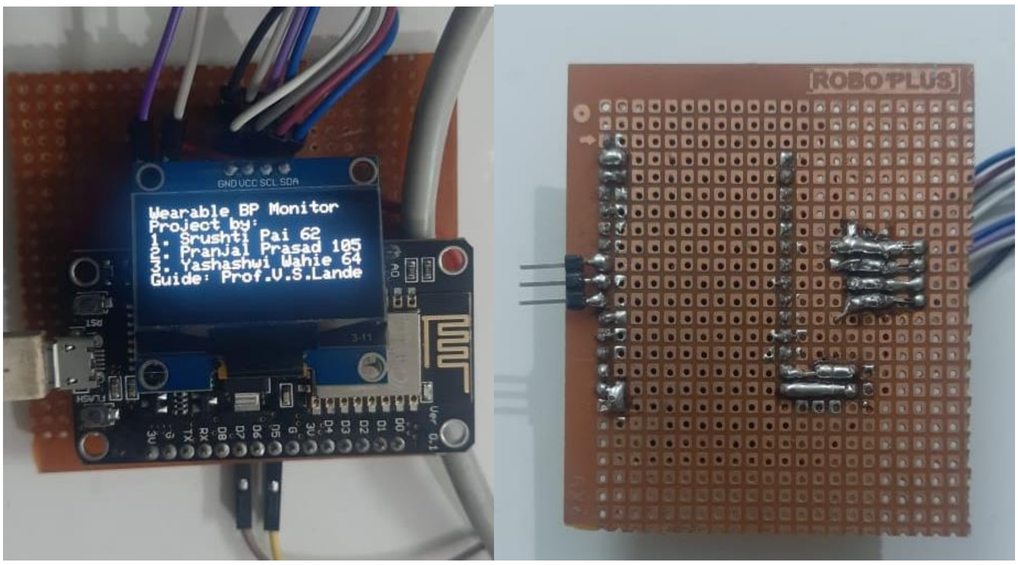


Fig no:5.1 OLED display and PCB Layout

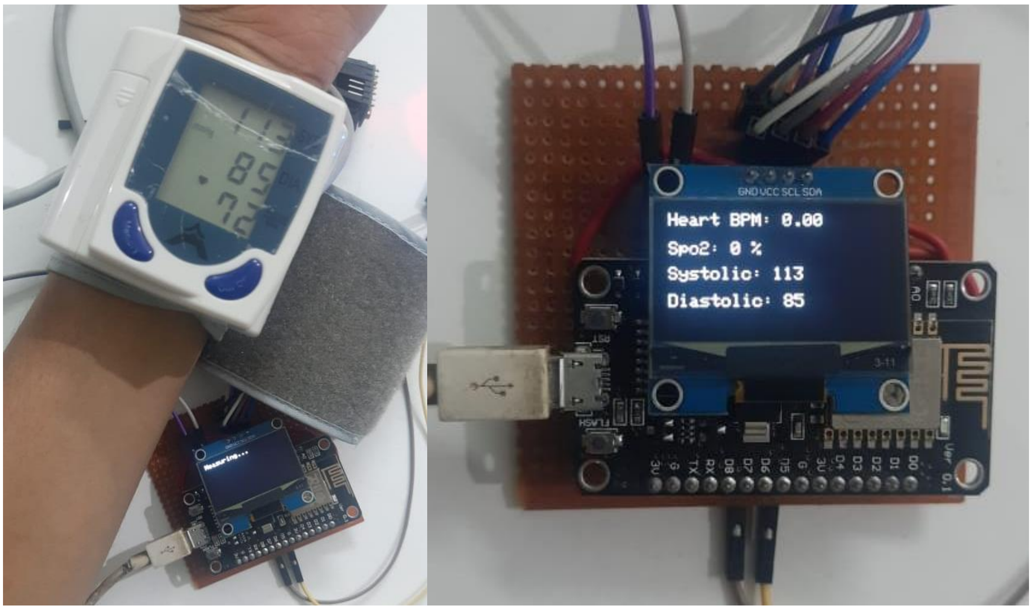


Fig no:5.2 BP module and OLED Display

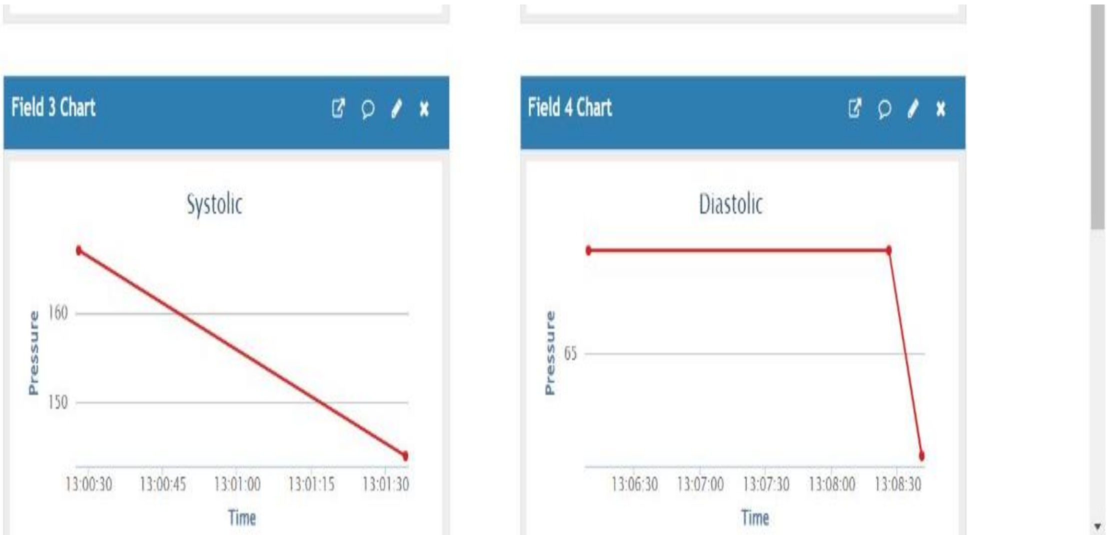


Fig no:5.3 Systolic and Diastolic Visualization

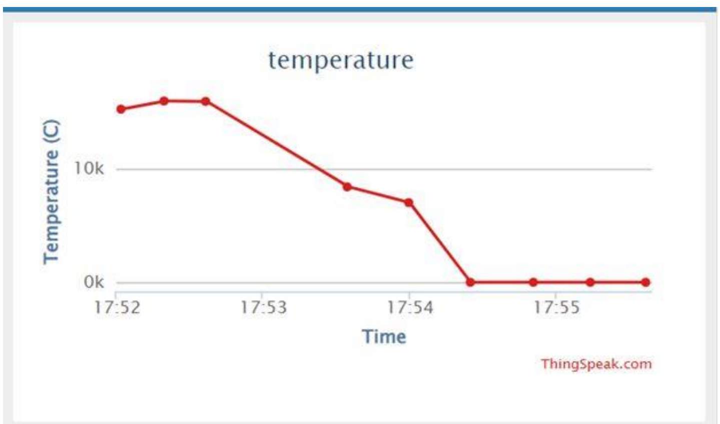
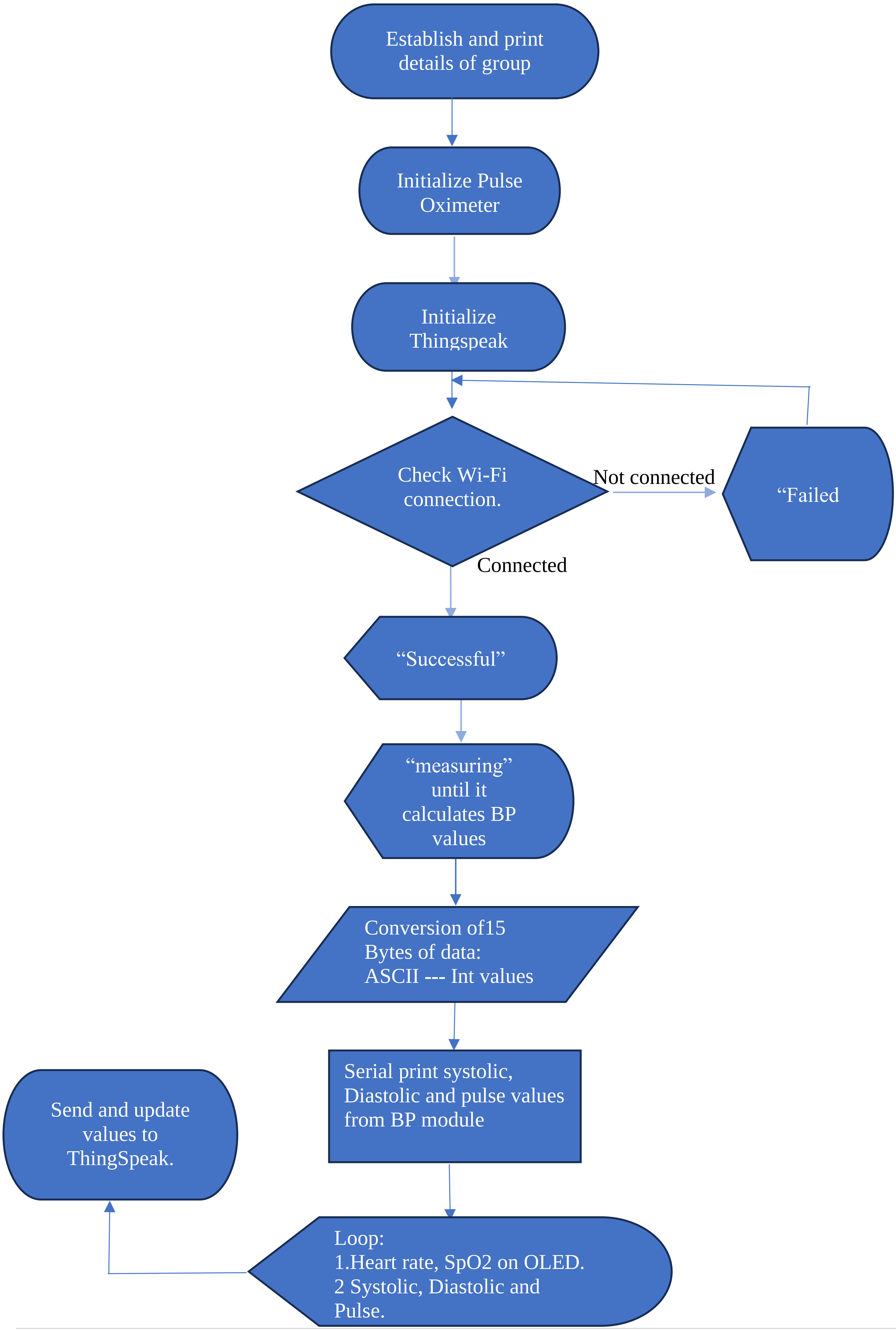


Fig no:5.4 Temperature

6. Working of Project:

Flowchart:



MAX30100 Sensor:

- The MAX30100 sensor is used as both a **heart rate monitor** and a **pulse oximeter**. These features are enabled by the construction of this sensor which consists of two LEDs, a photodetector, optimized optics, and low noise signal processing components. It is easily used with microcontrollers such as ESP8266 NodeMCU to build an efficient heartbeat and oxygen saturation device.
- MAX30100 IC lies at the center of the module.
- It consists of two different types of LEDs on the right-hand side.
- There is one Red LED and one IR LED. On the left-hand side you can view the photodetector.
- Blood oxygen saturation and heart rate are found using these two key features.

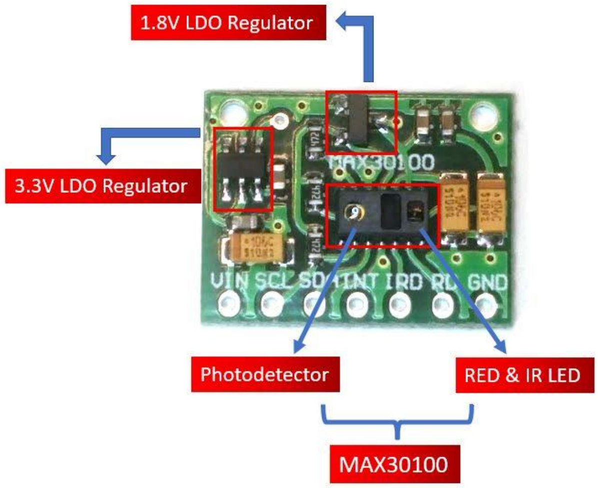


Fig no:6.1 MAX30100

Pulse Oximeter:

- MAX30100 sensor consists of two LEDs (Red and IR) and a photodiode. Both LEDs are used for SPO2 measurement. These two LEDs emit lights at different wavelengths, ~640nm for the red led and ~940nm for the IR LED. At these wavelengths, the oxygenated and deoxygenated hemoglobin have vastly different absorption properties.
- The diagram below is taken from the datasheet of MAX30100 IC. You may notice the difference shown in the graph between HbO2 which is oxygenated hemoglobin and Hb which is deoxygenated hemoglobin at two different wavelengths.

- The oxygenated hemoglobin absorbs more infrared light and reflects the red light whereas the deoxygenated hemoglobin absorbs more red light an reflects the infrared light.
- The reflected light is measured by the photodetector.
- MAX30100 is used to monitor the heart rate and the oxygen saturation (SpO2) in the blood [5].
- The ratio of IR and RED light received by the photodetector gives us the blood oxygen concentration.

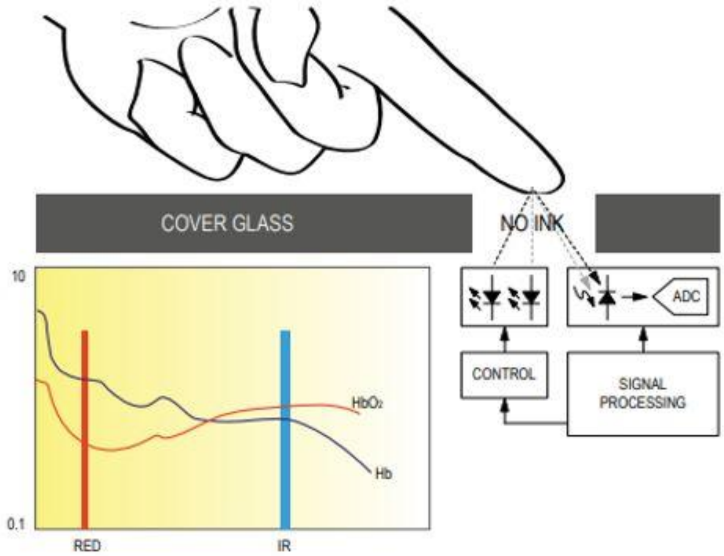


Fig no:6.2 Pulse Oximeter

BP Measurement:

A digital blood pressure (BP) module is a device used to measure and monitor blood pressure levels. The working of a digital BP module involves several steps and components. Here is a detailed description of how a typical digital BP module operates:

1**. Preparation**: To begin the measurement, the user typically sits in a relaxed position with their arm resting on a flat surface. The cuff of the BP module is wrapped firmly around the upper arm, positioning it at the same height as the heart.

2. **Inflation:** The measurement process starts by inflating the cuff. This is done by activating a pump or motorized mechanism within the BP module. As the cuff inflates, it compresses the brachial artery in the arm, temporarily cutting off blood flow.

3**. Pressure Sensing**: The BP module contains pressure sensors that detect the pressure within the cuff. These sensors measure the oscillations of the cuff pressure as blood flow is intermittently allowed through the compressed artery.

4**. Deflation and Detection**: After reaching the maximum pressure, the cuff gradually deflates. As the pressure decreases, the pressure sensors continue to measure the oscillations caused by blood flow.

5**. Data Processing**: The raw pressure data obtained from the sensors is processed to extract the systolic and diastolic blood pressure values. This processing typically involves filtering, amplification, and analysis algorithms to accurately determine the blood pressure readings.

6. **Display and Output**: The calculated systolic and diastolic blood pressure values are displayed on a digital screen or output through a digital interface. Some digital BP modules also provide additional information, such as pulse rate and irregular heartbeat detection.

7**. Calibration and Accuracy**: Digital BP modules require periodic calibration to ensure accurate readings. This calibration is typically performed using known pressure references to adjust and calibrate the sensors and algorithms within the module.

8**. Memory and Connectivity**: Many digital BP modules have built-in memory to store previous blood pressure readings. This allows users to track their blood pressure over time. Some models also offer connectivity options such as Bluetooth or USB to transfer data to a computer or mobile device for further analysis and monitoring.

It's important to note that different digital BP modules may have variations in terms of specific components, measurement techniques, and algorithms used. Therefore, it's advisable to refer to the manufacturer's instructions and documentation for detailed information on the working of a particular digital BP module.

Heart Rate Measurement:

To measure the heart rate, we do not require the Red LED, only the IR LED is needed. This is because oxygenated hemoglobin absorbs more infrared light. The heartbeat rate is the ratio of time between two consecutive heartbeats. Similarly, when human blood is circulated in the human body then this blood is squeezed in capillary tissues. As a result, the volume of capillary tissues is increased but this volume is decreased after each heartbeat. This change in volume of capillary tissues affects the infrared light of the sensor, which transmits light after each heartbeat.

The working of this sensor could be checked by placing a human finger in front of this sensor. When a finger is placed in front of this pulse sensor then the reflection of infrared light is changed based on the volume of blood change inside capillary vessels. This means during the heartbeat, the volume of blood in capillary vessels will be high and then will be low after each heartbeat. So, by changing this volume, the LED light is changed. This change of the LED light measures the heartbeat rate of a finger. This phenomenon is known as "Photoplethysmogram."

- The measured values are then transmitted over Wi-Fi using the WiFiClient object. The client.connect() function is used to connect to the ESP8266 module using the IP address of the module and the port number 80. The client.print() function is used to send the measured values as query parameters in the HTTP GET request.
- Finally, the measured values are printed to the Serial monitor for debugging purposes. The delay() function is used to wait for one second before generating the next set of blood pressure values.
- The Wi-Fi credentials and the IP address of the ESP8266 module are defined as global variables. The function prints the status of the Wi-Fi connection to the Serial monitor and the local IP address.
- Overall, the code measures blood pressure values using BP systolic and diastolic blood pressure values and transmits the measured values to ThingSpeak.

The working of sending and updating values on ThingSpeak involves the following steps:

1. **Create a ThingSpeak Account**: Start by creating an account on the ThingSpeak platform. This will provide us with access to the necessary tools and APIs for sending and updating data.

2. **Create a Channel**: In ThingSpeak, a channel is a container for data. Create a new channel and define the specific fields we want to send and update. Assign labels to the fields to indicate the type of data they represent (e.g., temperature, Systolic, Diastolic, SpO2 and heart rate, etc.).

3. **Obtain API Keys**: To send data to ThingSpeak, we need to obtain the Write API Key for the channel. This key is unique to the channel and serves as a security measure to ensure that only authorized users can update the data.

4**. Connect to ThingSpeak**: Establish a connection between the device or application and ThingSpeak. This can be done using various communication protocols, such as HTTP, HTTPS, MQTT, or TCP/IP.

5**. Send Data to ThingSpeak**: Format the data we want to send according to the specifications of our channel fields. Depending on the communication protocol, we can send the data in the form of HTTP GET or POST requests, MQTT messages, or direct socket communication.

6**. Include API Key**: When sending the data, include the Write API Key in the request or message headers to authenticate the data submission. This ensures that only authorized users can update the data on their specific channel.

7. **Update Interval:** Decide on the update interval at which we want to send data to ThingSpeak. This could be a fixed time interval or triggered by specific events or sensor readings.

8**. Data Processing and Validation**: Before sending the data, make sure to process and validate it as per your application requirements. Convert the data into the appropriate format and ensure its accuracy and integrity.

9. **Data Visualization and Analysis**: ThingSpeak provides built-in tools for visualizing and analyzing the collected data. Access the channel's interface on ThingSpeak to view the real-time and historical data in the form of charts, graphs, or gauges. We can also apply custom analysis algorithms or MATLAB functions to process and derive insights from the data.

10. **Data Access and Sharing**: We can access the data programmatically using Read API Keys or retrieve it via the ThingSpeak web interface. ThingSpeak also allows us to share your data with others by providing them with the appropriate access permissions.

12. **Continuous Data Updating**: To update the data on ThingSpeak continuously, repeat the steps of formatting, sending, and validating the data at your desired update interval.

By following these steps, we can send and update data on ThingSpeak, enabling real-time monitoring, analysis, and sharing of your IoT or sensor data.

7. Result and Future Scope:

The "Wearable gadget automatic blood pressure, heart rate, and oxygen saturation monitoring system" is designed to provide real-time monitoring and tracking of these vital health parameters.

1. **Wearable Device**: The project produces a wearable device that incorporates sensors for measuring blood pressure, heart rate, and oxygen saturation levels. The device is compact, lightweight, and designed to be worn comfortably on the user's wrist or another suitable location.

2. **Continuous Monitoring**: The wearable device continuously monitors the user's blood pressure, heart rate, and oxygen saturation levels throughout the day. It provides a non-invasive and convenient way to keep track of these vital health parameters without the need for frequent manual measurements.

3. **Real-Time Data**: The device collects the data from the built-in sensors and processes it in real-time. The measurements are displayed on a screen or communicated to a connected device, allowing the user to view their current blood pressure, heart rate, and oxygen saturation readings instantly.

4. **User-Friendly Interface**: The wearable device and companion application are designed with a user-friendly interface, making it easy for individuals of varying technical proficiency to interact with the system. The interface provides clear instructions, intuitive controls, and a visually appealing presentation of the health data.

5. **Improved Health Monitoring**: The result of this project ultimately leads to improved health monitoring and awareness. Users can track their blood pressure, heart rate, and oxygen saturation levels in real-time, allowing them to make informed decisions about their health and seek timely medical assistance if necessary.

6. **Potential for Health Intervention**: By providing continuous monitoring and real-time alerts, the system offers the potential for early intervention in case of abnormal or critical health conditions. This can potentially help prevent adverse events and enable timely medical interventions, leading to improved health outcomes.

It's important to note that the success and effectiveness of the project's result would depend on factors such as the accuracy and reliability of the sensors, the robustness of the data processing algorithms, and the usability and comfort of the

Future Scope:

1. **Alarm and Alerts**: The system can be programmed to trigger alarms or alerts when the measured values exceed or fall below predetermined thresholds. This functionality helps notify users of any irregularities or potential health risks, prompting them to take necessary actions or seek medical attention if required.

2. **Advanced Data Analysis**: Integrating advanced data analysis algorithms can give users more comprehensive insights into their health trends, patterns, and potential risks. This could involve developing machine learning or artificial intelligence models to analyze the collected data and generate personalized recommendations or predictions.

3. **Connectivity and Integration**: Exploring connectivity options to sync the wearable device with smartphones, smartwatches, or other devices can enhance the user experience. This allows users to access their health data on multiple platforms and share it with healthcare professionals for remote monitoring or consultations.

4. **Expanded Health Parameters**: The project can include monitoring additional health parameters, such as body temperature, respiratory rate, or stress levels. This would provide a more holistic view of an individual's health status and enable comprehensive health monitoring.

5.**Data Storage and Analysis**: The device stores the collected data for further analysis and tracking. It may utilize internal memory or communicate with a companion app or cloud platform for data storage. This allows users and healthcare professionals to review historical trends and patterns in the recorded measurements.

6. **Companion Application**: Depending on the project scope, a companion mobile or web application can be developed to enhance the user experience. The application can display comprehensive data visualizations, generate reports, and provide additional features such as health insights, reminders, or personalized recommendations.

The future scope of the project largely depends on the advancements in technology, user feedback, market demand, and research in the field of wearable health monitoring devices. Continuous innovation and collaboration with healthcare professionals can drive the evolution and success of the project in improving health monitoring and promoting overall well-being.

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