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i-MASK: INTEGRATED MONITORING SYSTEM EMBEDDED MASK

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ABSTRACT
The goal of this concept is to establish a unified monitoring system which can be integrated into a wearable mask.This system aims to continuously and in real time monitor vital health parameters such as body temperature, hearrate and oxygen saturation levels in blood. Through the utilization of IoT technology, the mask gathers data fromits embedded sensors and transmits it to a central monitoring system for analysis and display the date over secure custom web server. Additionally, a power management mechanism is implemented to optimize device power usage. Implementing this I-Mask system significantly reduces the need for manual intervention in healthcare facilities while improving patient management and monitoring, providing an additional layer of care.
Keywords: IoT, Web Server, Wearable Mask, Personal Equipment, Sensors, Arduino.

Introduction:
A cutting-edge ideology smart mask called the I-mask incorporates wearable technology for health monitoring. This cutting-edge product combines classic mask functioning with in-built sensors that track several health markers. These sensors provide real-time monitoring of vital indicators like heart rate, blood oxygenation level, and body temperature. A mobile app receives the collected data wirelessly, allowing for quick analysis and monitoring.[2] I-mask functionality for tracking user-specific health indicators is also available. Additionally, it has the ability to provide alarms for potential medical conditions including an erratic heartbeat or low blood oxygen levels. This smart mask represents a ground-breaking improvement in health monitoring since it providesa practical and non-invasive method for tracking several health indicators in real-time. Face mask use has been shown to be an efficient way to stop the spread of respiratory viruses, especially during pandemics.[13] The concept matches with the usage of face masks as a preventative tool against respiratory infections and its advantages in health monitoring.[1]
mask is a smart mask that can be worn and is shaped to fit over the bridge of the nose and mouth like a regular mask. However, it has sensors that can identify several health markers and send the information to a website forstudy. The smart mask has the benefits of being convenient and user-friendly, enabling extended usage and ongoing monitoring of health parameters. Users can monitor and assess their health indicators in real-time throughwireless data transmission to the responsive web server, allowing them to spot potential health issues and take appropriate action. The smart mask brings an interesting and novel approach to health monitoring with its non- invasive and practical features, providing useful insights into user's wellbeing and general health.

Objective
The development of a smart oxygen mask with built-in monitoring capabilities is the aim of this proposal. This mask will monitor temperature, suffocation risks, oxygen saturation levels, and provide proximity indications. Itwill also notify individuals if they attempt to remove the mask and various irregularities in vital data. By incorporating these features, the mask aims to offer real-time monitoring of health quality, providing convenienceand ease for users.

Literature Survey

In literature survey it has been found that some profound work has been theorized and implemented to some extent in this field of IOT enabled masks. "Smart Face Mask with IoT Sensors for COVID-19 Detection and Safety Monitoring" by Ahmed Elngar et al. (2020): This study proposes a smart face mask embedded with IoT sensors to detect COVID-19 symptoms and monitor user safety. The mask incorporates temperature, humidity, and gas sensors to monitor health parameters and alert users of potential risks.

"Design and Development of an IoT-based Smart Mask for Air Quality Monitoring" by Harsha Konda et al. (2019): The authors present an IoT-based smart mask that monitors air quality. The mask integrates gas sensors to detect pollutants and wirelessly transmits the data to a smartphone application for real-time monitoring and alerts.

"Smart Mask with Real-Time Health Monitoring and Emergency Alert System" by Arjun B. et al. (2018): This work focuses on a smart mask equipped with IoT sensors for real-time health monitoring. It incorporates sensors for temperature, heart rate, and oxygen saturation level. The collected data is sent to a central monitoring system,and in case of emergencies, an alert is generated.

"Internet of Things Based Smart Mask for Asthma Patients" by Neha Yadav et al. (2017): The authors propose an IoT-based smart mask specifically designed for asthma patients. The mask includes sensors to monitor respiratory parameters, such as airflow and breathing rate. It provides real-time data transmission and alerts for better management of asthma conditions.

"A Smart Wearable System for Monitoring Breathing Activity" by G. Palumbo et al. (2016): This study introduces a smart wearable system that includes a mask with embedded IoT sensors to monitor breathing activity. The mask captures respiratory parameters and wirelessly transmits the data to a smartphone application for analysis and visualization.

These works demonstrate the diverse applications of smart masks using IoT technology in monitoring health parameters, detecting diseases, and improving air quality. They highlight the potential of smart masks in enhancing healthcare management and providing timely alerts for better patient care.

Proposed Approach

We propose a smart solution which will enable a mask to become IOT functional and will measure vital parameters such as temperature, heart rate, blood oxygen saturation and alerts. Design is made for hospital friendly environment for healthcare purposes to remotely monitor patient’s vital signs in real time. It can overall enhance patient monitoring more effectively and efficiently, improved infection control measures, data-driven decision-making, and expanded telemedicine capabilities. These benefits contribute to better patient outcomes, more efficient resource utilization, and improved overall healthcare delivery within hospital settings.

Working Principle

By the combination of various sensors and a powerful microcontroller, the prototype model can be constructed which can be all along implemented in a mask. NodeMCU is an IoT development board that acts as the central processing unit for the smart mask. It is responsible for collecting data from the sensors, processing the data, and transmitting it to a designated server or cloud platform. It is paired to the internet using Wi-Fi or Bluetooth. It establishes a connection to a server or cloud platform where the processed data is sent. This can be achieved using protocols like MQTT or HTTP to transmit the data securely. The transmitted data can be accessed remotely by authorized devices such as smartphones, tablets, or computers. Healthcare providers or wearers can monitor the wearer's vital signs, temperature, and oxygen levels in real-time. These benefits contribute to better patient outcomes, more efficient resource utilization, and improved overall healthcare delivery within hospital settings.

Components used

Hardware

NodeMCU/ESP8266 Microcontroller
Operating Voltage: 2.3 - 3.8V
Input Voltage: 0 - 3.4V
Digital Pins: I/O programmable pins
Analog Pins: 12-bit ADC SAR
Wi-Fi: supports both 802.11b/g/n & 802.11a/n/ac standards
Bluetooth: compatible with Bluetooth (BR/EDR) & Bluetooth Low Energy (BLE)
Clock Speed: 85MHz - 245MHz

DHT11 sensor
The DHT11 is widely used temperature & humidity sensors commonly used in various applications.
Operating Voltage: 3.3V to 5.5V DC
Temperature Measurement Range: 0°C to 50°C (32°F to 122°F)
Temperature Measurement Accuracy: ±2°C
Interface: Single-wire digital interface (data pin), Sampling Rate: 1 Hz (1 reading per second)

MAX30100: SpO2 Level Detection
The MAX30100 device can accurately measure both heart rate and SpO2 levels within specific ranges, measuring from 30 to 200 beats per minute (BPM) and 0% to 100%, respectively. Despite its advanced features, the MAX30100 sensor utilizes low power, typically consuming only 600µA of electricity during operation and 0.7µA when it is shut down. This low power consumption is attributed to its integrated LEDs, photodetector, control circuitry, and interface components. [3]
Dimension: 5.5 mm x 3.4 mm x 1.54 mm
Input Voltage 1.6 V to 2.2V
Control voltage: 3.4-5.2V
The digital pins on the device include SCL (Serial Clock) and SDA (Serial Data)

Power Management
By placing a 330-ohm resistor in series with an LED or other low-power component, you can limit the current flowing through the component. This helps protect the component from excessive current and

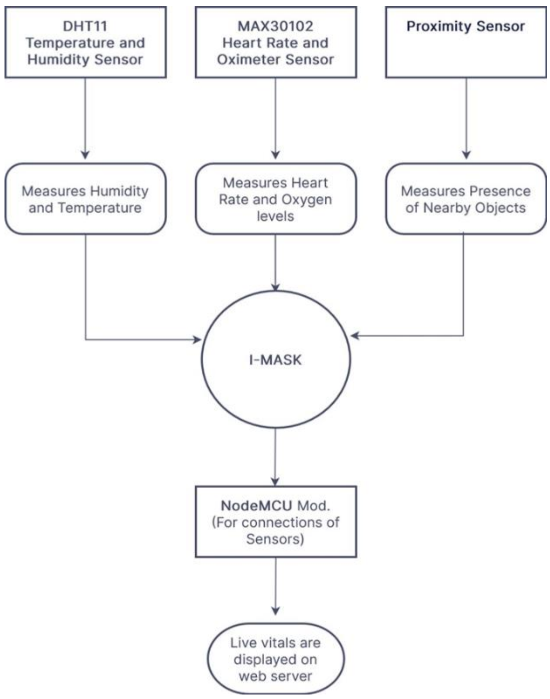
prevents damage.
Although the sensors used typically have their own internal circuitry and do not require an additional resistor for normal operation. But for testing the viability of circuit and to notify the status of the model, resistor valued 330-ohm is soldered to a PCB.

Power Supply
In this particular prototype, USB source is used to power the smart mask using a USB connection. This can be achieved by incorporating a USB port into the mask design and connecting it to a power source such as a USB power bank, a computer, or a wall adapter. This approach allows for easy charging and powering of the smart mask using readily available USB power sources.

Software
Web Server (ESP8266)

Here in this prototype implementation of an ESP8266-based web server for the mask is done. The system utilizes the ESP8266 or NodeMCU module, connected health monitoring sensors, and the ESP8266WebServer library to create a responsive web server. The NodeMCU connects to a Wi-Fi network and serves HTML templates to clients, providing real-time health monitoring data. The server handles client requests, such as displaying historical data, setting thresholds, and generating alerts. By leveraging the ESP8266's capabilities and libraries, this system enables remote health monitoring and enhances the accessibility of health information. The implementation and deployment of the ESP8266 web server for health monitoring systems have the potential to improve healthcare services and empowerindividuals to monitor their well-being effectively.

Block diagram



Algorithm
Begin
Initialize the NodeMCU and connect it to your Wi-Fi network.
Set up the web server on the NodeMCU to handle incoming requests.
Configure and initialize the MAX30102 and DHT11 sensor.
Read the heart rate and blood oxygen saturation values from the MAX30102 sensor. Read the temperature and humidity values from the DHT11 sensor. Check if the measured values are within the safe range for a smart mask.
Handle incoming requests on the web server to provide real-time sensor data.
Compile and upload the firmware to the NodeMCU board.
Assemble the hardware components (NodeMCU, MAX30102, DHT11, LEDs) onto the mask.
End

This algorithm provides a general outline for the implementation. Need to add the documentation and libraries for each component to understand the specific functions and methods required for initialization, data reading, and controlling the LED indicators.

Working
The incorporation of a multi-vital monitoring system in an oxygen mask is essential in today's context. To achieve this, a range of sensors is utilized to track various patient measurements. A proximity sensor is employed to provide alerts when the mask is not properly worn or removed from the patient. Temperature and humidity sensors are installed to monitor the moisture levels around the patient's face, as fluctuations in humidity can lead to suffocation and pose risks to the patient. To assess the patient's heart health, a pulse-oximeter and heart rate monitor are included to continuously monitor and alert any unexpected changes. The IoT device connected to the mask plays a vital role in processing and presenting essential physiological indicators, such as temperature and blood oxygen levels.

This sequential process includes multiple components such as:
Incorporating a multi-vital monitoring system: The first step is to integrate a multi-vital monitoring systeminto the oxygen mask. This system will be responsible for tracking various health parameters of the patient.
Set up the NodeMCU: Connect the NodeMCU microcontroller to a computer and configure it using the appropriate development environment (e.g., Arduino IDE). Install the necessary libraries and ensure the NodeMCU is ready for programming.

Temperature and humidity sensor placement: To monitor the humidity levels around the patient's face, temperature and humidity sensors are strategically placed within the mask. These sensors continuously measure the temperature and humidity to ensure a comfortable and safe environment for the patient.

Monitoring heart health: The system includes a sensor specially designed for measuring heart rate and oxygen saturation level. This sensor monitor the patient’s heart rate & oxygen saturation levels, providing real-time data on their heart health. Any unexpected changes or abnormalities in heart health are detectedand alerted through these sensors.

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Proximity sensor installation: A proximity sensor is installed in the mask to detect whether the mask is properly worn by the patient or if someone tries to remove it. This sensor provides alerts or notificationsin such cases.

Display and transmit data: The secure customized web server made using esp8266 libraries The ESP8266web server functionality is achieved by utilizing the ESP8266's firmware and programming it to handle HTTP requests and responses. It can serve static web pages, dynamically generate content, and interact with client through HTTP protocols.

Integration into the mask: Integrate the NodeMCU, sensors, and necessary components into the oxygen mask, ensuring proper placement and secure connections. Consider factors such as size, weight, and comfort for the wearer.

Power source: In this specific prototype, the smart mask is powered by a USB source through a USB connection. To accomplish this, the mask design includes a built-in USB port that can be connected to various power sources such as a USB power bank, a computer, or a wall adapter. This convenient setup enables simple charging and powering of the smart mask using commonly accessible USB power sources.

The NodeMCU establishes Wi-Fi connection and acts as a web server, serving HTML templates to clients. It enables real-time health monitoring by handling client requests for tasks like displaying historical data, settingthresholds, and generating alerts. The utilization of the ESP8266's features and libraries enable the establishment of a system that facilitates remote health monitoring and enhances the accessibility of health information. By implementing and deploying an ESP8266 web server for health monitoring systems, there is a promising opportunity to enhance healthcare services and empower individuals in effectively monitoring theirwell-being.

Circuits & Stimulations

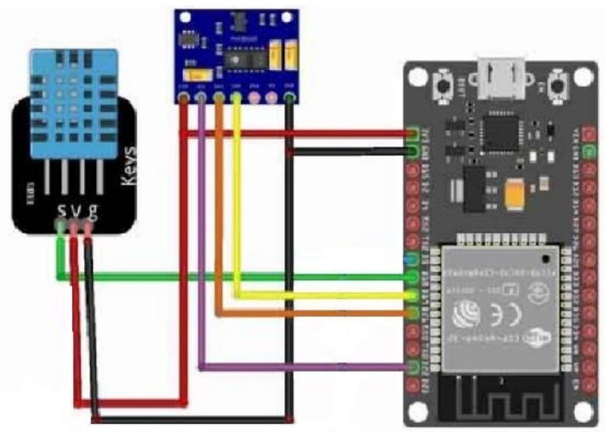

Fig 6.1 (raw circuit)

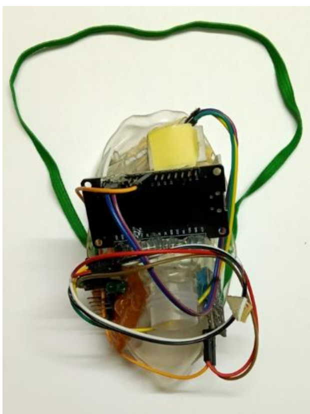

Fig 6.2 (mask’s front)

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Fig 6.3 (mask's inside)

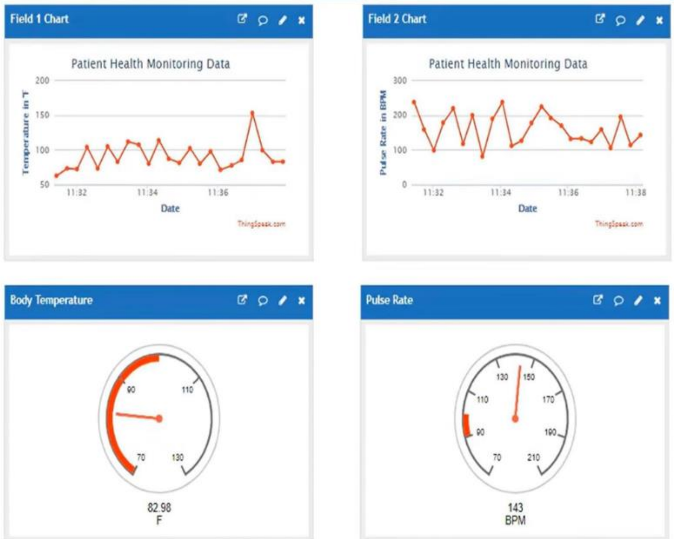

Fig 6.4 (ThingSpeak simulation)

Results

Fig 7.1 Home Page of Web Server

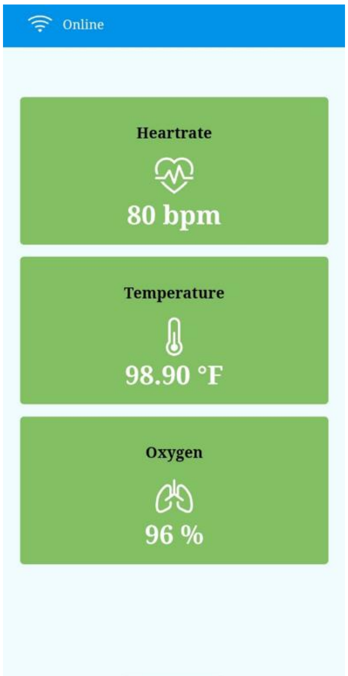

Fig 7.2 Mask is ON and Active

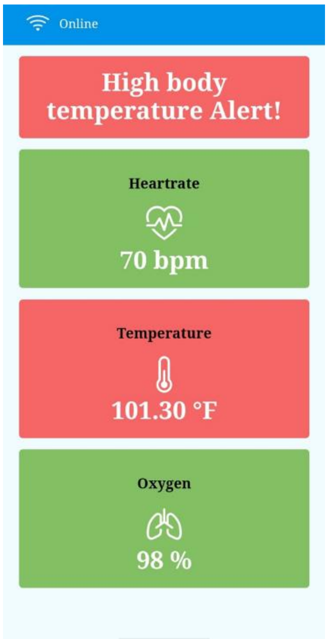

Fig 7.3 High Temperature Alert

All the vital measurements are updated in a 1-second time period and the ESP8266 server is designed to providereal-time data, it means that the health monitoring system can deliver up-to-date information to the users or clients accessing the web server. This responsiveness allows users to view the latest vital measurements without significant delays, enhancing the real-time monitoring capabilities of the system. This works on every device of any resolution.

Application

Personal heath tracking: By employing IoT-enabled masks, individuals can actively monitor their personal health by keeping tabs on vital signs like respiratory rate and heart rate, offering valuable insights into their well-being.

Air quality assessment: Equipped with sensors that measure various air quality parameters, such as particulatematter and carbon dioxide levels, an IoT-enabled mask provides real-time collecting data to assist individualsin avoiding allergens & pollutants.

Enhancing workplace safety: Workers in industries may encounter airborne hazards, IoT-enabled mask relates to vitals of body and deliver real-time updates regarding potential risks. This helps prevent accidents and ensures the safety of workers.

Integration with home devices: These masks may seamlessly integrate with other smart home devices like air purifiers or HVAC system. This integration allows for automated adjustment of air quality levels, enhancinghome comfort and convenience.

Medical applications: Smart masks have applications in medical settings, enabling monitoring of individuals suffering from respiratory illnesses or conditions such as chronic obstructive pulmonary disease (COPD). The vital data collected by the smart mask can assist doctors and healthcare professionals in managing patient careeffectively.

Conclusion

To conclude, i-mask represents a cutting-edge and inventive remedy for personal air quality monitoring and enhancement. Through the integration of diverse sensors, controller and connectivity capabilities, provides real time data on fingertips and empowering users to take proactive measures in optimizing their respiratory well- being.

By incorporating the NodeMCU microcontroller, smart masks gain remarkable flexibility and programmability, serving as a central controller that enables seamless communication between sensors and the web server. This opens up possibilities for customization and integration with various smart devices. As a result, smart masks can deliver advantages like automation and remote monitoring, making them well-suited for diverse applications across different fields.

This prototype system offers several advantages, including convenience, portability, and accessibility. Users can comfortably wear the smart mask and effortlessly access their health data through any device connected to the web server. Due to responsiveness of web server, data can be displayed over any device of any resolution with real time data with refresh rate of 1 second.

In conclusion, the I-Mask has a lot of potential to be a useful tool for people who place a high priority on air and respiratory health. It has the potential to improve quality of life in a variety of settings, from the home and workplace to healthcare facilities, thanks to its sophisticated features and connectivity with other smart devices.

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