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I-Mask: Mask with Integrated Monitoring System

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ABSTRACT:
The main purpose and concept of this idea is to create an integrated monitoring system attachable to a wearable mask in order to monitor real time health related parameters such as body temperature, blood saturation level, blood pressure and heart rate. This IoT enable mask collected data from the sensor inbuilt in the mask and send these data to the central monitoring system for the display and monitoring. A power management system is also required for to reduce power consumption of the device. This I-Mask system reduce man power requirement of the hospital and better patient management and monitoring with extra level of care to the patient.
KEYWORDS: *IoT, Mask, Personal Health, Sensors, Arduino, Blink app*

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I. INTRODUCTION

The I-mask is a novel concept in wearable technology designed for health monitoring. It combines the functionality of a traditional mask with sensors that measure various health indicators. Sensors installed in mask can detect vital signs such as heart rate, blood oxygen level and body temperature in real-time. The data collected by the sensors is then transmitted wirelessly to a mobile app, allowing for real-time monitoring and analysis. The I-mask is also designed to track user health related metrics. In addition to monitoring, the mask can also provide alerts for potential health issues, such as irregular heart rate or low blood oxygen levels. Overall, the I-mask represents an innovative approach to health monitoring, providing a convenient and non-invasive way to monitor a range of health indicators in real-time.[8] The use of face masks is an effective preventive measure against the transmission of infections and respiratory viruses. Various types of evidence, including theoretical, experimental, and clinical, have consistently shown that face masks provide [16] significant benefits in curbing the spread of respiratory viruses, particularly during pandemic. [1].

The smart mask such as I-mask is a wearable device that is designed to be worn over the mouth and nose, similar to a traditional mask. However, it is equipped with a range of sensors that can detect various health indicators and transmit the data to a mobile app for analysis. One of the key advantages of the smart mask is its convenience and ease of use. It can be worn for extended periods of time, making it ideal for continuous monitoring of health indicators. The wireless transmission of data to a mobile app allows for real-time monitoring and analysis, which can help users identify potential health issues and take appropriate action. In addition to vital sign monitoring, the smart mask is also designed to track user activity levels and sleep patterns. This data can be used to gain insights into a user's overall health and lifestyle. Overall, the smart mask represents an exciting new approach to health monitoring, providing a non-invasive and convenient way to track a range of health indicators and gain valuable insights into a user's overall health and wellbeing.

II. OBJECTIVE

The objective of this idea is to create an oxygen mask that monitors the aspects like temperature, humidity, time reminder, suffocation, oxygen saturation and the indication of proximity of mask. It also gives notifications if the person is trying to remove mask. Thereby provide individuals with real-time health quality monitoring with ease.

III. COMPONENTS USED

A. HARDWARE

1. NodeMCU/ESP32 Microcontroller

- Operating Voltage: 2.2 - 3.6V
- Input Voltage: 0 – 3.3V
- Digital Pins: 34 programmable I/O pins

- Analog Input Pins: 12-bit SAR ADC
- Wi-Fi: supports both the 802.11b/g/n and 802.11a/n/ac
- Bluetooth: supports both Bluetooth Classic (BR/EDR) and Bluetooth Low Energy (BLE)
- Clock Speed: 80MHz to 240MHz
- Baud Rate: 115200 bps

2. Humidity and Temperature Sensor

- BME280 sensor module is a powerful and versatile sensor that can measure barometric pressure, relative humidity, and temperature with high accuracy and low power consumption. The BME280 sensor module supports both I2C (Inter-Integrated Circuit, (clock frequency of 3.4 MHz)) and SPI (Serial Peripheral Interface, (clock frequency of 10 MHz)).[2]
- Module dimensions: 8 pins, which are arranged in a 2 x 4 grid and measures 2.5 mm x 2.5 mm x 0.93 mm
- Operating Voltage: wide range of supply voltages, from 1.71V to 3.6V.
- Temperature Range: -35 to 95°C, overall accuracy of ±1° C.

3. MAX30102: SpO_2 Level Detection

- MAX30102 measures SpO_2 with a range of 0% to 100% and heart rate with a range of 30 beats per minute (BPM) to 200 BPM. The MAX30102 consumes very low power, with a typical current consumption of 600 µA during operation and 0.7 µA during shutdown. Which includes the two LEDs, the photodetector, and the control and interface circuitry. [3]
- Package measures 5.6 mm x 3.3 mm x 1.55 mm.
- Supply Voltage range of 1.7 V to 2.0V
- Operating Voltage: 3.3-5V
- Digital Pins: SDA (Serial Data) and SCL (Serial Clock).

4. Infrared Thermometer Sensor

- The MLX90614 is a non-contact infrared temperature sensor that can measure the temperature of objects without physically touching them.
- The MLX90614 sensor has a measurement range of -70°C to +380°C with an accuracy of ±0.5°C between 0°C to +50°C. It has a field of view (FOV) of 35 degrees, which means it can detect the temperature of a small area with high accuracy. The sensor operates at a supply voltage of 2.6V to 3.6V and consumes very low power, making it suitable for battery-powered applications.[4]
- Non-contact range of temperature: -70°C to +380°C (-94°F to 716°F). The accuracy may be lower or higher outside of this temperature range.
- Supply Voltage: 2.6V to 3.6V.
- MLX90614 communicates with the microcontroller via the I2C interface, which requires two digital pins: SDA (Serial Data) and SCL (Serial Clock).

5. Proximity Sensor

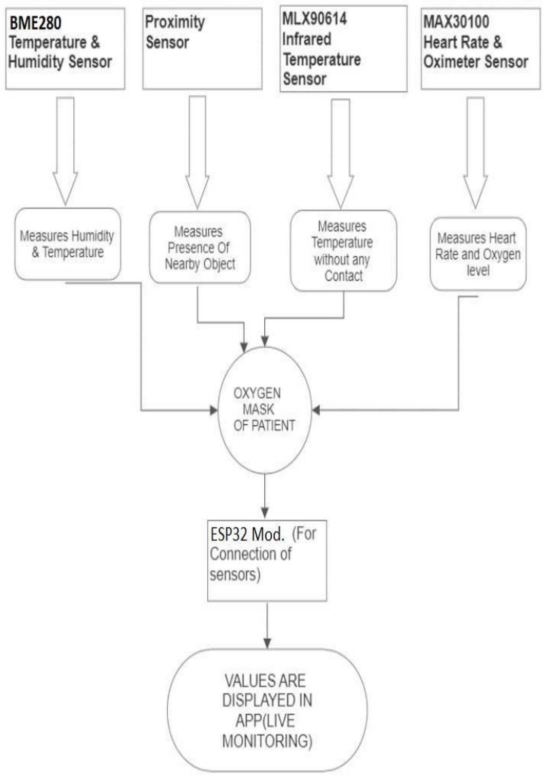
- A proximity sensor is a type of sensor that can detect the presence of objects or people in close proximity without physical contact. These sensors are commonly used in a variety of applications, including mobile devices, automotive systems, and industrial automation. There are several types of proximity sensors available, including capacitive, inductive, ultrasonic, and optical sensors. Each type uses a different method to detect objects and has its own set of advantages and disadvantages.[5]
- The output of a proximity sensor can be in the form of a digital or analog signal. Digital sensors provide a binary signal indicating the presence or absence of an object, while analog sensors provide a continuous signal indicating the distance to the object.

B. SOFTWARE

• Blynk Software

Blynk is a software platform that allows users to develop mobile applications for controlling and monitoring Internet of Things (IoT) devices. It provides an intuitive and easy-to-use interface for creating custom mobile apps that can communicate with a wide range of hardware devices. Blynk is a cloud-based platform, which means that users can access their projects from anywhere and on any device. This makes it easy to monitor and control IoT devices remotely, and to share access with others. Blynk provides real-time monitoring of data from IoT devices. Users can view data in real-time using widgets such as graphs, charts, and tables. Blynk is available as a mobile app for iOS and Android devices, and as a web-based platform.[6]

IV. BLOCK DIAGRAM



V. WORKING

An oxygen mask with a multi-vital monitoring system in it is a crucial implementation nowadays. To achieve we have to make use of various sensors that keep an eye on every measurement of the patient. We take proximity sensor to alert us when the mask is not on or if someone removes the mask from the patient. Also, we have to install infrared temperature sensor with the humidity monitoring sensor to check the humidity around the patient's face. Many deaths happened by suffocation and humidity variance around the patient. To this we need to add pulse-oximeter and heart rate measuring meter to check the condition of the patient's heart health and monitor it. Also, any changes that are unexpected in the heart health can be intimated using this sensing. The IoT device that is connected to the mask is responsible for processing and displaying important body parameters, including temperature and blood oxygen levels. Additionally, it is designed to monitor the levels of humidity that accumulate inside the layers of the mask over time.

This step-by-step process consists for various elements like:

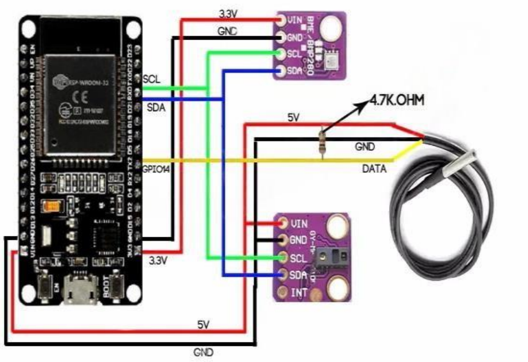
- Data collection: The sensors embedded in the smart mask will collect data on temperature, humidity, SpO_2 level etc.
- Processing: The NodeMCU/ESP32 microcontroller will process the data collected data gathered by various sensors to determine quality of the air the user is breathing.
- Actuation: Based on the analysis, the ESP32 will control the actuators (such as fans) to improve air quality by expelling CO2 and pulling in fresh air.
- Connectivity: The NodeMCU/ESP32 microcontroller will be connected to the internet via Wi-Fi or Bluetooth to enable communication with other devices such as smartphones or home automation systems.
- Power source: A smart mask requires a power source, typically a battery that can be recharged. Some smart masks may include features to optimize power usage, such as automatically turning off the mask when it is not being worn.

The output of the surrounding and in mask temperature, humidity around the patient, oxygen levels from the oximeter and heart rate readings are to be shown as the output through the "Blynk Software" and we can stay updated about the patient's condition anywhere and anytime using this software. Overall, a smart mask using ESP32 offers a range of features to improve air quality and provide real-time monitoring and control. It can be especially useful for individuals living in areas with high levels of pollution or allergens, as well as for those with respiratory issues.

A cloud-based solution called the blink mobile app was created for Android and iOS that allows for remote patient monitoring and health evaluation.

It measures vital signs that clinicians can use to monitor patients who are receiving home isolation, such as blood oxygen levels, temperature, and symptoms brought on by pressure variations in different altitudes.

VI. CIRCUIT



VII. APPLICATIONS

1) Personal health monitoring: A smart mask can help individuals monitor their own health by tracking their respiratory rate, heart rate, and other vital signs.
2) Air quality monitoring: With sensors that measure particulate matter, carbon dioxide levels, and other air quality parameters, a smart mask can provide real-time data on air quality to help individuals avoid exposure to pollutants and allergens.
3) Workplace safety: In industries where workers are exposed to hazardous materials, a smart mask can help monitor air quality and provide workers with real-time data on potential hazards. This can help prevent workplace accidents and improve worker safety.
4) Fitness monitoring: By tracking respiratory rate and other vital signs, a smart mask can provide valuable data for athletes and fitness enthusiasts to optimize their workouts and monitor their progress.
5) Smart masks can be integrated with other smart home devices, such as air purifiers or HVAC systems, to automatically adjust air quality levels and optimize home comfort. This feature allows for seamless integration and automation of air quality control in the home environment.
6) Medical applications: A smart mask can be used to monitor patients with respiratory illnesses or chronic obstructive pulmonary disease (COPD) [15], and provide data to doctors and medical professionals to help manage their care.

VIII. CONCLUSIONS

In conclusion, I-mask is a highly advanced and innovative solution for personal air quality monitoring and improvement. By incorporating various sensors, actuators, and connectivity features, it offers real-time data on air quality and enables users to take actions to improve their respiratory health.

The use of NodeMCU/ESP32 microcontrollers makes smart masks highly versatile and programmable, allowing for customization and integration with other smart devices. This can offer benefits such as automation and remote monitoring, making them suitable for a wide range of applications.

Overall, a smart mask has the potential to be a valuable tool for individuals concerned about air quality and respiratory health. With its advanced features and ability to integrate with other smart devices, it can help improve the quality of life for people in various settings, from home to work to medical environments.

As the interfacing of the proposed IoT system on to the mask requires the flexible PCB and it takes a lot of time to get imported and also the knowledge to work with this PCB is very different and new when compared to other boards, we are still left with this interfacing the whole system into the mask.

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