# IOT - Enabled Wifi Smart Mask for Monitoring Body Parameters and Location Through Cloud

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**Abstract: The latest interim guidance from the World Health Organization (WHO) recommended mask usage in communities, homes, and healthcare facilities in regions with confirmed COVID-19 cases. This guidance targeted various stakeholders, including community members, public health experts, infection prevention and control (IPC) professionals, healthcare managers, healthcare workers (HCWs), and community health workers. Masks mitigate respiratory droplet and contact transmission. Prolonged mask-wearing, especially for healthcare workers, poses challenges. Hence, a proposed full-face smart mask monitors wearers' health metrics like temperature, sneezing, and social distancing adherence. It includes wearer ID and geographic tracking for comprehensive data collection. The mask functions indoors and outdoors, with real-time processing for temperature and social distancing alerts. Cloud integration enables centralized data storage and analysis, aiding in hotspot identification. The prototype demonstrates feasibility and potential utility for mass adoption, enhancing COVID-19 safety measures.**

**Keywords: Smart mask, Temperature sensor, IoT, Cloud, COVID 19.**

## I.INTRODUCTION

The COVID-19 pandemic has highlighted the critical role of preventive measures, including mask usage, in reducing transmission risks and protecting public health. However, prolonged mask-wearing, particularly among healthcare workers, has posed challenges such as discomfort and potential health implications. In response to these challenges, the development and implementation of innovative solutions, such as the full-face smart mask, have emerged to enhance COVID-19 safety measures.

This project aims to explore the capabilities and potential utility of the smart mask in providing respiratory protection, monitoring wearer health metrics, and promoting adherence to social distancing guidelines. This smart mask aims to provide respiratory protection while also monitoring wearer health metrics such as temperature, sneezing, and adherence to social distancing guidelines. Additionally, the project aims to integrate wearer identification and geographic tracking features for comprehensive data collection. Ultimately, the goal is to enhance COVID-19 safety measures and mitigate transmission risks effectively through the mass adoption of this innovative solution.

In its recent interim guidance, the World Health Organization (WHO) recommended the widespread adoption of masks in various settings, including communities, homes, and healthcare facilities, especially in regions with confirmed COVID-19 cases. This recommendation targeted a broad audience, including community members, public health experts, infection prevention and control (IPC) professionals, healthcare managers, healthcare workers (HCWs), and community health workers.

Given that the primary modes of COVID-19 transmission are respiratory droplets and contact, masks have emerged as essential tools for public safety. However, prolonged mask-wearing, particularly among healthcare professionals, has presented challenges. To address this issue, there's a critical need for innovative solutions, such as a proposed full-face smart mask.

The envisioned smart mask aims to safeguard respiratory health while simultaneously monitoring vital metrics such as body temperature, sneezing incidents, and adherence to social distancing guidelines. Additionally, the mask

incorporates features for wearer identification and geographic tracking, ensuring comprehensive data collection.
Designed for both indoor and outdoor use, the smart mask offers real-time processing of wearer data, enabling immediate alerts for temperature fluctuations and breaches of social distancing protocols. Furthermore, the mask integrates with cloud-based systems to facilitate centralized data storage and analysis, empowering health authorities to identify and mitigate potential transmission hotspots effectively.

## II. RELATED WORK

Sharmistha Roy(2023) proposed “IOT Based Human Body Parameters and Surrounding Toxic Gas Monitoring System”, project aims to leverage IoT technology to develop a compact system that monitors toxic gas levels in the environment and provides medical aid and precautionary measures to both patients and the general population. By integrating various sensors, a microcontroller, and web or mobile applications, the system can transmit data to doctors and hospitals remotely, facilitating timely medical interventions, especially in remote areas. Advantages include real-time monitoring of toxic gases, early detection of health risks, and remote medical assistance, enhancing overall healthcare accessibility and efficiency. However, potential disadvantages may include issues related to data privacy and security, technological infrastructure requirements, and the need for continuous maintenance and updates to ensure reliable operation[1].

K. Brajesh et al.(2023) developed "Study of Different Body Parameters for Health Monitoring," This study aims to comprehensively understand various body parameters and their significance in diagnosing illnesses, considering factors like gender, height, weight, and lifestyle. It focuses on the electrical bio-impedance method, widely used due to its noninvasiveness, ease of use, cost-effectiveness, and safety. The paper elaborates on both single-frequency and multi-frequency bio-impedance analysis-based instruments, discussing their applications in measuring body parameters like fat mass, water content, and electrical characteristics. It provides ranges for these parameters in healthy and unhealthy individuals. While the project offers valuable insights into body analysis, its advantages lie in its noninvasive nature and comprehensive approach, yet potential limitations may include variations in accuracy depending on instrument calibration and individual factors like hydration levels[2].

Heltin Genitha C et al.(2022) introduced “Intelligent Face Mask and Body Temperature Detection System using Machine Learning Algorithm” it utilizes deep neural network-based Convolutional Neural Network (CNN) algorithms, specifically MobileNet V2, along with TensorFlow and Keras libraries, to recognize whether a person is wearing a face mask or not. Additionally, it integrates an LM35 temperature sensor to monitor body temperature. The system processes data, trains the model, and then detects face masks and predicts temperature. Upon detection, results are sent to an Arduino microcontroller, which activates LEDs to indicate mask presence; if absent, a buzzer alerts. MobileNet V2 offers advantages such as high performance, smaller network size, and minimal parameter requirements, making it suitable for real-time mask detection and temperature monitoring, crucial for mitigating the spread of COVID-19 in crowded areas[3].
Praveenchandar et al.(2022) designed “IoT-Based Harmful Toxic Gases Monitoring and Fault Detection on the Sensor Dataset Using Deep Learning Techniques” project aims to address the critical issue of industrial accidents caused by toxic gas leakage by implementing a comprehensive monitoring and control system. Utilizing an Arduino UNO R3 board as the central microcontroller, coupled with various sensors such as AQ3, Minipid 2 HS PID, IR5500, DHT11, and MQ3, alongside an ESP8266 WIFI Module for cloud connectivity, the system ensures real-time data monitoring and analysis. Machine learning and artificial intelligence algorithms are employed for intelligent prediction, enhancing safety measures. Particularly, a hybrid approach combining Hidden Markov Models (HMM) and Artificial Neural Networks (ANN) effectively

detects errors in sensor data, resulting in superior performance in gas monitoring and fault detection with an impressive 0.01% false positive rate. This innovative system not only prevents industrial accidents but also provides global access to real-time sensor data, thereby revolutionizing toxic gas monitoring in industrial environments[4].

Selvadass et al.(2022) presented “IOT- Enabled Smart Mask to Detect COVID19 Outbreak” A groundbreaking "smart mask" paradigm for telehealth, integrating IoT technology with essential health monitoring sensors like the LM35 temperature sensor. By continuously tracking vital parameters such as temperature, respiratory rate, and heart rate, it offers real-time analysis through cloud connectivity, enabling early detection of health anomalies, particularly relevant during the COVID-19 pandemic. Despite its innovative potential and low-cost implementation, challenges such as data privacy concerns and the need for widespread adoption may limit its effectiveness in certain contexts. Nonetheless, the project represents a significant step forward in leveraging IoT for proactive healthcare management[5].

K. Mukhopadhyaya et al.(2022) introduced "Detection of Toxic Gases and Temperature Sensing for Miners using IoT Based Intelligent Helmet," Leverage IoT technology to develop a compact system that monitors toxic gas levels in the environment and provides medical aid and precautionary measures to both patients and the general population. By integrating various sensors, a microcontroller, and web or mobile applications, the system can transmit data to doctors and hospitals remotely, facilitating timely medical interventions, especially in remote areas. Advantages include real-time monitoring of toxic gases, early detection of health risks, and remote medical assistance, enhancing overall healthcare accessibility and efficiency. However, potential disadvantages may include issues related to data privacy and security, technological infrastructure requirements, and the need for continuous maintenance and updates to ensure reliable operation[6].

Varshini B et al.(2021) proposed “IoT-Enabled smart doors for monitoring body temperature and face mask detection” This paper presents an innovative solution to combat the COVID-19 pandemic by introducing an IoT-enabled smart door equipped with a machine learning model for monitoring body temperature and detecting face masks. The system, applicable in various settings such as shopping malls, hotels, and apartment entrances, offers a cost-effective and reliable approach to creating a safer environment. Utilizing TensorFlow for face mask detection and non-contact temperature sensors for monitoring body temperature, the proposed framework leverages AI and IoT technologies to identify potential COVID-19 cases, thereby aiding in virus prevention and control efforts on a global scale[7].

S. I. Nahid et al.(2021) developed “Toxic Gas Sensor and Temperature Monitoring in Industries using Internet of Things (IoT)” the development and implementation of an IoT-based Toxic Gas Sensor and Temperature Monitoring Device to address health risks associated with hazardous gas exposure in workplaces, particularly in industries like textiles, garment manufacturing, and mining. The device detects toxic gases such as methane, hydrogen, and carbon monoxide, while also monitoring ambient temperature. Upon detecting excessive gas concentrations or extreme temperatures, the device triggers audio and visual alarms to alert nearby individuals. Additionally, the technology uploads real-time data to a web server and mobile app, enabling remote access and monitoring from anywhere globally, aiming to enhance safety measures and mitigate health hazards caused by harmful gases and temperature extremes[8].

X. Ding et al.(2021) designed "Wearable Sensing and Telehealth Technology with Potential Applications in the Coronavirus Pandemic," Focuses on leveraging wearable devices, unobtrusive sensing systems, and telehealth technologies to address the COVID-19 crisis. Wearable devices offer continuous monitoring of at-risk populations, aiding in triage processes and evaluating the health of caregivers, but may face challenges in widespread adoption and accuracy. Unobtrusive sensing systems enable early detection and monitoring of mild symptoms, crucial for improvised hospital settings, yet may require refinement for real-time effectiveness. Telehealth technologies provide remote monitoring and diagnosis, enhancing accessibility to healthcare, but could encounter limitations in reaching underserved communities[9].

Abubakar et al.(2021) introduced “Smart Fiber Optics Embedding in Powder-Based Materials: Numerical and Experimental Assessment” Embedding fiber-optic sensors within powder-based materials using two distinct techniques: cold compaction followed by furnace sintering and spark plasma sintering, with the aim of creating haptic sensorial materials for robotics applications. The results indicate promising potential for sensors to be seamlessly integrated anywhere within the material, employing a controlled process with known parameters. This enables the host materials to become fully sensorial, with sensors embedded at precise positions in three-dimensional directions. Numerical modeling and simulation demonstrate close alignment with experimental analysis, facilitating observation of the integrity of both host materials and sensors, as well as ensuring reliable reproduction of material behavior. However, while the project offers significant advantages in terms of precise sensor placement and material behavior replication, potential drawbacks may include the complexity and cost associated with implementing these techniques, particularly in manufacturing processes involving intricate geometries and the integration of actuators[10].

Mahmoud Meribout et al.(2021) presented “Online monitoring of structural materials integrity in process industry for I4.0: A focus on material loss through erosion and corrosion sensing, Measurement” review sensing techniques for online monitoring of alloy steel equipment in the process industry, encompassing structures like pipelines, tanks, and transformers. It explores various methods including RF, MFL, ultrasonic-acoustic, FBG, thin layer strips, and photoacoustic sensors. While advancements in IT and instrumentation, such as optical fiber and self-powered wireless sensors, offer promising avenues, challenges persist. Optical fiber sensors like FBGs offer scalability but lack sensitivity, especially for detecting corrosion and erosion on the opposite side of structures. Additionally, maintaining a permanent connection poses difficulty. Wireless sensors with ultrasonic capabilities show potential but face issues with power supply, albeit with potential solutions through energy harvesting. The project underscores the need for further development to address sensitivity, accuracy, universality, and cost-effectiveness shortcomings in existing technologies[11].

Prabhdeep Singh et al.(2020) proposed “An integrated fog and Artificial Intelligence smart health framework to predict and prevent COVID-19” a fog-assisted Internet of Things (IoT) framework aimed at combating the spread of COVID-19 by leveraging cloud and fog computing alongside artificial intelligence (AI). This framework utilizes real-time processing of individuals' health data gathered through IoT devices to predict potential COVID-19 infections based on observed symptoms. Upon detection, the system generates emergency alerts, medical reports, and precautionary measures for the affected individuals, their guardians, and medical professionals. Additionally, it collects pertinent information from hospitals and quarantine shelters through IoT devices to facilitate necessary actions and decisions. Moreover, the system sends alert messages to government health agencies to aid in controlling outbreaks and prompt responses to mitigate the spread of the virus. The integration of cloud/fog computing with AI enhances the effectiveness and efficiency of monitoring, predicting, and responding to COVID-19, offering a practical solution to combat the ongoing pandemic[12].

Pathak Y et al.(2020) developed “Deep Transfer Learning Based Classification Model for COVID-19 Disease” a deep transfer learning techniques to classify COVID-19 infected patients from chest CT images, addressing the challenge of predicting bilateral changes, which is inherently difficult due to its ill-posed nature. Additionally, it employs a top-2 smooth loss function with cost-sensitive attributes to handle noisy and imbalanced datasets. The advantage lies in its efficient performance compared to other supervised learning models, as demonstrated by experimental results. However, potential disadvantages may include the need for substantial computational resources for deep transfer learning, as well as the requirement for a sufficiently large and diverse dataset for training to ensure robustness and generalization of the model[13].

Pedro et al.(2020) designed “Conditions for a second wave of COVID-19 due to interactions between disease dynamics and social processes” This project highlights the interconnectedness between social behavior and disease dynamics in the context of the COVID-19 pandemic, offering a mathematical model to understand the feedback loop between the two. By examining the impact of lifting physical distancing restrictions on the spread of SARS-CoV-2, the study reveals that second waves of COVID-19 can arise due to complex interactions between social dynamics and epidemiological factors, even with varying efficacy of restrictions and basic reproduction numbers. This underscores the importance of considering behavioral feedback in pandemic response strategies. However, while the model provides valuable insights into the coupled behavior-disease system, its applicability may be limited by the simplifications inherent in any mathematical model and the need for accurate input parameters reflecting real- world conditions[14].

Rajvikram Madurai Elavarasan et al.(2020) introduced “Restructured society and environment: A review on potential technological strategies to control the COVID-19 pandemic” aims to shed light on the hidden yet crucial roles of technology in combating the COVID-19 pandemic. It underscores the importance of leveraging technological solutions to support healthcare systems, government efforts, and public adherence to containment measures. By exploring both implemented technologies and untapped potentials, the study offers insights into how technological innovations can enhance pandemic control and societal resilience. While the project provides valuable strategies and solutions, its limitations may include the dependency on technological infrastructure, potential privacy concerns, and the need for equitable access to technology across different demographics and regions[15].

## III. SYSTEM DESIGN

The development and implementation of full-face smart masks equipped with advanced sensor technology to enhance respiratory protection and health monitoring in various settings, particularly in the context of the COVID-19 pandemic. Smart masks represent an innovative approach to addressing the challenges posed by prolonged mask-wearing, offering real-time monitoring of wearer health metrics such as temperature, CO2 levels, and movement patterns. By integrating sensors and real-time processing capabilities, smart masks provide proactive alerting features, customizable notifications, and seamless integration with IoT devices and cloud platforms.

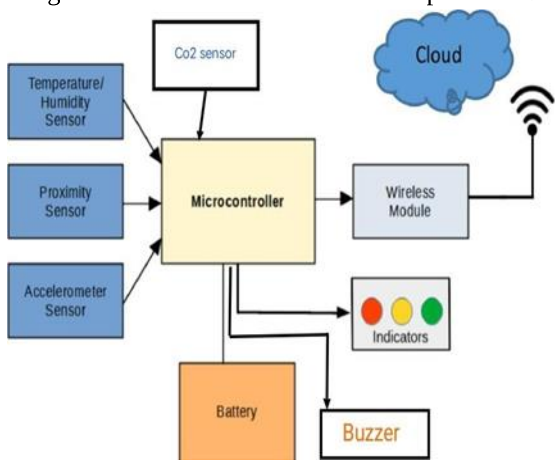


Fig 3.1 Block Diagram

The smart mask itself, equipped with various sensors and processing units. The sensors include a temperature sensor, CO2 sensor, accelerometer sensor, and proximity sensor, which continuously monitor wearer health metrics and environmental conditions in real-time. The data collected by the sensors are processed locally within the mask using an onboard microcontroller or processing unit. This local processing enables the mask to analyze wearer health metrics, detect anomalies, and trigger alerts based on predefined thresholds.

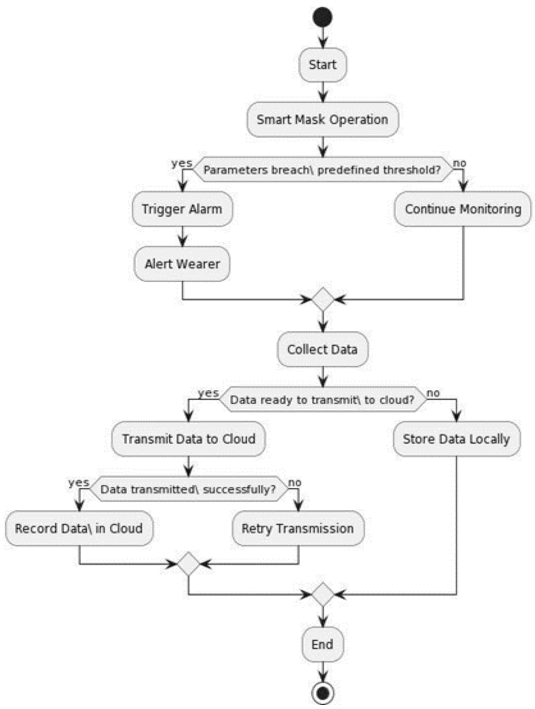


Fig 3.2 Flowchart

DHT 11 SENSOR: The DHT11 sensor is a low-cost digital temperature and humidity sensor. It provides basic temperature (0°C to 50°C) and humidity (20% to 80%) measurements with limited accuracy. It has a simple interface, slow response time, and is commonly used in DIY projects and basic environmental monitoring applications.

PROXIMITY SENSOR: A proximity sensor detects the presence or absence of an object within its vicinity without physical contact. It works by emitting electromagnetic fields, infrared radiation, or ultrasound waves and then analyzing the reflected signal. Proximity sensors are commonly used in smartphones, automotive systems, industrial machinery, and robotics for tasks such as object detection, motion sensing, and touchless interfaces.

NODE MCU: NodeMCU is an open-source firmware and development board based on the ESP8266 WiFi module. It integrates a microcontroller unit (MCU) and WiFi capability, enabling easy prototyping and development of Internet of Things (IoT) projects. NodeMCU supports the Lua scripting language, simplifying IoT application development with its user-friendly interface. It's widely used for home automation, sensor monitoring, and IoT projects due to its affordability, ease of use, and extensive community support.

BATTERY: A battery is a portable energy storage device that converts chemical energy into electrical energy. It consists of one or more electrochemical cells that store energy and can be discharged to power various electronic devices. Batteries come in different types, including alkaline, lithium-ion, nickel-cadmium, and lead-acid, each with its own characteristics in terms of capacity, voltage, and lifespan.

CO2 SENSOR: A CO2 sensor, or carbon dioxide sensor, is a device that measures the concentration of carbon dioxide gas in the surrounding environment. These sensors are commonly used in various applications, including indoor air quality monitoring, HVAC systems, industrial processes, and environmental monitoring. The sensor works by detecting the presence of CO2 molecules and converting this information into an electrical signal, which can then be measured and interpreted.

INDICATORS: Indicators are visual or auditory signals used to convey information or status. They provide quick and easily interpretable feedback about a system, process, or device. In various contexts, indicators can represent different states such as on/off, active/inactive, low/high, good/bad, etc. They are commonly used in electronic devices, control panels, dashboards, and user interfaces to communicate important information or alerts to users efficiently. Examples include status LEDs, warning lights, progress bars, and sound notifications.

## IV. EXPERIMENTAL RESUTS

The sensors continuously collect data, which is then processed locally within the mask. If any parameter such as temperature, proximity, or CO2 levels breaches a predefined threshold, the mask triggers an alarm to alert the wearer through a built-in buzzer.

If the smart respiratory mask detects a temperature of 36 degrees Celsius (or 98.6 degrees Fahrenheit), it indicates a normal body temperature for most individuals. A temperature reading within this range suggests that the wearer is not experiencing fever or elevated body temperature, which are common symptoms of illness or infection.

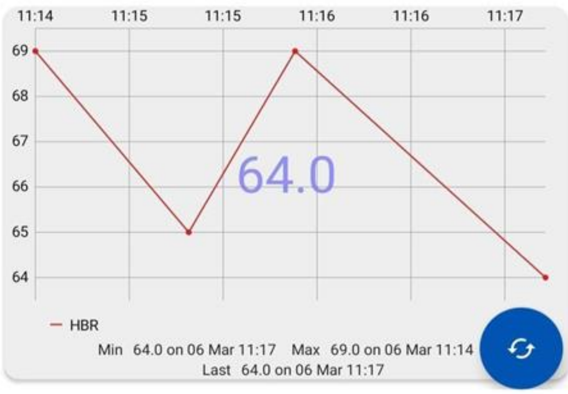


Fig 4.1 Value of Temperature with time.

If the smart respiratory mask detects a humidity level of 70%, it indicates that the surrounding environment has relatively high humidity.


Fig 4.2 Value of Humidity with time

If the smart respiratory mask detects a CO2 level of 124 parts per million (ppm), it indicates a relatively low concentration of carbon dioxide in the surrounding air. In most indoor environments, CO2 levels below 800 ppm are considered normal and safe for occupants.


Fig 4.3 Value of Co2 with time

In this project, the MEMS (Micro-Electro Mechanical Systems) sensor plays a crucial role in enabling the smart respiratory mask to monitor various environmental and physiological parameters.


Fig 4.4 Value of MEMS with time

If the mask detects a heart rate of 64, it means that the wearer's heart is beating at a rate of 64 beats per minute (BPM).


Fig 4.5 Value of HR sensor with time

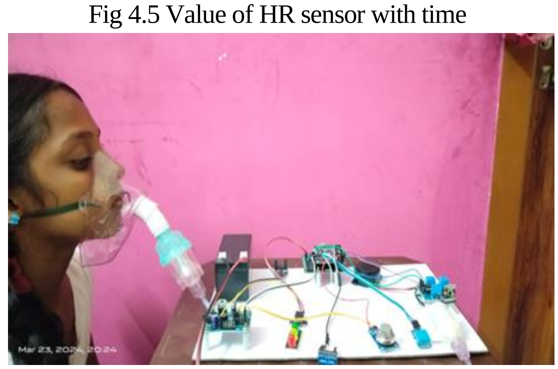

Fig 4.6 Prototype

## V. CONCLUSION AND FUTURE WORK

Conclusion

In conclusion, the development and evaluation of the IoT-enabled smart mask system represent a significant advancement in wearable technology for respiratory health monitoring and protection. Throughout this project, we have explored the challenges associated with conventional mask usage, particularly in the context of respiratory diseases like asthma. By leveraging IoT technology, advanced sensors, and cloud connectivity, we have proposed a comprehensive solution aimed at enhancing respiratory protection and promoting overall well-being.

Future work

The smart mask presented in this study serves as a platform for future development and integration of additional functions. Potential areas for expansion include: Integration of additional sensors for detecting other respiratory symptoms or environmental pollutants. Enhancement of data processing capabilities to enable real-time analysis and personalized feedback for wearers. Integration with wearable technology or mobile applications for seamless data monitoring and management. Collaboration with public health authorities for epidemiological research and disease surveillance using aggregated mask data. Overall, the smart mask has promising potential for further innovation and adaptation to meet evolving public health needs.

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