IOT based Active Protection Smart Mask

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***Abstract*—During the pandemic period of corona virus, face masks have become an unavoidable wearable for every individual. As the strictness for wearing mask has been decreased from the part of government, most of the people who were conscious about their health still continue to wear face masks. Many varieties of face mask are available and most of them provides only a passive protection i.e., simply act as an air filter. The proposed smart mask is developed to provide an active protection mechanism in which the sensor module detects the presence of droplets to which virus particles are most likely to be attached and activates a protection mechanism if such droplets are detected. The protection mechanism will spray a mist of alcohol solution which causes the virus laden droplets to settle down to ground. The system also communicates with predefined people with a notification via a mobile application if the user is in any critical situation.**

Keywords—Protection; Particulate Matter; Monitoring; Mask

I. INTRODUCTION

Since the beginning of 2020, the world has been struggling with the pandemic caused by the novel severe respiratory syndrome coronavirus 2. This novel virus has affected everyone's lives and economy severely. Many families have lost their beloved ones and greatly affected the financial stability. Even though people are actively adhering to social distancing norms, proper hygiene, and other technologically advanced preventive measures, normal day-to-day life is still impacted. Also new variant of the virus has been emerged out. To alleviate the situation and return to normalcy, preventive methods that actively fight the virus rather than providing passive protection are required. Implementing such methods necessitates the use of smart devices capable of detecting, quantifying, and actively eradicating viruses and other pathogens.

The proposed system detects airborne droplets containing viruses for COVID19, influenza, measles, or other diseases and uses an appropriate mitigation strategy to limit their spread. Also using an emergency button an alert notification can be send to family members and friends during any emergencies. In the initial implementation, a cold mist generator loads the droplets and causes them to fall quickly to the ground, while algorithms running on an on-board controller adjust the intensity and duration of the generator based on sensor data.

II. RELATED WORKS

Smart healthcare utilizes modern technologies such as the IoT, AI, big data, and edge and cloud computing, to make digitalized healthcare more efficient. At the same time, wearable healthcare technologies has moved beyond the transcribe and translate the wearer's speech into eight different languages via a smart phone or tablet, make calls and amplify the wearer's voice. LG Puricare consists of HEPA filters that medical practitioners and are becoming increasingly popular among the general consumers as a means to improve the self-wellbeing. Smart Masks, with various technical capabilities in addition to the usual functions of the mask, have been developed for different purposes over the years [1], [2], [3], [4]. Ngyuyen et al [5] studied the integration of biosensors to face masks, and they considered it as viable concept.

Tamura T et al [6] studied developments in wearable thermometers that are low-cost, accurate, easy to use devices can be worn or stick to the skin under clothing that records constant measurements of body temperatures. The use of these devices can be extremely helpful in the early detection of suspicious cases.

Ajaya K. Tripathy et al [7] developed an "EasyBand: A Wearable for Safety-Aware Mobility During Pandemic Outbreak" which helps in auto contact tracing. It is one of the most effective IoT devices to make sure people are practicing social distancing. This wearable device senses and collects data from other devices via the Internet of Medical Things (IoMT). EasyBand operates within a specific radius and alerts users to potential danger via LED lights if they are too close to each other.

Mohammed M et al [8] discussed about an IoT based smart helmet which detects the body temperature with the help of a thermal camera and send the location and the image of the person's face to the assigned mobile device with an alarm.

Mohammed M et al [9] also discusses about covid 19 detection using Iot enabled smart glasses which consists of Optical and thermal cameras to monitor crowds and inbuilt face detection technology for tracking procedure.

Using IoT-based drones is another common way to speed up the process of finding contaminated people and zones during this pandemic. Drone technology can reduce human interactions and can reach hard-to-access locations [10]. The thermal imaging drone was designed for capturing the temperature of people in crowds and can be used in the early diagnosis phase.

While smart masks can be a combination of various technologies, in general, smart masks can achieve advanced protection capabilities by optimising the various build materials, filtering mechanisms, integrated sensors, and other technologies. CX9 face mask provides 4-ply filter which can filter out ultra-fine particles. It consists of embedded LED that protects the skin from harmful bacteria, improves damaged skin and a fan module that helps the user to cool down. C-FACE is another smart mask which provides a moderate level of filtration. It can be internet connected, can

can block 99.95% of airborne particles. It contains a respiratory sensor which detects the wearer's breathing rate and automatically adjusts fan speed to match it (circulate air).

Also contains an UV-LED light for decontamination before reuse.

The monitoring and measuring functionalities provide various feedbacks for the user while enabling other permitted third parties such as healthcare professionals to remotely monitor the situation. Furthermore, one of the primary advantages of smart masks is their reusability. As a result, smart masks not only solve the mask shortage during a pandemic, but also help to address the issue of increased plastic pollution as a result of very high use of single use plastics as part of personal protective equipment in such situations.

III. METHODOLOGY

The proposed smart mask consists of three parts: a sensing module, a mitigation module and an emergency button. The sensing module senses the presence of airborne aerosol droplets of diameter range below 2.5 µm near users' mouth and nose. It consists of a pm sensor and a humidity and temperature sensor. Based on sensor data the quality of incoming air is classified as high risk, medium risk and low risk by running on board algorithms. If a high-risk air quality is detected, it triggers the mitigation module to spray a mist which is safe for human exposure using a micro nozzle, hence causing the virus laden aerosol droplets to settle down quickly to the ground, Fig. 1.

The emergency button provided on the mask can be pressed whenever the user is in any critical situation that he/she needs others help. When the emergency button is pressed twice within 5 seconds, an emergency alert will be sent to predefined persons via blynk app and the location of the user can be accessed using the app

The mask is rechargeable and can be decontaminated after each use by keeping it inside a decontamination box which consists of several UV LED's.

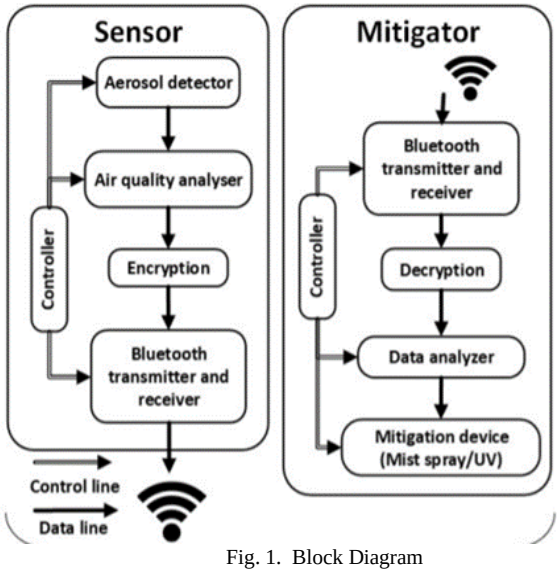

Fig. 1. Block Diagram

Remote detection approach is used in this project. Remote detection of pathogens has been demonstrated using a variety of optical methods, using asymmetric microsphere resonant cavities; laser induced fluorescence, and random Raman lasing, as well as non-optical methods, such as THz imaging and spectroscopy. A PM sensor that uses light scattering principle is used here to precisely count airborne particles.

Using a piezoelectric transducer, the mitigation device generates aerosolized mist on demand. To generate the mist, various types of liquids such as pure water or mixtures of water with various impurities in order to increase droplet mass or disinfectants can be used. Common disinfectants include diluted bleach, soap, and > 70% alcohol solution.

Both the sensing and protection modules are implemented using low-cost commercial hardware and software components such as a low-power microcontroller and a wireless system-on-module built within a mask, thus enabling widespread deployment in the vulnerable population.

IV. RESULTS

Whenever the emergency button provided on the mask is pressed twice within 5 seconds, an alert notification will be sent to friends and family members via blynk app so that they can access the location of the user using the blynk app set on their android phones.

When the device is powered on the PM sensor continuously checks the air quality based on the particle concentration as shown in Fig. 2.

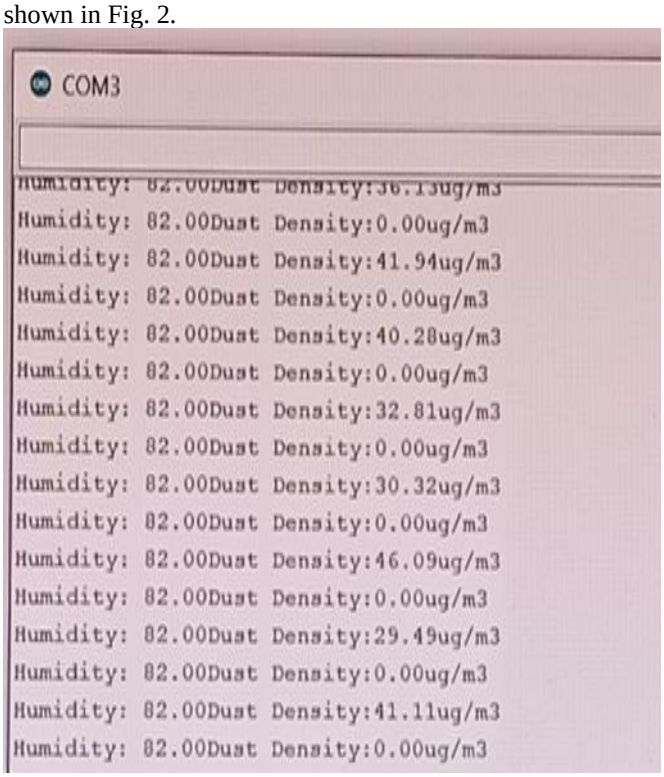

Fig.2. PM sensor readings

If the air quality is detected as unhealthy the mitigation device will spray the mist that loads the aerosol droplets near the user and makes them settle into ground without spreading into air as shown in Fig. 3.

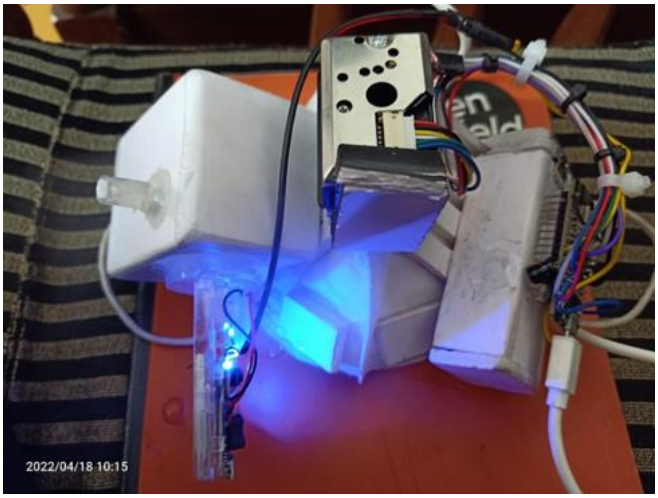

Fig. 3. Spraying of mist.

If the emergency button is pressed twice within 5 seconds an emergency alert will be send to predefined persons as in Fig. 4 using blynk and exact location of the user can be found by opening the blynk app as shown in Fig. 5.

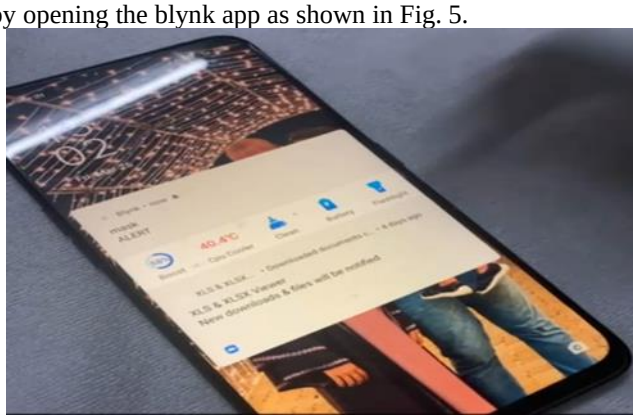
Fig. 4. Emergency Alert Via Blynk

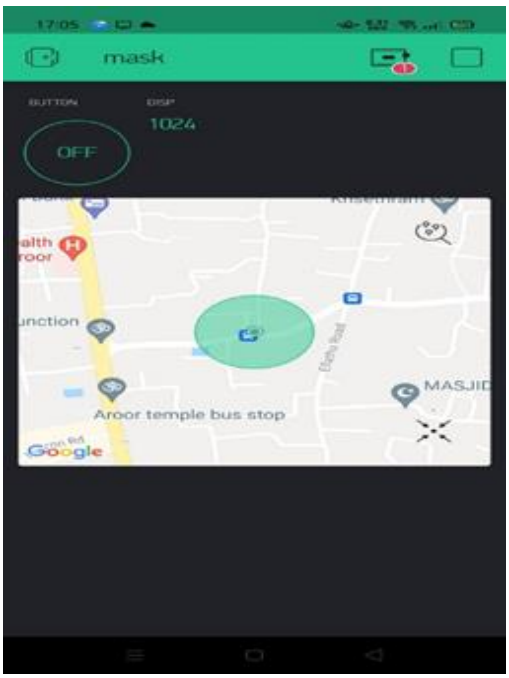

Fig. 5. Location access using blynk

V. CONCLUSION

A variety of air purifier that provides protection from dust, smoke, pollution, ash, pollen etc. are available. However, they don't claim that they protect from respiratory viruses like COVID-19. The proposed IOT based smart mask will provide an active protection mechanism to protect from respiratory viruses. It added features that are not available elsewhere, such as improved safety through sensing the quality of air, activating mitigation mechanism. The Smart Mask presents a tremendous opportunity to apply advanced analytics for healthcare. If the data is made available to analytics, the latest methods can be applied for both real-time and predictive use cases. When the data is shipped to the cloud, there are numerous possibilities available for applying advanced AI techniques, such as deep neural networks to model parameter norms and help classify outliers. Furthermore, long-term trends can be identified, or data can be associated with related populations under normal conditions.

REFERENCES

[1] B. Myers, J.A. Nahal, C. Yang, L. Brown, S. Ghiasi, A. Knoesen, Towards data-driven pre-operative evaluation of lung cancer patients: the case of smart mask, in: Proceedings of the 2016 IEEE Wireless Health (WH), 2016, pp. 1–6.

[2] L.D. Tripp Jr, W.B. Albery, Development of an Oxygen Mask Integrated Arterial Oxygen Saturation (SaO2) Monitoring System for Pilot Protection in Advanced Fighter Aircraft, Harry G Armstrong Aerospace Medical Research Lab Wright-Patterson AFB OH, 1987.

[3] Y. Cheng, C. Wang, J. Zhong, S. Lin, Y. Xiao, O. Zhong, H. Jiang, N. Wu, W. Li, S. Chen, B. Wang, Y. Zhang, J. Zhou, Electrospun polyetherimide electret nonwoven for bi-functional smart face mask.

[4] L. De Sio, B. Ding, M. Focsan, K. Kogermann, P. Pascoal-Faria, F. Petronela, G. Mitchell, E. Zussman, F. Pierini, Personalized reusable face masks with smart nano-assisted destruction of pathogens for COVID-19: a visionary road, Chemistry 27 (2021) 6112–6130.

[5] P.Q. Nguyen, L.R. Soenksen, N.M. Donghia, N.M. Angenent-Mari, H. de Puig, A. Huang, L. Rose, S. Slomovic, T. Galbersanini, G. Lansberry, H.M. Sallum, E.M. Zhao, J.B. Niemi, J.J. Collins, Wearable materials with embedded synthetic biology sensors for biomolecule detection, Nat. Biotechnol. (2021) 1–9.

[6] Tamura T, Huang M, Togawa T (2018) Current developments in wearable thermometers. Adv Biomed Eng 7:88–99.

[7] Tripathy AK, Mohapatra AG, Mohanty SP, Kougianos E, Joshi AM, Das G (2020) Easyband:a wearable for safety-aware mobility during pandemic outbreak. IEEE Consumer Electronics Magazine.

[8] Mohammed M, Syamsudin H, Al-Zubaidi S, AKS RR, Yusuf E (2020) Novel COVID-19 detection and diagnosis system using IoT based smart helmet. International Journal of Psychosocial Rehabilitation 24(7):2296–2303.

[9] Mohammed M, Hazairin NA, Syamsudin H, Al-Zubaidi S, Sairah AK, Mustapha S, Yusuf E (2020) 2019 novel coronavirus disease (COVID-19): detection and diagnosis system using IoT based smart glasses. International Journal of Advanced Science and Technology 29(7 Special Issue):954–960.

[10] Chamola V, Hassija V, Gupta V, Guizani M (2020) A comprehensive review of the COVID19 pandemic and the role of IoT, drones, AI, Blockchain, and 5G in managing its impact. IEEE Access 8:90225–90265.