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SMART MASK USING DESIGN THINKING FRAMEWORK

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Abstract* — The COVID-19 pandemic can be fought in part by wearing face masks. In this study, we propose the Smart Mask, an ecosystem and platform powered by the Internet of Things (IoT) that aims to stop and limit the transmission of respiratory viruses like COVID-19. Sensing, materials, AI, wireless, IoT, and software integration will aid in the collection of health information and the real-time detection of health-related events from the user as well as their environment. On a larger scale, accurate diagnoses and treatment plans made possible by AI-based analysis of health data allow for the prediction and reduction of medical costs, and the comparison of individual data with extensive public data allows for the creation of personal health trajectories, among other things. Future research directions are also mentioned along with the main research issues for smart respiratory protection equipment. To research the idea, a Smart Mask prototype was created together with a user application, backend, and health AI.

***Keywords*—** *Artificial intelligence, covid 19 prediction, smart mask*

I. INTRODUCTION

More than a year after the first cases of the coronavirus epidemic were discovered, the global public health emergency it caused is still in effect. Despite the availability of several vaccines, nonpharmaceutical strategies including social isolation and hand cleanliness are crucial in the pandemic's mitigation. Additionally, using a face mask can help stop the spread of the COVID-19 illness and other respiratory viruses.

Face masks in the general population have already been shown to significantly reduce the spread of respiratory viruses, especially in pandemic scenarios, according to theoretical, experimental, and clinical evidence [1]. At the start of the epidemic, just a few nations suggested wearing face masks, but as more and more governments have started requesting it from their residents, it has now spread throughout the entire world.

Some nations have even made it mandatory, with penalties for noncompliance. Mask use is regarded as being at least as significant as other mitigating strategies like social withdrawal and handwashing. By preventing harm from spreading, wearing a mask works in conjunction with other precautions. Since many nations are attempting to transition into the usual settings with safeguards and restrictions rather than employing draconian lockdowns observed at the beginning of the pandemic, masks have become crucial for both key personnel and the general public [2]. As it is anticipated that masks would be utilized everywhere, there will be significant demand. The market for respiratory protection equipment (RPE) as a whole was valued at 6.81 billion USD in 2019, and from 2020 to 2026, it is anticipated to increase at a CAGR of 4.6%. The estimated value is 11.05 billion USD in 2026. The COVID-19 pandemic has raised the need for protective gear, and the supply currently on hand appears insufficient. In order to satisfy demand, the World Health Organization (WHO) advised various businesses and governments to expand the production of respiratory protection equipment by 40%. The market for air-purifying respirators is anticipated to expand beyond daily consumer use since they are extensively utilized in many industries to protect employees from, among other things, dust, smoke, fumes, vapours, mists, and silica particles

II. LITERATURE SURVEY

In this section, we briefly review several related works on the smart mask,

[1] M. Gupta, K. Gupta, S. Gupta.The use of facemasks by the general population to prevent transmission of COVID-19 infection: a systematic review MedRxiv (2020), 10.1101/2020.05.01.20087064. The pandemic of COVID-19, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has become a serious worldwide public health emergency. This systematic review aims to summarize the available evidence regarding the role of face masks in community settings in slowing the spread of respiratory viruses such as SARS-CoV-2.

[2] K.K. Cheng, T.H. Lam, C.C. Leung

Wearing face masks in the community during the COVID-19 pandemic: altruism and solidarity. The Lancet (2020), 10.1016/S0140-6736(20)30918-1 there are concerns that mask-wearing could engender a false sense of security in relation to other methods of infection control such as social distancing and handwashing. We are unaware of any empirical evidence that wearing masks would mean other approaches to infection control would be overlooked. It is important, however, to emphasise the importance of this point to the public even if they choose to wear masks.

[3]M. Irfan, H. Jawad, B.B. Felix, S.F. Abbasi, A. Nawaz, S. Akbarzadeh, M. Awais, L. Chen, T. Westerlund, W. Chen A growing number of advanced smart systems and solutions are being designed for the elderly, helping them to live longer at home. These systems need to provide unobtrusive monitoring and safety for their users and information for healthcare professionals and family members. Multi-modal sensor data enables the possibility for in-depth behavioural analysis. To gather multi-modal data, we propose an IoT-based smart ambient behaviour observation system (SABOS). SABOS provides unobtrusive monitoring of daily living activities by utilizing various sensors integrated into the residential house. To reduce the amount of data, we present a data reduction algorithm. The data reduction algorithm effectively reduces over 90% of the submitted data with full recovery in the cloud. Data is sent to ThingSpeak for MATLAB visualization and analysis to generate graphical illustrations of daily living activities. In an emergency, an “if this then that” (IFTTT) service combined with ThingSpeak triggers an applet to send a defined message to a healthcare professional or a family member.

[4] L. Li et al., “COVID-19 patients’ clinical characteristics, discharge rate, and fatality rate of meta-analysis,” J. Med. Virol., vol. 92, no. 6, pp. 577–583, Jun. 2020. The aim of this study was to analyze the clinical data, discharge rate, and fatality rate of COVID-19 patients for clinical help. The clinical data of COVID-19 patients from December 2019 to February 2020 were retrieved from four databases. We statistically analyzed the clinical symptoms and laboratory results of COVID-19 patients and explained the discharge rate and fatality rate with a single-arm meta-analysis. The available data of 1994 patients in 10 literatures were included in our study. The main clinical symptoms of COVID-19 patients were fever (88.5%), cough (68.6%), myalgia or fatigue (35.8%), expectoration (28.2%), and dyspnea (21.9%). Minor symptoms include headache or dizziness (12.1%), diarrhea (4.8%), nausea and vomiting (3.9%). The results of the laboratory showed that the lymphocytopenia (64.5%), increase of C-reactive protein (44.3%), increase of lactic dehydrogenase (28.3%), and leukocytopenia (29.4%) were more common.The results of single-arm meta-analysis showed that the male took a larger percentage in the gender distribution of COVID-19 patients 60% (95% CI [0.54, 0.65]), the discharge rate of COVID-19 patients was 52% (95% CI [0.34,0.70]), and the fatality rate was 5% (95% CI [0.01,0.11]).

III. EXISTING SYSTEM

The Existing system for heart disease prediction is to detect covid 19 to prevent the spread of virus and improve healthcare.

The following are some of the system's drawbacks:

The facial recognition system is highly sensitive to pose variations.

Changes in facial expressions may produce a different result for the same individual.

IV. PROPOSED SYSTEM

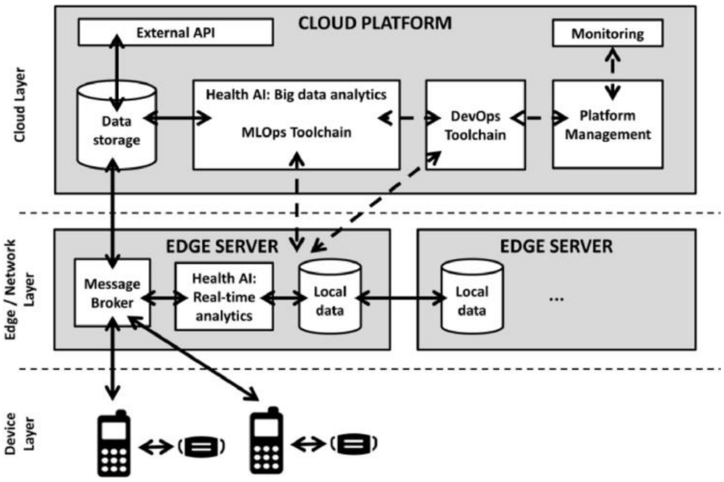
Single-use surgical masks and reusable fabric-based face masks for breathing protection are the most popular types of masks for COVID-19 protection. In addition to taking up space on the mask, adding electronics also makes the mask heavier. The masks must also be reusable, at least for the electronics. Two concepts were put to the test: a 3D-printed mask with incorporated electronics and a single-use/washable fabric mask. The smart mask prototype was built using a 3D-printed mask with a replaceable filter. Mask, material and design. FlexFill 98A, a flexible filament, was used to produce the 3D-printed mask (Fillamentum, Czech Republic). In contrast to the typically hard polylactide (PLA) filaments used in 3D printing, the filament is based on thermoplastic polyurethane (TPU), which is flexible. When compared to stiff mask pieces, a flexible filament offers a more comfortable mask. Designing the 3D-printed components required Solidworks. The filter is given the spotlight first. Several rounds of testing were used to iterate the filter's size. The user had to exert extra power to breathe since the filter area was too small, which was painful. The majority of test participants judged the wider area filter to be the most effective. The final face mask, whose design is still being worked on, will be different. For instance, the face mask needs to be less bulky and more acceptable in society. At this time, the mask weighs 93 g. (the electronics compartment is 49 g and the mask without the electronics compartment is 44 g). However, enhancements will be made and the weight of the mask can be changed to suit user preferences by altering the size of the battery. With the aid of 3D printing, several designs can be tested, and the size and shape of the mask may be altered to suit the demands of each individual. Additionally, the mask can be made to feel more comfortable by using various materials. The 3D-printed chassis of the mask prototype houses an easily detachable electronics module. Behind the user's head, stretchy, movable straps secure the mask to the head while the filter is replaced.

The sensing and communication module's goal is to give users precise and trustworthy information, for instance regarding the quality of the air beneath the mask or any potential mask movement. Therefore, in this work, we focused on the kinds of sensors that must be incorporated into the Smart Mask prototype in order to gather this pertinent information and data.

Certain types of events can be detected using various types of sensors. As a result, there are numerous techniques to detect any movement of the mask. In theory, a mask that is not securely fastened to the wearer's skin offers little protection. For instance, to gauge the amount of light, ambient light sensors (ALS) might be positioned beneath the mask. It can be considered that the mask does not fit comfortably on the user's skin at a specific light intensity, or when the accessible light reaches a threshold value and does not adequately shield the user. The potential movement of the Smart Mask can also be measured using the data from an accelerometer. Another option is to implant sensors in the mask holder. By monitoring variations in resistance, it is possible to determine whether the mask has moved and whether the user needs to reposition it.

An equivalent carbon dioxide (eCO2) sensor, which can also measure the total quantity of volatile chemicals in the air, can be used to measure the quality of the air beneath the mask in a manner similar to that described above. It is important to note that users are more likely to touch their masks to release hot air from underneath if the quality of the air beneath them is deteriorating. In this situation, users can spread the virus to their masks by touching them. The intentional or unintended movement away from the mask must be avoided by the wearer to maximize the level of protection.

In general, the sensors built into the Smart Mask must offer users accurate and trustworthy data. So, we investigated how sensor readings were affected by the position of the sensor within the mask. As an illustration, when checking the temperature beneath the mask, we found that the sensor's location (for instance, at the button or side of the mask) had an impact on the reading. As a result, depending on where in the mask the temperature sensor is placed, it will give greater temperature readings. As was already noted, one of the important aspects examined throughout the design and development of the Smart Mask was the air quality beneath the mask. It was discovered that as soon as the person dons their mask, the temperature swiftly increases. But if the user doesn't change, the temperature eventually reaches saturation (e.g., when sitting in a bus). The saturation temperature was shown to be affected by the filter used in this study. It's important to keep in mind that every user will have a varied level of comfort and, as a result, a variable threshold temperature that is acceptable beneath the mask. Once sensor data has been gathered, it is critical to give users access to that data right away. We focused on real-time connection between the sensors and the user's smartphone in this manner. For the Smart Mask prototype, Wi-Fi connection was used. However, we are thinking about adopting Bluetooth Low Energy (BLE) connectivity rather than Wi-Fi in the future iteration of the prototype due to the required data rate and to increase the energy efficiency of the Smart Mask. It can be difficult to achieve energy efficiency [3], especially in small wearable technology. As a result, energy management is a key feature of the Smart Mask. For users to be satisfied, the battery life is crucial. In other words, consumers may become irritated if they have to frequently recharge their mask's battery. Additionally, one of the main factors in the weight of the mask is the rechargeable battery. A bigger battery capacity may be required, increasing the total weight of the mask, if the Smart Mask's communication with the smartphone consumes a lot of energy and/or the battery's state of charge (SoC) is rapidly depleted from data collection from sensors.



A smartphone application was created to work in conjunction with the actual Smart Mask. The application was created using a user-centred design approach to maximise user acceptance and user experience, identify user requirements, context requirements, and cultural aspects related to the use of masks, and provide a seamless connection and user experience between the Smart Mask, application, sensors, analytics, and data visualisations between the mask, app, and backend. The mobile application's user interface (UI) provides crucial details on the state of the Smart Mask and notifies the user when necessary (e.g., battery running low, an air leak in the mask, the filter needs to be replaced). These warnings generated by the Smart Mask ecosystem were crucial in maintaining secure operational conditions.

The mobile application's user interface was developed using user research that was done at the outset of the project through in-depth interviews with seven potential users who represented various user groups and usage circumstances. The user study also supplied crucial user needs for the physical Smart Mask's design as well as for the features and usability of the mobile application based on the statistical significance p-value that have a substantial impact on heart disease.

V. Advantage of Proposed System

The advantages of the proposed systems are listed below:

A. Prevents the spread of disease

B. Easy to use.

VI. Conclusion and Future Scope

Currently, "unintelligent" cotton masks, respirators, and surgical masks are in high demand. There aren't many products that attempt to give the mask some intelligence. The most cutting-edge masks currently on the market are "stand-alone" products with a few extra features (such as fans to make wearing masks more comfortable or sensors to detect air intake), rather than integrated and intelligent systems that are a part of a full ecosystem, like Smart Mask (i.e., device+cloud+services+application).

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