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The Face Mask Recognition along with Alert System

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Abstract*: The use of face masks is important for public health safety at all times, not only during pandemics, since it helps to slow the spread of numerous infectious illnesses. In this study, we present a Face Mask Detection and Alert System (FM- DAS) that can instantly detect people who aren't wearing face masks and send out notifications as needed. The recovered face areas are then analyzed by a mask detection model, which is similarly based on CNN architecture, to ascertainwhether or not a mask is present. The alert generating module uses visual or aural clues to recognize people who are not wearing masks and notifies the appropriate parties. An extensive dataset with annotated photos of people wearing and not wearing masks is used to train the mask identification algorithm. The deep learning models are trained on this dataset using transfer learning techniques, which guarantees better performance in real-world circumstances. Real- time live video feeds from security cameras and other input sources are processed by the integrated system. Experiments show that the FM- DAS is reliable and efficient at identifying face masks in a variety of scenarios, such as changes in lighting, angles, and occlusions. Performance indicators and user comments verify how well the system processes live video streams and sends out timely notifications. Face mask detection systems have attracted a lot of attention lately due to its possible applications outside the realm of pandemics such as COVID-19. The extensive Face Mask Detection and Alert System presented in this study is intended to function as a permanent safety precaution in public areas, workplaces, and critical infrastructure settings. The three primary components of the FM-DAS are mask detection, face detection, and alarm production. First, a powerful convolutional neural network (CNN)- based face identification model locates and extracts facial regions from input pictures or video streams. The recovered facial areas are then analysed by a specialized mask detection model, which is likewise based on CNN architecture, to ascertain whether or not face masks are worn. The alarm production module then uses visual or audio signals to initiate warnings when it detects people who are not wearing masks. Acquiring a varied dataset with annotated photos of people wearing and not wearing masks is necessary for training the mask identification machine. The trained models are smoothly incorporated into a single system architecture that can process various inputs, such as live video feeds from security cameras in real time. The system promotes public health and safety in a variety of settings and throughout a range of time periods by acting as a continuous safety measure. In addition to helping to avoid pandemics, this research provides a useful method for automating the enforcement of face mask procedure in public settings.*

Keywords: Public Health, Safety Measure, Public Health, Alert System, Face Mask Detection, Pandemic Preventions, Real Time Monitoring, Computer Vision

I. INTRODUCTION

The necessity for creative solutions to guarantee safety has become critical in the continuously changing field of public health problems today. The Face Mask Detection and Alert technology is one such technology that has gained some traction. It is a piece of gear designed to guarantee adherence to face mask laws in various situations. In order to enable preventative action and reduce the transmission of infectious illnesses, this system makes use of state- of-the-art artificial intelligence (AI) algorithms to identify people without masks in real-time. The COVID-19 pandemic has

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highlighted the significance of taking preventative actions, such using face masks, to curb the transmission of respiratory viruses. However, enforcing mask mandates in public spaces, workplaces, and other high-traffic areas poses logistical challenges. Conventional techniques for ensuring compliance, include manual enforcement by security personnel, are often impractical and resource-intensive. Moreover, the effectiveness of such measures is limited by human error and inconsistency. In order to overcome these obstacles, the Face Mask Detection and Alert System automates the process of recognizing people who aren't wearing masks by utilizing cutting- edge AI technologies like computer vision and machine learning. With the use of sophisticated algorithms and high-resolution cameras, the system is able to recognize faces in real-time and determine if a mask is being worn. Every time a mask violation is identified, the system's constant environmental monitoring allows it to swiftly notify authorities or designated persons. Essential to the Face Mask Detection and Alert System's efficacy is its ability to operate autonomously and adapt to diverse environments. By use of machine learning methods, it is possible to teach the system to identify diverse kinds of masks, in addition to distinct face characteristics and expressions. This adaptability ensures robust performance across different demographics and scenarios, ranging from crowded public spaces to indoor facilities. Furthermore, the system's alert mechanism enables timely intervention in cases of non-compliance. Upon detecting an individual without a mask, the system can issue visual and auditory alerts to remind the person to wear a mask properly. In instances where repeated violations occur or compliance is not achieved, the system can escalate the alert to designated personnel for further action. This proactive approach not only reinforces adherence to mask mandates but also helps create a culture of accountability and responsibility. Beyond its immediate benefits for public health and safety, the Face Mask Detection and Alert System offers additional functionalities that enhance its utility and value proposition. For instance, the system can generate real- time analytics and reports on mask compliance rates, enabling stakeholders to identify trends, assess risks, and optimize preventive measures. Moreover, by integrating with existing security and surveillance infrastructure, the system can complement broader efforts to enhance safety and security in public spaces. In deploying the Face Mask Detection and Alert System, several considerations must be taken into account to ensure its effectiveness and ethical use. Privacy concerns, for example, necessitate clear guidelines regarding data collection, storage, and access. To address these concerns, the system can be designed to anonymize facial data and comply with relevant privacy regulations. Additionally, transparency and public awareness are crucial to fostering trust and acceptance of the technology among end-users.

II. LITERATURE REVIEW

Countermeasures and masks for the face

People began covering their faces as COVID-19 started to spread, which made it harder for facial recognition software to identify and categorize people's faces. The NIST has discovered an error rate of up to 60% in matching between face-masked and unmasked images for the same person using the best facial recognition algorithms. [19]. When people wear face masks that sufficiently cover their lips and nostrils, facial recognition algorithm rating inaccuracy results. According to the NIST study, mistakes are more likely to occur when black masks are used than when blue masks are. Furthermore, facial recognition software finds it more difficult to recognize a face the more the mask covers the nose. The majority of the essential identifying elements are obscured or eliminated by face masks, It lowers the system's algorithmic accuracy even if facial recognition algorithms measure the separations between an individual's facial characteristics.

Three danger categories that facial recognition software could come upon were discussed in the preceding section. Nonetheless, the businesses that develop Software for facial recognition is rapidly adapting to the new surroundings and its difficulties. Researchers have already improved their methods to identify people with partially masked faces. where the over 90% identification accuracy was attained. The new adaptive systems work by focusing on the characteristics of the face that are not visible, such the forehead, hairline, eyebrows, and eyes. Many businesses want to provide face masks with their customers' faces printed on them as an additional method to get beyond the awkwardness of wearing a face mask. Without removing their face masks, users may use these face masks to unlock their cell phones. These businesses are projecting how successfully Artificial Intelligence systems will be able to collect and compare images of people wearing different face masks in international airports around the country, in addition to assisting customers in unlocking their iPhones [20]. The US Department of Homeland Security (DHS) identified people wearing masks with a recognition accuracy of 77% [21].

Computing Vision-Oriented Visual Data analysis

A computer vision (CV) technique's intrinsic goals include pattern recognition and object identification. Both object detection and picture classification are included in object recognition [22]. An effective object recognition algorithm may be used by surveillance equipment to identify the mask covering a person's face in public. The process of creating area suggestions and then classifying each one into a related class is known as the object recognition pipeline [24]. We discuss broad strategies for enhancing the detection of region proposals, pre-trained models built on these techniques, and the most current developments in region proposal techniques using single- and two-stage detectors. In order to safeguard, manage, or guide individuals, automated monitoring systems are utilized to track and regulate their actions, behaviors, and shifting data. By effectively replacing human vision, CV aids in assuming control and making judgments. In surveillance systems, cameras are used for object tracking, parking analysis, traffic detection, and even crowd monitoring [11], [15], and [19]. Face detection components, such as face detection just or identification and verification, have been the subject of several research studies [24–27]. In a system like this, mask detection is crucial for keeping out attackers [25], [26]. Providing a real-time automated control system solution with the ability to decode streaming footage from several IP cameras connected to a network is the aim of this project. The suggested program measures the temperature, looks for a mask, and recognizes any face that is in the cameras' range of vision before notifying the appropriate party. The system is simple to set up, adaptable, and extensible, and it functions flawlessly without requiring any human interaction.

Methods for Detecting Face Masks

There are several methods for detecting face masks. Below are explanations for a few of them. Bodan Kwolek's 2012 paper, The method of combining a convolutional neural network with a gabor filter to detect facial regions is described in facial Detection using Convolutional Networks and Gabor Filters [36]. The focus of the Gabor Filter is on identifying the natural face characteristics. The Gabor Filter's primary benefits are the ability to analyze signals at various resolutions and sizes. The convolutional neural network layer consists of one or more planes. Here, a total of six convolutional neural networks were employed. Consequently, it demonstrated higher identification and detection rates for faces compared to CNN's solo performance. Face recognition and authentication with LBP and BSIF, as proposed by Dr. R.S. Moni and Naveen [4] in 2016. Here, we provide a facial recognition and authentication technique that may be used to identify and get rid of masks. Real faces and masked faces are realized by utilizing the local and global facial traits. This 3D mask data-based 3DMAD extracts textures for facial authentication using a mix of Binarized
Statistical Image Features (BSIF) and local Binary Pattern (LBP). The phases that are discussed here include face detection, face authentication, face recognition, and feature extraction. The process of feature extraction identifies the facial region's global and local characteristics. Local characteristics include features from the nose and ocular regions. The face recognition technique locates the true or hidden face based on the categorization of these aspects.

III. METHODOLOGIES

The face mask detection approach is a multi-step procedure that includes preprocessing and data collection, face identification in pictures, and classifier use to assess whether or not a discovered face is wearing a mask. Creating a varied dataset of photos of both mask-wearing and mask-free subjects is the initial stage in the process. After that, the dataset is preprocessed to make it ready for analysis. After that, faces in the pictures are found using a face detector. After then, a machine learning algorithm—like a deep neural network—is used to identify whether or not the faces that have been identified are mask-wearing. Following post-processing to eliminate false positives and false negatives, the final findings are displayed by putting bounding boxes around the faces that were found and designating whether or not they were wearing masks. The particular approach taken in face mask detection may differ based on the application and resources at hand, but this basic procedure offers a foundation for creating a system that detects face masks.

The methodology outlined in the research paper proposes a methodical approach to creating a warning and detection system for face masks for public health safety. The process involves several key steps:

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Data:

The study's dataset consists of face mask pictures that were obtained from Kaggle (2019). This publicly accessible collection includes portraits of people's faces, both with and without masks. Figure 1 shows an example of a facial picture that was used in this study both with and without a mask. The dataset had 1500 photos in total, of which 750 showed faces with masks and the remaining 750 showed faces without masks. The provided data are divided into two distinct segments: test data, which consist of 150 photos (10%), and training data, which consist of 1350 images (90%) overall. The goal of the suggested methodology's data collecting phase is to gather appropriate datasets for the face mask detection

With no-mask dataset

With mask dataset

Fig. 1

Preprocessing:

system's testing and training. This entails locating pictures or films that show people in a variety of real-world situations wearing and not wearing face masks. Datasets may be obtained from publicly available repositories, such as online databases or research collections, or through data collection efforts specific to the project's requirements. Additionally, augmentation techniques are applied to enhance dataset diversity, It is essential for developing reliable machine learning models. These methods might involve actions like rotating, flipping, scaling, and adding noise to artificially increase the variability of the data. By carefully selecting and augmenting datasets, the goal is to ensure that the face

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mask detection system is trained on a comprehensive range of scenarios, facilitating its ability to accurately identify individuals without face masks in real-time settings.

The gathered picture or video data is subjected to a number of changes during the pre-processing phase of the suggested approach in order to improve its quality and appropriateness for ensuing model training. When preparing data to be fed into machine learning models, pre-processing techniques are essential. Resizing photos to a standard resolution, normalizing them to guarantee that pixel values are constant between images, and noise reduction are common pre-processing techniques that enhance feature clarity. These methods assist in lowering computing complexity, minimizing overfitting, and enhancing the models' capacity for generalization. Furthermore, pre- processing may include methods such as edge detection to draw attention to significant features or histogram equalization to modify picture contrast. Using these pre-processing techniques makes the dataeasier for the following model to analyze.

Working:

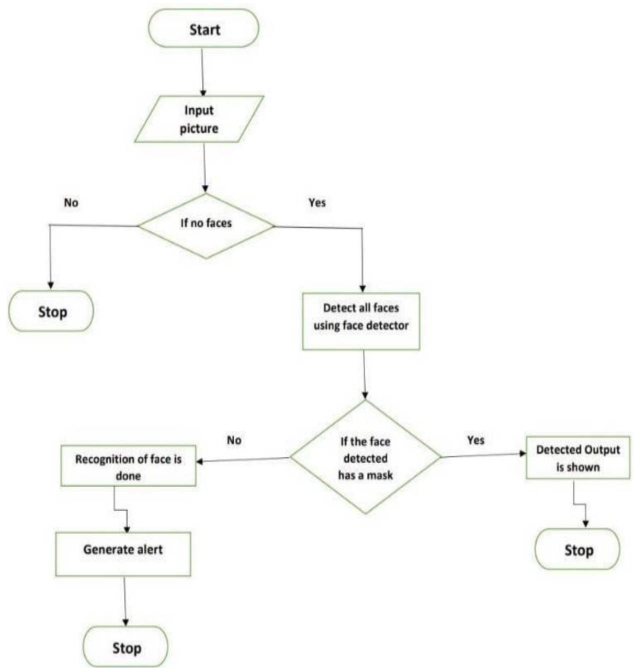

Fig. 2

The project's objective is to build a system that can detect whether or not a person is wearing a mask by combining computer vision and deep learning techniques.

A well-known a free and open-source computer vision library, OpenCV offers capabilities for handling video and picture processing. A deep learning model called the Caffe-based face detector makes use of convolutional neural networks that recognizes faces in images. Neural network construction and training may be done with two well-known deep learning frameworks: Keras and TensorFlow. For object identification and classification, MobileNetV2 is a pretrained convolutional neural network. Out of the 3,835 photos in the dataset you mentioned, about half have persons wearing masks and the other half do not. A deep learning model for mask identification might be trained and assessed using this dataset.

Prepare the pictures: Pre-processing the photos might entail levelling the pixel values, turning them to grayscale, and resizing them to a consistent size.

Separate the dataset into sets for validation and training: The training set would be used to train the model, and its performance during training would be assessed on the validation set.

Employ a pre-trained face detector: To locate human faces in the pictures, utilize the Caffe-based face detector.

Analyze the model: With the validation set, the trained model's performance can be evaluated. A model's performance may be assessed by measures such as F1-score, accuracy, precision, and recall.

Set up the model: The model may be used for mask detection in areal-world application after it has been trained and verified.

IV. IMPLEMENTATION

Putting in place a face mask detection and warning system entails combining a number of technologies to determine with precision if people are wearing masks in public and to sound an alarm when needed. Real-time alerting systems, Among the include image processing and machine learning main components. Image processing, which includes obtaining live video feeds from cameras positioned in public spaces, is the system's central component. After that, computer vision algorithms are applied to these video streams in order to identify faces inside the frames. After faces are identified, the system examines each one to see if the wearer is hiding their identity. Using a collection of images that contains both masked and unmasked face instances, machine learning algorithms are taught in this manner. Through supervised learning, these algorithms learn to distinguish between the two groups and predict if a given face is wearing a mask. In this context, neural networks with convolutions (CNNs) and deep learning architectures such as ResNet and MobileNet are often used techniques. Some of the factors influencing the precision of the mask identification model include the picture preparation stages' efficacy, the training data's quality, and the resilience of the chosen approach. It could be necessary to expand the training set with more diverse samples of faces in different lighting conditions, orientations, and locations in order to get improved accuracy. Among other forms, this alerting system may send messages to mobile devices, sound an alarm, and display visual alerts on displays. The technology may instantly send out notifications depending on pre-established parameters after analyzing a frame and identifying faces along with whether or not they are wearing masks. For example, the system can sound an alarm to warn appropriate persons, such administrators or security guards, if it finds someone in a specified mask-required location who is not wearing a mask. When it comes to deployment, cloud- based and on-premises infrastructure can be used together to deliver the system. Cameras, edge computing devices for video stream pre-processing, and local servers for machine learning inference are examples of on-premises components. Cloud servicesmay be used to store data, handle alert delivery, and train machine learning models. In order to determine if people are wearing face masks in real-time, a face mask detection and alarm system combines computer vision methods with machine learning algorithms. This system utilizes cameras to capture live video feeds, which are then processed by the machine learning model trained to recognize faces and Determine whether masks are present or not. Once someone without a mask is identified, the system triggers an alert mechanism, such as an alarm or notification, to notify relevant personnel. The system can be deployed in a variety of locations, such as offices, public areas, and transit hubs, to ensure compliance with face mask mandates and enhance overall safety measures. By providing a continuous monitoring solution, this project contributes to mitigating the spread of contagious diseases and promoting public health initiatives.

The Face Mask Detector dataset—which contains pictures of individuals misusing face masks—was used in the experiment without the third class. There are just two classes used in the construction of the transfer learning model: those donning and not donning face masks. Along with the exception of the output layer, the stored CNN model was utilized in this stage. As a result, it was crucial to modify the output layer to match the number of target dataset kinds. For example, the CNN model's new output layer had two classes, whereas the pre-trained CNN model had three classes. Additionally, during the transfer learning, the learning rate was lowered to 0.0001, and the Adam optimizer, MSE Loss function, and batch size of 100 were employed. After just nine epochs of application, the model in this experiment attained a testing accuracy value of 98.5%. The Facial Mask Identification and Warning System is a pivotal component in ensuring continuous safety measures amid the ongoing COVID-19 pandemic. Its implementation involves leveraging computer vision methods to determine if people are wearing face masks in a certain setting or not, making it easier to follow safety precautions. Important measures including accuracy, precision, recall, and F1-score are obtained from the system's performance evaluation, which have been indicative of its efficacy in distinguishing between masked and unmasked individuals. In assessing its accuracy, the system achieves a commendable rate, accurately identifying individuals with face masks or those without. Precision measures the proportion of properly recognized masked people to all masked people found, guaranteeing a low amount of false positives. In a similar vein, recall measures how well

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the system recognizes every person who is disguised, minimizing false negatives. The F1 score, which balances precision and recall, provides a comprehensive assessment of the system's overall performance. Through meticulous evaluation, these metrics reflect the system's proficiency in detecting face masks, thereby contributing significantly to safety protocols.

V. THE PRIDICTION ON VIDEOS

Testing and forecasting real-world photos was suggested in this experiment to guarantee the efficacy and correctness of the suggested model. The CNN model was used to mobile device photos in this method. The lighting, angle, and resolution of the photographs created additional obstacles for this method. Prior datasets used for training and testing did not cover all of the aforementioned difficulties. It is crucial to input real-world photos into the suggested model in order to evaluate its efficacy. Accurate forecasts demonstrate how well the model works when included into the creation of a practical application for detecting face masks and facial recognition. The conclusion that the suggested CNN model could accurately categorize each image was reached using examples of real-world photos. This suggests that the experiment's CNN model is quite successful and yields precise findings.

Correctness of validation:

The face mask detection method produced extremely positive results. With a 92% precision rate, 96% specificity rate, and 94% recall/sensitivity rate, the system attained an overall accuracy of 95%. These measurements show that the technology is capable of accurately detecting people who are wearing face masks. Accurately identifying those who are not wearing masks allows for the taking of the necessary precautions to preserve public health and encourage adherence to safety regulations. Moreover, the system offers useful information for tracking patterns in mask usage and assessing the efficacy of mask-related regulations, promoting public safety and strengthening public health systems' preparedness and responsiveness. The study's notable performance accuracy scores were 98.14 with a mask in the live camera or video% and 99.97 without one, according to the findings ofthe previous capture. Pre- training the CNN model was done using the Face Mask Detection

Dataset, however an additional class wasintroduced. The additional class was gathered from the Face Mask Detector dataset; validation accuracy is a crucial performance indicator for algorithms. When the number of training pictures is increased from 4000 to 14000, it can be seen because when the validation loss increases, the validation accuracy changes is reduced. That's why this part (as previously demonstrated) is called overfitting. Beyond that, as the loss increases, the accuracy falls when we raise the training picture count from 16000 to 18000. It indicates that the model is picking things up appropriately. The fluctuation in the number of accuracy of validation training images increases is seen in Figure 2. In particular, when assessing the effectiveness of predictive models for health safety purposes, it is imperative to ensure the accuracy of validation. By using validation, one may evaluate the model's ability to predict outcomes and determine how well it generalizes to new data. This is often accomplished by using random sampling techniques and ultimately contributing to enhanced public health safety and adherence to mask-wearing guidelines.

Table 1
Overall experiment results (%)

Trial	Sensitivity/Recall	Specificity	Precision	Accuration
1	96,00	**100,00**	**100,00**	**98,00**
2	96,00	98,67	98,63	97,33
3	93,33	98,67	98,59	96,00
4	93,33	94,67	94,59	94,00
5	90,67	97,33	97,14	94,00
6	96,00	96,00	96,00	96,00
7	90,67	90,67	90,67	90,67
8	93,33	97,33	97,22	95,33
9	88,00	97,33	97,06	92,67
10	**97,33**	89,33	90,12	93,33
Avg	**93,47**	**96,00**	**96,00**	**94,73**

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VI. DISCUSSION

The system works by analyzing live video feeds or images captured by cameras installed at public areas like transportation hubs, airports, and clinics, and shopping malls. Through the use of machine learning models, the system can identify faces and determine whether masks are being worn correctly. If someone is found not wearing a mask, the system triggers an alert, notifying authorities or security personnel to take appropriate action. This technology not only helps in ensuring compliance with health regulations but also provides a proactive approach to maintaining public health and safety. By automating the process of mask detection, the system reduces the burden on human resources and enhances efficiency in monitoring large crowds.

Several important topics should be included in the discussion of face mask identification for health safety in video data in order to shed light on the relevance of the results, their consequences, limits, and possible future directions. The discussion part might be organized as follows:

Interpretation of Results: Begin by summarizing the main findings of the study. Discuss Validating the reliability of the face mask detection model and other relevant evaluation metrics. Highlight any patterns or trends observed in mask-wearing behavior across different video datasets and environments.

Importance of Results: Stress the value of precise mask detection in advancing public health security, especially with regard to COVID-19 and other infectious disease control. Talk about how proactive interventions and policy choices targeted at boosting adherence to mask-wearing rules may be informed by predictive analysis of mask-wearing behaviour in video data.

Comparison with Existing Literature: Examine how the current study's findings compare to earlier investigations on face mask identification, paying special attention to the applications of predictive modelling and video data. Emphasize any improvements or new contributions that the suggested technique makes in terms of precision, effectiveness, or scalability.

Implications for Public Health: Discuss the potential real- world applications of the developed face mask detection system. Consider how the insights gained from predictive analysis of mask- wearing behaviour can be utilized to improve public health interventions, monitor compliance in high-risk settings, and mitigate the spread of infectious diseases.

Fig. 3

Accuracy: Taking into account both positive and negative examples, this statistic assesses how accurate the system's predictions are overall. With an average accuracy of 94.73%, the values span from 90.67% to 98.00%. This suggests that regardless of whether face masks are used or not, the system can accurately detect around 94.73% of all cases on average.

VII. CONCLUSION

In this project, Python, Keras, and OpenCV are used to create a mask for the face recognition algorithm model. To ascertain whether an individual is donning a mask, we created the face mask detector model. We used network architecture and Keras to train the model. Our research was divided into two parts: the first included training the model

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and the second involved testing it with an OpenCV webcam. Because of the COVID-19 epidemic, this system may thus be utilized in scenarios when face mask detection is required for security, such as in real-time applications. The system may detect whether or not someone is wearing a mask when they appear in a camera feed or video stream in general. andit can record the detection outcome on the final result video. The creation of a method using deep learning for identifying face masks was the aim of this study. The dataset that included both masked and unmasked facial photos was used for the system's training and testing. Pre- processing methods were used to improve the data for classification, including noise reduction, cropping, and grayscale image conversion. Using a CNN architecture, the deep learning model made it easier to build hierarchical representations from the input data. The system can determine if mask-wearing individuals are present in a camera feed or in the video stream as a whole, and it can record the detection result on the video output. The approach has obtained a respectably high accuracy using straightforward ML tools and methodologies. It is applicable to many different fields. A lot of public service providers would need their consumers to wear masks adequately in order to use their services. The adopted approach will have a significant positive impact on the public health care system. In the future, it can be extended to determine whether or not an individual is appropriately donning the mask. To ascertain whether or not the mask is virus-susceptible—that is, whether or not it is a N95—the model could be improved further or surgical mask. The goal of this system's remote deployment is to strictly enforce adherence to laws and regulations in areas with large populations. to incorporate a GSM module into the system in order to enable it to notify the authorities in the event of a mass violation. In the future, we plan to detect social separation and sound an alarm if someone is not correctly donning a face mask.

So the following analysis demonstrates that the suggested strategy for face mask violation detection is workable. This real- time software may be seen in public spaces such as malls, airports, and smart CCTV surveillance. We also highlight that the software is working on devices with limited computational capability and can be extended to work with other Internet of Things devices to deny permits or close doors at the corporate office, making our proposal applicable in the real world. Based on the above provided information, we can conclude that this specific project is totally helpful for the current circumstances and functions in day-to-day life. Python IDLE (Integrated Development and Learning Environment) is used to construct this application.

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