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Deep Learning Based Face-Mask Detection: An Approach to Reduce Pandemic Spreads in Human Healthcare

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Abstract- For the past two years, the rapid spread of pandemic viruses such as COVID-19 has been significant threat to health of people all around the world. The direct touch that people have with one another is one of the primary factors that contributes to the rapid spread of this illness. Despite the fact that there are numerous preventative steps that can be taken for lessen the transmission of any virus, most significant one is to utilize face masks when you are in communal places. The identification of face-masks in communal places is significant obstacle that must be conquered to lessen likelihoods of virus being passed from person to person. Using deep learning-DL algorithms, framework for face-mask identification has been proposed as a means of efficiently controlling the spread of this deadly disease. This system is intended to meet the issues that have been presented. For the purpose of achieving effective face mask identification, this work makes use of transfer learning models that are built on deep convolution neural networks (DCNN). On our dataset, we conducted an analysis to determine how well these models operate. Our dataset is split into two fragments: training dataset and testing dataset. 10% of data is utilised for testing, whereas 90% of data is used for training. The accuracy of the method that has been proposed is not less than 95%.

Keywords- Face Mask, Deep Learning, Hospitals, Healthcare, DCNN.

Introduction-

Pandemics, defined as global outbreaks of infectious diseases, have been a significant threat to human health throughout history. Understanding the mechanisms of pandemic spread is crucial for developing effective prevention and control measures[1]. This study's purpose is to provides a inclusive overview of factors that contribute to pandemic spread. The pandemic has spread with alarming rapidity, leaving a trail of devastation in its wake. Its relentless march across borders has spared no nation, wreaking havoc on societies and economies alike. The virus has exploited our interconnected world, utilizing global travel and trade routes to establish a foothold in distant lands. Its insidious nature has made containment efforts a daunting task, as asymptomatic carriers unknowingly spread the contagion[2,3]. Healthcare systems[4,5] have been pushed to their limits, struggling to cope with the surge in patients. The economic fallout has been equally severe, with businesses forced to close, unemployment soaring, and global supply chains disrupted. Fear and uncertainty have cast a pall over communities, as people grapple with the threat to their health, livelihoods, and way of life[6]. The pandemic has exposed the fragility of our systems and the urgent need for global cooperation and solidarity. It has laid bare the inequalities that exist within and between nations, highlighting the disproportionate impact it has had on marginalized and vulnerable populations. As the world grapples with the ongoing crisis, it is imperative that we learn from the past and work together to build a more resilient and equitable future. Recently world undergoes the COVID-19 Pandemic[7,8]. Due to this world comes to use the face masks in the places like Hospitals, Schools/ Colleges, or market like places.

In addition to viral infections, face masks also protect against airborne pollutants, allergens, and dust(Figure 1). Air pollution masks, equipped with activated carbon filters, remove harmful gases and particles from the air. Allergy masks, designed with hypoallergenic materials, block allergens such as pollen and pet dander. Dust masks, made from non-woven fabrics, prevent the inhalation of dust particles in construction, mining, or woodworking industries{9,10,11,12].

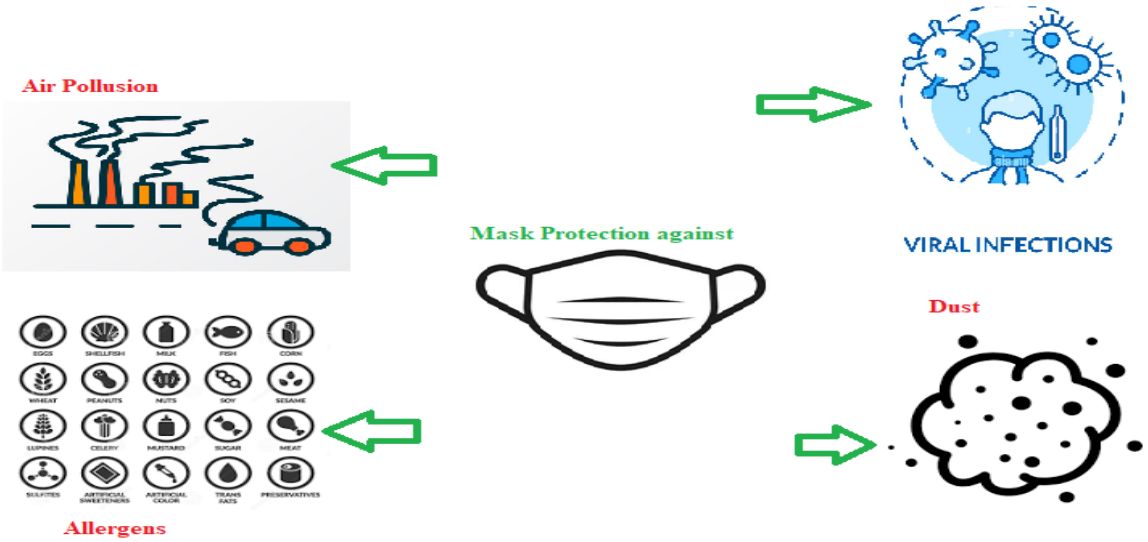

Figure 1- Mask protects against

Choosing the appropriate face mask depends on the specific disease or hazard being faced. Healthcare professionals and individuals exposed to high-risk environments should opt for N95 respirators or surgical masks. For everyday use in community settings, cloth face masks are generally sufficient. For protection against air pollution or allergens, specialized masks with appropriate filters should be used. By understanding the different types of face masks and their specific applications, we can effectively protect ourselves from a wide range of diseases and hazards[13-17].

According to 209th report of WHO, which was published on August 2020, the coronavirus illness (COVID-19)[18,19] began by serious respiratory disease (SARS-CoV2) had caused more than 379,941 deaths worldwide and has infected more than 6 million individuals around the world. In order to effectively manage COVID-19 pandemic, it is essential to realm social separation, expands surveillance, and strengthen health systems. The investigators at AIMS conducted study on understanding methods to fight COVID-19 pandemic. The findings of this study revealed that wearing face-mask or additional covering throughout Mouth & Nose reduces the jeopardy of COVID spread by more than 90 percent. This is accomplished by preventing the forward-traveling distance voyaged by person's respired breath. An elaborate investigation was also conducted by Steffen and colleagues to determine the effects that wearing a mask has on everyday life in the general population. It is possible that a fraction of the general populace in New Delhi and Mumbai may be infectious without exhibiting any symptoms. In Delhi, data indicate that the near universal adoption(80%) of even weak masks(20% effective) has the potential to save 17–45% of anticipated deaths over a period of 2-months and reduces peak daily mortality rate by 35–55% . Following the findings of some studies, it is strongly recommended that face masks be used in public places to prevent transmission of COVID[18,19]. As a further point of interest, the reopening of countries that were under COVID-19 lockdown has resulted in the recommendation of face masks by government and public health authorities as important steps to ensure our safety when we are out in public. The development of a method that compels persons to put on a mask prior to entering public areas is a key step in the process of mandating the usage of facemasks[20,21].

A person's face-mask detection is the technique that determines if or not they are wearing a mask. The name "face-mask detection" relates to this procedure. As a matter of fact, the issue at hand is the contrary engineering of face discovery, which is the process of identifying a face through the application of various ML Algorithms. One of the most important aspects of the field of CV_computer vision and PR_pattern recognition is the detection of faces. Over course of past, a considerable organization of exploration has subsidized to the development of progressive frameworks for face revealing. The first research on face detection was accepted in the year 2001. This research involved the creation of handcrafted features and implementation of conventional ML techniques in order to train efficient classifiers for the purpose of detection and recognition. The technique in question is plagued by a number of issues, the most notable of which are the great complexity of the feature design and the low detection accuracy. In recent years, there has been a noticeable increase in the development of face identification algorithms that are based on deep convolutional neural networks(DCNN). These methods aim to improve the detection performance[22,23].

There's a noticeable difference among "identification of face under mask" and "identification of

mask over face," which is a term that is used interchangeably despite the fact that a great number of academics have dedicated their efforts to the development of effective frameworks for face detection and recognition. It has been established by the research that is now accessible that there is a very little amount of research that attempts to identify masks over faces. In light of this, the purpose of our research is to create a method that is capable of properly detecting masks that are worn over the faces in community places (like Hospitals, Schools, Colleges, buses, autos) to prevent spread of the Coronavirus and, as a result, contribute to the improvement of public healthcare. Furthermore, it's not simple to identify faces in public settings that are either wearing or not wearing masks. This is due to the fact that the dataset that is available for identifying masks on human faces is quite tiny, which makes it difficult to train the model[24,25]. In this context, the idea of transfer learning is utilised in order to transference learned kernels from network that were trained for face detection job that is comparable to the one being performed on a large dataset. There are a variety of face images included in the dataset, such as faces with and without masks in the image/video, and pictures without masks that are ambiguous. Our method obtains an impressively high level of accuracy of 95% when applied to a dataset. Below is a list of the most important contributions that the proposed effort will make:

1. Create a novel approach for detecting objects to accurately detect the object from Video/images streams while also including learning at back-end.

2. In order to crop the facial portions from uncontrolled videos/photos that have changes in face's size, background and orientation an amended affine transformation has been devised. By taking this step, it is possible to more accurately localise the individual who is breaching the facemask standards in public spaces or offices.

3. The development of a facemask dataset that is objective and has an imbalance ratio that is close to one of one.

4. The model that has been proposed uses less memory, which makes it extremely simple to implement for embedded devices that are utilised for surveillance reasons.

Literature Survey-

Pattern recognition and object identification are inherent challenges which computer vision(CV) approach needs to cope with in order to function properly[26,27,28]. The process of object recognition incorporates both the classification of images and the detection of objects. The accomplishment of task of recognising the mask that is placed over a face in pubic area may be accomplished by utilising surveillance devices that are equipped with an effective object recognition algorithm. The object recognition pathway is comprised of the generation of region suggestions, which is then followed by the classification of every proposal into a class that is related to previous proposals.

A DL-based model is provided in the work that Shilpa et al.[16] have done in order to recognise masks that are placed over people's faces in public places in order to prevent spread of Coronavirus

community. By utilising a combination of single and two stage detectors, the suggested model is able to manage a wide variety of occlusions in dense situations in an effective manner. The ensemble technique not only contributes to the achievement of high accuracy but additionally significantly enhances the speed at which detection is performed. During the mask detection process, the model attains accuracy of 98.2%, with an average inference time of 0.05 sec per image.

Effective face-mask detection is achieved by the utilisation of DCNN and MobileNetV2-based learning models, as demonstrated in the work carried out by Hussain and colleagues[19]. They assessed the enactment of their two models on 2 distinct datasets, namely, their own dataset that was produced by taking into consideration real-time scenarios that contained photos (dataset-1) and dataset that was obtained from PyImage (dataset-2). In contrast to DCNN, which obtained accuracy on both datasets, MobileNetV2 was able to achieve and accuracy 98% & 99% on dataset1, dataset-2, respectively, as proven by the results of the experiments. On the basis of our findings, it is possible to draw the conclusion that the transfer learning model that is based on MobileNetV2 would be alternative to DCNN model for the purpose of detecting face-masks with a higher degrees of accuracy.

Vahida et al.[20] have proposed the implementation of a smart cart system that is built using RFID technology. This system would be able to monitor the products that have been purchased as well as the transactions that have been made through online billing. In addition to this, the system will provide product recommendations to users with the help of a centralised system that is based on their purchase patterns. The system that is being proposed consists of camera that use DL in order to recognise the object, as well as load-cell that serves the purpose of weighing the thing that is attached to shopping cart. The bill will be generated by the system when the consumer scans the thing in-front of camera that is permanently installed in the cart. There are a variety of approaches that can be utilised to carry out object recognition. To generate bounding boxes, techniques such as R-CNN and YOLO make use of area suggestions[29]. These bounding boxes are then utilised to execute classifiers throughout the process. Next, the duplicates are eliminated through the application of post-processing methods. Because of this, we found it helpful to employ the YOLO paradigm.

Methodology-

Face-mask detection using DL_deep learning has emerged as a crucial technology in fight against COVID-19 pandemic[30] and beyond. Deep learning algorithms, predominantly DCNNs, have confirmed extraordinary capabilities in identifying and classifying faces with and without masks. DCNNs are trained on vast datasets of categorized images, enabling them to extract intricate features from facial images. These features include facial contours, facial landmarks, and occurrence or nonappearance of mask. By leveraging these features, deep learning models can accurately detect faces and determine whether an distinct is wearing mask. This technology has significant applications in public health, such as monitoring compliance with mask mandates in public spaces, healthcare settings, and workplaces. Additionally, it can assist in automated screening and early detection of individuals potentially infected with respiratory illnesses, as mask-

wearing is often a key preventive measure. Furthermore, face mask detection using deep learning can enhance security systems by identifying individuals who may be attempting to conceal their identities. The ongoing research and advancements in this field promise even greater accuracy and efficiency in face mask detection, causative to the improvement of robust and reliable solutions for innumerable applications.

Figure 2 –Training of classifier

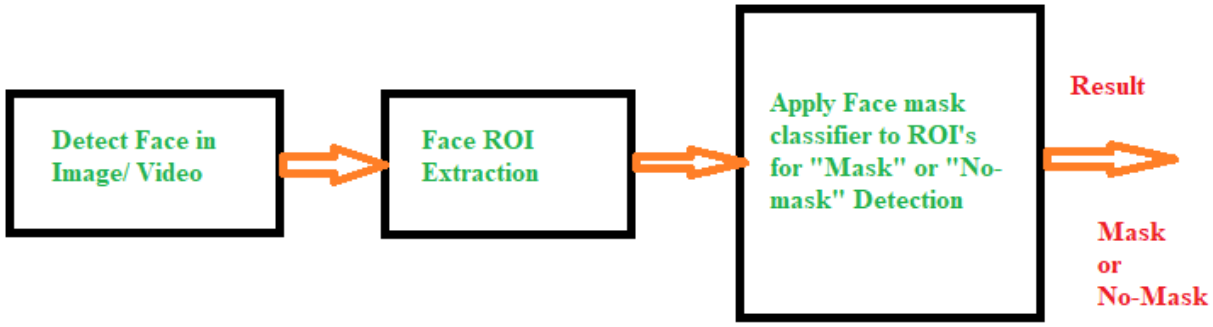

Figure 3 - Classifier method for Mask detection

DCNN which is based on transfer learning, are deep learning-DL architectures that we are taking into consideration in this study. The datasets that have been utilised in order to assess the effectiveness of the model that has been proposed are ones that we have produced ourselves. Both of these datasets were given the names Training and Testing dataset, respectively, for the sake of convenience. When it comes to the Deep Convolutional Neural Network (DCNN), in each dataset, 90% of the data was utilised for training, and enduring 10% is utilized for testing our model. In order to boost the amount of data, a technique known as data augmentation was utilised. This technique involved making negligible adjustments to Images, like as totating, Zooming & resizing them. This method contributes to the reduction of the issue of overfitting that occurs during the training of the model. Photos were downsized to, alternated to degrees, and zooms in using zoom-in factor. Both of these operations were performed on photos. A representation of the DCNN for the detection of face masks is shown in Figure 3.

In reality, deep convolutional neural networks (DCNN) are not simply deep neural networks with numerous hidden layers; rather, they are deep networks that replicate the way in which the visual

cortex of the human brain processes and recognises images. The processing of an input image involves first conveying relevant weights, which are learnable constraints, to different sections of image, and then distinguishing between various properties of image. When compared to other classification algorithms, it requires a significantly smaller amount of preprocessing and takes significantly less time with DCNN. Unlike previous methods, which require the development of filters by manual labour, DCNN are capable of learning to create filters through adequate training. During the course of our investigation, we utilised the DCNN architecture, which is illustrated in Figure 4. Convolutional layers, average-pooling layers, and 1 fully connected layer are components that makes up these convolutional layers.

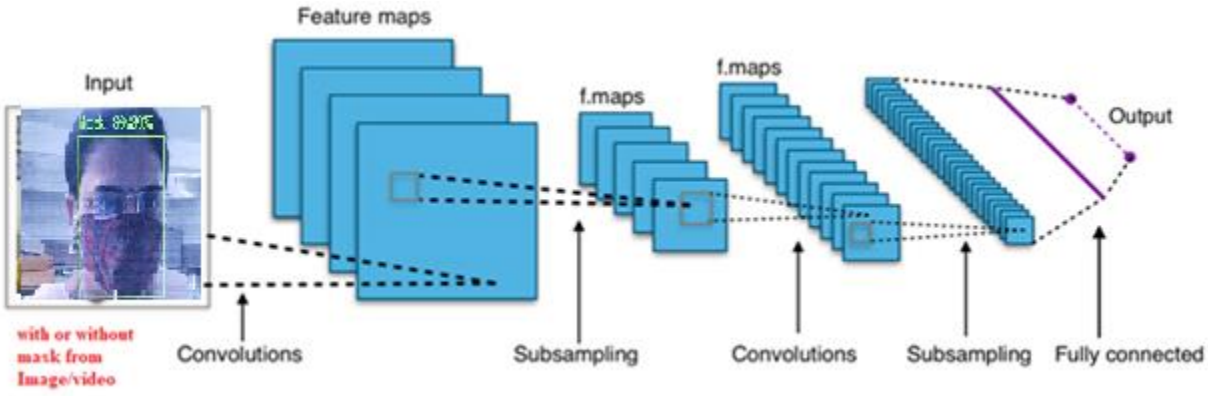

Figure 4- DCNN Architecture for Face mask detection

Results and Discussion-

Face mask detection using DL has materialized as a crucial approach to mitigate the spread of pandemics in hospitals. Through the utilisation of the capabilities of AI-artificial intelligence, DL algorithms are able to do picture analysis and videos to identify individuals wearing face masks, ensuring compliance with hospital protocols and reducing the risk of infection. This technology has proven effective in crowded hospital environments, where manual monitoring of mask usage is challenging. By automating the process, deep learning models can continuously monitor and flag individuals who are not wearing masks, allowing healthcare professionals to intervene promptly. Additionally, face mask detection can be integrated with surveillance systems to provide real-time alerts and assist in contact tracing efforts. As hospitals strive to maintain a safe and healthy environment for patients and staff, deep learning-based facemask detection offers a valuable tool to combat the spread of transferable illnesses and protect well-being of individuals within hospital settings.

Figure 5, 6 shows the results of our proposed system. Figure 5 shows the person without mask. Firstly, ROI of face is detected and then from that ROI, the mask is detected. Then the mask area is detected. If no mask on Face, then % of non-masking are is shown.

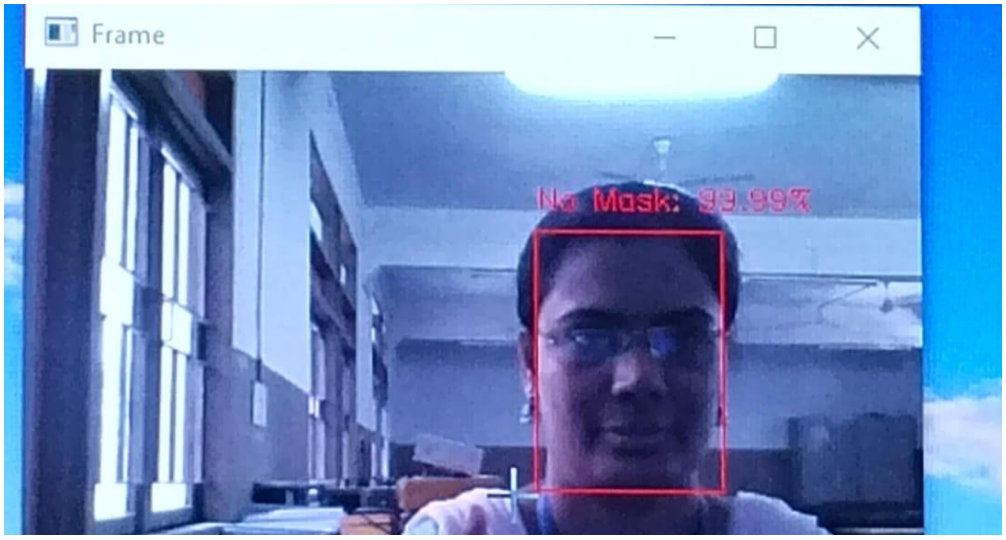

Figure 5- Face without mask

Figure 6, show the person with the mask, which is detected by our proposed system.

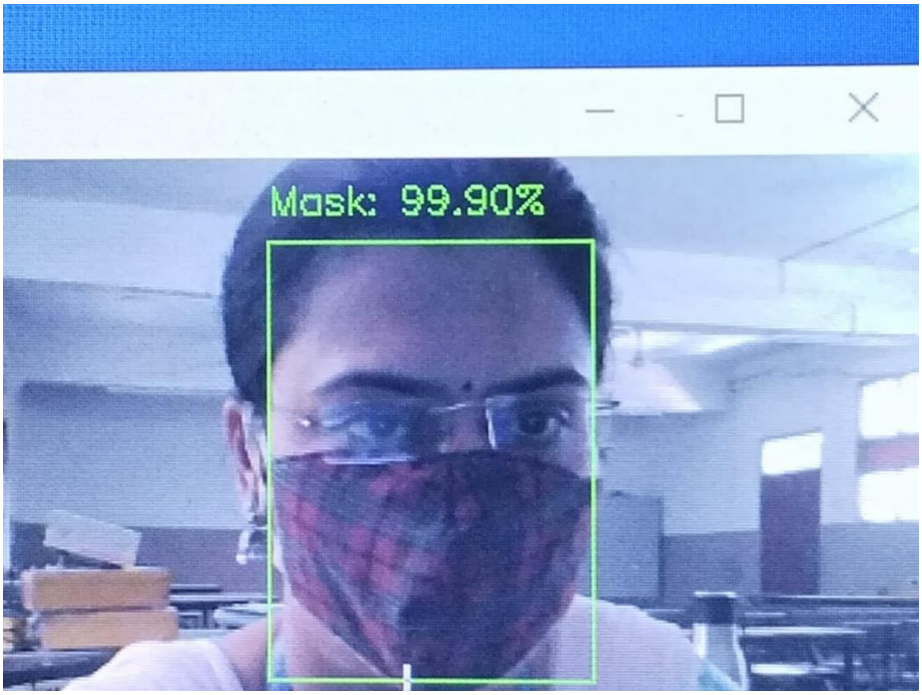

Figure 6- Masked person.

Training and validation visualisations of DCNN prototypical on dataset are displayed to in Figure 8. During the course of fifty epochs, DCNN model was capable to procure a high level of training and validation accuracy on the datasets, as demonstrated in Figure 7.

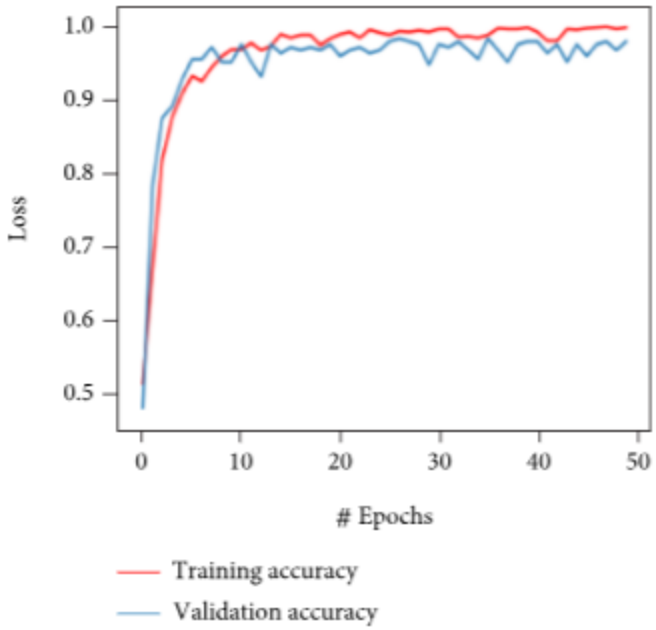

Figure 7- Accuracy for DCNN

As Epochs changes, accuracy changes. The maximum accuracy of 95% is achieved at 50 Epochs. At lower Epochs, accuracy is less, means accuracy loss is more.

Conclusion-

Face mask detection using DL has developed as powerful tool in the fight against pandemic spread. By leveraging advanced machine learning algorithms, deep learning models can accurately identify individuals wearing face masks, ensuring compliance with public health guidelines. This has been particularly crucial during the COVID-19 pandemic, where face-masks have become an essential protective measure. By implementing DL-based face-mask detection systems in public spaces, workplaces, and educational institutions, governments and organizations can effectively monitor mask usage and enforce mask mandates. This not only reduces risk of virus transmission but also promotes sense of responsibility and collective action. Furthermore, deep learning models can be trained on diverse datasets, enabling them to detect face masks in various lighting conditions, facial expressions, and skin tones. This adaptability ensures that face mask detection systems are robust and reliable, even in challenging environments. As the world continues to navigate the challenges of infectious disease outbreaks, deep learning-based face mask detection will remain a valuable tool in protecting public health and mitigating the spread of pandemics. The accuracy of proposed method is 95% and more. In Future, the decision making is required based on mask, so that will implemented by KSK approach suggested by Dr Kazi K S, which uses AIIoT.

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Conflict- No Conflict

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