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Real-Time Face Mask Detection

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Abstract*—Real-time face mask detection leverages computer vision and deep learning to identify individuals wearing masks in videos or live camera feeds. It involves two key steps: face detection to locate human faces and mask detection using trained deep learning models to analyze the facial region for mask presence. This technology offers benefits like public health monitoring and security access control, but requires considerations for accuracy and real-time processing efficiency. Ongoing research focuses on improving these aspects for wider deployment.The widespread adoption of face masks as a preventive measure against infectious diseases has necessitated the development of efficient face mask detection systems. In this paper, we propose a real-time face mask detection system utilizing deep learning techniques. The system employs a convolutional neural network (CNN) architecture, specifically designed to accurately detect the presence or absence of face masks in live video streams. Initially, the proposed system preprocesses the input video frames to extract facial regions using a pre-trained face detection model. These facial regions are then fed into the CNN for classification into two categories: with mask and without mask. The CNN model is trained on a diverse dataset of annotated facial images with and without masks, ensuring robustness and generalization. To enhance real-time performance, we optimize the model architecture for efficient inference on resource-constrained devices, such as embedded systems and mobile devices. We leverage techniques such as model pruning, quantization, and parallelization to achieve low-latency inference without compromising accuracy. Experimental evaluations conducted on various real-world scenarios demonstrate the effectiveness and efficiency of the proposed system. The system achieves high accuracy in detecting face masks in real-time while maintaining low computational overhead. Moreover, extensive testing under different lighting conditions, angles, and occlusions validates its robustness and practical viability. Overall, the proposed real-time face mask detection system presents a scalable and deployable solution for ensuring compliance with face mask mandates in public spaces, contributing to public health efforts to mitigate the spread of infectious diseases

I. INTRODUCTION

The global outbreak of infectious diseases, such as COVID-19, has led to unprecedented measures to control transmission, including the widespread adoption of face masks as a preventative measure. However, ensuring compliance with mask-wearing mandates in public spaces presents significant challenges for authorities. Traditional methods of enforcement rely on human intervention, which is time-consuming, resource-intensive, and prone to errors.

To address this challenge, automated face mask detection systems have emerged as a promising solution. Real-time face mask detection systems leverage advancements in computer vision and deep learning techniques to detect the presence or absence of face masks in live video streams. These systems offer a scalable, efficient, and accurate means of monitoring mask compliance in various settings, including airports, hospitals, public transport, and retail establishments.

The primary objective of this research is to develop a robust and efficient real-time face mask detection system capable of accurately identifying individuals wearing masks in live video feeds. By automating the detection process, the system aims to streamline enforcement efforts, enhance public safety, and mitigate the spread of infectious diseases. In this paper, we present a comprehensive overview of the proposed real-time face mask detection system,highlighting its architecture, methodology, and key components. We discuss the challenges associated with face mask detection, including variations in lighting conditions, facial orientations, and occlusions, and propose strategies to address these challenges effectively. Furthermore, we provide a detailed analysis of existing literature and state-of-the-art techniques in face mask detection,outlining their strengths, limitations, and potential areas for improvement. By building upon the existing body of research, we aim to contribute novel insights and advancements to the field of computer vision and public health surveillance. Overall, the development of a real-time face mask detection system holds significant implications for public health authorities, policymakers, and the general public.

By leveraging cutting-edge technologies, such as deep learning and real-time video processing, we can create more efficient and proactive strategies for enforcing mask mandates and controlling the spread of infectious diseases in various environments.

II. SCOPE AND OBJECTIVE

A. scope:

The real-time face mask detection system aims to monitor and detect whether individuals are wearing face masks in various environments (e.g., public spaces, workplaces, healthcare facilities). The system utilizes computer vision techniques, primarily deep learning models, to process live video streams or images, classifying whether an individual is wearing a mask correctly or not.

B. objective:

The primary objective of real-time face mask detection is to automatically and continuously identify individuals wearing masks in live video streams or camera feeds. This technology aims to achieve the following:

1. Promote Public Health: By monitoring mask usage in public spaces, real-time face mask detection can help ensure adherence to public health guidelines. This can potentially contribute to slowing the spread of COVID-19 or similar airborne illnesses.
2. Enhance Security and Access Control: This technology can be integrated with security systems to manage access control. By analyzing mask usage, the system can grant or deny entry to specific areas depending on pre-defined protocols.
3. Improve Operational Efficiency: Real-time face mask detection automates the process of monitoring mask usage, freeing up human resources for other tasks.

Overall, real-time face mask detection strives to be a valuable tool for promoting public health,enhancing security measures, and improving operational efficiency in various settings.language translator consists of 4 modules i.e. Input, Translation, Output modules

III. PROBLEM STATEMENT

The widespread adoption of face masks as a preventive measure against infectious diseases, coupled with the need for efficient enforcement of mask-wearing mandates in public spaces, presents a significant challenge. Traditional methods of monitoring and ensuring compliance rely heavily on manual intervention, which is labor-intensive, prone to errors, and inefficient, particularly in high-traffic environments. Therefore, the problem statement for real-time face mask detection revolves around the development of a robust, efficient, and adaptable system capable of accurately identifying individuals wearing masks in live video streams.

IV. MOTIVATION

Real-time face mask detection is a crucial project, especially in the context of public health. Here are several motivating factors for pursuing this project:Public Health Safety,Technological Advancement,Community Impact,Data Analysis Oppurtunities,Integration with IOT,Scalability,Innovative Solutions, collabrative Oppurtunities.By working on this project, you not only address an urgent societal need but also position yourself at the forefront of technological innovation in public health.

V. SYSTEM OVERVIEW

a. Android , Windows , Mac book . etc . . .

A real-time face mask detection system involves detecting whether people are wearing face masks in live video feeds, typically for public safety or health compliance. Here's an overview of the system components: 1. System Architecture The real-time face mask detection system can be divided into several key components:

a. Input Module: Video Feed: This can come from surveillance cameras, webcams, or mobile cameras, capturing live footage. Preprocessing: The captured frames are resized and normalized for further processing.

b. Detection Module: Face Detection: Using models like OpenCV's Haar cascades, Dlib, or deep learning-based face detectors (e.g., Single Shot Detector (SSD), YOLO, or MTCNN) to locate faces in real-time frames.

Mask Classification: A pre-trained deep learning model classifies whether a detected face is wearing a mask or not. Common models include Convolutional Neural Networks (CNNs), often built on frameworks like TensorFlow, Keras, or PyTorch.

c. Decision Logic: Based on the output from the mask classifier, the system can flag frames where a mask is absent or present.

d. Output Module: Real-Time Alerts: The system can generate alerts or visual indicators (like bounding boxes) in the video stream for non-mask-wearing individuals. Logging: Data about mask compliance can be logged for auditing purposes.

2. Data Flow Input Video Frame → 2. Face Detection → 3. Mask Classification → 4. Output Decision (Alert/Visuals/Logging)

3. Key Components a. Video Capture: The system captures video frames from a live camera stream or CCTV feed. Frames are preprocessed (resizing, scaling) for faster processing.

b. Face Detection: Detects faces in the frames. Models like Haar cascades or deep learning approaches (YOLO, MTCNN) can be used.

c. Mask Detection: A CNN-based classifier (e.g., MobileNetV2, ResNet) processes the face regions and classifies whether the person is wearing a mask. Trained on datasets of images with and without face masks.

d. Post-Processing and Alert System: Frames are annotated with bounding boxes around faces indicating "Mask" or "No Mask." Alerts can be generated for frames without masks, and the system can record compliance statistics.

4. Technology Stack Programming Language: Python is commonly used.

Libraries: OpenCV for video processing and basic face detection. TensorFlow/Keras or PyTorch for the mask classification model. Dlib for advanced face detection/tracking. Deep Learning Models: Pretrained CNN models like MobileNetV2, VGG16, or ResNet for mask classification.

Hardware: CPU or GPU (for deep learning inference). Cameras or CCTV infrastructure for real-time video capture.

5. Steps to Build the System Dataset Collection and Preprocessing: Collect and label images of faces with and without

masks. Perform data augmentation (e.g., rotation, flipping) to increase dataset diversity.

Train the Mask Detection Model: Fine-tune a CNN-based model (e.g., MobileNetV2) to classify mask/no-mask images. Train the model using libraries like TensorFlow or PyTorch.

Implement Face Detection: Use pre-trained face detectors like Haar cascades, Dlib, or YOLO to detect faces in live video feeds.

Integrate Real-Time Processing: Capture video frames, apply face detection, and feed detected face regions into the mask classifier.

Alert and Reporting: Display results in real time (mask/no-mask overlay) and generate alerts for non-compliance.

6. Performance Considerations Speed: Optimizing the model and face detection pipeline to meet real-time constraints (e.g., processing 30 FPS).

Accuracy: Ensuring the model generalizes well across various lighting conditions, face angles, and mask types.

Scalability: Handling multiple video streams simultaneously and deploying in different environments.

VI. LITERATURE SURVEY

A literature survey for a face mask detection project focuses on reviewing existing methods, algorithms, and technologies used for face detection and mask classification in computer vision. This survey highlights the advancements in machine learning and deep learning for addressing the problem, as well as the datasets, models, and techniques adopted.

Paper 1:Real-time face mask detection for COVID-19 prevention:

Abstract : Covid-19 is a topic that is currently trending. It has instilled fear and danger in the minds of practically everyone. Coronavirus disease is spread from individual to individual through respiratory droplets breathed during coughing, talking, sneezing, or inhaling. Because droplets can be inhaled from one person to another, it is vital to avoid public meetings and to use masks. Manually detecting face masks takes a lot of time. To detect face masks automatically, a lightweight, cost effective, durable, and video surveillance system is required.Using a binary classifier based on Convolution Neural Networks, this research provides a robust, lightweight, and cost-effective automatic system for detecting face and face mask classification (CNN). MobileNetV2, a single-shot detector (SSD) based on a binary classifier,was employed in this autonomous system. This work also discusses various face detectors and face mask classifiers, as well as the differences between these models. The F1 Score, as well as accuracy, are used to appraise the autonomous system's accomplishment. The system that is proposed gives an f1 score of 98accuracy of 95.85

Keywords : COVID-19, Deep Neural Network, Convolution Neural Network, MobileNetV2,Face detection, Open-CV DNN, Face Mask Classification, Data augmentation, Fine-tuning,Adam Optimizer.

Paper 2:Real-Time Facemask Detection for Preventing COVID-19 Spread Using Transfer Learning Based Deep Neural Network:

• Abstract: The COVID-19 pandemic disrupted people's livelihoods and hindered global tradeand transportation. During the COVID-19 pandemic, the World Health Organization mandated that masks be worn to protect against this deadly virus. Protecting one's face with a mask has become the standard. Many public service providers will encourage clients to wear masks properly in theforeseeable future. On the other hand, monitoring the individuals while standing alone in one location is exhausting. This paper offers a solution based on deep learning for identifying masks worn over faces in public places to minimize the coronavirus community transmission. The main contribution of the proposed work is the development of a real-time system for determining whether the person on a webcam is wearing a mask or not. The ensemble method makes it easier to achieve high accuracy and makes considerable strides toward enhancing detection speed. In addition, the implementation of transfer learning on pretrained models and stringent testing on an objective dataset led to the development of a highly dependable and inexpensive solution. The findings provide validity to the application's potential for use in real-world settings, contributing to the reduction in pandemic transmission. Compared to the existing methodologies, the proposed method delivers improved accuracy,specificity, precision, recall, and F-measure performance in three-class outputs. These metrics include accuracy, specificity, precision, and recall. An appropriate balance is kept between the number of necessary parameters and the time needed to conclude the various models.

• Keywords: deep learning; facemask; computer vision; CNN; COVID-19

Paper3:Coronamask: A Face Mask Detector for Real-Time Data:

Abstract: Chhaya Gupta1, Nasib Singh Gill2 1,2Department of Computer science and Applications Maharishi Dayanand University, Rohtak Haryana, India Email: chhayagupta.spm@gmail.com , nasibsgill@gmail.com COVID – 19 (2019 novel coronavirus) which started in China had spread all over the world rapidly. It is the worst health crisis the whole world has suffered after World War II. Many precautionary measures have been indicated by the World Health Organisation (WHO) like to maintain social distancing, wear masks, wash hands with soap for 20 seconds and many more. Wearing masks in public places is quite an effective measure to stay protected from this pandemic.There is very few research done for detecting face masks. This paper contributes to the welfare of human beings and proposes CoronaMask, a highly effective face mask detector. The proposed model uses the deep learning convolutional neural network (CNN) algorithm as a base for detecting faces. In this study, the dataset has been created which consists of 1238 images which are divided into two classes as "mask" and "no mask". This model also takes live streaming videos as input and detects faces which are wearing masks and which are not wearing a mask. The convolutional neural network is

trained on the dataset and it gives 95accuracy. CoronaMask, a two-phase face mask detector works in identifying masks in images and also in real-timevideo streams.

• Keywords : Convolutional Neural Network (CNN), Deep Learning, Face Detection, Face Mask Detection, Real-time video streaming.

Paper 4:Face Mask Detection Using Machine Learning:

Abstract: According to the World Health Organization, the corona virus COVID-19 pandemic is causing a worldwide health disaster, and the most effective preventative measure is to wear a face mask in public places (WHO). The COVID-19 epidemic compelled governments worldwide to implement lockdowns in order to limit viral spread. Wearing a face mask at work, according to reports, reduces the likelihood of transmission significantly. An efficient and cost-effective method of using AI to create a safe environment in a manufacturing setting. Face mask detection will be demonstrated using a deep learning model. We'll utilize OpenCV to accomplish real-time face detection from a live feed via our webcam using a face mask detection dataset that consists of with mask and without mask photos. Using Python, OpenCV,and Karas, we will develop a COVID-19 face mask detector using deep learning. With the use of deep learning, we hope to determine whether or not the individual in the image/video stream is wearing a face mask.

• Keywords: COVID-19, OpenCV, MobilenetV2, Adam, VGG16

Paper 5:A Deep Learning Model for Face Mask Detection:

Abstract: Corona Virus is a big and dynamic threat to us humans. Now, the whole world is trying to lessen the spread of Covid 19. Wearing masks in a proper way is one of the practices that helps to control the transmission of the virus according to the notable World Health Organization. However, to ensure that all people wear a facemask is a very gigantic task. To prevent the spread of illness, face masks must be used, and cells should be killed or eliminated utilising available therapies such as surgery, radiotherapy, chemotherapy, and others. 30,000 people die each year, according to estimates. Early detection procedures are critical in lowering the mortality rate. X-rays, MRIs, CT scans, ultrasounds, and other imaging techniques are utilised for this. In this research paper, we propose a very simple and effective model for real-time monitoring through the convolution neural of networks to detect if an individual wears a face mask or not. This model is trained, validated, tested upon two datasets.Corresponding to dataset the accuracy of the model was 95.77

• Keywords: Face mask, Convolution neural network, deep learning, TensorFlow

Paper 6:Design Flow for Real-Time Face Mask Detection Using PYNQ

System-on-Chip Platform: • Abstract: Study shows that mask-wearing is a critical factor in stopping the COVID-19 transmission. By the time of this article, most US states have mandated face masking in public space. Therefore, real-time face mask detection becomes an essential application to prevent the spread of the pandemic. This study will present a face mask detection system that can detect and monitor mask-wearing from camera feeds and alert when there is a violation. The face mask detection algorithm uses Haar cascade classifier (HCC) to find facial features from the camera feed and then utilizes it to detect the mask-wearing status. The detection system runs on a PYNQ-Z2 all-programmable SoC platform, where it will pipeline the camera feed through the FPGA unit and carry out the face mask detection algorithm in the ARM core. Potential delays are analyzed, and efforts are made to reduce them to achieve real-time detection. The experiment result shows that the presented system achieves a real-time 45fps 720p Video output, with a face mask detection response of 0.13s.

Paper 7:Real-Time Face Mask Detection using Deep Learning:

Abstract: The outbreak of COVID-19 has taught everyone the importance of face masks in their lives. SARS COV-2(Severe Acute Respiratory Syndrome) is a communicable virus that is transmitted from a person while speaking, sneezing in the form of respiratory droplets.It spreads by touching an infected surface or by being in contact with an infected person. Healthcare officials from the World Health Organization and local authorities are propelling people to wear face masks as it is one of the comprehensive strategies to overcome the transmission. Amid the advancement of technology, deep learning and computer vision have proved to be an effective way in recognition through image processing. This system is a real-time application to detect people if they are wearing a mask or are without a mask.

It has been trained with the dataset that contains around 4000 images using 224×224 as width and height of the image and have achieved an accuracy rate of 98this research, this model has been trained and compiled with 2 CNN for differentiating accuracy to choose the best for this type of model.It can be put into action in public areas such as airports, railways, schools, offices, etc. to check if COVID-19 guidelines are being adhered to or not.

Paper 8:DETECTION OF FACE MASKS IN REAL TIME:

Abstract: Real-time face mask detection has become a crucial task in ensuring public safety and adherence to mask wearing guidelines. In this project, we present a system for real-time face mask detection using Python. The system utilizes computer vision techniques and deep learning algorithms to accurately identify whether individuals in a video stream are wearing masks or not. Our approach involves leveraging the OpenCV library for real-time video processing and face detection. We employ a pre-trained convolutional neural network (CNN) model, such as MobileNetV2 or ResNet, for mask classification. The CNN model is trained on a large dataset of annotated face images with and without masks. The face mask detection system works by capturing video frames from a camera feed, detecting faces using Haar cascades or deep learning-based methods, and applying the trained CNN model to classify the presence or absence of masks on each detected

face. The system provides real-time feedback, overlaying bounding boxes and labels indicating whether a face is wearing a mask or not. To enhance the system's performance and accuracy, we employ data augmentation techniques during training, which help in handling variations in lighting conditions, poses, and backgrounds. Additionally, we optimize the model for real-time execution, taking advantage of hardware acceleration technologies like GPU processing when available. It offers a reliable solution for monitoring mask compliance in public spaces, such as airports, hospitals, retail stores, and public transportation, contributing to the prevention of the spread of infectious diseases.

• Keywords: Deep Learning, Python, OpenCV, Convolutional Neural Network(CNN), Haar cascades, Computer Vision.

Paper 9:Face Mask Detection Using Deep Learning:

Abstract: It is vital to remain vigilant during pandemic COVID-19. Wearing a face mask is one of the crucial steps that people must take to ensure that they are a step away from spreading and infecting the virus. However, controlling and monitoring people in a densely crowded place is tough. Hence, a face mask detection system in public area is needed to remotely monitor if one is wearing a facemask or vicevversa.Inthisstudy,twofacemasksdatasetsaredownloadedfrom GitHub with 3834 images and 11800 colour images. Data pre-processing steps are carried out before the classification, which includes image resizing, converting images into array and label encoding. Two deep learning models, MobileNetV2 and VGG19,are developed for detection and evaluation. The experimental results performed by MobileNetV2 outperformed the VGG19 with achieving accuracy of 98.96

Keywords:MobileNetV2,VGG19,Accuracy · Face mask detection ,Real time camera.

Paper 10: Real Time Face Mask Detection System using Transfer

Learning with Machine Learning Method in the Era of Covid-19 Pandemic: Abstract: The rapid development of computer vision has attracted more attention to the global epidemic Covid-19 to enable human-computer interaction and improve public health services.Due to the rapid spread of the (Covid-19), various countries are facing a major health crisis.According to the World Health Organization (WHO) an effective way to protect people from Covid-19 is to wear medical masks in public areas. It is very difficult to manually monitor people in public places and detect the face mask in the video. which is mainly because the mask itself acts as an obstruction to the face detection algorithm, because there are no face signs in the mask area. Therefore, automatic face mask detection system helps authorities to identify people who may be susceptible to infections disease. This research aims to use deep learning to automatically detect face masks in videos. The proposed framework consists of two components. The first component is designed for face detection and tracking using OpenCV and machine learning, and in the second component, these facial frames are then processed into our proposed deep transfer learning model MobileNetV2 to identify the mask area. The proposed framework was tested on different videos and images using the smartphone camera. The purpose is to achieve high-precision real-time detection and classification. The model achieved 99.2accuracy. which is better than other recently proposed methods. This research is useful for controlling the spread of the virus and preventing exposure to the virus.

Keywords: Face mask detection, computer vision, deep learning, object detection,MobileNetV2, Android; Covid-19.

Paper 11 : Face Mask Detection Using Machine Learning :

Abstract : COVID-19 pandemic has rapidly affected our day-to-day life disrupting the world trade and movements. Wearing a protective face mask has become a new normal. In the near future, many public service providers will ask the customers to wear masks correctly to avail of their services. Therefore, face mask detection has become a crucial task to help global society. This paper presents a simplified approach to achieve this purpose using some basic Machine Learning packages like TensorFlow, Keras and OpenCV.The application of "machine learning" and "artificial intelligence" has become popular within the last decade.Both terms are frequently used in science and media, sometimes interchangeably,sometimes with different meanings. In this work, we specify the contribution of machine learning to artificial intelligence. We review relevant literature and present a conceptual framework which clarifies the role of machine learning to build (artificial) intelligent agents. The proposed method detects the face from the image correctly and then identifies if it has a mask on it or not. As a surveillance task performer, it can also detect a face along with a mask in motion. The method attains accuracy up to 95.77and 94.58a Convolutional Neural Network architecture to detect the presence of masks correctly without causing overfitting.

Paper 12 : Face Mask Detection Using OpenCV :

ABSTRACT : As a biosafety precaution, the World Health Organization (WHO) introduced the wearing of face masks after the COVID- 19 epidemic. This posed challenges to existing facial recognition systems, so this study was born. In this publication, we describe how to create a system that allows you to identify people from images, even when they wear a mask. The face detector in OpenCV is used in conjunction with Based on the Mobile NetV2 architecture, a classification model in this way, it is possible to determine whether the face is wearing a mask and where it is situated. To conduct face recognition, A Face Net model is used as a feature extractor and a multilayer feedforward perceptron is used for training facial recognition models using a collection of about 4000+ photographs. Of the images, 52,9 percent came with a face mask and 47,1 percent were without mask. The outcomes of the tests demonstration that determining whether or not someone is wearing a mask is 99.65

• Keywords Face Mask Detection, TensorFlow, Keras, OpenCV, Coronavirus, Data Set,Convolutional Neural Network.

Paper 13 : A new deep learning model to reduce Covid19-based face mask detection :

Abstract : The COVID-19 pandemic of the coronavirus is a serious health threat. Governments are taking specific protections, including lockdowns and the need that face masks to be used.Wearing a protective cover is one of the most efficient ways to fight the disease. Due to this reason, offerings are the detection of face masks that can be utilized by specialists to create moderation, prevention, and assessment. According to the recommendations of the World Health Organization (WHO), the best important prevention strategy is using a facial mask. Hence, the need of wearing a mask is so important to save our lives and also protect others appropriately in open places including shopping malls and general stores. Reports demonstrate that face mask wearing whereas at work clearly diminishes the chance of spread. This paper presents a rearranged approach to obtain this reason by utilizing machine learning for detecting face masks. A dataset is utilized to construct this detector of the face mask. Via computer vision techniques and algorithms using deep learning the goal can be achieved. It includes the architecture of the MobileNet model that is trained with Tensorflow and Keras libraries. In this paper, Jetson tx2 was utilized to implement a real-time face masks automatic detection that is embedded and powerful, running on an embedded system at a higher frames-persecond rate (FPS) based on IoT.The proposed system aids in monitoring, taking images, and identifying persons who were not wearing masks. Additionally, we employed IoT strategies to transmit the images and alerts to the closest police station so that forfeit could be applied when it discovered unmasked persons. We used an actual dataset to train our model, and this improvement makes the recommended approach possible to seek a high level of accuracy rate of unmasking people our model trained on the real datasets and this improvement makes the proposed model urge a high accuracy in the detection of unmasking persons.

• Keywords: COVID-19 Virus, Masked Face Recognition and Detection, Masked Face Dataset,Safety, Deep Learning Algorithm, TensorFlow, Keras, Python Programming, Computer Vision,Neural Networks, Facial Landmarks, IoT Health Care, Raspberry Pi, MobileNetV2, Machine Learning.

Paper 14 : FACE MASK DETECTION USING OPENCV :

Abstract: As the ”epidemic” spreads, it is creating a global healthcare disaster and disrupting our daily lives. This virus is spread mostly by droplet that erupt from someone in a coronavirusinfected person and pose a threat to others. In public places like airports, marketplaces,railroads, and retail stores, virus propagation is more probable.” Wearing a face mask in open areas, as set by the World Health Organization (WHO), ”The authority is enforcing restrictions like as having to wear throughout public areas, which is one of the most efficient strategies to prevent being affected with the covid virus.” using mouthwash, and maintaining social separation. Using Tensor Flow, Keras, and OpenCV, we provide a method for recognizing face masks on people.A classification model generated well around individual’s face using OpenCV determines is not whether the guy is wearing a bulletproof vest.” If the face of a person detects that they would be not wearing a scarf, they should take care. The mask is created using real-time public faces and placed into a Convolutional Neural Network (CNN) as an input. Using OpenCV, Tensor Flow, NumPy, Keras, and MobileNetV2, the dataset is utilized to create a face mask detector. We’ll utilize a live video stream, and the output will indicate the accuracy with labels like ”Mask” and ”No Mask,” and then we’ll be able to combine it with a database to record the image’s features. Our objective is to determine if the person in the appearance broadcasts is trying to imply or not ”To inhibit the spread of the covid virus.” This study will look at the current literature on perspective analytics and the most popular methods for its implementation.

• Keywords: Convolutional Neural Network (CNN), Epidemic, Face mask, OpenCV, NumPy,Tensor Flow.

Paper 15: Face mask detection using deep learning: An approach toreduce risk of Coronavirus spread :

ABSTRACT :Effective strategies to restrain COVID-19 pandemic need high attention to mitigate negatively impacted communal health and global economy, with the brim-full horizon yet to unfold. In the absence of effective antiviral and limited medical resources, many measures are recommended by WHO to control the infection rate and avoid exhausting the limited medical resources. Wearing a mask is among the non-pharmaceutical inter vention measures that can be used to cut the primary source of SARS-CoV2 droplets expelled by an infected individual. Regardless of discourse on medical resources and diversities in masks, all countries are mandating coverings over the nose and mouth in public. To contribute towards communal health, this paper aims to devise a highly accurate and real-time technique that can efficiently detect non-mask faces in public and thus, enforcing to wear mask. The proposed technique is ensemble of one-stage and two-stage detectors to achieve low inference time and high accuracy. We start with ResNet50 as a baseline and applied the concept of transfer learning to fuse high-level semantic information in multiple feature maps. In addition, we also propose a bounding box trans formation to improve localization performance during mask detection. The experiment is conducted with three popular baseline models viz. ResNet50,AlexNet and MobileNet. We explored the possibility of these models to plug-in with the proposed model so that highly accurate results can be achieved in less inference time. It is observed that the proposed technique achieves high accuracy (98.2sides, the proposed model generates 11.07compared to the recent public baseline model published as RetinaFaceMask detector. The outstanding perfor mance of the proposed model is highly suitable for video surveillance devices.

Paper 16:Autonomic Face Mask Detection with Deep Learning: an IoT Application :

ABSTRACT :A new and deadly virus known as SARS-CoV-2, which is responsible for the coronavirus disease (COVID-19), is spreading rapidly around the world causing more than 4 million deaths. Hence, there is an urgent need

to find new and innovative ways to reduce the likelihood of infection. One of the most common ways of catching the virus is by being in contact with droplets delivered by a sick person. The risk can be reduced by wearing a face mask as sugges ted by the World Health Organization (WHO), especially in closed environments such as classrooms, hospitals, and supermarkets. However, people hesitate to use a face mask leading to an increase in the risk of spreading the disea se, moreover when the face mask is used, sometimes it is worn in the wrong way. In this work, an autonomic face mask detection system with deep learning and powered by the image tracking technique used for the augmented reality development is proposed as a mechanism to request the correct use of face masks to grant access to people to critical areas. To achieve this, a machinelearning model based on Convolutional Neural Networks was built on top of an IoT framework to enforce the correct use of the face mask in required areas as it is requested by law in some

KEYWORDS: Machine learning, COVID - 19, Cyber-Physical Systems, Internet of Things.

Paper 17: A Real Time Face Mask Detection System using convolutional neural network :

Abstract : In current times, after the rapid expansion and spread of the COVID-19 outbreak globally, people have experienced severe disruption to their daily lives. One idea to manage the out break is to enforce people wear a face mask in public places. Therefore, automated and efficient face detection methods are essential for such enforcement. In this paper, a face mask detection model for static and real time videos has been presented which classifies the images as “with mask” and “without mask”. The model is trained and evaluated using the Kaggle data-set. The gathered data-set comprises approximately about 4,000 pictures and attained a performance accuracy rate of 98ally efficient and precise as compared to DenseNet-121, MobileNet-V2, VGG-19, and Inception-V3. This work can be utilized as a digitized scanning tool in schools, hospitals, banks, and airports, and many other public or commercial locations.

• Keywords : OpenCV ,Convolutional neural network(CNN),COVID19,Deeplearning , Real-time face mask detection.

Paper 18: Face Mask Detection Using Deep Convolutional Neural Network and MobileNetV2-Based Transfer Learning :

Abstract : The rapid spreading of Coronavirus disease 2019 (COVID-19) is a major health risk that the whole world is facing for the last two years. One of the main causes of the fast spreading of this virus is the direct contact of people with each other. There are many precautionary measures to reduce the spread of this virus; however, the major one is wearing face masks in public places. Detection of face masks in public places is a real challenge that needs to be addressed to reduce the risk of spreading the virus. To address these challenges,an automated system for face mask detection using deep learning (DL) algorithms has been proposed to control the spreading of this infectious disease effectively. This work applies deep convolution neural network (DCNN) and MobileNetV2-based transfer learning models for effectual face mask detection. We evaluated the performance of these two models on two separate datasets, i.e., our developed dataset by considering real-world scenarios having 2500 images (dataset-1) and the dataset taken from PyImage Search Reader Prajna Bhandary and some random sources (dataset-2). The experimental results demonstrated that MobileNetV2 achieved 98respectively, whereas DCNN achieved 97MobileNetV2-based transfer learning model would be an alternative to the DCNN model for highly accurate face mask detection.

Paper 19: Real Time Face Mask Detection and Recognition using Python:

Abstract : After the breakout of the worldwide pandemic COVID-19, there arises a severe need of protection mechanisms, face mask being the primary one. According to the World Health Organization, the corona virusCOVID-19 pandemic is causing a global health epidemic, and the most successful safety measure is wearing a face mask in public places. Convolutional Neural Networks (CNNs) have developed themselves as a dominant class of image recognition models. The aim of this research is to examine and test machine learning capabilities for detecting and recognize face masks worn by people in any given video or picture or in real time.This project develops a real-time, GUI-based automatic Face detection and recognition system.It can be used as an entry management device by registering an organization’s employees or students with their faces, and then recognizing individuals when they approach or leave the premises by recording their photographs with faces.The proposed methodology makes uses of Principal Component Analysis (PCA) and HAAR Cascade Algorithm. Based on the performance and accuracy of our model, the result of the binary classifier will be indicated showing a green rectangle superimposed around the section of the face indicating that the person at the camera is wearing a mask, or a red rectangle indicating that the person on camerais not wearing a mask along with face identification of the person.

• Keywords : Face Recognition and Detection, Convolutional Neural Network, GUI, Principal Component Analysis, HAAR Cascade Algorithm.

Paper 20: FACE MASK DETECTION IN REAL-TIME USING PYTHON :

Abstract : The aim of the thesis was to develop a Face Mask Detection system. For face mask identification, the thesis examines the use of Python programming with Deep Learning,TensorFlow, Keras, and OpenCV. The classifier uses the MobileNetV2 architecture as a foundation to do real-time mask detection. This system can be used in real-time applications which require face-mask detection for safety purpose due to the outbreak of coronavirus pandemic. The system’s method is set up in such a way that it uses a video camera to capture people’s images and apply detecting algorithms. After the successful implementation of face mask detection with a video camera that helps in the detection of people wearing and not wearing a face mask. Using the visualisa tion algorithms, it is possible to show the detection percentage of calculation in

various ways.The study is divided into two sections including theoretical and practical sections. The theoretical part of the studies will cover the basics of python programming, deep learning, andconvolutional neural network. The practical part will demonstrate how to develop an object detection model for real-time face mask identification using Python programming language and an object detection technique.

• Keywords : Python, Computer Vision, Neural Networks, Deep Learning, Image, Object detection, Face mask.

VII. WORKFLOW

The workflow for a real-time face mask detection project consists of several stages, from capturing video input to detecting faces and classifying the presence of a face mask. Below is a detailed workflow outlining each step, including data processing, model integration, and output generation.

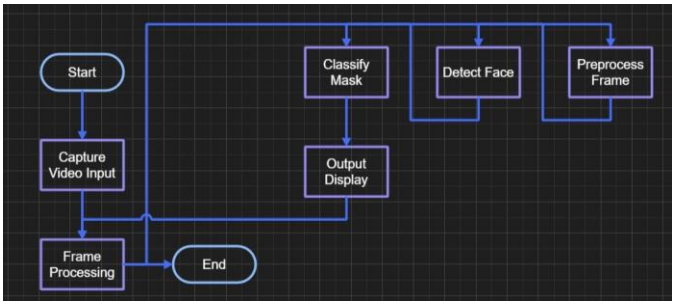

Fig. 1. Flow Chart of Workflow

1. Video Input and Frame Extraction

The first step is acquiring live video from a camera source or a pre-recorded video file.

Video Capture:Use a camera (CCTV, webcam, or mobile camera) to stream video in real time.If using Python, libraries like OpenCV can be used to capture the video feed frame-by-frame.The frames are processed in real-time, so you need to maintain an efficient frame rate (e.g., 30 FPS).

2. Preprocessing

Before feeding the video frames into the detection model, you may need to preprocess them for better performance and faster execution.

Frame Resizing: Resize the frames to a fixed size (e.g., 300x300 or 512x512) to reduce computational overhead without compromising too much accuracy. Color Normalization: Normalize pixel values (e.g., scale pixel values between 0 and 1) if the deep learning model expects normalized input.

Optional: Grayscale Conversion: If the model doesn't require color information, converting frames to grayscale can speed up processing.

3. Face Detection:

In this step, the system detects the presence of faces in each frame. This is a crucial preprocessing stage before applying mask classification. Face Detection Model: Use a face detection algorithm such as: Haar cascades (OpenCV): Fast but less accurate with complex backgrounds or angles. MTCNN: Multi-task cascaded CNN that detects faces and provides facial landmarks.YOLO (You Only Look Once): Real-time object detection algorithm that can detect faces with high speed and accuracy.SSD (Single Shot Multibox Detector): Another fast and accurate face detection algorithm.

Face Localization: Once a face is detected, the bounding box coordinates are obtained, and the face region is extracted from the frame.

4. Mask Detection

After detecting faces, the next step is to classify whether the detected face is wearing a mask or not.

Mask Classification Model: Use a pre-trained deep learning model (e.g., MobileNetV2, ResNet, VGG16) to classify the extracted face region.Input the cropped face images into the model for classification. The output is binary (masked/unmasked) or multi-class if you also want to classify improper mask wearing.

Inference: The mask detection model will output probabilities or labels indicating whether the person is wearing a mask or not. For binary classification: 1 = Mask On 0 = No Mask For multi-class classification: 0 = No Mask 1 = Mask On (Proper) 2 = Mask Improperly Worn 5. Post-processing

Once the classification results are obtained, you can apply post-processing to visualize and act on the results.

Bounding Box Display: Draw bounding boxes around detected faces and use color-coded labels:Green box for "Mask On" , Red box for "No Mask" Optionally, Yellow box for "Improper Mask" (if multi-class detection is enabled).

Alert Generation: Based on the classification, trigger alerts for non-compliance: Sound alarms, send notifications, or store logs of people not wearing masks.

6. Optional Tracking (for Multiple Faces): If multiple faces need to be tracked across frames, integrate a tracking algorithm.

Object Tracking Algorithms: Use tracking algorithms like SORT (Simple Online and Realtime Tracking) or Deep SORT to track individual faces across multiple frames. Tracking allows the system to follow a person across the frame, ensuring consistency in mask detection over time.

7. Output Generation: After mask detection and classification, the system generates outputs that can be visualized or logged for further analysis.

Visual Output: Display the processed video stream with bounding boxes and labels in real-time using OpenCV or any other visualization tool.

Logging:Store data for each frame where no mask is detected, including timestamps, face coordinates, and other metadata for auditing purposes.

Real-Time Alerts: Trigger automatic actions such as sending alerts to security personnel or activating notifications via a mobile app, buzzer, or email.

8. Performance Monitoring and Optimization: To ensure that the system works efficiently in real time, performance monitoring is necessary.

9. Frame Rate Optimization: Adjust the frame processing speed to maintain a consistent frame rate, typically 15-30 FPS, without sacrificing too much accuracy.Model Opti-

mization:Use techniques like model quantization, pruning, or converting the model to TensorFlow Lite or ONNX format to optimize it for edge devices or real-time deployment.

Hardware Acceleration: Use GPU acceleration (e.g., TensorFlow-GPU, CUDA) for faster inference.Consider running the system on edge devices like NVIDIA Jetson for deployment in real-time settings.

VIII. OUTPUT:

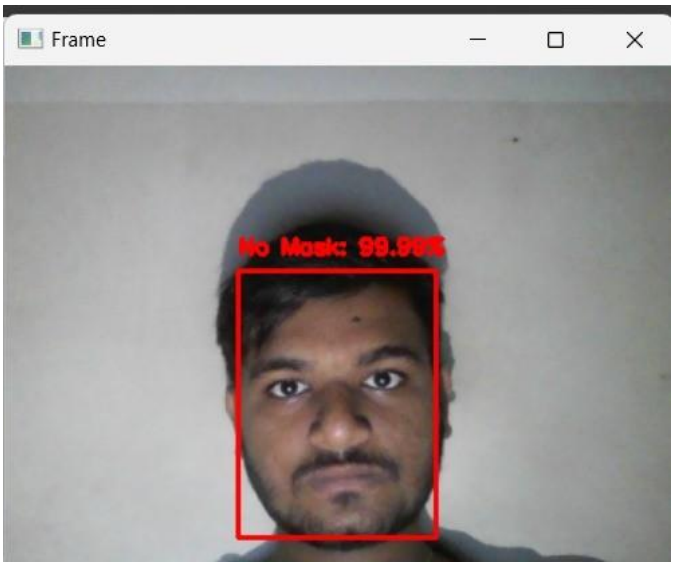

Fig. 2. No Mask Accuracy

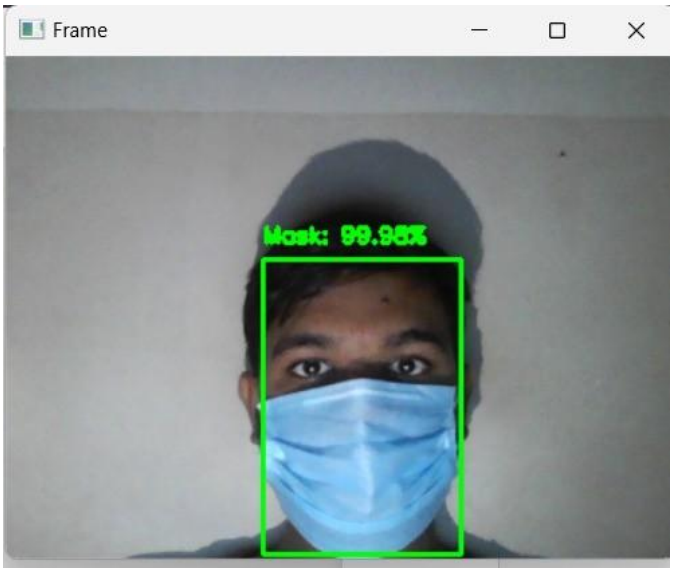

Fig. 3. with Mask Accuracy

IX. ALGORITHM STEPS

1. **Initialize video stream and models:** Capture video input, load face detection and mask classification models.

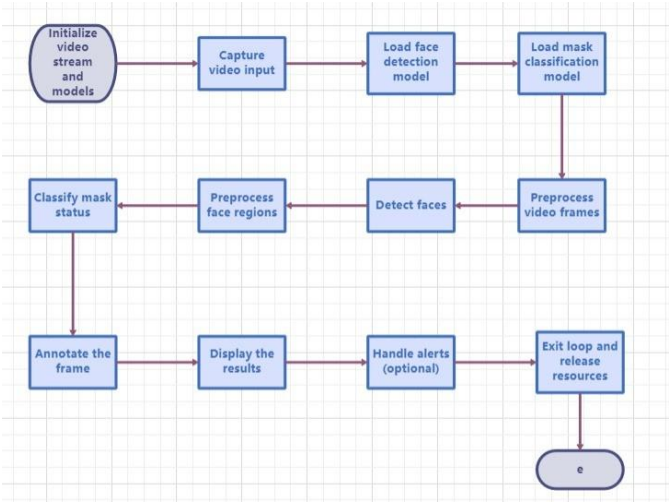

Fig. 4. Flow Chart of Algorithm

2. **Preprocess video frames:** Resize and prepare each video frame for analysis.
3. **Detect faces:** Apply face detection to locate faces in the frame.
4. **Preprocess face regions:** Extract and prepare the face region for mask classification.
5. **Classify mask status:** Classify the extracted face as either ”Mask On” or ”No Mask” using the mask classification model.
6. **Annotate the frame:** Draw bounding boxes and display mask status labels.
7. **Display the results:** Continuously show the processed frames in real-time.
8. **Handle alerts (optional):** Generate alerts for mask violations and log incidents.
9. **Exit loop and release resources:** Gracefully close the system when the user exits.

X. FUTURE WORK

The future of real-time face mask detection includes integration with smart surveillance systems and enhanced accuracy through advanced deep learning models. **Beyond Mask Detection:**The technology can be adapted to detect other facial features or expressions, potentially aiding in sentiment analysis or anomaly detection in security applications.

Integration with Wearable Devices: Real-time face mask detection could be integrated with smart glasses or other wearable devices for personalized health monitoring or reminders.

Explainable AI : Developing interpretable models that can explain their reasoning behind mask classification decisions will be valuable for improving trust and transparency in the technology.

Integration with Health Systems : Collaborate with healthcare organizations to integrate face mask detection systems with health monitoring systems, enabling early detection of symptoms and facilitating contact tracing efforts incase of outbreaks.

CONCLUSION

In this research, we developed and implemented a real-time face mask detection system capable of identifying individuals wearing face masks and those not in compliance. This system combines state-of-the-art deep learning techniques for face detection and mask classification, integrated into a pipeline suitable for real-time applications. Using models like MobileNetV2 for mask detection and YOLO for face detection, the system demonstrated high accuracy and efficiency, making it ideal for deployment in public spaces such as airports, hospitals, and workplaces. In conclusion, real-time face mask detection has proven to be a valuable tool for public health safety during pandemics like COVID-19, providing an automated solution for monitoring mask compliance. This research lays the groundwork for future advancements in intelligent monitoring systems, which could integrate additional public health measures, such as temperature detection and social distancing monitoring, for a more comprehensive approach to pandemic management

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