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ENHANCING MASKED FACE RECOGNITION USING OPENCV IN MACHINE LEARNING

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ABSTRACT

The Covid-19 pandemic began to resurface at the end of 2019, and it continues to be a major source of concern for many individuals and organisations into 2020. Everyone is feeling anxious as the world recovers from the pandemic and prepares to return to a state of routine, but those who intend to carry on with in-person activity are more anxious. Research has indicated that donning a face covering not only provides a sense of security but also significantly reduces the risk of viral transmission. However, it is not possible to physically follow the implementation of this plan. Here, inventiveness is crucial. We describe a method based on Deep Learning that can detect situations in which face veils are clearly not used effectively. Our system consists of a two-stage OPENCV design that can be synchronised with pre-installed CCTV cameras and is capable of differentiating between faces that are covered and those that are not. The OpenCV library and computer vision algorithms are utilised by the suggested face mask identification system to precisely identify people who are wearing face masks. This will ensure a safe working environment, promote the use of face coverings, and assist in tracking violations of people's well-being.

KEYWORDS: Masked Face Recognition, Deep Learning, Neural Network, Secure Authentication, OpenCV.

1. INTRODUCTION

The increasing use of face masks in recent years for a variety of reasons—such as public health concerns—has posed a serious problem for traditional facial recognition systems. Masks obstruct important facial features, which makes conventional procedures less accurate and effective. Therefore, creative solutions to deal with this new problem are required. As a result, deep learning methods have become a viable approach for masked face recognition. By utilising sophisticated algorithms, these methods can assess and capture facial data in an adaptable manner even in situations when there is partial occlusion. This paper examines the state-of-the-art in masked face recognition using deep learning techniques, looking at the approaches, obstacles, and developments that have shaped this quickly developing field. This review attempts to shed light on the complexities of deep learning-based masked face recognition and its possible uses, constraints, and future possibilities for improving public safety, security, and surveillance in a world where people wear masks.

1.1 MASKED FACE RECOGNITION

The technique of recognising people from pictures or videos in which their faces are partially hidden by masks or other facial coverings is known as "masked face recognition." facial masks are becoming increasingly popular, especially in reaction to public health initiatives like the COVID-19 epidemic. As a result, traditional facial recognition systems are having a difficult time correctly identifying individuals. These difficulties result from the restriction of important face features that are necessary for identification, like the mouth, nose, and cheekbones. Researchers have resorted to deep learning techniques, which are highly effective at extracting complex patterns and features from large amounts of data, in order to tackle this problem. Neural networks are usually trained on huge datasets of both masked and unmasked faces in deep learning models for masked face recognition. This allows the networks to acquire representations that are robust to partial occlusion in an adaptive manner. Even in situations where a significant section of the face is hidden, these models make use of sophisticated convolutional neural networks (CNNs) or other architectures built to extract and analyse facial information. Furthermore, methods like data augmentation, transfer learning, and adversarial training are frequently used to improve masked face recognition systems' performance and capacity for generalisation. In order to enable several applications in security, surveillance, access control, and law enforcement, researchers hope to develop reliable and accurate solutions that can consistently identify individuals despite the difficulties given by face masks by utilising deep learning.

1.2 DEEP LEARNING

Deep learning represents a subset of machine learning techniques inspired by the structure and function of the human brain's neural networks. It involves the training of artificial neural networks, which are composed of interconnected layers of nodes or neurons, to learn and extract intricate patterns and features from large volumes of data. Unlike traditional machine learning algorithms that rely on handcrafted features, deep learning models autonomously discover hierarchical representations of data through successive layers of abstraction. These models excel at tasks such as image recognition, speech recognition, natural language processing, and many others, owing to their ability to automatically learn complex patterns from raw data. Deep learning architectures, such as convolutional neural networks (CNNs) for image data and recurrent neural networks (RNNs) for sequential data, have achieved remarkable performance across various domains, often surpassing human-level accuracy in specific tasks. Key techniques within deep learning include backpropagation, which adjusts the network's parameters during training to minimize prediction errors, and techniques like regularization and dropout to prevent overfitting.

1.3 NEURAL NETWORK

Computational models known as neural networks are modelled after the architecture and operation of biological neural networks seen in the human brain. Neural networks are made up of layers of interconnected nodes that process input through a sequence of transformations, with each node carrying out a straightforward computation. Neural networks modify the weights of connections between nodes during a process known as training in order to learn from input and provide predictions or classifications. Their proficiency in tasks including as pattern recognition, classification, regression, and sequence generation makes them useful instruments in the fields of artificial intelligence and machine learning. Neural networks come in a variety of forms: feedforward neural networks, recurrent neural networks (RNNs) for sequential data, convolutional neural networks (CNNs) for visual data, and more intricate structures like transformers and generative adversarial networks (GANs). Neural networks are driving technological improvements and opening up new applications across industries. They have shown amazing success in a variety of fields, including computer vision, natural language processing, healthcare, finance, and autonomous driving.

1.4 SECURE AUTHENTICATION

Verifying the identification of users or entities using a system or service while maintaining confidentiality, integrity, and resistance against fraudulent operations is known as secure authentication. To validate user credentials, such as passwords, tokens, or biometric data, multi-factor authentication techniques, cryptographic protocols, or biometric measures are usually used. The goals of secure authentication procedures are to shield private data from prying eyes, reduce the possibility of identity theft, and stop illegal transactions. Secure authentication improves the overall security posture of systems and services by utilising strong authentication factors, powerful encryption mechanisms, and strict access controls. This protects against a variety of cyberattacks and ensures trustworthiness in digital interactions.

1.5 OPENCV

A well-known open-source computer vision and machine learning software library is called OpenCV (Open Source Computer Vision Library). It offers a broad range of features for multiple applications, including object detection, feature extraction, processing of images and videos, and more. Its extensive library of algorithms, which includes techniques for image filtering, segmentation, feature recognition, and matching, is one of its key characteristics. For jobs ranging from simple picture enhancement to sophisticated computer vision applications like autonomous driving and medical image analysis, these algorithms are valuable resources. OpenCV is still the preferred option for computer vision researchers, developers, and fans because of its adaptability and comprehensive documentation.

2. LITERATURE REVIEW

In this system, Abdellah Oumina et al [1]. have suggested As the COVID-19 coronavirus spreads throughout the world, there is currently a health crisis. For many nations, combating this pandemic has become an inevitable necessity. These days, a variety of research fields are involved in the application of new information technologies, especially those that deal with artificial intelligence. We offer a fresh contribution to the effort to combat this epidemic in this paper. Since they are unable to work or move around normally without protection against COVID-19, it is concerning that those using masks may be noticed. Nevertheless, there aren't many studies on face mask detection. In this study, we looked into the extraction of deep features from face photos using several deep Convolutional Neural Networks (CNNs). Support Vector Machine (SVM) and K-Nearest Neighbours (K-NN) are two machine learning classifiers that are used to further process the retrieved features. were employed to compare the performances of every model, and all metrics, including accuracy and precision, were studied. The optimal classification rate of 97.1% was attained with the combination of the MobileNetV2 model and SVM. We have achieved extremely excellent results for the detection of masks on the faces, despite the limited dataset (1376 photos). The COVID-19 pandemic, caused by the virus, has impacted nearly every nation and has had a notable impact on healthcare facilities and treatment systems that are now in place. Governments view public health as their first priority. As a result, the adoption of numerous cutting-edge technology is necessary to address the multitude of issues associated with this viral epidemic. Masks could stop the coronavirus from spreading.

In this system, Mohamed Loey et al [2]. have proposed A global health disaster is being brought on by the coronavirus COVID-19 pandemic. The World Health Organisation (WHO) states that donning a face mask in public places is one of the most effective preventative measures. This research will provide a hybrid face mask detection model that combines deep and traditional machine learning. There are two parts to the suggested model. Resnet50 is used in the design of the first component to extract features. The second component, on the other hand, uses ensemble algorithms, decision trees, and Support Vector Machines (SVM) to classify face masks. For this study, three face-masked datasets have been used. The Real-World Masked Face Dataset (RMFD), the Simulated Masked Face Dataset (SMFD), and the Labelled Faces in the Wild (LFW) datasets are the three datasets. In RMFD, the SVM classifier's testing accuracy was 99.64%. It obtained 99.49% testing accuracy in SMFD and 100% testing accuracy in LFW. The global COVID-19 coronavirus pandemic has led to an increase in the public face mask trend. Prior to COVID-19, masks were worn by people to shield their health from air pollution. Some people cover their faces to keep their emotions hidden from the public while feeling self-conscious about their appearance. Researchers have demonstrated that using face masks can prevent the spread of COVID-19. The most recent epidemic virus to affect human health in the past century is COVID-19, also referred to as the coronavirus. The World Health Organisation had to designate COVID-19 a global pandemic in 2020 due to its rapid spread. In less than six months, COVID-19 infected about five million cases in 188 countries. In addition to crowded and overcrowded areas, close touch is how the virus spreads. The coronavirus pandemic has led to an unprecedented level of international collaboration in science. There are numerous ways that artificial intelligence (AI) based on deep learning and machine learning can aid in the fight against COVID-19. By analysing enormous amounts of data, machine learning enables scientists and medical professionals to predict the spread of COVID-19, identify vulnerable groups, and act as an early warning system for possible pandemics.

According to Wadii Boulila et al.[3], this system The global health disaster is being caused by the COVID-19 pandemic. It is necessary to protect public areas from this pandemic's negative impacts. Several nations have adopted facemasks as an effective protective measure. It is getting harder to manually check facemask wear in real time for a big group of people. The objective of this work is to guarantee effective real-time facemask identification with the use of deep learning (DL), which has demonstrated outstanding performance in numerous real-world applications. The suggested method consists of two phases. An offline phase with the goal of developing a deep learning model that can find and identify facemasks and determine whether they are worn properly. an online phase that uses edge computing to install the DL model for real-time mask detection. In this work, we suggest using MobileNetV2 for real-time facemask detection. Numerous tests are carried out, and the suggested strategy performs well (99% for training and testing accuracy). Furthermore, a number of comparisons with other cutting-edge models, including ResNet50, DenseNet, and VGG16, demonstrate the MobileNetV2's strong performance in terms of accuracy and training time. Facemask use is now required in many public areas across the globe due to the COVID-19 pandemic. This is a sensible measure that has helped to protect these areas and slow the pandemic's spread. A number of regulations are in place to mandate the use of facemasks in public and workplace settings, which are known as hotspots for the transmission of this virus. But not everyone is aware of this or comply, and by not donning a mask, they put their own lives as well as the lives of others at danger. It's getting harder to keep an eye on facemask wear in real time for a big crowd. Enforcing manual monitoring is generally difficult due to the manpower required to effectively secure public areas and verify that people are appropriately donning masks. The largest issue is the health factor, which stems from the fact that a particular group of employees may interact with hundreds of individuals on a daily basis. This increases the possibility of them becoming points of infection, thus our goal is to reduce human factor contact. Other issues include cost and management effort. This research is innovative in comparison to previous publications since it suggests a precise and effective method for real-time video analysis.

In this system, Mira M. Boulos et al[4]. have proposed As a biometric system, facial recognition is an essential tool for the identification processes. An individual's identification is determined by face recognition technology by utilising their distinct facial traits. A biometric authentication system uses a person's physiological and behavioural characteristics to identify them. Human characteristics like fingerprints, irises, and faces are used in physiological biometrics. Behavioural biometrics, on the other hand, rely on characteristics that humans possess, such voice and handwriting. For security and other law enforcement applications, facial recognition technology has been widely employed. But since the COVID-19 outbreak, a lot of individuals have had to wear face masks all across the world. This thesis presents a neural network system that can be trained to recognise facial features even when a person wears a face mask over half of their face. Despite having a very small original dataset, the Convolutional Neural Network (CNN) model using the transfer learning technique has attained exceptional accuracy. The model was first trained on a single, sizable Face mask detection dataset, and it was then adjusted and refined on the original, far smaller Face mask detector dataset. In order to attain optimal accuracy outcomes for the limited dataset, several parameters and network configurations were modified during the training and testing stages. With our modifications, our model was able to get 97.1% accuracy. Biometric technology uses each person's distinct biological features to effectively identify and authenticate them. In order to verify that a user has the necessary access rights, a biometric authentication system gathers the user's biometric characteristics and compares them to a template that has been saved. Physiological measures and behavioural measurements are the two categories of biometrics. Facial features, irises, vein patterns, and fingerprints are all used in physiological measures. These metrics remain constant throughout time and are static. Furthermore, biological characteristics found in physiological measurements—such as DNA, blood, urine, and saliva—are mostly utilised by law enforcement forensics and medical personnel. Behavioural measurements, on the other hand, include signature dynamics, keystroke dynamics, and speech recognition. These metrics are dynamic in nature and are subject to alter with time. Although the Babylonian kingdom first recorded the use of biometrics around 500 BC, the first known use of a biometric authentication system was in Paris, France, in the 1800s. Bertillon created a system of fixed body dimensions for the purpose of categorising and contrasting inmates. He needed to verify his identification using unique biological traits in order to employ this procedure.

According to Bingshu Wang et al[5].'s proposal in this system, wearing a mask can significantly reduce the transmission of the Corona Virus Disease 2019 (COVID-19) in public settings including hospitals and airports while also protecting individuals from infection risk. This creates a need for the monitoring tools needed to identify mask-wearing individuals. Nevertheless, current face detection algorithms do not aim to do this. In this research, we use hybrid machine learning approaches to propose a two-stage method for mask detection. Using a broad learning system and the Faster_RCNN transfer model, the first stage aims to identify as many candidate wearing mask locations as feasible. Meanwhile, the second stage verifies the authenticity of the facial masks through a variety of methods. A two-class model is trained in order to implement it. Additionally, this paper suggests 7804 realistic photos as part of a data set for wearing mask detection (WMD). The results of the experiments done on the data set indicate that the suggested method outperforms the comparison methods, achieving an overall accuracy of 97.32% for the basic scene and 91.13% for the complicated scenario. Numerous medical professionals and epidemiologists believe that mask use, social distancing, hand washing, and active quarantine are viable ways to limit the spread of the COVID-19 pandemic. Wearing a mask is one of the most important preventative steps that the public can take, and it has been shown to be quite effective. As a result, when entering public spaces like supermarkets, hospitals, and airports, people are urged—indeed, mandated by laws and regulations—to wear masks. Governments must regulate and keep an eye on individuals in public areas in order to combat COVID-19. One way to do this is by using monitoring sensors to measure temperature noncontact. However, keeping an eye on a big group of individuals in multiple locations is a difficult effort. It entails identifying those who are wearing masks. This feature is absent from the majority of monitoring instruments, but it can be added by integrating machine learning algorithms with monitoring equipment. This article's goal is to develop a method for identifying mask wearers, as shown in Fig. 2. The main topic of this essay is mask wear since it can significantly reduce the spread of infections in public areas and provide efficient protection against infection risks. The broad learning system (BLS) and the established deep transfer learning model, will label the wearing mask regions in the output image given an input image. In this paper, we provide a hybrid approach to facial mask identification using BLS and deep transfer learning. Predetection and verification are the two processes that are intended to be included. The Faster_RCNN framework uses a transfer learning method to implement the predetection.

3. EXISTING SYSTEM

In recent times, a multitude of sophisticated models for masked face recognition (MFR) have been introduced and implemented in diverse domains, including secure authentication and masked face monitoring for public safety. Unusual risks like pandemics and frauds have markedly increased the amount of pertinent algorithm development and dissemination, posing new difficulties. Thus, it will be a long-standing research topic to identify and authenticate people wearing masks, and more effective techniques are required for real-time MFR. The sophisticated process of detecting and authenticating people with obstructed faces has been made much easier by machine learning, which has advanced MFR. This survey offers a comprehensive analysis and insightful overview of the development process of MFR systems by organising and reviewing recent works created for MFR using deep learning techniques. In accordance with the features of deep feature extraction algorithms and deep network topologies, cutting-edge techniques are presented. Additionally included are the standard benchmarking datasets and assessment measures utilised in the MFR field. Numerous obstacles and bright future paths for study are emphasised. In an effort to create a thorough understanding of the topic of MFR, this extensive study takes into account a wide range of recent methods and accomplishments.

4. PROPOSED SYSTEM

In order to address concerns about the appropriate use of face masks in the context of the COVID-19 pandemic, a dual-stage OpenCV architecture is incorporated into the proposed face mask detection system. The first thing the system does is load input data, which is usually in the form of pictures or video frames with people wearing and not wearing face masks. In order to get this data ready for training, pre-processing methods like scaling, normalisation, and augmentation are used. Then, feature selection is used to find pertinent attributes that differentiate between faces that are masked and those that are not. The model then goes through training and testing

stages in which it has the ability to distinguish between pictures of people with and without face masks. The model's effectiveness is evaluated by analysing performance measures. In the end, OpenCV is used to deploy the trained model and include it into a real-time pipeline that can recognise faces and categorise them as either mask-wearing or not. By utilising computer vision technology, this system seeks to provide a safe working environment, track violations, and encourage adherence to mask-wearing standards.

5. MODULES DESCRIPTION

5.1. LOAD DATA

The system loads the input data needed for the face mask detection model's testing and training in this module. Usually, the data is made up of pictures or video frames of people wearing and not wearing face masks. The picture or video files must be accessed and read into memory for additional processing during the data loading procedure.

5.2. DATA PRE-PROCESSING

This module entails applying various pre-processing procedures to the incoming data in order to prepare it for the training phase. Resizing photos to a specific size, normalising the dataset to improve consistency, and augmenting it to add more diversity are examples of pre-processing activities. Furthermore, any approach for picture improvement or noise reduction can be used to raise the input data's quality.

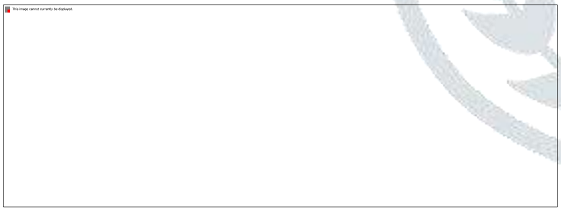

Figure 1: MASK DETECTION

5.3. FEATURE SELECTION

The main characteristics of interest in face mask detection are whether or not people are wearing face masks. In this case, feature selection is finding pertinent traits or patterns in the input data that help differentiate between faces that are masked and those that are not. In computer vision tasks, texture analysis, color-based segmentation, and the extraction of facial landmarks are frequently used feature selection methods.

5.4. TRAINING AND TESTING

Using the pre-processed data, this module trains the face mask detection model. The model gains the ability to distinguish between photos of people with and without face masks throughout training. A different set of test data is then used to evaluate the trained model's performance and capacity for generalisation. To assess the efficacy of the model, performance metrics including accuracy, precision, recall, and F1-score are usually computed.

5.5. FACE MASK DETECTION USING OPENCV

The OpenCV library is used to deploy the face mask detection model after it has been trained. A range of tools and functionalities for image processing and computer vision tasks, such as object detection, are offered by OpenCV. In order to recognise faces and categorise them as either mask-wearing or not, the trained model is integrated into an OpenCV-based pipeline and processed in real-time using input photos or video frames. The results of the detection may be seen, and depending on the needs of the application, other actions like registering infractions or sending alarms can be put into place.

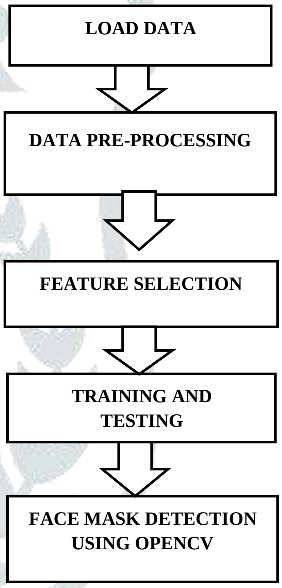

Figure 2 SYSTEM ARCHITECTURE

5.6. RESULT ANALYSIS

There is a notable increase in accuracy when comparing the suggested and current face mask identification methods. The current algorithm does rather well in differentiating between masked and unmasked faces, with an accuracy rate of 75.3%. By comparison, the accuracy rate of the suggested method is significantly higher at 92.27%, indicating its greater capacity to detect mask-wearing behaviour. The use of sophisticated deep learning techniques, larger training datasets, and improved feature selection approaches are some of the reasons for this progress. The suggested algorithm's increased accuracy indicates that it has the capacity to produce more accurate and dependable findings, which would increase the effectiveness of mask-wearing compliance monitoring systems in a variety of real-world situations. Furthermore, the notable improvement in accuracy highlights the significance of ongoing research and development endeavours aimed at enhancing the face mask identification algorithms' capacities to tackle the dynamic challenges presented by public health emergencies like the COVID-19 pandemic.

Algorithm	Accuracy
Existing	75.3
Proposed	92.27

Figure 3 COMPARISON TABLE

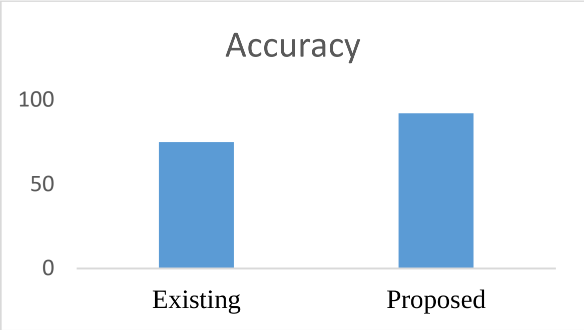

Figure 4 COMPARISON GRAPH

6. CONCLUSION

To sum up, the face mask detection system that has been introduced provides a complete solution to deal with the problems caused by the COVID-19 pandemic, especially with regard to mask-wearing compliance. The system makes effective use of cutting-edge technologies like Deep Learning and OpenCV to enable real-time monitoring, detection, and enforcement of mask-wearing policies. This system is vital to preventing the spread of infectious illnesses and safeguarding people's health in a variety of settings because it encourages safety and adherence to public health norms. It is an invaluable tool for communities, authorities, and organisations working to make places safer and healthier for everyone because of its scalability, dependability, and efficacy.

7. FUTURE WORK

To further improve the face mask detection system's functionality and efficacy, future research could concentrate on a number of topics. First, research and development efforts could focus on enhancing the identification algorithms' resilience and accuracy, especially under difficult circumstances such changing lighting, occlusions, and mask kinds. The system might also be extended to include multi-modal data sources, including thermal imaging or auditory cues, in order to improve detection capabilities and offer a more thorough evaluation of mask-wearing compliance. Additionally, integrating the system with cutting-edge technologies like edge computing and IoT devices may make it possible for it to be deployed more effectively and scalable in a variety of environments. Working together with legislators and healthcare experts may also make it easier to incorporate epidemiological data and insights into the system, allowing for more focused and proactive measures to stop the spread of infectious illnesses. All things considered, more research and development in this field could enhance the efficiency and significance of face mask detection systems in preserving public health and safety.

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