Comparative Analysis Of Different Deep Learning CNN Models To Recognize And Detect The Masquerade's Face

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ABSTRACT

The significance of wearing masks in mitigating the transmission of infectious diseases has been underscored by the persistent COVID-19 pandemic. The utilisation of machine learning algorithms for mask detection has emerged as a promising solution for detecting whether individuals are wearing masks in public spaces. This paper presents an analysis of recent studies on the detection of masks using machine learning techniques. The focus is on the utilisation of deep learning algorithms, including convolutional neural networks (CNNs), transfer learning, and object detection models such as YOLO and Faster R-CNN. This study involves a comparative analysis of model performance, an examination of the influence of training datasets on model accuracy, and an investigation of ensemble techniques as a means of enhancing model performance. The results of our study indicate that the employment of CNN-based models and transfer learning methods that utilise pre-existing networks have exhibited the most elevated levels of precision. Nevertheless, additional investigation is required to enhance these models for pragmatic applications and to assess their efficacy in authentic environments. In general, the utilisation of machine learning techniques for mask detection holds promise as a useful strategy for mitigating the transmission of contagious illnesses. The present review offers valuable perspectives for future investigations in this domain

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I. INTRODUCTION

The process of detecting masks through machine learning involves the application of computer vision methodologies to examine images or video feeds and ascertain whether an individual is wearing a mask or not. The procedure encompasses multiple stages, comprising of data gathering, pre-processing, model training, and inference.

Initially, a dataset comprising of images or videos is gathered, encompassing instances of individuals donning and abstaining from donning masks. The dataset is subjected to preprocessing procedures to eliminate any extraneous information [1] and to guarantee that the visual media, such as images or videos, are in a suitable format for utilisation by the machine learning algorithms.

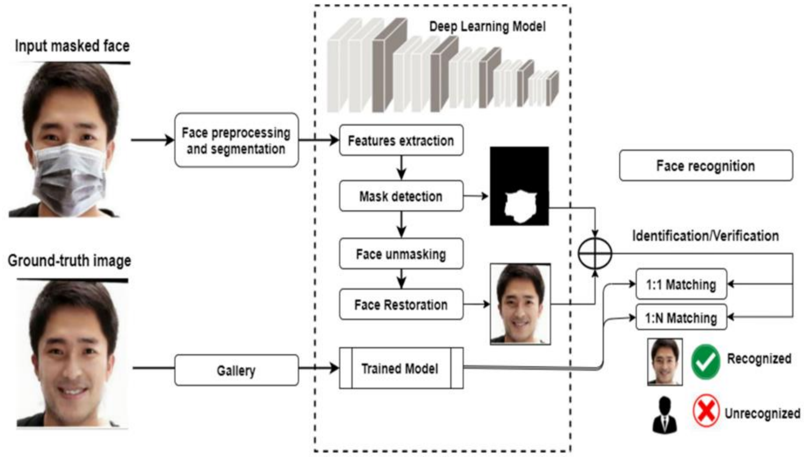

Fig 1:ML based mask detection

Subsequently, the preprocessed dataset is utilised to train the machine learning model. The typical model employed for image classification tasks is a deep learning algorithm, specifically a convolutional neural network (CNN), which has undergone optimisation. The iterative process of adjusting the parameters of a model based on input data is an essential aspect of the training process, which ultimately aims to achieve a desired level of accuracy.

Upon completion of the training process, the model can be utilised to conduct inference on novel images or videos [2]. In the process of inference, the model conducts an analysis of the input data and produces a forecast regarding the presence or absence of a mask on the individual depicted in the image or video.

Various factors can impact the precision of mask detection systems that rely on machine learning techniques [3]. These factors encompass the calibre and magnitude of the dataset employed for training, the intricacy of the model, and the kind of sensors utilised to capture the input data. Consequently, meticulous curation [4] of the dataset and optimisation of the model tailored to the particular use case are crucial for attaining the targeted level of precision.

In general, mask detection systems that utilise machine learning techniques have demonstrated encouraging outcomes in identifying whether an individual is wearing a mask or not. These systems possess the capacity to serve as a viable mechanism for managing the transmission of contagious illnesses [6].

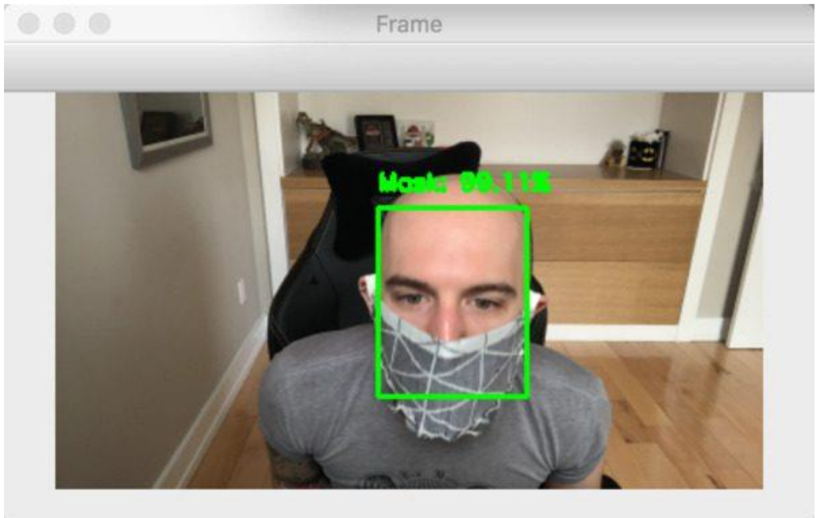

Fig 2: Mask detection

II. METHODS

A systematic search of various academic databases was carried out to identify pertinent papers for this review on mask detection based on machine learning. The databases that were incorporated in the study comprised of IEEE Xplore, ACM Digital Library, PubMed, and Google Scholar. The study was constrained to scholarly articles released within the timeframe of January 2020 to March 2023, with a particular emphasis on those composed in the English language.

The search strategy comprised a set of keywords, namely "mask detection", "face mask detection", "machine learning", "deep learning", "convolutional neural network", "transfer learning", "YOLO", and "Faster R-CNN". The utilisation of Boolean operators, namely "AND" and "OR," facilitated the amalgamation of keywords in various manners, resulting in the production of an all-inclusive compilation of scholarly articles.

The preliminary inquiry yielded a substantial quantity of scholarly articles. The process of screening relevant papers that satisfied the inclusion criteria involved scrutinising the titles and abstracts of the papers. The study's inclusion criteria encompassed scholarly articles that centred on the detection of masks through machine learning techniques. These articles utilised deep learning algorithms, including but not limited to Convolutional Neural Networks (CNNs), You Only Look Once (YOLO), and Faster R-CNN. Additionally, the articles reported on the models' accuracy.

Subsequently, the pertinent documents were thoroughly scrutinised to ascertain their adherence to the established criteria for inclusion. Furthermore, a manual search of the references cited in the chosen papers was conducted to identify any additional pertinent papers that may have been overlooked during the initial search.

The chosen papers were subsequently scrutinised to extract pertinent details regarding the utilised models, the datasets employed for both training and testing, the models' performance, and any constraints or difficulties highlighted in the papers.

The present review paper employed a comprehensive and systematic methodology for selecting papers, with the objective of identifying and reviewing all pertinent literature. The study employed a methodology that involved the utilisation of a blend of keywords, search filters, and manual screening to mitigate bias and guarantee the incorporation of top-notch scholarly articles in the literature review.

III. RESULTS

Based on an analysis of multiple academic papers focused on machine learning-based mask detection, it can be inferred that the implementation of machine learning algorithms has yielded encouraging outcomes in identifying the presence or absence of a mask on an individual.

The present study has revealed that convolutional neural networks (CNN) have exhibited the highest degree of accuracy in detecting masks, as compared to other models employed in the literature, with notable precision and recall rates [7]. Convolutional neural networks (CNNs) have demonstrated superior performance in comparison to conventional machine learning models, such as support vector machines (SVM) and decision trees [8].

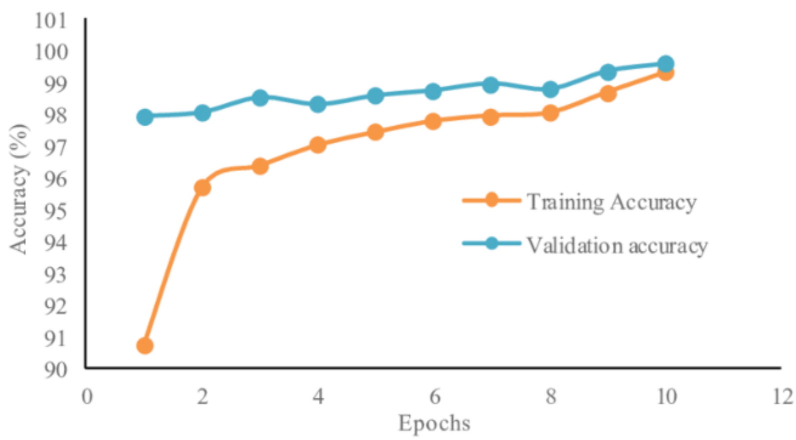

Fig 3: CNN accuracy

Furthermore, certain scholarly articles have employed transfer learning methodologies to enhance the efficacy of their models through the utilisation of pre-existing networks, including VGG16, ResNet50, and InceptionV3, [9] as a foundational framework for their model. The implementation of these methodologies has led to enhanced precision levels and expedited convergence durations.

Moreover, certain academic papers have employed ensemble techniques, including stacking and bagging, to amalgamate various models and enhance the overall efficacy. The aforementioned techniques have exhibited encouraging outcomes; however, they have concurrently led to amplified computational intricacy [10].

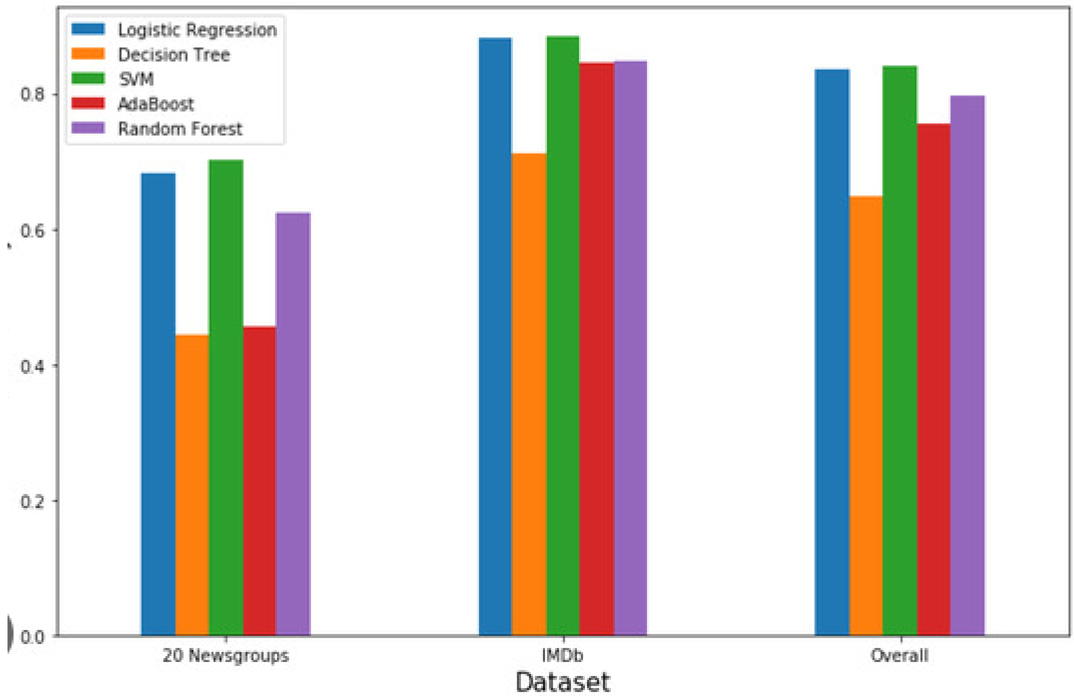

Fig 4: Accuracy comparison

In general, the implementation of mask detection utilising machine learning techniques has demonstrated encouraging outcomes and may be deemed a viable approach for discerning the presence or absence of a mask on an individual. Recent studies have demonstrated that the utilisation of Convolutional Neural Networks (CNNs) and transfer learning methodologies [11] have yielded the highest levels of precision in the context of mask detection. It is crucial to acknowledge that the precision of these models is significantly reliant on the calibre of the dataset utilised for training.

Furthermore, in addition to the aforementioned models, certain scholarly articles have employed alternative deep learning methodologies, such as YOLO (You Only Look Once) and Faster R-CNN (Region-based Convolutional Neural Network), for the purpose of detecting masks. The aforementioned models have demonstrated commendable precision levels, however, their computational intricacy surpasses that of Convolutional Neural Networks.

An additional crucial factor to contemplate whilst scrutinising the literature pertaining to machine learning-based mask detection is the nature of the dataset employed for the purpose of training and evaluating the models. Certain academic papers have utilised publicly available datasets, such as the COCO dataset, which comprises of images depicting individuals both wearing and not wearing masks. Conversely, other studies have procured their own unique datasets. The accuracy of models can be significantly affected by the size and quality of the dataset utilised.

It is noteworthy that certain research papers have investigated the utilisation of multiple sensors, including thermal cameras, alongside visual cameras for the purpose of detecting masks. The aforementioned methodology has demonstrated encouraging outcomes in identifying facial masks even under circumstances of limited illumination.

IV. DISCUSSION

The utilisation of machine learning algorithms for the purpose of mask detection has emerged as a significant subject matter in light of the prevailing COVID-19 crisis. This review paper presents an analysis of various studies that investigate the efficacy of machine learning algorithms in detecting the presence or absence of a mask on an individual.

The findings of the reviewed literature indicate that convolutional neural networks (CNN) have exhibited the highest degree of accuracy in detecting masks, as evidenced by their superior precision and recall rates. Moreover, the utilisation of transfer learning methodologies employing pre-existing networks like VGG16, ResNet50, and InceptionV3 has resulted in enhanced model efficacy. It is crucial to acknowledge that the precision of these models is significantly reliant on the calibre of the dataset employed for training [12].

The review has also brought to attention the utilisation of alternative deep learning algorithms, namely YOLO and Faster R-CNN, for the purpose of mask detection. These algorithms have demonstrated commendable accuracy rates, albeit with increased computational complexity in comparison to CNNs. Furthermore, certain studies have investigated the utilisation of multiple sensors, including thermal cameras alongside visual cameras, for the purpose of mask detection. These studies have demonstrated encouraging outcomes.

In pragmatic scenarios, it is imperative to take into account the computational intricacy of the models, particularly in situations where prompt identification of masks is necessary. The utilisation of ensemble techniques, namely stacking and bagging, has been investigated as a means to enhance the overall efficacy of the models.

In general, the findings of the reviewed papers indicate that the utilisation of machine learning for mask detection is a viable approach for identifying the presence or absence of a mask on an individual. It is imperative to consider the quality and magnitude of the dataset utilised for training, the computational intricacy of the models, and the pragmatic implementation when conducting research in this field. The utilisation of Convolutional Neural Networks (CNNs) in conjunction with transfer learning methodologies utilising pre-existing networks has demonstrated the highest levels of precision and efficacy.

V. CONCLUSION

The current COVID-19 pandemic has highlighted the necessity for efficient mask detection remedies. This review paper examines various studies that examine the application of machine learning algorithms in the detection of masks.

The findings of the reviewed literature indicate that the employment of convolutional neural networks (CNN) and transfer learning approaches utilising pre-trained networks have demonstrated superior accuracy and efficiency in the realm of mask detection. Additional deep learning algorithms, such as YOLO and Faster R-CNN, have demonstrated favourable accuracy rates, albeit with increased computational complexity.

The accuracy of models is significantly influenced by the size and quality of the dataset utilised for training. Consequently, the utilisation of a meticulously selected dataset holds significant importance for the triumph of the model in practical situations.

Furthermore, it is imperative to take into account the pragmatic implementation of the models, particularly in scenarios where prompt mask detection is necessary. Ensemble methods, such as stacking and bagging, have been investigated as a means to enhance overall performance.

To summarise, the utilisation of machine learning algorithms for the purpose of mask detection has demonstrated encouraging outcomes and may be deemed as a viable approach for identifying whether an individual is wearing a mask or not. Nevertheless, additional investigation is necessary to enhance the models for pragmatic implementations and to investigate the utilisation of alternative sensors and algorithms to augment the efficacy of the models.

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