Title: Face Mask Detection Using Artificial Intelligence and Machine Learning

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Abstract

The Coronavirus Disease 2019 (Covid-19) has halted the world causing an impact on more than 603 million and casualties in almost 7 million deaths. Covid-19 is an airborne virus that is highly transmissible between people or through contaminated surfaces. Research has shown that to counteract the highly contagious disease, masks are required to obstruct the spread of the disease. Many countries have proposed a "No Mask No Service" policy to counteract the pandemic, however, enforcing the policy is a major issue due to the dense population of people. Hence, machine learning and artificial intelligence can play a major role in providing solutions to monitor face masks on faces within the public. There are many obstructions that are currently preventing the implementation of face mask detection within society. This article will articulate the feasibility of face mask detection within society and ultimately explore the numerous object detection algorithm to provide a quick and precise system. Deep learning technique such as Convolutional Neural network is shown to be heavily favoured due to the highly advantageous speed and minimal resources utilised to operate. The algorithms which will be explored includes YOLOv3 and CNN.

1. Introduction

According to estimates from the World Health Organization, the pandemic outbreak of Coronavirus Disease 2019 (Covid-19) has cataclysmically pushed the world into a catastrophe impacting more than 603 million and resulting in nearly 7 million deaths. The airborne virus spreads through person-to-person, as well as through human contact and contaminated surfaces. Due to the severity of the crisis, the world ground to a standstill during the epidemic, with both industrialised and developing nations experiencing severe social, public health, and economic implications. Numerous proposals have been made by governments of many nations to provisionally impose a "No Mask, No Service" policy in order to kerb the infectious transmission of Covid-19. However, there are numerous obstacles associated with implementing this regulation, as a community-wide effort to wear masks correctly is essential to prevent the spread of the disease. Due to the population density, conventional measures such as human enforcement by law enforcement authorities are not always viable for monitoring a person wearing a facemask. Consequently, research on face mask detection via artificial intelligence and machine learning may provide solutions to monitor face masks on faces, thus enforcing these legislations.

Face mask detection system involves a form of object detection algorithm to recognise masks on faces as objects inside photos. During the pandemic, various studies and proposals on face mask recognition algorithms were conducted to increase the precision and reliability of the detection. However, there are many unreliabilities within these studies as they are all dependent on existing research such as the identification of chest radiographs as a continuation of object detection to form suggestions and conclusions about face mask detection. As the detection of chest radiographs and face masks are two distinct paradigms, these conclusions can provide inaccurate outcomes. Thus, this research will investigate the feasibility of face mask detection within society, as well as the many types of object identification algorithms in the form of face mask detection algorithms, and recommend the most accurate and dependable approach for face mask detection.

2. Review of the literature

Face Mask Detection may be implemented in the community through a variety of technological methods. However, the following literature review will justify the feasibility of face mask detection in society and the significant shift towards artificial intelligence and machine learning as the core technologies utilised to develop a face mask detection system. Additionally, through current research publications, the review will provide the most pragmatic approach for identifying face masks reliably and accurately.

Feasibility of Face Mask Detection within Society

Face mask detection systems are not generally accessible in today's culture for a variety of reasons. This is due to the system's viability since it must meet certain criteria and regulations to be freely available to the public. Face mask identification has proven to be a challenging endeavour due to a combination of factors, including the absence of technology-based face mask detection systems and the need for strict compliance with privacy policies. The article by Mbunge et al. (2021) states the obstacles that are faced within face mask detection include diverse mask types, various camera pixels, varying degrees of obstruction, variations such as resolution, rotation, angle of view, and illumination, real-time detection accuracy, deployment of a detection model on a computer with limited processing power, and the storage space necessary to manage the images. Face mask identification is an under-studied concept in the context of the pandemic, but it is crucial to recognise masked faces in static photos, video and real-time recording in order to avoid viral transmission.

Face mask detection systems are often associated with artificial intelligence and machine learning since several studies have shown that this is the only way capable of overcoming obstacles. A study by Zhang et al (2021) demonstrates that configuring a system to execute image processing for the many sorts of masks, people and obstacles would be prohibitively complicated since each situation must be programmed for the system to function. However, through Zhang et al (2021) research, results from the article demonstrate that with the utilization of machine learning and artificial intelligence opens realms of possibilities to quickly identify multiple faces with masks within nanoseconds using object detection algorithms. Through the application of artificial intelligence and machine learning, computers can be trained through the usage of models to recognise face masks in real-time without requiring intensive usage of processing resources to operate.

Legal restrictions on the community's use of the face mask detection system or any computer vision system represent a significant barrier to its deployment for enforcing the laws. Privacy and data protection are typically amongst the most difficult legal issues involved. The main concerns which were articulated within Goldenfein (2019) article express data protection concerns such as how the data is withheld and used to analyze the information, as the data may lead to the possibility for deception, inaccuracy, or distortion in instances when individuals are incorrectly transcribed based upon computer vision pattern analysis. Privacy is also a crucial problem in the implementation of face mask detection, since surveillance of individuals without their agreement may result in substantial litigation. The article by Senior (2005) expands on the legalities between computer vision and privacy laws, ultimately stating that object recognition is currently not possible in today's society due to the archaic legislation prohibiting invasion of video privacy Therefore, to deploy a face mask detection system, the system must be used as an indication and warning for people to wear their masks, and not as a device for law enforcement, as there are numerous unanticipated inaccuracies. Additionally, warning signs must be displayed while individuals are in the vicinity of the system to obtain consent.

Face Mask Detection Algorithms

Face mask detection algorithms is a specialised term for object detection algorithms as the term is specified for the concept of detecting masks within faces. Object detection algorithms are a generalized concept of detecting objects within images or video frames using computer vision. Research has demonstrated that numerous forms of object detection algorithms currently exist, each of which uses unique approaches to accomplish face mask detection. The article by Nowrin et al. (2021) demonstrates that for identification, object detection algorithms are categorised as two major learning algorithm concepts: image classification, image localisation, or both. The technique of image classification recognises objects by categorising the images; for face mask detection, the images will be categorised into "Face Mask" and "No Face Mask" categories. Image localisation accomplishes identification by determining the location of the facemask and drawing bounding boxes around its perimeter. Research from Nowrin et al. (2021) has revealed the weaknesses in traditional techniques of object identification due to occlusion such as varied camera pixels, changing degrees of blockage, and differences such as resolution, rotation, angle of view, and lighting may alter the result of the object detection. Therefore, deep learning-based object identification is heavily favoured within face mask detection due to its ability to deal with occlusion as well as understand contextual information and complex features.

Deep learning is considered a combination of machine learning and artificial intelligence. The field of deep learning allows for information to be trained before providing desired outputs through the analysis of advanced artificial intelligence algorithms. Deep learning is shown to be advantageous in the article by Sethi et al. (2021), since it permits the reduction in the computational resource through training models, reduces process time, and improves accuracy.

Convolutional Neural Network (CNN) is a deep neural network learning-based object recognition algorithm that recognises associations within a collection of data by mimicking the functionality of the human brain using the concept of neural networks. CNN can analyse visual input and execute tasks like segmentation, image classification, and object recognition. Islam et al. (2020) generalize the process of detection within CNN through the utilisation of raw pixel data within images, the models are then trained and autonomously extract the features based on the pixels for comprehensive classification. The input dataset is routed through various layers of the CNN architecture in order to train the model. The architecture of a CNN typically has around five to seven layers, the core layers which are mandatory within the CNN are the convolutional layer and the pooling layer. Islam et al. (2020) state that the convolutional layer is CNN's foundation since it computes the convolutional operation of the input image dataset using kernel filters to extract the essential features. Within the CNN architecture, the pooling layer is used to minimise the dimensions and noise of the feature map created by the convolutional layer. Lowering the number of parameters within the data becomes advantageous as it enables models to be trained more quickly.

You Only Look Once (YOLO) Algorithm

You only look once (YOLO) first published by Redmon and Farhadi (2017) is one of the most popular single stage detector algorithms. The algorithm is able to achieve close to real-time object detection, however, this is at the expense of some loss of accuracy. YOLO achieves detection by splitting the images into numerous sections and concurrently predicting the boxes and probabilities of each region. As stated by the article by Jiang et al. 2021, YOLO was tested to be extremely fast at object detection compared to the other two-stage detector algorithms. Through multiple enhancements and iterations, as shown in Jiang et al. 2021, YOLOv3 was designed to improve the flaws within YOLO through a more backbone network and multiscale training to enhance the accuracy and speed of the algorithm. There have been many extensions that have been applied to YOLOv3 to improve the overall performance. An example from the article by Huang et al (2019) includes the utilisation of MobileNet as a replacement for the current DarkNet-53 utilised in YOLOv3 to lessen the computational complexity of the algorithm. The conversion from DarkNet-53 to YOLOv3 has enabled lightweight improvements without compromise of accuracy, ultimately enhancing the YOLO algorithm by two times.

Resnet

The Resnet algorithm is currently the most popular method within the convolutional neural network. Resnet 50 is a variant of the Resnet algorithm that processes and classifies objects using 50 layers. The article by Walia (2021) demonstrates that Resnet 50 consist of 48 convolutional layers, 1 max pool layer and 1 average pool layer. Research from Loey (2021) has demonstrated that Resnet 50 is the most optimal choice for training and building pre-processing models that detect face masks within faces. Although it requires a lot of fine tuning, the Resnet 50 is proven to be accurate in identifying the scenario, however, there are issues with computational time as it requires a long time to identify the face mask. Hence to achieve real-time detection using Resnet-50, configurations are required to be made to optimise the processing time.

3. Conclusions

In conclusion, Face mask detection systems are proven vital in order to restrict the spread of Covid-19. Machine learning and Artificial intelligence play a critical role in enabling the face mask detection system within society as enables computers to identify face masks within faces in real time without requiring massive processing power. Although the implementation of face mask detection within society is still unknown due to the privacy and data protection legislation, there are workouts around through the addition of warning signs to notify people within the vicinity. The face mask detection system will be utilised as indicators instead of a law enforcement tool due to the current outdated data protection legislation. For face mask detection algorithms, there are numerous algorithms widely available for face mask identification however deep learning and convolutional neural network is shown to be the most effective methods for detection. Through analysing the most popular convolutional neural network algorithms, Yolov3 is demonstrated to be the most appropriate method for handling detection due to its ability to process and identify face masks in real time.

4. References

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