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Facemask Detection using Deep Learning Algorithm

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Abstract: ***The concept of deep learning has attracted a variety of application domains. However, it is necessary to improve the precision and effectiveness of the many contemporary systems. In this work, an attempt is made to limit the occlusions in crowded conditions by using a mix of single - stage and two - stage detectors. In spite of its speed, the ensemble approach ought to provide results that are highly precise. Previous work on topics such as the Internet of Things, pattern rearrangement, and face mask detection assisted in the discovery of research challenges associated with this topic. Combining compression, edge detection, and a neural network is an interesting concept with the goal of improving performance while maintaining or improving accuracy. The f - score, the recall value, and precision are the metrics that are used to evaluate the performance and accuracy of the work.***

Keywords: Face Mask, Deep Learning, Internet of Things (IoT), Edge Detection, Accuracy

1. Introduction

The neural classifier technology has been employed in certain areas to check that people entering the premises are wearing masks. One of the first steps in facial recognition is semantic segmentation [1]. The form of a person's mask may be determined using a neural classifier. Face mask detection is linked to video surveillance. For the sake of safety, cameras are linked to the internet [2]. If an IoT device fails to recognize a person’s mask, a warning is sent out. There has been a rise in the use of smart CCTV surveillance systems. IoT devices that work with video surveillance systems are becoming more helpful [3, 4]. The density of people in public places is often monitored with the use of these kinds of equipment. If somebody in a crowded location is found without a face mask, this system may warn or activate an alarm. It can also detect persons who are closer to the system. Furthermore, this strategy does not need the use of a disguise. As a result of the integration of various technologies, video monitoring has become more effective [5]. For monitoring crowd density in public settings, these kinds of gadgets are often used by security personnel. It is possible to tell whether someone is wearing a mask by using a sophisticated video surveillance system. A more comprehensive warning system may be designed with less difficulty when the mask is gone. Using modern technology, a person who is not wearing a mask may be fined if the mask pattern cannot be recognized. Every day, the use of intelligent surveillance systems grows in popularity [6].

To enhance face mask identification, researchers during COVID 19 employed deep learning. A number of systems have been built on the concept of deep learning. Nevertheless, deep learning's precision and effectiveness may be improved. To deal with a wide variety of occlusions in a densely populated location, the suggested model employs a multi - stage detector and a succession of single - stage detectors. As a result, the detection time is reduced significantly using the ensemble approach. With an average inference time per picture of less than 0.05 seconds, the mask detection accuracy is reported to higher than 98%. Results were gathered by conducting experiments using the three most often used baseline models: Resnet50, AlexNet, and Mobile Net. It has been shown that ResNet 50 is capable of achieving a 98.2 percent level of accuracy when tested.

Rest of the paper is being organized as follows. Section 2 introduces the background of IoT environment and deep learning. Section 3 discusses related work carried out by the contemporary researches. Section 4 presents the proposed methodology. Section 5 discusses the concluding remarks of the work.

2. Background of IoT Environment and Deep Learning

This section first provides a brief overview of the IoT environment. Subsequently, it discusses the background of learning techniques.

2.1 IoT Environment

In the Internet of Things, things are interconnected by sensors, electronics, software, and networking links [4]. This category includes things like appliances, autos, and buildings. IoT aims to increase computer systems' overall productivity, accuracy, and economic value by bringing the actual world closer to them. It does this by enabling remote monitoring and control of devices through the Internet. Cyber - physical systems, such as smart grids, smart homes, intelligent transportation systems, and more, may be built using IoT sensors and actuators. An embedded computer system may be used to identify a specific object with pinpoint precision utilizing an existing Internet infrastructure. According to estimates, the Internet of Things will be home to more than 50 billion users by 2024. As far

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as Internet connectivity is concerned, IoT is at the forefront. Co - located items may identify one another and exchange information [1]. Through network infrastructure and services provided by the IoT, it is possible to connect real devices at will as depicted in Figure 1. It is because of the interaction and judgments that IoT provides that many elements of education, technology, and business are influenced [2]. If the hype around IoT is to be believed, it will be a game changer in our time. In addition to the capacity to make better choices with more precise information, save costs, detect and monitor resources and environmental issues, and deliver better and creative medical treatment using these devices, improving the quality of life is also feasible.

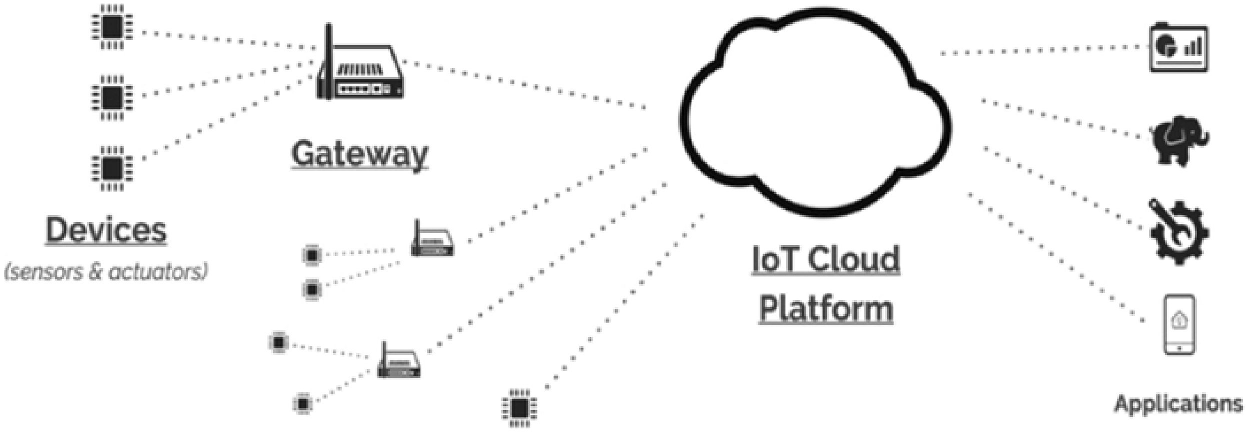

Figure 1: Building blocks of IoT ecosystems [4]

2.2 Deep Learning

DNNs, or ANN, are a subset of a wider family of ML methods known as representation learning [7]. It's possible to study under close supervision, in a semi - unsupervised setting, or on one's own. A number of areas have used artificial neural networks, including computer vision and voice recognition [8]. For example, they've been used in medicine design and medical picture analysis; climate research; material inspection; and board game programming. The term "deep learning" refers to the process of incorporating a large number of network layers into a single model. The universal classifier that we were using before to this research was a network with no polynomial activation function and a hidden layer with unlimited breadth. A unlimited number of bounded size layers may be used to accomplish practical application and effective implementation of deep learning while retaining theoretical universality. The "structured" part of deep learning comes from allowing the layers to be diverse and to deviate significantly from physiologically informed connectionist models.

3. Related Work

Meenpal et al. [1] introduced a mask detection mechanism using semantic segmentation. They developed a technique for accurately creating face segmentation masks from images of any size. The VGG - 16 Architecture's Predefined Training Weights were used to extract features from RGB images of any size. Semantic segmentation of the faces in the picture was accomplished by training using Fully Convolution Networks. Training and loss functions are implemented using Gradient Descent and Binomial Cross Entropy, respectively. It was necessary to further process the FCN's output picture so that it may be cleaned up of extraneous noise, erroneous predictions, and bounding boxes. Furthermore, the suggested model has performed very well when it comes to detecting faces that aren't frontal. Besides this, it was also capable of detecting numerous face masks in the same picture. Tests on the Multi Parsing Human Dataset yielded 93.884% accuracy for the segmented mask faces.

Qianyu Zhang et al. [2] focused on investigation of image edge detection techniques - based flood monitoring in real - time. Flooding was becoming a common danger that may cause significant harm to people's lives and property all around the globe. Image edge detection algorithms were utilized in this work to monitor the status of the flood region in real - time in order to reduce the devastation caused by floods. Consider the method's processing time, which has a direct impact on the system's ability to monitor floods in real - time. The benchmark for assessment might alternatively be based on the accuracy of the forecasted flood area. The experimental results have been influenced by the altering parameters of each algorithm, and the approach with the best accuracy and the shortest processing time has been predicted. Using the findings from this study as a basis, Canny edge detection is being explored for implementation on actual hardware in the outside environment in the future.
Martin - Gonzalez et al. [3] explored neural classifiers for screw shape recognition. Our vision system is based on neural networks and was designed to monitor the production of micro pieces in micromechanics. So that we can regulate and improve our production process, we may use the system to detect the shape of micro pieces. Limited Receptive Area Grayscale is the name of the neural classifier used for form recognition. The new vision system has a 98.90% accuracy rate. An automated micro machine control system is the driving force behind this project. The model and learning principles are described in full in this work, and future prospect are discussed.

Gulve et al. [4] looked implementation of IoT - based smart video surveillance system. Smart video surveillance was an IoT - based application since it uses the Internet to perform a wide range of functions. For additional security, the suggested system would notify everyone in the neighborhood and record any activity that they engage in.

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Before leaving the premises, the user enters their password to activate the system. Motion is detected first, then persons are detected, and finally the system counts the number of people in the room before notifying the next - door neighbor. Aside from that, the user is also alerted by SMS and email. Open - CV (for video surveillance) and a GSM module complete the recommended system's software implementation, which includes a Raspberry Pi and Arduino boards. When the user forgets to switch off their electronics, the system is intelligent enough to minimize power consumption loss by coding each gadget individually.

Neha Patil, et al. [5] presented IoT based smart surveillance security system using raspberry pi. It was the goal of this work to describe an Internet of Things - powered safekeeping alert device that helps the observer and notifies when movements or gestures are present, and then sends photographs to a cloud server. In addition, internet of things - centered use might be applied shakily to examine the activity and get warning when gestures or other indications are present. When a cloud attendant isn't available, the photos are stored on a Raspberry Pi. The size of a standard credit card using the Wi - Fi module, a Raspberry Pi with Open - CV software controls the image processing, control methods used for the attention, and then displays the captured photographs to the email address of the concerned individual. A regular webcam is used by the system.
Junia Valente, et al. [6] focused on privacy and security issues related to the internet - connected cameras. It is possible to collect and distribute information about real - world occurrences, including potentially sensitive information about users' decisions and actions, thanks to IoT. Internet - connected webcams pose a number of security and privacy concerns. They compare two types of cameras: a baby monitor camera offered to consumers and a security camera marketed to businesses. There are security flaws in both cameras that enable a remote attacker to see video frames that were collected by them, even if the transmission is encrypted.

Sutrisno Warsono Ibrahim et al. [7] carried a comprehensive review on intelligent surveillance systems. The rising need for security and safety has led to a growing interest in ISS. Image, video, audio, and other types of surveillance data may be automatically analyzed by ISS without or with minimum human participation. Sensor devices, computer vision, and machine learning all play a key part in allowing this intelligent system. Cameras such as CCTV, infrared cameras, thermal cameras, and radar are among the sensor modalities and fusion scenarios that are discussed in this study. Background - foreground segmentation, object classification, tracking and behavioral analysis are also covered in this study.

Hampapur et al. [8] presented smart surveillance applications, technologies and implications. It addresses a number of questions such as: when it comes to smart surveillance, what are some of its uses? What were the architectures of smart surveillance systems? What are some of the most important tools? What are some of the most difficult technical issues you're facing? What were the security and privacy consequences of smart surveillance?

Michał Zabłocki, et al. [9] reviewed intelligent video surveillance systems for public spaces focusing on their most desired attributes and features. In order to consider all the options, the following categories were taken into consideration: systems based on object detection and tracking, systems that can identify and warn against dangerous and alarming situations, systems that analyze traffic and parking lots, systems that count objects, systems that use multiple integrated camera views, and systems that protect privacy. Solutions for each type of intelligent monitoring systems are presented in this study, along with their major functions.

Davies et al. [10] provided a progress review of intelligent CCTV surveillance systems. Various features of surveillance are discussed in relation to closed - circuit video surveillance systems in conjunction with distributed computing systems.

Sefat et al. [11] presented implementation of vision based intelligent home automation and security system. The user may activate the system by speaking a command while leaving the premises. When the user leaves the home or workplace, the system continues to monitor. Automatic surveillance may be activated at a certain time of day. An SMS and an alert will sound if the user has left the premises and the system identifies the presence of a human being in there. When the alarm is activated, the system records video to an SD card, which the user may see at a later time. An image processing method used to count how many people are in a room may also be used to shut down power when no one is there. As a result, there will be less wasteful use of energy.

Ramakrishna et al. [12] focused on design and implementation of an IoT - based smart home security system. IoT - enabled home automation and security systems can now be built at a fraction of the cost due to the substantial developments in smart phones and open - source hardware platforms. Smart home security systems can exploit various types of sensors like motion detection sensors, temperature sensors etc. A home gateway connects these sensors, smart appliances, and other IoT devices to the Internet. An Android app is to be used to notify a user when a door. It uses Raspberry Pi 2 board for communicating with the remote server. In addition, the authors also highlight the implications of such monitoring systems such as interference from the other radio frequency.

4. Proposed Methodology

To reduce training & testing time, current research processes picture data using edge detection mechanisms. Furthermore, using such a strategy would improve the precision with which study findings are drawn [13]. Also taken into account are the variables that are simulated. During an examination of standard pattern detection methods, a number of flaws were discovered. Methodology for mask identification using edge - based CNN algorithm [14] is implemented using MATLAB. The proposed work consists of following steps:

- The data set acquired by a camera would be used to build an image database.

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- Use a traditional CNN classifier to see how much space and time it takes to process a given set of data.
- Analyze the picture collection using the edge detection algorithm.
- Make use of the suggested CNN classifier to see how much space and time it will take to implement.

During simulation dataset of image of face masked and non face mask has been considered from Kaggle [15]. Edge - based CNNs take less time to implement than normal CNNs. When comparing to the conventional strategy to the one they offered, the Figure 2 shows the difference in time.

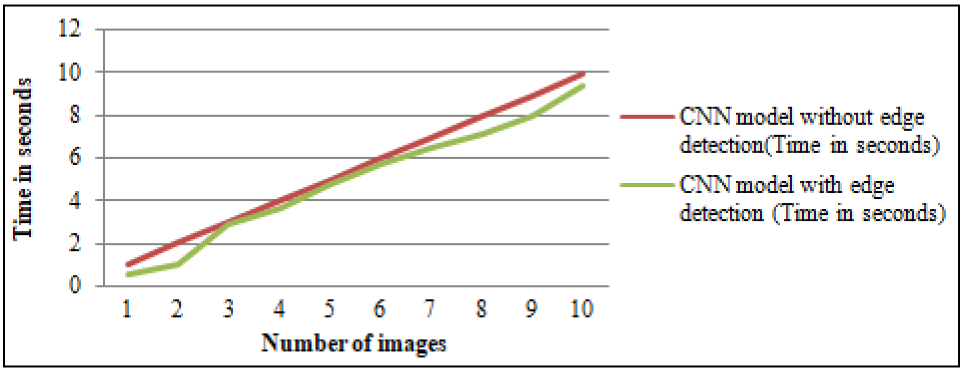

Figure 2: Comparison of time consumption in case of conventional and proposed model.

As a bonus, edge detection minimizes amount of storage space required by the data set. So, the area requirements are shown in Figure 3.

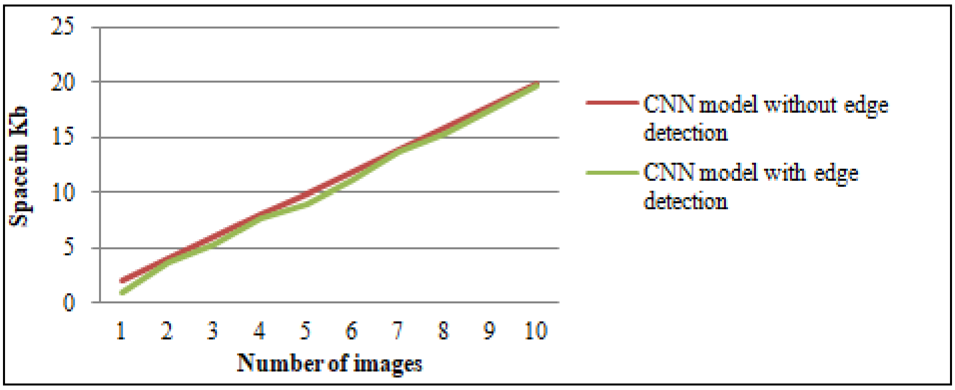

Figure 3: Amount of storage space required.

5. Conclusion

The use of canny edged detection requires less time than the present CNN approach, according to the results. In contrast, graphical examples take substantially less space. The classification and prediction methods are unaffected by this modification. Neuroscientists hope that the proposed research would improve the decision - making abilities of convolution neural networks. It is 14 percent more accurate than the traditional technique, according to the simulation. A picture's degree of accuracy might vary based on the picture's size and the amount to which an image dataset has been altered. CNNs are better at analyzing and classifying graphical data than SVMs in terms of textual data, according to traditional research. Face mask detection on CNN might need more research. In contrast to CNN, SVM focuses on textual data, whereas CNN focuses on pictorial data. Detecting the properties of a mask - based data collection is done using layers in CNN. It has been proposed in this study that the classic neural network model's efficiency may be improved using an edge detection technique. The identification of irregularities in brightness is used to carry out edge detection. Both picture segmentation and data extraction have been accomplished using it. As an example, it's been put to use in a variety of fields including graphics processing and computer vision. Graphical pattern detection models are also understudied due to the difficulties involved in the work.

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