Covered face detection for enhanced surveillance using Deep Learning

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***Abstract*— In today's world day to day criminal activities have been increased and for that the real time security system is highly demandable. Crime records in ATM, bank, public transport systems etc has brought the vulnerability of the innocent publics. Frequent safety ultimatum may seriously infect everyone's lives. In this regard we proposed a covered face detection system using deep learning. The work describe in this paper gives a low cost video supervision with rectified accuracy and less complexity.**

Index Terms: **Face recognition, Security, Surveillance camera.**

INTRODUCTION

With rapid increase of computational efficiency, use of deep learning we can use the to increase the security of the people by installing a camera and computer system. In present day the criminal activities are increases and they generally used to covered face and do any unethical practice in public transport system, bank, ATM, shops etc.We can send the alert to the nearest police station or traffic control room by accessing the location of the ATM, shop or bank. Hence it is required to maintain a strong security system. By considering the present situation we decided to proposed needful security enhancement technique to prevent these robberies or criminal activities so that no users will face any problem. Researchers have proposed various methodologies in this regard. Many solutions have been furnished in this regard, but still some issues hang around unanswered. In [1-3] we can see that they are detecting abnormal gestures of person using surveillance camera for detecting robbery threat. Whereas in [4] authors to detect that if a person trying to hide his or her face using any scarf, helmet etc. But in our work, we are detecting whether a person is trying to hide his or her face. And in case they are hiding that then we are sending alert message and e-mail to a specified e-mail id and phone number continuously with some span of time and when we are sending the e-mail alert, we are also sending one attachment with photo where the suspicious person can be seen. We are detecting whether a person is trying to hide his or her face. In Enhanced Security here we used Digital Image Processing, firstly it checks if the person's face is covered using a helmet, mask or a scarf making use of deep learning.

LITERATURE SURVEY

The researchers already proposed various methodologies [1-10] to overcome this problem and we have reviewed few of the research papers as listed below.

In [1] we can see that they are detecting abnormal gestures of person using surveillance camera for detecting robbery threat. We have find in [2] that they are only detecting whether a person has put on full mask or not. In [3] authors are only detecting that a person wearing a normal mask or not. Authors have proposed in [4] a new methodology which can be used to detect that if a person trying to hide his or her face using any scarf, helmet etc. In [5] researchers are only detecting that a person wearing a normal mask or not due to outbreak of Covid-19. Authors in [6] are detecting people with half face mask or not as well as they are also detecting the distance between them using surveillance camera. In [7] researchers have built a system by which they candetect mask, classify mask type, mask position and recognizeidentity. Authors in [8] have proposed one system which has capability of detecting people's face mask and used pre-trained networks like MobileNetV2. We can see in [9] authors have build system to detect normal face mask using camera. We find in [10] that the system is

detecting half face mask and if it's not detected then an alarm will alert the concerned authority.

In our project, we are detecting whether a person is trying to hide his or her face. And in case they are hiding that then we predict he is covering his face or not? Our project has a accuracy above 90%. After detecting the fully covered face an email and sms alert will be going continuously with some span of time and when we are sending the e-mail alert, we are also sending one attachment with photo where the suspicious person can be seen.

DESIGN METHODOLOGY

Now a days ATM robberies with the help of covered faces becomes a common phenomenon. Thus, identification of covered face using real time monitoring will serve an effective solution to control these robberies. This paper showcasesa novel approach to identify face from ATM surveillance camera images.It works on the principle of identifying covered face person through an image or video stream with the help of Deep Learning and Machine Learning using Keras, TensorFlow, OpenCV and the Scikit-Learn library. Whenever a person with covered face enters in the ATM premises, it sends one alert SMS and Email and snapshot of that person with the help of smtplib, tkinter, requests.

TECHNOLOGY USED:

1. Machine Learning:

Machine Learning (ML) is a most widely used technique to predict the outcome of any occurring events based on their past data or experiences. Machine Learning algorithm is classified into two phases:

a) Training of data

b) Testing of data

At first it breaks the dataset into two datasets training data and testing data. It builds a mathematical model based on the training data and trains the model. After that the trained model is further tested with the testing data for better accuracy.

2. Deep Learning:

Deep Learning a subset or form of Machine Learning that deals with the artificial neural networks. It uses the multiple layers to increasingly take out advanced features from raw input data and the algorithms are stacked in a hierarchical order of increasing complication and conception.

MODULE DESCRIPTION:

1. OpenCV:

OpenCV is a very useful open-source library for image processing. It is used for executing infinite loops using webcams which identifies the faces using Cascade Classifier. It has 2000+ enhanced and upgraded algorithms formachine vision.

2. TensorFlow:

TensorFlow is an end-to-end open-source library which is used for machine learning applications like Symbolic Mathematics Library and Neural Networks. It is used to train the classifier to automatically identify that a person is covered his face or not.

3. Keras:

Keras is a high-level neural networking API. It pursues the best methods to decrease the load and furnishes steady and tensile APIs that reduces the user actions needed for normal usage circumstance and furnish clear and accessible error or alert messages.

4. MobileNet V2:

MobileNet V2 is a Neural Network architecture model for object detection. It is easily executable on smart phones with high accuracy as compared to other CNN architectures.

5. SMTPLIB:

SMTPLIB is a python library for sending email messages using SMTP or ESMTP listener daemon.

6. TKinter: Tkinter is a python GUI library. It furnishes a quick and easy way to create GUI applications. It also furnishes a strong object-oriented interface to the TK GUI toolkit.

MobileNet V2 Architecture

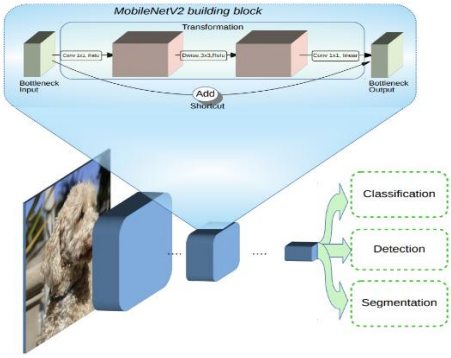

Figure 1: MobileNet V2 Architecture

The MobileNetV2 architecture is centred on an inverted residual structure where the input and output of the residual block are thin bottleneck layers opposite to regular residual models which use expanded representations in the input. There is a 1 x 1 convolution that helps to change the dimensions from smaller dimensions to large dimensions. Then the 3 x 3 depth wise convolution is applied. Now we have used another 1 x 1 convolution to reduce the dimensions. After that we are adding residual connection between the blocks which has smaller number of channels.

Why we have used MobileNet V2 ?

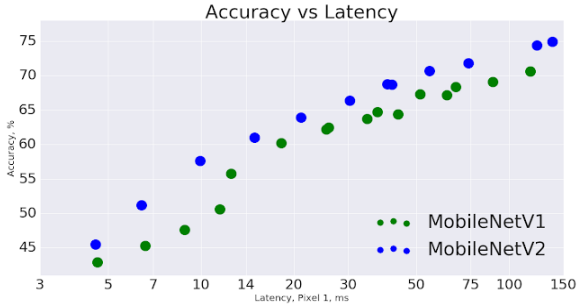

Figure 2: differenec between MobileNet V1 and MobileNet V2

MobileNetV2 is a potent feature extractor for object detection and segmentation.

It need 30% fewer parameters, uses 2x fewer operations, and are about 30-40% faster on a Google Pixel phone than MobileNetV1 models, all while achieving higher accuracy.

On the whole, the MobileNetV2 models are speedy for the same accuracy across the entire latency spectrum.

LABEL BINARIZER

```
>>lb.fit_transform(labels)
[[0]
 [0]
 [0]
 ...
 [1]
 [1]
 [1]]
>>to_categorical(labels)
[[1. 0.]
 [1. 0.]
 [1. 0.]
 ...
 [0. 1.]
 [0. 1.]
 [0. 1.]]
```

Figure 4:Label Binalizer

The LabelBinarizer method turns every value into binary within a matrix where that value is indicated as a column. In layman terms, it will turn a list into a matrix, where the number of columns in the target matrix is exactly as many as unique value in the input set. There are two unique values in the input set i.e., “with mask” and “without mask”, so a two-column matrix will be constructed. When the current data are either of “with mask” or “without mask”, it is going to denote as 1 whether that data correspond to the label “with mask” or “without mask”.

The fit_transform method converts multi-class labels to binary labels and the to_categorical function returns a matrix of binary values (1 or 0). It Has total columns equal to the number of classes and total rows equal to the length of the input list.

CLASSIFICATION REPORT

	precision	recall	f1-score	support
with_mask	1.00	1.00	1.00	30
without_mask	1.00	1.00	1.00	384
accuracy			1.00	414
macro avg	1.00	1.00	1.00	414
weighted avg	1.00	1.00	1.00	414

Figure 5: Classification Report

The precision is 1 for both the classes i.e., “with mask” and “without mask” which means the model has accurately predicted the desired output. Recall value is also 1 that means the model was able to find all the positive instances. And same goes for the f1-score, all the positive predictions were correct. The support shows that there are 30 “with mask” data and 384 “without mask” data.

CONFUSION MATRIX

```
[[ 30   0]
 [  0 384]]
```

Figure 6:Confusion Matrix

From this matrix we can say that our model has predicted all the cases correctly. The first row and first column denote that 30 rows with “with mask” has been predicted correctly and the second row and second column is implying that there were 384 rows with “without mask” which also has been predicted accurately.

RESULT & ANALYSIS

Covered Face Detection for Enhanced Surveillance uses Deep Learningin its core. We have done an extensive use of Python language to lay-down the foundation of this system.

With the creation of this covered face detection system, we have incorporated some key functionalities which are of utmost use. Whenever a person enters a secured environment under surveillance along with his face covered, the system successfully detects the face to be covered. On top of that, it also detects and flashes the percentage or the amount of face covered (as depicted in fig.7 and fig. 8).

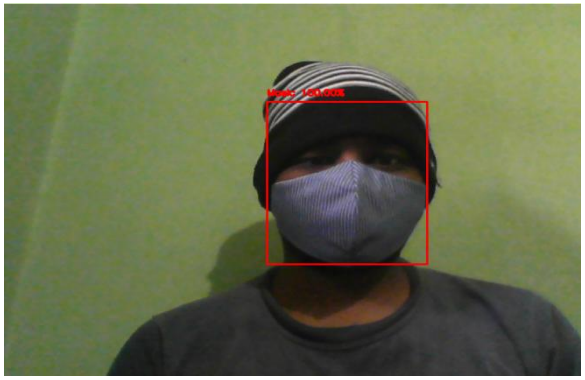

Figure7: Face detected to be 100% covered

Figure 8: Face detected to be 100% covered

If the individual's face is not covered, it detects his/her face in green box with the message as 100% without mask (as depicted in fig. 9 and fig. 10).

Figure 9: Face detected to be 100% uncovered

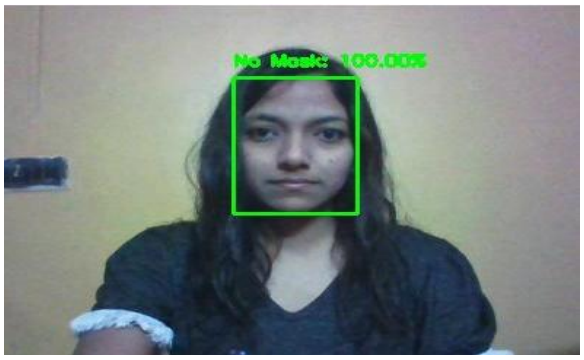

Figure 10: Face detected to be 100% uncovered

Figure 11: E-mail alert with the image of the suspect

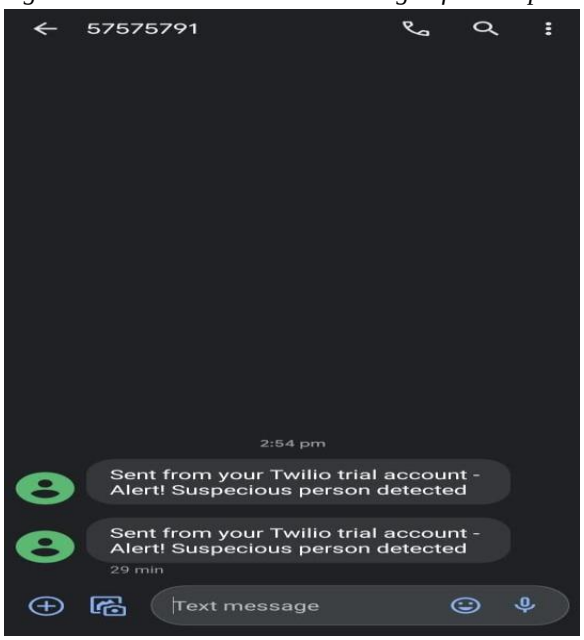

Figure12: SMS alert

Adding to the functionality of the covered face detection, the system also sends an SMS and an e-mail along with the snapshot of the suspect to the concerned higher authority (as depicted in figure 11 and figure 12).

Hence the system maintains the surveillanced environment to be fully secured.

The covered face detection system keeps the concerned authorities completely aware of all the activities of the perimeter under surveillance.

TRAINING LOSS AND ACCURACY:

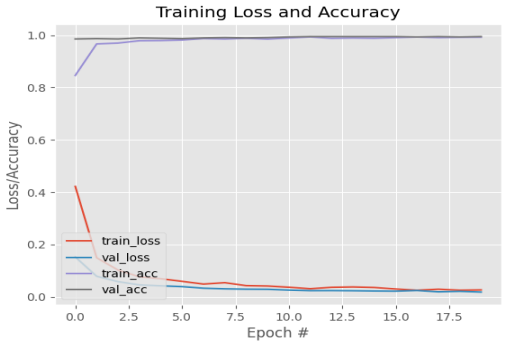

Figure 13: Plot of Accuracy and Loss

As we can see that by increasing the number of epochs , training loss as well as the validation loss decreases , By carefully observing the graph , we need to choose the epochs in such a way that model does not not overfit . So , we would choose an epoch of 20 for training our model.

In Fig.13 we plot accuracy and loss of training and validation data against epoch. \%. When epoch increases our accuracy also increases and loss decreases. Validation accuracy is our prediction accuracy which is more than 90%. When epoch increases our accuracy also increases and loss decreases.

FUTURE SCOPE

1. In future with some modifications, we can send the alert to the nearest police station or traffic control room by accessing the location of the ATM.
2. It can be installed not only in ATMs but this can also be used in Jewellery, electronic shops, shopping malls, banks and public transports etc.
3. It increases possibility of reducing crime rate like robbery cases.
4. It enhances the security coverage area because no or a few people required to operate it.

CONCLUSION

We have created a full-face covered mask detector and alert system for enhanced surveillance using Deep Learning, Keras, Tensor flow and OpenCV. We trained it to identify people with full covered face. We have used MobileNet V2 classifier with the ADAM optimizer for the best result. The model is tested with photos and real-time video streams. It detected the face from the images/videos and extracts each individual's face and apply the face mask classifier to it. Since, we have used the MobileNet V2 architecture we can easily deploy our model to the embedded systems such as Raspberry Pi, Jetson, Google Coral, Nano etc. After detecting face which is fully covered, we sent an alert SMS and E-mail in a particular number and mail id respectively. This can be very helpful for the society and can possibly contribute to the public safety.

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