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Deep Learning Based Face Recognition Technology in Bank Branch – An Application

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Abstract: Today with the rapid advancement and enhancement of technology everything is becoming automated in some or the other way. Face detection and recognition is one of the flourishing technology and has a lot of scope for development and implementation. The goal of any biometric system like iris scanner, fingerprint scanner etc. is to take advantage of the unique physical features of the human body. Benefits of face recognition based technology over other biometric technologies are the high degree of uniqueness it provides due to its dynamic nature and how effortless the process of authentication becomes. In this paper, an application of face recognition based authentication in the banking sector, is being discussed. Face recognition system along with the liveness detector implementation can make the visit to a bank branch absolutely contactless, smooth and much faster.

Keywords: Computer Vision, Deep Learning, Face Detection, Face Recognition, Convolution Neural Network, Banking System.

1. INTRODUCTION

Over the past few years, a lot of research and development has been done in the field of computer vision [1, 2, 3]. Human face has a lot of information to be decoded like gender [4], age [11], expression [5], feeling [5] etc. Face recognition [3, 13] in the field of computer vision deals with the detection [10] and identification [13] of a face from an image or from a video. As face recognition is an effortless method of authentication and provides a high degree of uniqueness, it has a huge potential to replace other biometric technologies. The dynamic nature of human face makes it difficult to implement as human face varies in different cultures, also haircuts, growing beards etc. adds to the difficulty of this type of authentication. But detection of landmarks [13] in the face and extracting the features [13] with the help of convolutional neural network (CNN) in face recognition technique, the problem has been solved to a large extend. Even 3D convolutional neural network [6] helps to apply the convolution operation on a 3D structure and eventually detects the liveness of the face in the image.

In this paper, an application of face recognition system [13] in the field of banking is discussed. As today everything is becoming automated, for the convenience and comfort of the customers, a visit to a bank branch is still considered to be a hustle for many people, especially in the countries with a huge population. Forgery in the identification card or signature to get the details of a person is a common practice. Banks have taken a lot of measures to get rid of this type of forgery attempts, but the comfort and the convenience have been compromised as for bank, security is always their priority. With face recognition system [13], the security will be kept intact and the missing comfort and convenience can be brought back by making the visit absolutely contactless and much faster. So, by installing a face recognition system in the bank branch, the customers don't have to show any ID card or signature for their verification. The verification will be done with their face, thus getting rid of any forged ID card or signature. After the verification, the customer can do their banking operation, thereby making a visit to a bank branch hustle free and contactless to a large extend. Also if the bank wants to keep the traditional method of signature authentication, then face recognition can act as an extra layer of security for the customers. An overview of the system is shown in figure 1.

2. LITERATURE SURVEY

Face Recognition System [3, 13] has been implemented in various fields. This kind of system can be seen in the offices especially in China where automation and artificial intelligence has taken over completely. A face recognition system in office has made the process of entry of attendance by employees convenient and smooth [7, 8]. Thus the employees don't have to swipe or touch their ID card to the machine to make the entry, thereby making the process contactless and faster. This system is slowly replacing other biometric system like fingerprint scanners. Face recognition technology has also been implemented in the security surveillance camera system [9]. This technology helps the security team to get an alert when a wanted person is detected in the camera which would have taken a huge human force to detect with accuracy otherwise. There has also been research work on face recognition system in transportation, like metro for calculation of total fare automatically [12].

Now as far as implementation of this type of system in the banking sector is concerned, ATM has been a place where the implementation of face recognition like technology has been researched about a lot [15, 16]. In the ATM booth, the face recognition gives an extra layer of security along with the pin code security. The mechanism [16] on which this system works is that if the pin code entered for the ATM card matches then it tries to match the face captured through the camera fixed in the ATM with the image of the face already stored in the database of the ATM or the bank, corresponding to the ATM card. If the face is recognized, then the transaction is valid and the process is taken forward otherwise the transaction is denied. This face recognition system also helps in getting rid of the cloning of cards trick which is a very common way of stealing money through ATM cards.

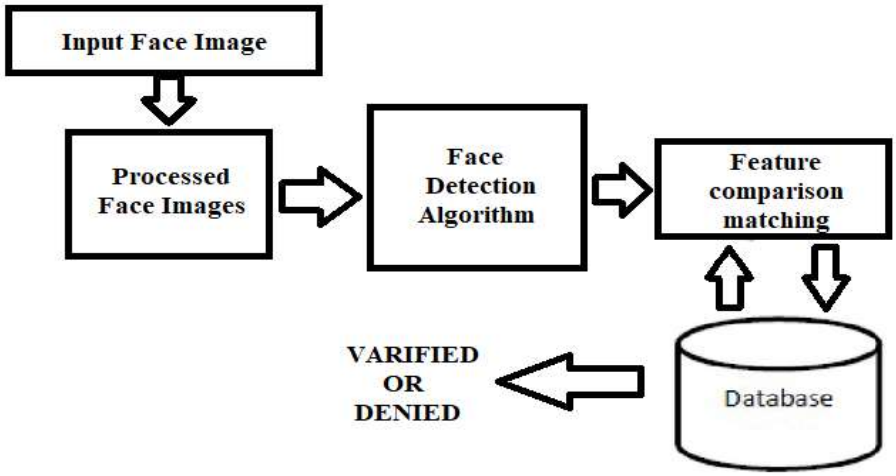

Figure 1. Overview of the proposed Face Recognition system that is to be applied in the bank branch.

3. DESIGNED METHODOLOGY ANALYSIS

The proposed method for making the withdrawal of money from bank branch or for any authentication process, convenient and contactless, a face recognition system [13] has been implemented with the concept of Deep Learning technology. This face recognition system will be connected with the database of the bank which will then be used to fetch the details of the customer when the face recognition is valid. So, in this methodology, a single picture of each customer has to be kept in the database which will be used for comparison with the image captured. Then the first step will be to capture an image of the customer through a webcam and pass the image in the face detection algorithm [10] and then face recognition neural network for the identification of the face. If the input image matches with any of the images which is already present in the database, then the transaction will be processed further otherwise denied. A flowchart of the designed methodology is depicted in figure 2.

3.1. FACE DETECTION NETWORK

The first step in this methodology is to capture the image of the customer through the webcam. The image is then passed on to the face detection neural network for detection of the face or multiple faces. The main fundamental of face detection [10] is the detection of edges [17] in the images. This detection of edges can be made possible through convolution operation with the help of a filter. The convolution operation is done on the grey image rather than the RGB format image. So the image captured is first converted into a grey-scaled image then the convolution operation is performed. Padding and Stride operation makes the edge detection [17] faster and efficient. Each convolution operation forms an activation layer for the next layer thus together forming a convolution neural network. Different type of layers in a convolution neural networks are – convolution, pooling and fully connected layers. Figure 3 shows the detection of vertical edges through a convolution operation. Similarly, horizontal and angled edges in the image can be detected.

Now the face detection process is divided into multiple sub-processes. So, in order to detect a face, Image Classification and then Localization has to be performed. Image Classification is nothing but finding out what objects the model is going to detect and how it looks like. So the model is trained with the dataset for detection of that object, here the object is a human face. Localization means to find out where the object is present in the image. In Image Localization, the convolution neural network results into a vector which gives us the information whether the object is there or not and in case of multiple object detection, which are the objects present in the image. After detection [10] of the face, which is the object in this case, a box is drawn around the face to specify the area where the face is there. Landmark detection algorithm [13] also helps in the detection of different features of the face in the image and helps in the process of feature extraction which eventually can help in detecting the face more accurately.

Figure 4 depicts the different stage of face detection. The first step is the image classification. In the example, the image is classified to be a human face. The next step is to find the face in the image and draw a box for localization of the face. Finally, Detection can be performed on any image given as input including multiple face detection in a single image.

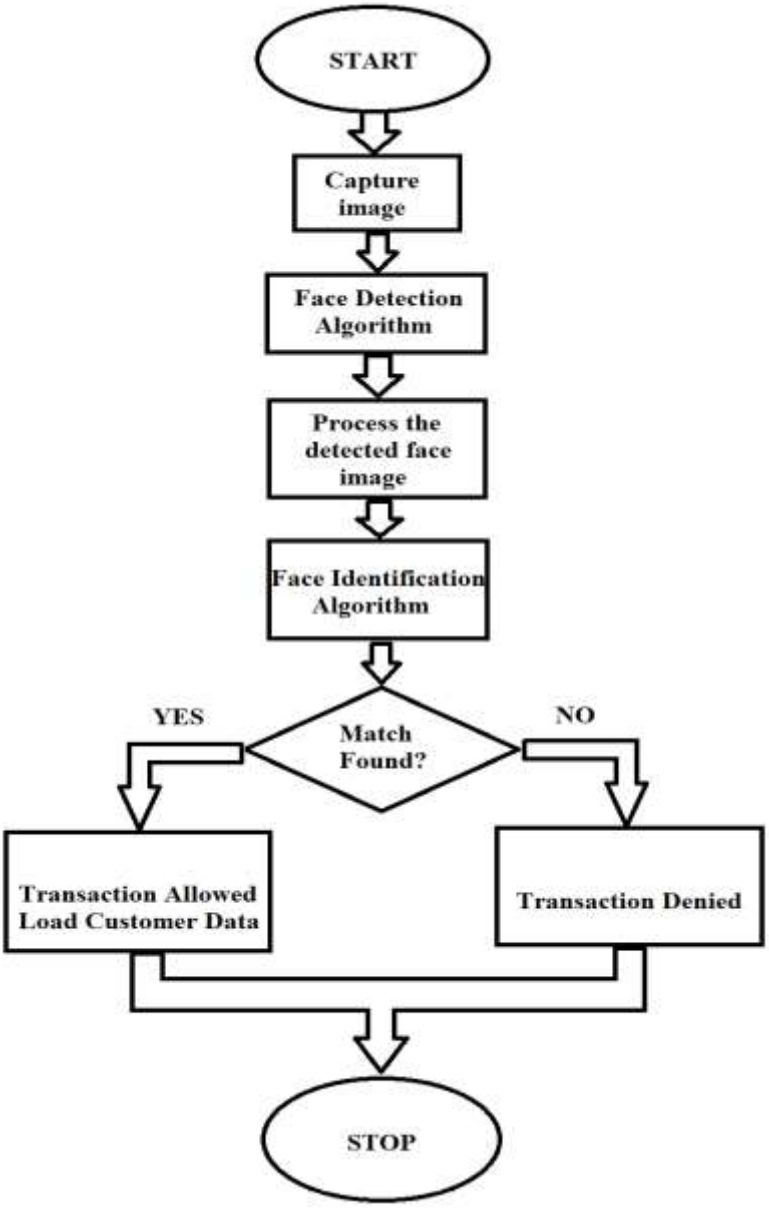

Figure 2. Flowchart of the proposed methodology for authentication using Face Recognition system in the bank branch.

To detect faces there are many algorithms like Support Vector Machine (SVM) classifiers [19] using Histogram of Oriented Gradients (HOG) features or AdaBoost [18] classifier using Haar and Local Binary Pattern (LBP) features. In this methodology, YOLO (V3) or You Only Look Once algorithm network has been applied for detection of a face in the image. YOLO algorithm is much faster than other algorithms like Sliding Detection Algorithm where the time complexity is very large. YOLO-V3 which came from the YOLO and YOLO-V2 [20] is a much better and faster neural network for face detection as this network transforms the problem into a regression. So compared with the other neural networks like RCNN, YOLO-V3 is a much faster algorithm for the detection problems. In the YOLO algorithm [20], the image is divided into grids, and then classification and localization is performed in each of the grid. Then the Non-

Max Suppression Algorithm helps in the detection of objects by cleaning up the multiple detections. This cleaning is done by finding the highest IOU value or Intersection over Union value and then suppressing or deleting the unwanted boundary boxes. If the IOU is more than 0.5 it is considered to be a good value.

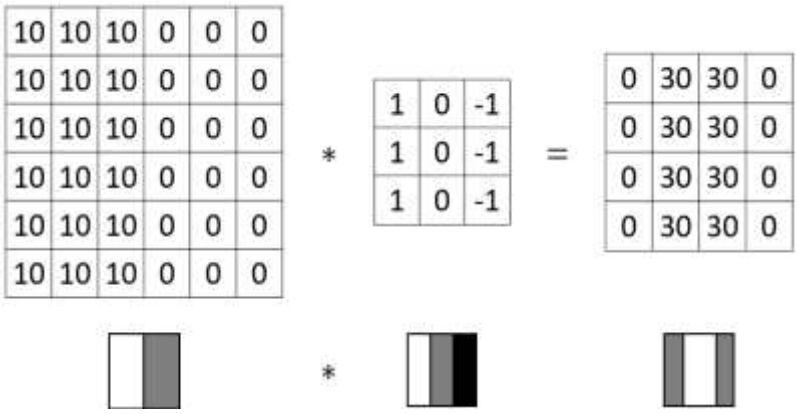

Figure 3. Convolution operation for detection of the vertical edges in the image.

3.2. FACE RECOGNITION NETWORK

Now after detection of the face in the image which was captured through the webcam, the face has to be recognized. Face recognition [3, 13] is a process where it is found whether the input face image in the network model is matching with any of the images stored in the database. Hence this makes face recognition as 1:K problem.

Figure 4. Image Classification with Localization.

The traditional method for making a face recognition system is to train the model individually for each customer. But the drawback of this method is that the model has to be trained every time a new customer joins the bank. Thus this method is not feasible for this purpose. This method will work fine if a personal face recognition system has to be implemented. But for banking purpose where hundreds of new customer join every day, it is practically not possible to train the model every day. Thus one-shot learning problem arises. The one-shot learning problem is a challenge to identify a face with only one image in the database which will be captured by the bank officials while opening the account. This problem can be solved by learning the similarity function (∂(x(i), x(j))). Similarity function is a function which takes two images as arguments and gives an output very small if both the images are similar and the output will be very large if both the images are different. So, the similarity function gives the idea about how different or similar two images are. This similarity function can be implemented with the help of Siamese network [21]. Siamese network take each of the images in the database as input and results into a vector which acts as an encoding function for that image. Also the images captured through the webcam are also passed into the network with same parameters for the generation of the encoding functions. These encoding functions are passed into the similarity function. If the images match then the similarity function will produce a very small output which signifies that the person is a present customer of that bank. Mathematically,

∂(x(i), x(j)) will be min || f(x(i)) - f(x(j)) || as i = j, thus the two images are equal.

∂(x(i), x(j)) will be max || f(x(i)) - f(x(j)) || as i $\neq$ j, thus the two images are different.

Figure 5 is a diagram that depicts how the encoding function is obtained by passing an image into a convolution neural network, which is called Siamese Network [21]

Now in order to solve the one shot learning problem with similarity function (∂(x(i), x(j))), triplet loss function (L(A,P,N)) [22] is implemented, where A is the anchor image, P is the positive image, and N is the negative image. Here, three arguments are taken as input, the anchor image, one positive image, and one negative image for finding the

similarity function. In the function, the encoding of each of the argument is found and the similarity function between the anchor image and positive image is obtained. Simultaneously, the similarity function between anchor image and the negative image is obtained. The difference between the two similarity functions should be less than or equal to zero. Mathematically, the triplet loss function is

$$L(A,P,N) = \max(\| f(A)-f(P) \|2 \ \| f(A)-f(N) \|2 + \alpha, 0)$$

Where,

A is an anchor input, P is a positive input of the same class as A, N is a negative input of a different class from A, α is the margin between positive and negative pairs. Thus,

$$\| f(A) - f(P) \|2 + \alpha <= \ \| f(A) - f(N) \|2$$

$$\| f(A) - f(P) \|2 – \| f(A) - f(N) \|2 \ + \alpha <= \ 0$$

which shows that the difference should be less than or equal to 0.

So by using the triplet loss function [22], one short leaning problem can be solved and thereby the model can recognizes a faces from the database after an input is given into the neural network from the camera.

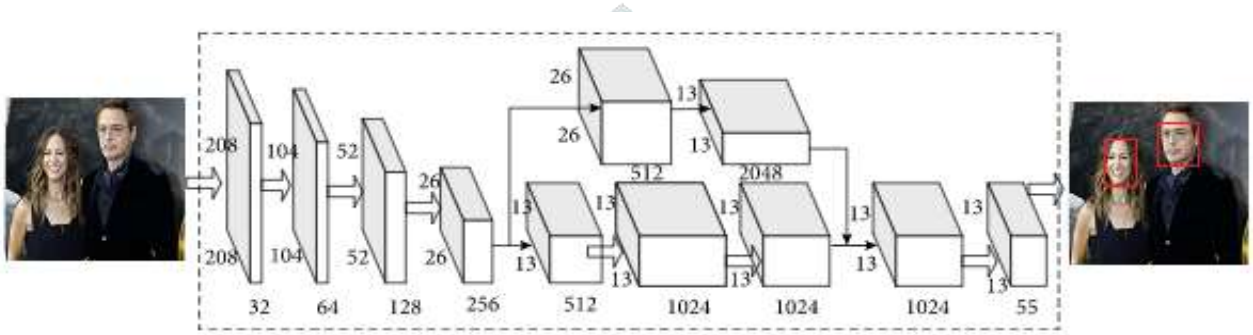

Figure 5. Convolution Neural Network used for detection of face from an image.

3.3. FACE ANTI-SPOOFING

One of the features that make this technology so reliable is the face anti-spoofing system [23]. Although face recognition [13] is a convenient process of authentication, it is vulnerable to spoofing attacks by photos or videos. So, implementing an anti-spoofing mechanism [23] into the system is a necessity such that the attacker cannot perform authentication with the help of the picture or a video of the customer.

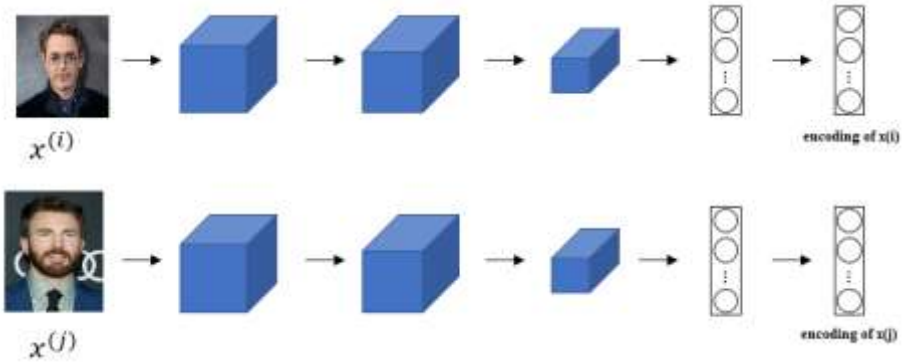

Figure 6. Finding the encoding of an image for Similarity function through Siamese Network.

Modelling an anti-spoofing system is nothing but implementing a liveness detector [14] to detect the liveness of the image captured through the camera and determine whether the image is captured from a real person or from a photograph. This can be implemented by detecting the movement of eyes, blinking, facial expression, movement of the mouth or the head etc. Also, some other biometric features like speech recognition features can be added to make the system robust and more secured.

In the proposed method, a deep 3D convolution neural network-based model [6] is used for anti-spoofing. Most of the attack will be through photo print or video replays, which are 2D planar structures, whereas live faces have complex 3D structures. Light reflection will be much different from a 3D structure to a 2D structure. These texture-based method helps a 3D convolution neural network [6, 23] to identify between a fake and a real face. Thus the 3D CNN extracts the features and helps in secured authentication through face recognition.

4. CONCLUSION

So, this is the implementation of a face recognition system with liveness detector in bank branch. Thus the customers don't have to be dependent on their ID and signature. Their face will provide the authentication required. Moreover, if the bank wants to continue with the traditional way of authentication then the face recognition system can provide an extra layer of security for the customer. The liveness detector makes sure that spoofing can be stopped thus making the system much more reliable and secured. After the customer verification is done, the customer's corresponding account details can be fetched from the bank's database, for taking the transaction forward. This will definitely make the process much more convenient and contactless which is the main goal of this research paper.

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