Face Recognition as a Genuine Technique in Electronic Voting

Abhishek Jain
Department of CSE
MANIT,Bhopal,India
1997abhishekjain@gmail.com

Ayush Srivastava
Department of CSE
MANIT,Bhopal,India
11ayush11@gmail.com

Amritesh patidar
Department of CSE
MANIT,Bhopal,India
amriteshpatidar@gmail.com

Abstract --In this research Face Recognition is proven to be an authentic technique for online voting. Online voting would allow the candidate to vote from any place in constituency or out of constituency. In this paper we present a secure two step technique which can be used for online voting.

The steps are as follows:

Firstly, the face of the candidate will be captured by a web camera and sent to the database for recognition. Then we apply face recognition algorithm over the candidate's image. If the image is recognized from the database then we go to the second level of security.

In the second phase, voter id of the candidates is matched with the voter id of recognized face stored in the database. If it matches, then we allow the voter to cast his vote.
For doing face recognition we have chosen two algorithms and have compared their results in terms of time taken to train and their accuracy to correctly classify the image. The two algorithms are Eigenface with svm classifier and convolutional neural network.

The result shows that the two proposed algorithm i.e. (Eigenface method and cnn) are capable of finding over 93% and 98% of the faces in database.

I. Introduction

The election is a well-known thing in modern days of Democracy. Electronic online voting over the Internet would be much more profitable. Also, voters might appreciate the possibility of flexible voting (i.e. any place voting). This paper proposes a method by which people who have been authorized by election commission of India to vote can cast their vote online without going to any polling booth.
For such an online voting system, security and privacy are the main concerns.
Also, it should maintain the integrity of a voter's ballot and it should be resistant against tampering.

In this research, our proposed voting method would serve the following purpose:

1) Maintain the integrity of Election Commission : Only eligible persons vote, No person gets to vote more than once, the vote is secret, and each (correctly cast) vote gets counted.
2) Make voting more secure: To do so we have added two levels security i.e. first face recognition and then

voter id match, hence it has improved the reliability of the system and made election voting more secure
3) Reduce the costs: This mechanism would replace the paper ballot voting and so costs of running elections would be lowered.

The remainder of this paper is organized as follows. The data we used is shown in Section 2 and related work in Section 3. The components and details of our system are described in Sections 4. We present our results in Sections 5. Section 6 lists describes for further research and we draw conclusions.

II. DATA

We have used the faces94, faces95 and faces96 image dataset from Libor Spacek's Facial Images Database[1]. Total it comprises of 333 distinct subjects with over 20 different images per subject. There are certain changes in facial expression (open eye/closed eyes, smiling face/ non smiling face), and facial details (glasses/no glasses). Thumbnails of few of the images are shown in Fig. 1.For processing purpose images were reduced to gray scale with a resolution of 100 * 100.

Fig 1

III. RELATED WORK

Deutsch proposed voting system based on Punch-card and mark-sense optical scan systems as Well as direct recording electronic voting systems (DRE). It does not include any biometric security.
Malladi *et.al.* Process of voting starts with the card punching algorithm and then the actual process of online voting begins with ATM terminal. It ensures duplicate vote avoidance through dual-tier authentication using One Time Password (OTP) and a Random Security Question (RSQ).
Jambhulkar *et.al.* and Mona Mursi and others. Proposed a Cryptographic schemes and a digital signature method that maintains the anonymity of the vote casted by voter and will also the ensure authenticity of voter. Malkawi *et.al.*, Sridharan and Anandaraj *et.al.* Proposed e-voting system using simple biometrics for election process.
IV. IMPLEMENTATION

The Online Voting System is an online application designed to be operated by two users, the election controller or administrator and the voter.

"Candidate Authentication" involves two stages: First is Face Recognition, where the image processing algo. is applied to remove noise from facial image there after face recognition algo. is applied. If the candidate's face matched with someone stored in the database then we go to the next stage authentication. In the second stage we match the voter id of the candidate with the voter id of the face matched in the database.

Here we have compared between two face recognition algorithms. The first algorithm is face recognition using Eigen face and the second algorithm is Face Recognition with Cnn.

A. First algorithm – Eigen face recognition

A schematic diagram for the Online Voting System Based on Face Recognition using Eigen Filters is show in Figure 2.

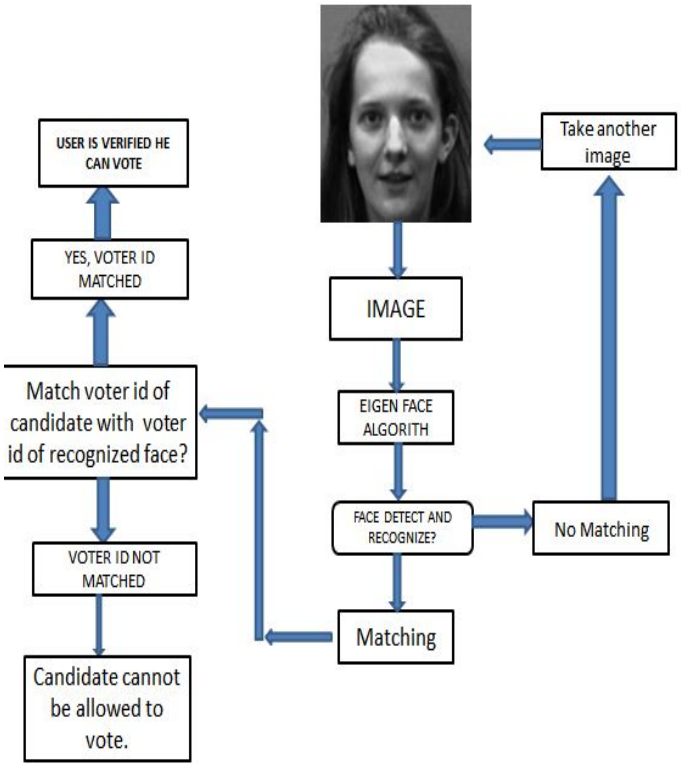


Fig 2

The most noticeable difference among the face recognition algorithm is the way they retrieve and display facial features and components. Till now, many methods have been proposed for extracting face features and they can be categorized into two general types, i.e. structure-based methods and feature-based methods. Precisely in Eigen face Principal Component Analysis (PCA) is used to extract the feature from the face image. After the features are extracted, the SVMs are learned and the disjoint test set enters the system for recognition.

a) PCA: Feature extractor

Let a face image *I(a, b)* be a two-dimensional r by r array of intensity values or a vector of dimension r^2. The main concept behind principal component analysis (PCA) is to find the vectors which would best describe for the distribution of the face images within the entire image space.

Algorithm:

Transform each image into a vector of size P and place into the set. Calculate the average face in face space and then return the top Eigen face vectors. Thereafter, use these differences to find the covariance matrix *C* for this dataset. The covariance between two sets of data reveals how much the sets correlate.

$$\Psi = \frac{1}{M} \sum_{p=1}^{M} \tau_p$$

$$\mu_i = \tau_i - \Psi_i$$

$$C = \frac{1}{M} \sum_{p=1}^{M} \tau\, p\, \tau\, p^T$$

$$= S S^T$$

$$S = \{\mu_1, \mu_2, \mu_3, \ldots, \mu_p\}$$

To find eigenvectors from the covariance matrix is a huge computational task. Since (M<<p)
So we construct M by M matrix.

$$L = S^T S$$

Find the M eigenvector, v_i of L. These vectors (v_i) determine linear combinations of the M training set face images to form the Eigen faces u_i. Project each of the original images into Eigen space. Now we have got the vector of weights which would account for each Eigen faces that would be needed to reconstruct the given image.

$$U_i = \frac{1}{M} \sum_{k=1}^{M} v_{ik}\ \mu_k \quad ^3$$

$$\omega_i = u_i^T(\tau - \Psi)$$

$$\sigma^T = \{\omega_1, \omega_2, \omega_3, \omega_4 \ldots \omega_k\}$$

U_k is the kth eigenvector and ω_k is the kth weight in the vector

b) CLASSIFIER: SUPPORT VECTOR MACHINES

SVMs perform face recognition between two classes by searching a decision surface that has the largest distance to nearest points in training set these are known as support vectors [9].

The decision surface has the equation:

$$f(x) = \Sigma\, y_i\ \alpha_i\, k(x_i, x_j) + b$$

The kernel functions that we have used in the experiments are radial basis functions (RBFs) defined as:

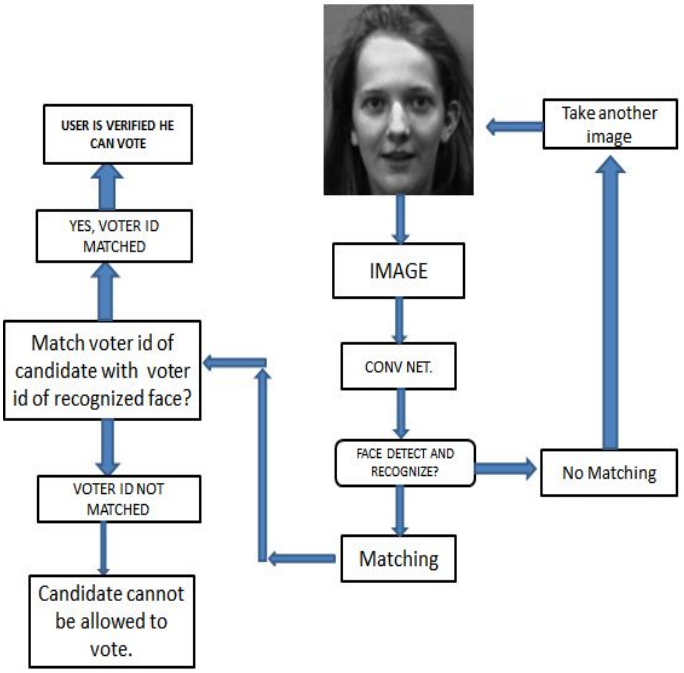
$$K(x_i, x_j) = e^{-\gamma((x(i)-x(j))*(x(i)-x(j)))}$$

x_i, x_j denote two samples. The user-controlled parameter is the γ value in the case of the RBF kernel.

Here we have used one vs all type of classifier where there is one SVM classifier associated to each class. For each class m $\in$ {1,.....,m} the corresponding classifier is trained to separate the examples in this class (positive labelled) from the remaining ones (negative labelled). The new input vector is now categorized in one of class for which associated classifier has highest score w.r.t all classifiers.

B. Second algorithm – Convolution Neural network.

A schematic diagram for the Online Voting System Based on Face Recognition using Convolution Neural Network is show in Figure 5.



Artificial Neural Networks were inspired by biological findings relating to the behaviour of the brain as a network of units called neurons .

The problem of face recognition from 2-D images is typically very ill-posed, i.e., there are many models which fit the training points well but do not generalize well to unseen images.

Additionally, for Multi-Layer Perceptron (MLP) networks with 2-D images as input, there is no invariance to translation or local deformation of the images.

A typical convolutional network is shown in Fig. 3 and Fig 4 shows our developed convolution layer.

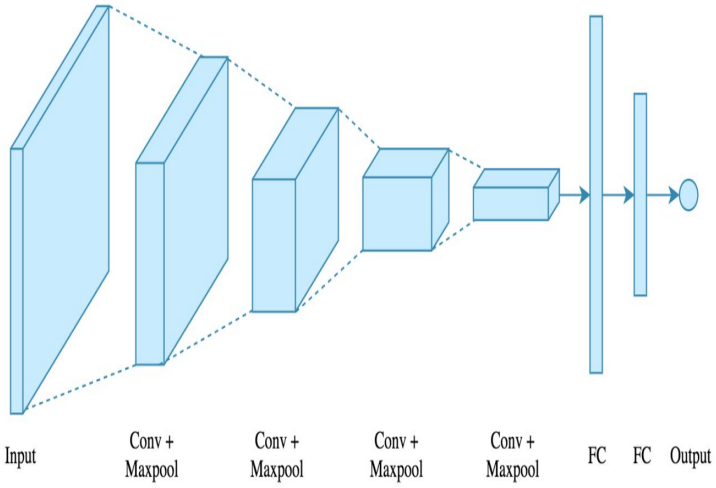
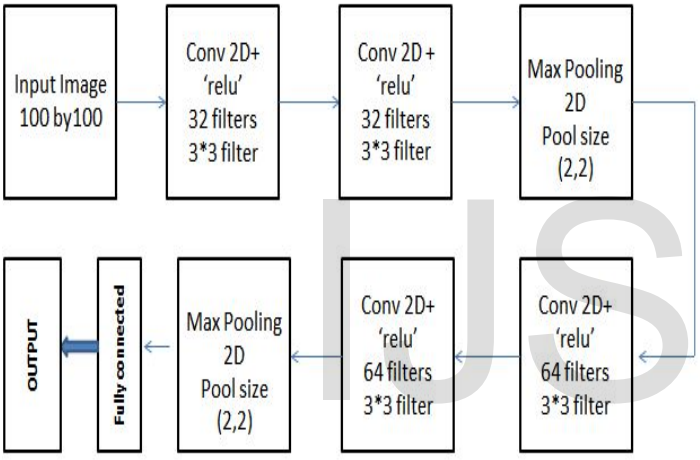


FIG -3



Layers of Cnn

a) Convolutional layer:

The Conv. layer is regarded as the building block of a Convolutional Network and it basically reduces the computational efforts. It produces a 2-dimensional activation map that gives the responses of the filter that we slide at every spatial position. In our case filter was of 3*3 size. It is impractical to connect neurons to all neurons so we connect each neuron to its local region of input value.

At the start,

input size is 100*100*1 filter size is 3*3

So, every neuron in convnet would have 3*3*1 = 9 connections.

b) Pooling Layer:

It gradually reduces the spatial size of the representation in order to decrease the number of variables and computation in network, and hence to also control overfitting. The Pooling Layer operates independently on every depth slice of the input and resizes it spatially, using the MAX operation.

Pooling layer:

- Accepts a volume of size $w_1 \times h_1 \times d_1$
- Requires two hyper parameters:
  1. their spatial extent F
  2. The stride S.
- Produces a volume of size $w_2 \times h_2 \times d_2$ where:
- $w_2 = w_1/s - f/s + 1$
- $h_2 = (h_1 - f)/s + 1$
- $d_2 = d_1$

c) Fully Connected Layer:

In fully connected layer neurons are interlinked to all activations that were there in the last layer,Activation of the Neural network is calculated by doing matrix multiplication followed by a bias offset.

V. RESULTS

We have obtained the results when we used Eigenface algorithm. We have used *rbf* kernel for this algo.Also we have varied the training images per class sample in order to see how accuracy varies also we have taken top 100 Eigenfaces in order to reconstruct our training image.

Training image per class	Time for Training	%(Face correctly detected)
3	1163s	84
4	1262s	85
6	1700s	93
9	4220s	93.4

Our experiment shows that that choosing optimal no of images per class for Eigenface algorithm would yield accuracy around 94%.We could have increased the training image per class but it would had increased the training time significantly.

Also, we have obtained 98.7% accuracy for CNN algorithm. When we varied the training image per class sample we got the best results when training image per sample was 20.

From the tables above it is evident that as we increase the training image per class for Eigenface algorithm training time increases and so the accuracy. And so forth for Cnn algorithm, since we were constrained to maximum of 20 images per class we good achieve only 98.7% accuracy.

VI RESEARCH AND CONCLUSIONS

There is still no discussion on how face recognition technique would be deployed in future, rather than directly bringing it into main stream voting it should first tested practically. But if this method is successful then it would leverage the voter's task of going to the voting booth and standing in queue. People can vote from their home, office or anywhere in the country. By online voting system percentage of voting might increases. As people who have some physical or health problems would prefer to vote from their home. Also this method would decrease the cost and time of conducting an election. It would also make booth capturing an ineffective method for tampering the voting procedure as people would prefer voting from home rather than going out so we might in future require less pooling booth. An effective and solid framework is crucial for the reliable and fruitful usage of this innovation.

But we need to do research on how we can make our face recognition and vote casting technique more secure and reliable, as attackers might try to tamper our system. Secondly, we need to think how we can create a mobile platform for this methodology. Thirdly, prior to launching this technique we need to effectively train people to how can they make use of it. Also this technique requires proper and constant internet facility and good web cam quality so to capture images of creating voters database and for testing purpose.

References

[1]Dr. Libor Spacek, Dataset from Libor Spacek's Facial Images Databases, http://cmp.felk.cvut.cz/~spacelib/faces/
[2] Herb Deutsch (2005), 'Public opinion influence on voting system technology', IEEE Standards Association.
[3] Kausal malladi, Srivatsan sridharan, Jayprakash L.T. (2014), 'Architecting a large-scale ubiquitous e-voting solution for conducting government elections', IEEE International conference on advances in electronics, computers and communications.
[4] Jambhulkar S.M., Jagdish B. Chakole, and Praful. R. Pardhi (2014), 'A Secure approach for web based internet voting system using multiple encryption', IEEE International conference on electronic systems, signal processing and computing technologies.
[5] Mona F.M.Mursi., Ghazy M.R.Assassa., Ahmed A. AbdelHafez, and Kareem M. AboSamra (2015), 'A secure and auditable cryptographic based e-voting scheme', International conference on mathematics and computers in sciences and in industry, IEEE.
[7] Anandaraj S., Anish R., and Devakumar P.V. (2015), 'Secured electronic voting machine using biometric', IEEE International conference on innovations in information, embedded and communication systems.
[8] Srivatsan sridharan (2013), 'Implementation of authenticated and secure online voting system', IEEE International conference on computing, communication and networking technologies.
[6] Mohammad Malkawi., Omar Al-Jarrah., Thaier S. Hayajneh., Munzer S. Ebaid, and Mohammed Khasawneh (2008), 'A biometric-secure e-Voting system for election processes', IEEE symposium on mechatronics and its applicationsMay 27-29.
[9] Zhifeng Li, Xiaoou Tang, Using Support Vector Machines to Enhance the Performance of Bayesian Face Recognition, Information Forensics and Security, IEEE Transactions onVolume 2, Issue 2, Page(s):174 – 180, June 2007
[10] http://home.postech.ac.kr/~taey16/index.files/ML2007/ML_FACE_KPC A.pdf
[11] Md. Al Mehedi Hasan, Mohammed Nasser, Face Recognition using PCA and MLP, International Conference on Electronics, Computer and Communication 2008, University of Rajshahi, Rajshahi, Bangladesh, pp368-371, ISBN 984-300-002131-3.