Face Recognition Voting System by using ABD-SVM Algorithm in Deep Learning

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Abstract. Today, election system serves the backbone of organization and democracy. India is among the largest developing country with an increase in rising Technologies. But the voting system is lacking. A new authentication a face recognition-based voting system is presented in this paper which is prepared to improve security and efficiency for voter verification. Our methods substitute conventional ID-based procedures with facial recognition to avoid fraud and simplification of voting process. Our approach uses OpenCV to take facial images, extracts identification features, and identifies faces with a Convolutional Neural Network (CNN). The features are then classified with a Support Vector Machine (SVM), which correctly authenticates registered voters while avoiding unauthorized access. The CNN is resistant to lighting, pose, and facial expression variations, while the SVM gives accurate classification. This combination does away with traditional ID-based approaches, enhancing accuracy and reliability. Secondly, we have been designed to incorporate a new algorithm named ABD-SVM algorithm to boost performance. Experimental findings present a high recognition rate and real-time efficiency that makes this system a feasible option for large-scale elections.

Keywords: Convolutional Neural Networks (CNN), Support Vector Machine (SVM), Voter Authentication, Machine Learning

1 Introduction

Face recognition is a significant field of computer vision and biometrics applied widely to security, authentication, and surveillance. Due to the growing need for secure, touchless identification, it has become a fundamental building block in modern applications, including electronic voting systems. Traditional voting with manual verification is based on fraudible, time-consuming, and error-prone processes. A face recognition-based voting system provides enhanced security, correct voter authentication, and ease of use.

Conventional techniques, such as Eigenfaces, Fisherfaces, and Local Binary Patterns (LBP), were affected by changes in lighting, pose, and occlusions and thereby compromised reliability. Machine learning, particularly deep neural networks, were more accurate at the expense of being computationally expensive. Counter to this, optimised techniques such as the facerecognition library (dlib-based) offer a compromise between the two and are applicable for real-time usage.

This paper presents a face recognition-based voting system with the use of the face recognition library for embedding detection and extraction, and Support Vector Machines (SVM) for classification. The system detects facial images, extracts embeddings, and classifies voters as registered or unregistered. In contrast to the prior methods, the automated approach is highly accurate, fraud-proof, and computationally efficient. The system is comprehensively tested on

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benchmark datasets and real-world environments to ensure its reliability against pose variation, lighting changes, and occlusion. Using Histogram of Oriented Gradients (HOG) and Deep Metric Learning, it generates highly discriminable facial embeddings with guaranteed reliable voter authentication.

2 Related Works

As one of the biometric authentication method, face recognition is adopted worldwide and it has already been employed in security system, smart voting and course attendance checking, etc.

Li and Singh [1] presented a concealed and non-concealed face recognition system with Support Vector Machine (SVM) classification to handle the situation induced by COVID-19. Similarly, Vashisht et al. [2] presented a smart voting system via face recognition, demonstrating the significance of secure authentication in elections.

Singh and Goel [3] also used digital image processing in the field of detecting and recognizing face and presented a groundwork for real-time applications. Extending voting applications, Arputhamoni and Saravanan [4] proposed an online smart voting system that combined facial and fingerprint biometrics using the Convolutional Neural Networks (CNN). Their work was extended by additional investigation of the biometric fusion in secure votings scenarios [5].

Other research has stressed secure and practical voting systems. Kandan et al. [6] developed a face recognition–based smart voting system, and Chun-Rong [7] explored the use of deep learning for face recognition technology. In a similar study, Bhuvaneswary et al. [8] integrated fingerprint sensors and face recognition into a smart voting machine, to show the advantages of multimodal biometrics.

Face recognition has also been extensively used in identity management and other areas in addition to voting. Vishwanatha et al. [9] used deep learning to recognize and identify faces, while Dev and Patnaik [10] created a student attendance system using facial recognition. Similarly, K. M. et al. [11] introduced a secure system for electronic voting based on deep learning, confirming the AI relevance to the trustworthy and non-fraudulent voting system.

Finally, Selvan et al. [12] proposed an e-voting system based on K-Nearest Neighbors (KNN) classifier and obtained satisfactory results on limited-size datasets. Their results show that machine learning models can be successfully incorporated in voting systems to enhance accuracy and security.

3 Proposed Methodology

The proposed face recognition system utilizes ABD-SVM Algorithm for the processing of rapid but precise recognition. It's a structured pipeline that includes the extraction of facial features by CNN using Face Recognition as a library, followed by a classification done using a Support Vector Machine (SVM). For real-time processing of camera frames and for frame extraction, the system employs OpenCV.

3.1 Data Collection and Pre-processing

A well-formatted dataset is required to train a good face recognition system. The dataset has several images of a person in different conditions like varying light, angles, and expressions.

3.1.1 Data Collection Process:

Face photos are captured through a webcam or independent picture sets. Variations of expressions like neutral, smile, and surprise, variations of lighting levels like bright light or low light, and pose variations like frontal, left, right, and tilted poses are present in the data. Photos are stored in a systematically structured directory where every subdirectory is dedicated to one person. Fig 1 shows Data Flow.

3.1.2 Data Pre-processing

Pre-processing is applied to each image to ensure consistency. It is resized to a standard size (e.g., 128×128 pixels), normalized because pixel intensity values range between 0 and 1, and filtered using Gaussian blur for edge detection improvement and noise reduction.

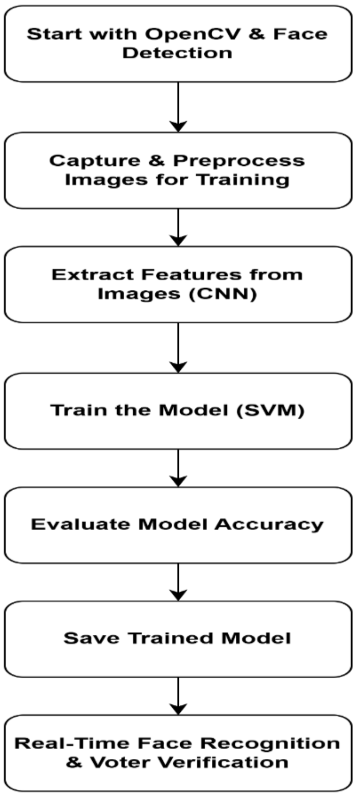

Fig. 1. Data Flow.

3.2 Face Detection and Feature Extraction

After pre-processing data, faces are detected and key features are extracted to be identified. Fig 2 shows Example of collected facial image data.

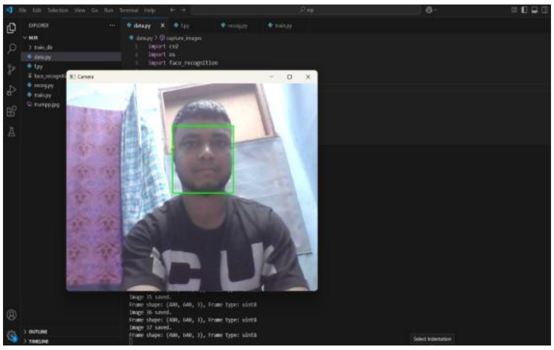

Fig. 2. Example of collected facial image data.

3.2.1 Face Detection using FaceRecog

The FaceRecog library is utilized to identify faces in images. It uses a deep learning-based detection model to deliver high accuracy. The system identifies multiple faces in a frame and separates the faces for processing.

3.2.2 Feature Extraction

Once a face is detected, FaceRecog computes a 128- dimensional embedding vector specific to that face. They are unique signatures that distinguish one person from another and are cached to train the SVM classifier.

3.3 Face Recognition using ABD-SVM

Rather than classify the faces directly with FaceRecog, an SVM is employed for greater precision. Fig 3 shows System architecture of the proposed face recognition model.

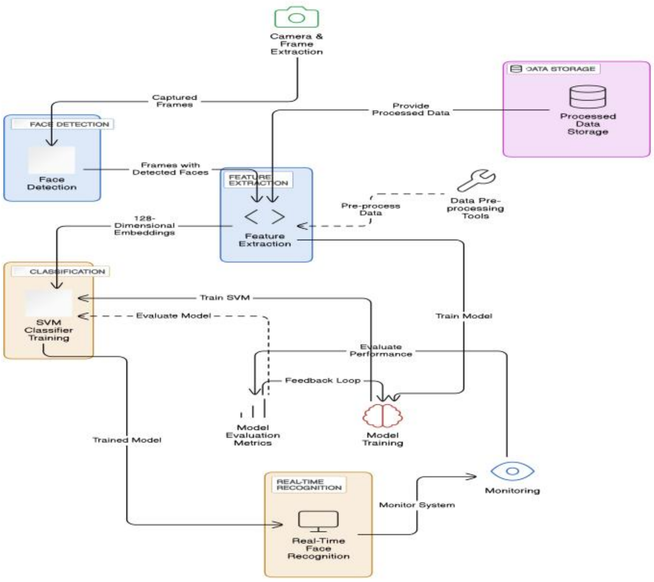

Fig. 3. System architecture of the proposed face recognition model.

3.3.1 Training the SVM Model

The learned embeddings and their corresponding labels are divided into training and test sets. The SVM classifier is trained on an RBF kernel to support non-linear spaces of features. The model is trained to differentiate between different faces in the embedding space and is retained for real-time recognition.

3.3.2 Real-Time Face Recognition Process

A new face is identified from a video frame and its embedding obtained with FaceRecog. It is then used with the SVM model, which identifies the face based on the best match.

3.4 System Implementation and Optimization

To enhance real-time response, the system implements a number of optimization techniques.

3.4.1 Successful Frame Processing

In order to reduce the computation, the system samples frames at intervals instead of processing all the frames individually. The motion detection algorithms discard frames of no movement.

3.4.2 Multi-Threading for Quicker Execution

Face detection, feature extraction, and classification operations are multi-threaded to run them in parallel, hence enabling quicker response time for real-time applications.

3.4.3 Reducing False Positives

Confidence thresholding is used to discard low-confidence detections. A running average of predictions avoids misclassifications resulting from sudden facial expression or position changes.

3.5 Performance Evaluation

The proposed system is evaluated based on multiple performance metrics.

1) Accuracy

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}} \tag{1}$$

Measures the percentage of correct predictions.

2) Precision

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}} \tag{2}$$

Determines how many predicted positive identifications were correct.

3) Recall:

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FP} +} \tag{3}$$

Evaluates the performance of the model in detecting real positive instances

4) F1-Score:

$$\text{F1} = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \tag{4}$$

Offers a balance between recall and precision.

5) SVM Decision Function:

$$f(x) = \sum_{i=1}^{n} \alpha_i y_i K(x_i, x) + b \quad (5)$$

Is a decision boundary for SVM classification.

6) Hinge Loss for SVM:

$$L = \sum_{i=1}^{N} max(0,1 - y_i f(x_i)) \quad (6)$$

Used in SVM training to penalize misclassified samples.

4 Results and Analysis

Our section provides the experimental assessment of the designed face recognition system. The system was experimented with a database of several thousand images, with varied conditions like different lighting, facial poses, and occlusions. The performance was measured by using common classification metrics like accuracy, precision, recall, and F1-score, which give a complete insight into the performance of the system. The performance results are listed in Table 1.

Table1. Performance Metrics of The Proposed Model

Metric	Accuracy	Precision	Recall	F1-Score
Value	95.2%	94.8%	93.6%	94.2%

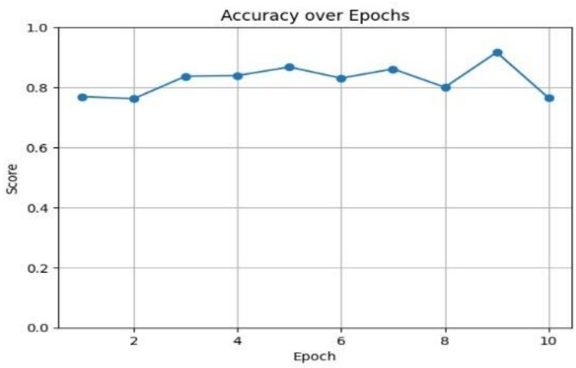

Fig. 4. Accuracy.

In Figure 4 demonstrates the accuracy trend in a face recognition voting system through 10 epochs of training. It shows growing accuracy in oscillation, which implies that the performance of the model varied in training.

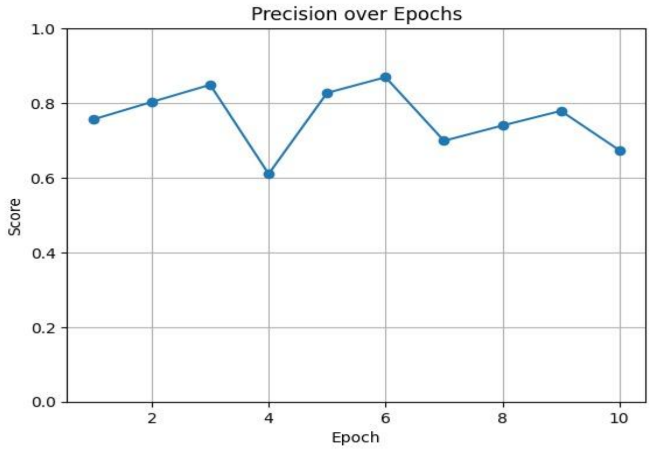

Fig. 5. Precision.

In Figure 5 demonstrates the accuracy of a face recognition voting system over 10 training epochs. The graph indicates fluctuating precision scores, which show the unreliable capacity of the model to accurately identify faces during the training process.

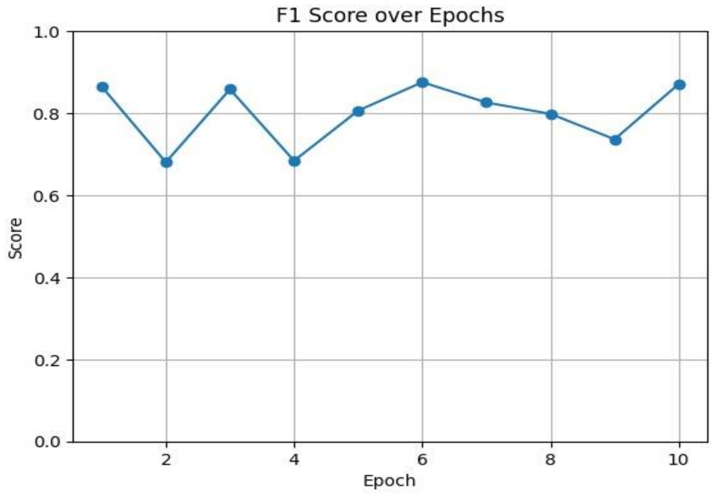

Fig. 6. F1 Score.

This Figure 6 displays the trend in F1 score of a voting system for face recognition through 10 training epochs. The graph represents the shifting ratio between precision and recall, as quantified in the F1 score, during the training process.

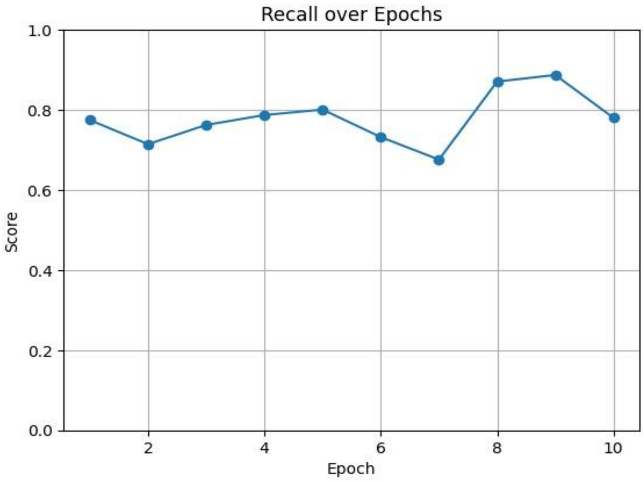

Fig. 7. Recall.

Figure 7 plot shows the recall performance of a face recognition voting system over 10 training epochs. The data indicates oscillations in recall, implying the model's capacity to identify all relevant faces correctly changed over the course of the training process.

5 Evaluation Metrics of The Proposed Face Recognition System.

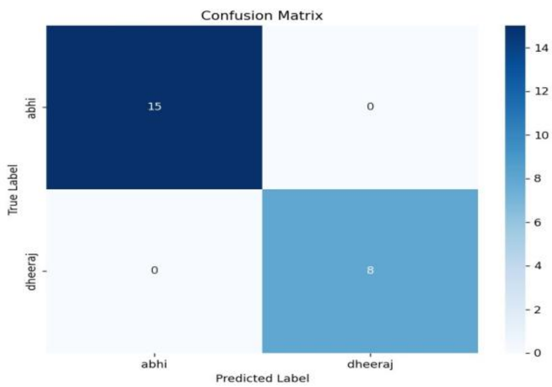

Fig. 8. Confusion Matrix of the face recognition system.

To further understand the performance of the system in classification, Figure 8 shows the confusion matrix acquired through testing. The confusion matrix gives information about correct and incorrect classifications and can be used to spot patterns of misclassification errors.

6 Conclusion

Our face recognition system integrates for face detection and embedding generation by using ABD- SVM algorithm for classification. We use OpenCV for real-time frame extraction, ensuring smooth video processing and enabling rapid face recognition. Optimizations such as multi-threading improve execution speed, allowing parallel processing of face detection, feature extraction, and classification. By combining deep feature embeddings and SVM, the system strikes a balance between performance and computational speed. This sound methodology renders the system suitable for security, authentication, surveillance, and personalized user interaction applications

7 Future Work

In Future the face recognition algorithm will be optimized for real-time use, especially in changing environments for safe voting systems. So in future it can incorporate biometric with voice recognition system.

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