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DigiVoter-Smart Voting System Using Biometrics-Based Facial Features

Ankita Gawali[1], Anjali Ithape[2], Shailly Nagar[3], Dr. Amar Buchade[4]
[1, 2, 3]*Student,* [4]*Professor, Dept. of Computer Science & Engineering MIT Art, Design and Technology University, Loni Kalbhor Maharashtra Pune, India*

Abstract: ***Although India is a democratic country, it still uses traditional voting machines that are costly and require manual labor. However, an alternative web-based voting system has been proposed that would allow voters to cast their ballots from anywhere in the world. To participate, voters must register on the government's website and provide their name, address, and biometric information, such as fingerprints and facial images. This information would be securely stored in a server database. On election day, voters would log in to the website using their biometric information, similar to unlocking a mobile phone. This process would eliminate the need for physical presence and save time for voters. Moreover, using biometric information would reduce the risk of fraudulent voting. The proposed system would use ten print images to match the correct voter's name. To enhance security, the system would also take into account the constant distance between a person's eyes and eyebrows, which does not change with age***

Keywords: capturing the face of the voter, recognizing the face using Haar cascade, preprocessing the fingerprint images, and matching the fingerprint images using CNN.

I. INTRODUCTION

The current system of conducting elections in our country has several flaws that are being exploited by political parties and contestants. Electronic machines used for voting are time-consuming, expensive, and require a lot of manpower for transportation and monitoring. A proposed solution is the Smart Voting System, which uses facial and fingerprint recognition technology to allow people to vote from anywhere, reducing the possibility of duplicate votes. The system uses image processing and deep learning techniques to detect and match facial and fingerprint images with the database.

The voting process is conducted online through a web-based system, which is much cheaper than the current system and requires less manpower if strong cybersecurity measures are implemented. A

fter the key information is entered to distinguish eligible voters from fake ones, voters can vote for any leader in the election, and the system disables other leader slots.

Votes are stored on the server, and counting is completed at the end of the election. This system is an authentic model and has many advantages over the existing system.

II. LITERATURE SURVEY

A. Iris Detection

To confirm the eligibility of a voter, the Smart Voting System captures an image of their eyes and uses image processing techniques to detect their iris. The iris is then compared with stored images, and if there is a match, the system checks the voter's Aadhar details to confirm their eligibility to vote. Since the Aadhar database contains all relevant information, including iris and fingerprint data, as well as address and blood group, it is easy to track and verify voters. This method is highly secure and requires minimal manpower.

B. Thumbprint Recognition

The process of Fingerprint Recognition involves using a sensor to capture a fingerprint and saving it to a database. When a biometric image is read, the microcontroller's serial port sends the information to the web application. The input image is then compared with the existing image in the database. If the images match, the server sends a message confirming the voter's identity, which is then displayed on an LCD screen. If the images do not match, the LCD screen displays a message indicating that the voter is not eligible.

C. *Modern Voting*

The Smart voting system will obtain the necessary information on individuals above the age of 18 from the Aadhar database. The voting process consists of three phases. In the first phase, voters will receive an ID and password via email to authenticate their identity. The second phase involves validating the voter's identity using their fingerprint data, after which they will be permitted to vote. In the third phase, the voter's ID will be deleted to prevent any possibility of voting again. The Aadhar details used by the voter will be locked to track them for future reference. The vote count will be updated

D. *CNN-based Multimodal Biometric System*

The latest approach for Multimodal Biometrics involves the utilization of face, iris, and palmprint images to enhance security. Convolutional Neural Networks are used for extracting features from these images. This is an upgraded version of the Multimodal Biometrics method which also utilizes CNN. The input image is compared with the database images using CNN, and the matching of fingerprint images is also accomplished through CNN. The latest version of CNN employs two-layer fusions.

III. PROPOSED SYSTEM

The proposed smart voting system utilizes face and fingerprint recognition through image processing and CNN, providing improved security compared to existing systems. The system's primary security measure involves verifying the voter's face and fingerprint against the face and fingerprint images in the election commission's database. The online platform was created using Visual Studio and HTML software, and the algorithm was implemented. The minutiae-based matching method is used to match fingerprint images against the images provided by the election commission. If the captured image is verified, the voter is authorized to cast their vote.

IV. APPROACH

The proposed voting system is web-based and requires software that utilizes web technologies for database creation and image processing. The system is authorized by the government and allows eligible voters to cast their votes through a website. Facial and fingerprint recognition are used to verify the voter's identity. On the day of the election, voters can access the website with the provided IP address and click on the vote button. The voter's face and fingerprints are captured using the device they are using and sent to the server, which checks for a match with the images stored in the database. The Haar Cascade algorithm is used for face detection, and if a match is found, the voter is recognized and allowed to vote. Fingerprint matching is done using CNN to compare the input with the stored image. If the match is not found, the voter is not allowed to vote. The ten fingerprint images are taken to calculate the position and count of fingers, which helps to identify the correct voter fingerprint. The voting page displays the list of political parties, and voters can select their preferred party, which cannot be changed later. The server accepts and stores the votes and keeps track of the count of each political party's candidates. The vote-counting process is also straightforward and produces quick results.

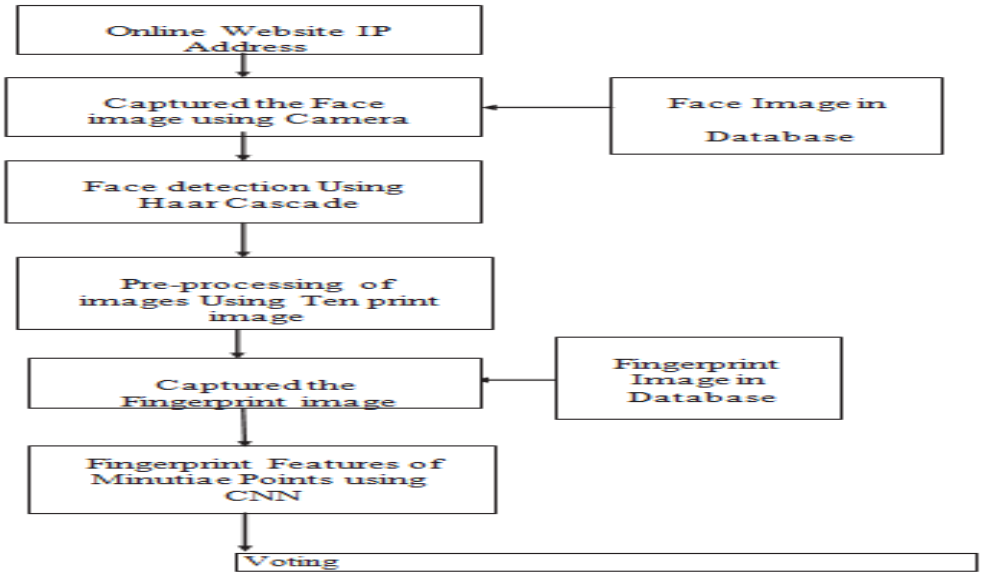


Fig.1 Methodology of the System

V. FACE DETECTION USING HAAR CASCADE

The face detection algorithm is utilized to recognize objects within an image or video. It functions by detecting facial features using a sequence of square-shaped functions known as Haar features. The algorithm then utilizes classifiers to differentiate between faces (1) and non-faces (0). The detection process is conducted in four stages, which include the detection of Haar features via integral images, Adaboost, and the cascade of classifiers.

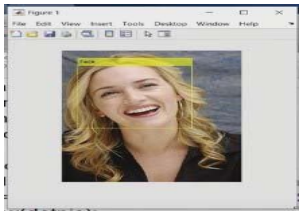


Fig.2 Face Detection

A. *Detecting Haar features*

Previously, detecting faces in images involved a lot of manual work as it relied on analyzing the intensity of each pixel in the image. However, Haar wavelets were introduced which made the process easier by considering smaller portions of a face at a time and computing the sum and difference of their pixel intensities. This method also takes into account the normalization of greyscale pixels in black-and-white images.

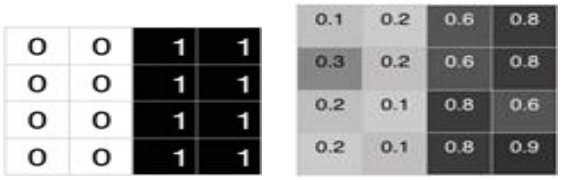


Fig.3: Pixel intensities of detected Haar-features (a) ideal case (b) real case.

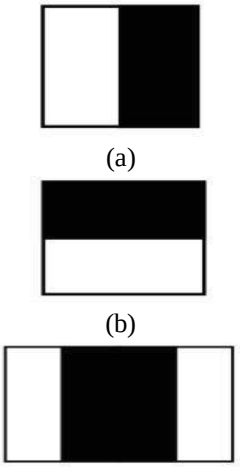
Detecting the Haar feature in the image

$$\Delta = \frac{1}{n}\sum_{dark}^{n} I(x) \frac{1}{n}\sum_{white}^{n} I(x)$$ Eq. (1) Ideal case: Δ

= (1/8)*(8) — (1/8)*0 = 1

Real case: Δ = (1/8)*(5.9) — (1/8)*(1.3)=0.575

Haar features have proven to be highly effective in detecting rectangular features, which makes them a powerful technique for face detection. An example of this is shown in Figure 3(b), where the darker region corresponds to the eye and the lighter region to the cheek. Since the eyes are usually the darkest parts of the face in grayscale images, they are often detected first. Similarly, in Figure 3(a), the bridge of the nose is typically elevated and darker than the cheek, which is how Haar features that detect lines and edges are able to identify the face or its subsections.



(a)

(b)

(c)

Fig. 4: Some common Haar features (a) Nose (b) Eyes (c) Mouth

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B. Integral images

The calculation of Haar features returns a vast number of features, and to determine which ones are relevant, an algorithm called integral images is used.. This reduces the number of operations required to determine whether a window is useful or not, which is crucial for detecting the part of the face we want to detect. For instance, in a given subset of a face where the numbers are pixel intensities, we can use the cumulative sums to compute the sum of pixel intensities more efficiently than by adding them up one by one. Integral images are a speedy, efficient, and effective way of computing the cumulative sum of pixel intensities for subsets of increasing size.

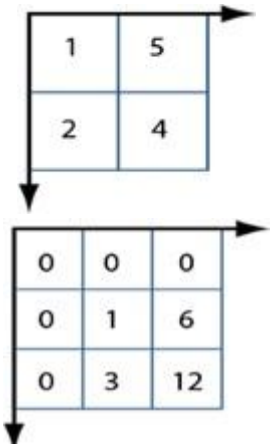


Fig.5: The generated subset of a grid. (a) input image (b) integral image

C. Adaboost

In addition to being numerous, some features may also be irrelevant. Adaboost is a technique that selects both the best and weak features and trains classifiers to use them. The algorithm constructs a 'strong' classifier, which has a lower error rate and is more likely to be part of the face, while 'weak' classifiers have an error rate of less than 50%, indicating that they are likely to be a feature of the face. By combining these weak classifiers into strong ones, Adaboost helps detect a face.

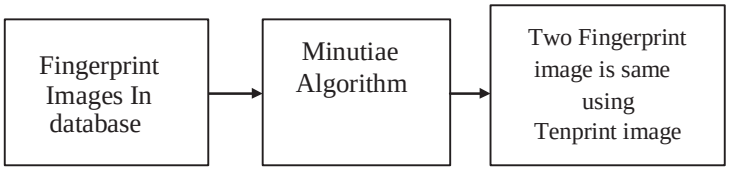
D. Cascade Of Classifiers

When detecting a face in an image, there are parts of the image that are considered face regions and others that are not. Only the relevant features are considered, and the remaining features are discarded. The second stage of features is only applied if it passes the first stage. The desired face region is the one that passes every stage. Cascade is used to optimize the detection process by avoiding the unnecessary processing of non-face regions. The window will only move through all the stages if it has detected a face feature. The cascade of classifiers helps to identify the features that belong to the face region, and the stages combine to form a larger window that results in the detection of the face.

VI. PRE-PROCESSING USING TENPRINT IMAGE

If two fingerprint images match, the Ten print image method can be used. This involves taking ten fingerprint images and recording features for each image in a database. The attributes of these features are discussed in detail, excluding the minutiae attributes which are discussed separately. When two people have matching fingerprints, their ten-print image mate minutiae record, along with all other image records in the database, are assigned a physical finger position. If two voter fingerprints match, minutiae features such as ridge endings are recorded. The ideal minutiae on the ten print image mates are initially detected by an automatic AFIS system. The ten fingerprint images are combined and features are recorded by minutiae points, allowing for comparison of the two images to determine the correct voter.

Block Diagram of Ten print image



Ten print image Algorithm: -

1) The first step is to take the input image. Then, we convert the gray image to a binary image through a process called binarization. After that, we thin the image to remove unnecessary pixels that could affect the training algorithm. If two fingerprint images match in the database, we use tenprint images to record the position of fingers and count the number of occurrences. Finally, we compare the latent image with the tenprint image in the database.
2) To start the process, we need an input image of a fingerprint. We then apply binarization to the grayscale image to create a binary version. Next, we use thinning to remove any extra pixels that might interfere with the training algorithm. If we encounter two matching fingerprint images in the database, we can use tenprint images, which include ten fingerprints and their respective finger positions. Finally, we compare the latent image to the tenprint image in the database to determine if there is a match.
3) Our fingerprint recognition process begins with taking an input image of the fingerprint. Then, we convert the grayscale image to a binary image using binarization, and we thin the image to optimize it for the training algorithm. If we have two identical fingerprint images in the database, we utilize tenprint images, which record the finger positions and occurrence counts. Finally, we compare the latent image with the tenprint image in the database to see if they match

VII. MINUTIAE-BASED FINGERPRINT RECOGNITION USING CONVOLUTIONAL NEURAL NETWORKS (CNN)

Voter fingerprints can be captured and saved in a database on a server using a sensor. The fingerprint given by the voter is then compared to the fingerprint provided by the election commission. Fingerprint recognition can be used to verify a voter's identity and allow them to cast their vote. This involves the detection and matching of minutiae points on the fingerprint. Machine learning and deep learning are different techniques, with machine learning requiring a longer time for training compared to deep learning, which has a finite duration and is shorter.

A. *Fingerprint Images Matching With Minutiae CNN*

1) The fingerprint is scanned through a sensor and saved in the database. A second input is provided to a Convolutional Neural Network (CNN), which compares the two fingerprints and extracts image features.
2) The CNN is responsible for detecting minutiae points in Dv=(S1,S2).
3) In addition to minutiae points, the CNN also compares the fingerprints of Dv for matching purposes.

B. *Basics of CNN*

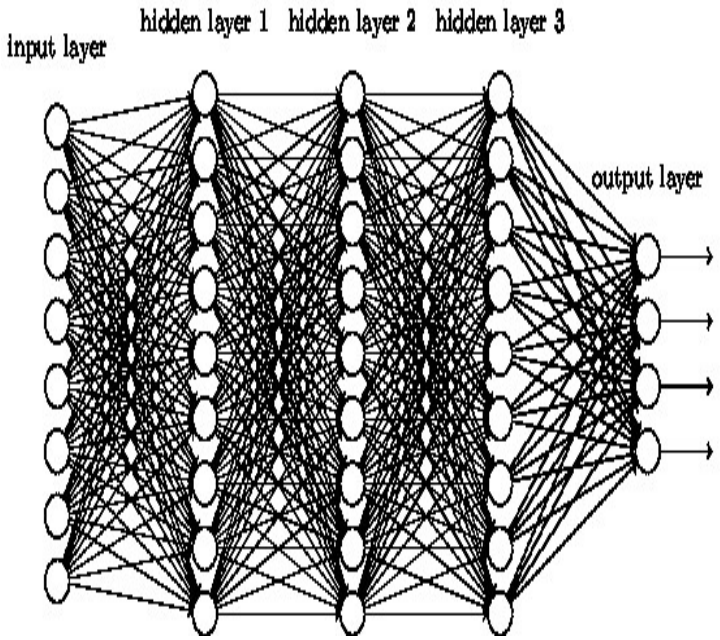


Fig. 6 Block Diagram of CNN

CNN is a type of neural network that combines convolution layers and filters with ANN. CNN reduces the computational speed required to process large images. The input image size for CNN is 128128, and the output filter size is 55. ANN is also a trained algorithm that takes several minutes to complete. However, CNN is trained faster than ANN and provides results for feature extraction of fingerprint images. Using CNN, image segmentation, edge detection, fingerprint matching, and feature extraction from images can be performed. In CNN, 55 pixels are convolved with a 33 pixel filter to produce a 4*4 pixel output.

VIII. PROSPECTIVE IMPROVEMENTS

To increase the level of security, we can incorporate additional verification methods such as unique identification numbers like Aadhar card, palm and eye verification, or voter ID number. Fingerprint verification can be added to face recognition if the Aadhar database is linked since it has iris and fingerprint information. The system can be made more accessible by creating an IOS or Android application for verification purposes. Face recognition can be done through the phone camera and OTP generation can be integrated into the verification system. The algorithm can be modified and its performance can be improved through training.

IX. CONCLUSION

The new system is more secure and efficient than the current one, with a reduced voting time and prevention of fraudulent voting. Unique features such as the distance between the eyes and eyebrows remain constant over time and can be used for identification. Fingerprint features cannot be altered, but they may be identical for two individuals. However, by using the Ten print images of minutiae records, the database can identify which voter's fingerprint is being used. This system is also less time-consuming, cost-effective, and easy to implement, making smart voting a superior method for conducting elections.

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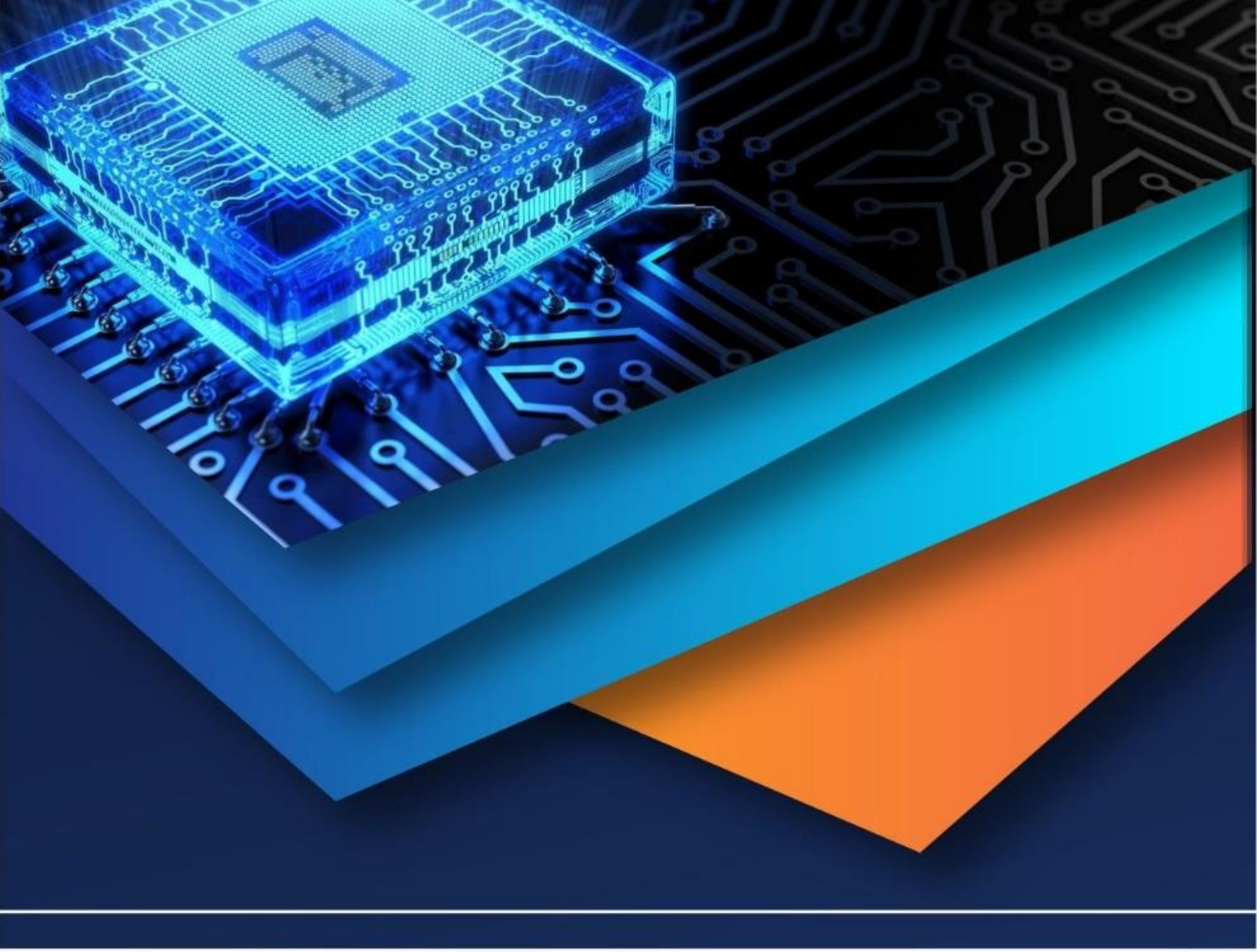

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