College Election System using Facial Authentication

Akash Maurya, Pooja Shetty, Ganesh Yadava, Leena Ladge

SIES Graduate School of Technology

Corresponding author: Pooja Shetty, Email: poojashetty1003@gmail.com

Voting is commonly related to politics and is often ended with exploitation. Manual voting may lead to malpractices sometimes, so there is a need to implement a secured online voting system. The voting system that we propose is a web portal which is designed using the MERN stack and the authentication of the voter is done using facial recognition. For this, the Eigen-face algorithm is used. The user will have to register and login into the portal. After that, the users will upload their respective documents which will be verified by the admin. For the voter's assistance, the portal has several features like slot booking for the voting day, reminder for the voters, viewing of the candidates standing for the elections and a FAQ chatbot. The candidates can do online campaigning, set online rallies and build their profiles for the voters to see. The whole website is secured using a JWT token which ensures that every request made to the website is made by a legitimate and admin verified user. The voter is verified using facial authentication before he is allowed to vote. Our system uses the Eigen-Face algorithm with an accuracy of around 87%.

Keywords: Student Body, MERN Stack, Eigen-face, JWT Token.

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1   Introduction

Voting is a very effective way to reveal opinions about an issue or subject from a group of people based on the promise of greater efficiency, better scalability, faster speed, lower cost and convenience [1]. Voting in India is currently conducted on automated electronic-based processing. One person, one vote is the principle of political equality and the basis of a truly democratic system [2]. Violation of this rule can compromise the fairness of an electoral process. Nowadays the wide range of applications of voting includes its use in student body elections, shareholder meetings, and the passing of legislation in parliament. The current election process in India consists of a number of steps (see Fig. 1). It explains each stage of the current voting process. This system has a few drawbacks like the proper authentication of the voters is not done. It is very important to make sure that no one else can vote on behalf of some other voter. Also, avoiding crowds, switching to e-campaigning etc. are the needs of the era.

The system that we have developed is a web-based voting system that will help you manage your elections easily and securely and make sure that no manipulation of voting is involved. The main goal of this idea proposed is to encourage more people to vote and make the voting process faster, feasible and fair. Currently the voting portal that we have developed using the MERN stack can be used for student body elections. There is a database that is maintained in which all the names of the voters with their complete information are stored.
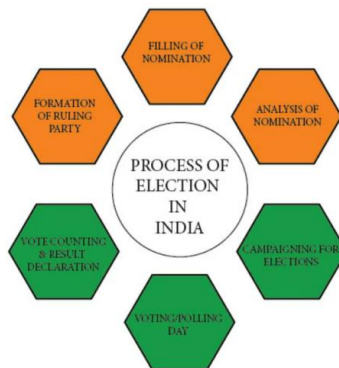

Figure 1. Election Process in India

The paper is organized as follows: Section II presents the literature review. Research on around 10 to 12 papers have been done and their key findings have been mentioned in this section. Section III explains all the existing systems till date. Section IV presents the system architecture. It further contains two sub-sections, first is the proposed system and then comes the module explanation. The results and discussions achieved from this project have been presented in Section V. Finally, the conclusions derived are shown in Section VI. The references used during the development of this project are mentioned in Section VII.

2   Literature Review

We studied and went through the following research papers listed below to get more knowledge and ideas about the implementation of our project.

Ram Govindraj et al. [1] describes the system wherein the user can vote from anywhere. The registered user will be given a chance to vote only once. The main drawback of this system is that the user is allowed

to vote from anywhere which increases the problem of fraudulent voting. Also, they haven't focused on the authentication as well as the security of the users of this system.

M. Jagtap et al. [2] has developed a system wherein the use of Fingerprint scanning and OTP is used for authentication. Their system enables secure authentication by using biometric features and steganography. The voter is allowed to vote from the chosen location. This leads to bogus voting. Although the security is maintained using steganography and biometric, the system becomes quite complex and expensive.

S. Agarwal et al. [3] also proposed a similar system which included the use of biometric devices. The biometric device is used to take the fingerprint of the voter and then it is linked with an Aadhar card. If the fingerprint matches, then only the user will be allowed to vote. Biometric is a good device to enable proper secured authentication but it might become expensive.

In a paper by Z.A. Usmani et al. [4], a system was proposed wherein the user can create their own voting ballot. In this system, the users won't have to do the registration first, thus saving time. They just have to provide the Aadhaar Card number which is also called the National Identification Number. This would ensure the individuality of the user as the database consists of contents such as Barcode and OTP which are used for security verification. This system lacked the multilevel authentication required to allow only legitimate users to use the portal.

Gowtham Lingala et al. [5] proposed a secured voting system that offers privacy with proper voter authentication and transparency. It focuses on the potential working of face recognition and biometric authentication namely biometric-scan which improves the security and decreases the duplicity of votes to make the system as more efficient and user friendly as possible in nature. Although the system was quite perfect, it lacked other features which could have increased the voter-candidate interaction like online campaigning, FAQ chatbot etc.

E. V. Palekha et al. [6] proposed a system in which the identity of the voters is stored using android mobile through facial recognition systems. The entire system is made online and the voter can vote from anywhere. Since the voter could vote from anywhere, high probabilities exist that someone else would vote on behalf of the actual voter. Also, this system doesn't include any method to keep the user's identity safe.

G. N. de los Santos et al. [7] proposed an online voting system which used the uniqueness of the minutiae of the human fingerprint to further enhance the level of trust and confidentiality of the voters in the system. Although the authentication is done properly, it becomes expensive to make use of biometric at multiple voting booths. Also, the verification of the user needs to be done after registration and for that any updated procedure is not included in this system.

S Ganesh Prabhu et al. [8] proposed a system that enabled the user to vote remotely from anywhere using his/her computer or mobile phone through two step authentication of face recognition and OTP system. This project also allowed the user to vote offline. But the system didn't include any method to secure voter's information. Also, it didn't include any third party to authenticate the users registering into the system.

K. Hasta et al. [9] developed an online voting system which is highly secured, with a simple design and also reliable. The proposed software is developed and tested to work on Ethernet. This was a very basic system which had no proper authentication and security features. Also, the use of JDBC made the system heavy and slow.

Therefore, to overcome all these problems, we propose a system that provides multi step authentication for the users to ensure only valid users access the portal. Also, this system includes multiple features for the user's assistance thus making it user-friendly.

3   Existing System

In this section we have discussed the features of several traditional voting systems that have been in use since decades.

- Previously, there was a Paper Ballot System, which involved a lot of manual counting and consumed a lot of time [4]. This conventional method was used in most parts of the globe for many decades.
- Subsequently, the E-Voting System came into prominence and replaced the conventional Paper Ballot system. An E-voting system is a type of voting system in which voters cast their secret vote using the electronic ballot. This is done using the EVM's which is the Electronic Voting Machine but it also has many limitations like it can record a maximum of around 3000 votes only, and can cater to a maximum of 64 candidates at a time [7]. Also, this system has a lot of flaws regarding security. Since the voter is not verified properly, many instances occur where one person votes multiple times with different identities.
- In schools and colleges, generally presidential elections are conducted using either a paper ballot system or SMS voting [11]. Using these methods makes the post-elections counting procedure quite tedious and difficult.

Hence to solve these problems we have created a web-based portal where voters will be authenticated using Facial Recognition first and only then he/she would be allowed to vote. Currently, it is developed for college elections and it includes three modules having different features which are discussed further.

4   System Architecture

This section consists of two sub-sections. Part 1 explains the proposed system and Part 2 gives the module explanation.

A) Proposed System

The system that we have proposed aims at solving all the problems that we found while analyzing the current election system. The objective of our project is to develop an online web-based voting system that can be used for the student-body elections conducted in schools and colleges. The online system must meet basic standards, such as the software being trusted and secure. It is a secured system since each user can vote only once because the database will not accept more than one vote per user. This system should be able to handle big databases. This online voting mechanism is both simple to use and effective. In comparison to traditional voting systems, this technique does not necessitate as much effort. The election process of this web portal is much simpler and faster (see Fig. 2).

Figure 2. Election Process in India

This system includes two-way authentication. Firstly, the user will have to login using his/her credentials into the system. For this, it is necessary that the user has priorly registered into the system. On registering, the admin will check all the information and documents uploaded by the user on the dashboard and will thus verify the user. The entire system is secured with JWT to make sure only legitimate users can access the portal. After logging in, the voter will be allowed to enter the voting portal where facial authentication would be done. The voter's face will be captured using the camera. The face captured will be matched with the already stored face in the database using the Eigen-Face algorithm. If a match is found, then only he can vote else he will not be allowed to vote. Once he votes, the portal will get closed so that he cannot vote again. At the end, entire counting of the votes will be done automatically and the admin will get to see all the calculations using the graphs. Apart from the voting part, multiple other features are included in this system which will assist the voters as well as the candidates that are standing in the elections.

B) Module Explanation

This system would consist of 3 types of users - The Voter, Candidate and the Admin.

1. Voter Module

Initially, the user will have to first register on the portal, provide all the necessary information, upload the photo and all the documents that are asked on the portal. The voter module has multiple features like the Reminder which will give a message to the voter saying "You have elections tomorrow, so be a responsible voter and spare some time". This feature will thus ensure that maximum voters come and vote (see Fig. 3).
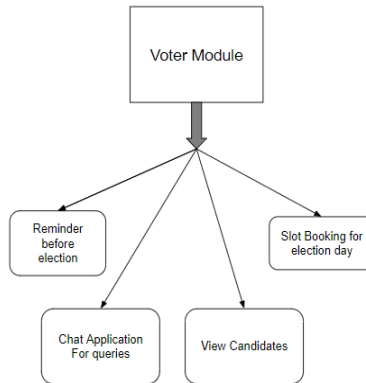

Figure 3. Voter Module

Then there is a chat application where the voter's queries would be answered. The voter can also view all the candidates standing in the election and know more about them by watching their campaigning contents like posters, videos, or any messages that the candidate wants to convey. The most important feature is the Slot Booking. The current voting system conveys only the start and end time of voting to the people. This leads to crowd accumulation since everyone rushes at the same time and then stand in long queues waiting for their turn. Thus, slot booking would help in reducing this crowd which is very important in recent covid times. The user can book a slot and can arrive at that time to cast his vote.

2. Candidate Module

This module is for the users who want to stand in the elections. Figure 4. explains all the features available for a candidate. So firstly, to become a candidate, the user will have to register himself into the portal and upload all the necessary documents that are asked.
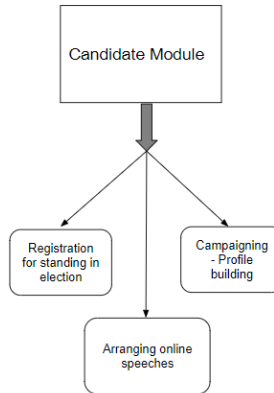
Figure 4. Candidate Module

The admin will then check those documents and approve the application if everything is found correct. After the admin's approval, the user will become a valid candidate. Once the registration is completed, the candidate will be redirected to his dashboard where multiple features are provided for his assistance. The candidate can also view other candidates standing in the elections. Our portal also has a separate place where the candidates can do e-campaigning by posting the banners, posters, slogans if any in order to convey their messages to the voters. The candidates can also organize online rallies where he could interact with the audience and promote his future visions and ideologies.

3. Admin Module
The admin module is the most crucial part of the system, since admin is the one who will be controlling the entire voting process. As shown in Figure 5. the admin will have multiple responsibilities including starting the voting process.
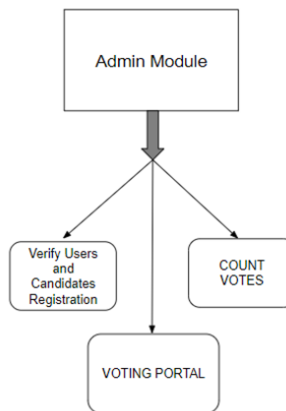

Figure 5. Admin Module

Since, the voters are coming to the center to vote, the admin first will login into the voting section and then the voters can go one by one and cast their vote. The admin's role would be verification of these candidates standing in the election and the authorization of voters participating in the election. The admin will have to validate all the documents uploaded by the voters and the candidates to make sure

that only eligible people can register into the portal. Then after the elections, total votes would be calculated and it will be visible only to the admin.

4. Face-Recognition Algorithm

For the voter authentication part, facial recognition is used. The voter has to go to the voting center on his booked slot and login into the face-authentication module. The main goal is to differentiate and identify the current live image of the voter with those that exist in the voter database, where the biometric and the basic details of a registered voter are collected and stored priorly. At times, the input image can be highly noisy or there might be a couple of changes in an individual's latest facial features because a human face is a dynamic structure which keeps changing rapidly with time. Considering this, the Eigen-face approach is the efficient one for comparison between the facial pictures. Eigen-faces are the unique features in every individual's face (eyes, iris, nose, mouth, ears) which can be extracted from any image using a mathematical approach called Principal Component Analysis (PCA). Using this, one can transform the original image into its respective eigen-faces. By adding up all the eigen-faces in the correct proportion the original image can be reconstructed. Since the reconstructing of all the extracted eigen-faces is mostly impossible, the reconstructed image will be an approximation of the original.
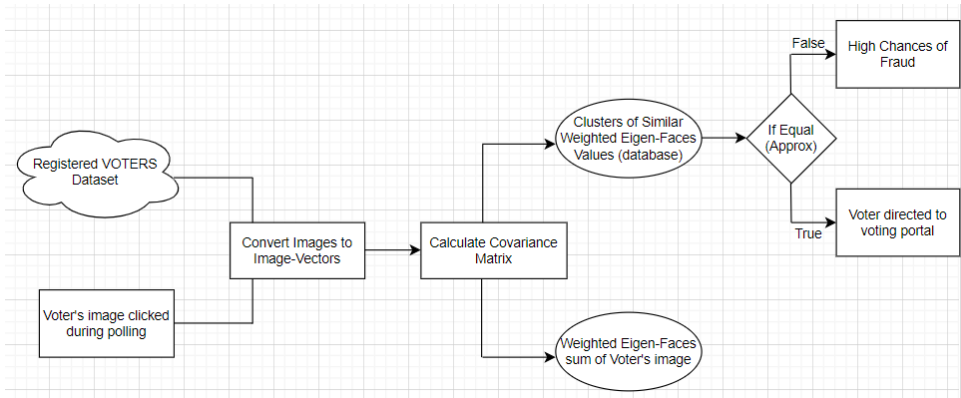

Figure 6. Face-Recognition Using Eigen-Face Algorithm

Principal Component Analysis (PCA) plays an important role in this algorithm. It finds an arrangement between the projection vectors (eigen vectors) and the Eigen estimations of the actual image which is performed as follows:

1) Construct the Voter Dataset:
- The images of all the registered voters (of the same size) stored in the database should be converted into their respective vectors and each vector will have their own respective eigen-faces.
- For example, there are M images I1, I2, I3, …….IM of size NxN and they are converted into respective vectors
Γ1, Γ2, Γ3, ΓM.

2) Calculate the mean of Image-vectors:
- The mean of the image-vectors is calculated and is used in further calculation of eigen-vectors.

$$\Psi = \frac{1}{M}\sum_{n=1}^{M} \Gamma n \qquad\qquad (1)$$

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3) Calculating the Covariance Matrix:
- Initially the mean of image-vectors is subtracted from the required image say Γi

$$\phi_i = \Gamma_{i-}\varphi \qquad (2)$$

- Now by using the below formula, covariance matrix C is obtained:

$$C = \frac{1}{M}\sum_{n=1}^{M}\phi_n\phi_n\Gamma \qquad (3)$$

4) Calculating Eigen-Faces from the covariance matrix:
- From the multiple matrices that are obtained from the above step, consider one matrix say L and L vi = μvi, where vi is an individual eigen-vector

- The ith Image is given by the formula:

$$ui = \sum_{i=1}^{M} vi.\phi i \qquad (4)$$

5) Thus, the Eigen-Faces can be calculated. Only the larger eigen-face values are considered and the lower ones are ignored because only the major features of the face should be taken into account. In the same way the eigen-faces and also the weighted eigen-faces sum of each image of a registered voter in the database must be calculated and stored. Images that are having approximately equal or similar weighted-sum can be clustered together for making the computations easier while checking. When an individual is trying to cast a vote, the eigen-faces and the weighted-eigen sum of that particular image is calculated by using the above process. After that, the eigen-faces of the current image are compared with those of the closest cluster in the database. The individual is a legal voter only if the match is found or else there are high chances of voter fraud.

5 Results And Discussions

As shown in Figure 7. The Proposed Voting System using Face recognition has been implemented for our college-level elections. The user has to register into the portal and then login using his credentials. Once the user logs in, he will be redirected to the voter dashboard.
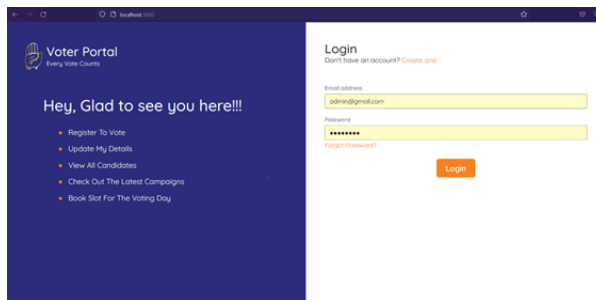

Figure 7. Implemented Portal

Figure 8. is the screenshot of the voter dashboard where the voter can update their profile and make use of all the features available for them.
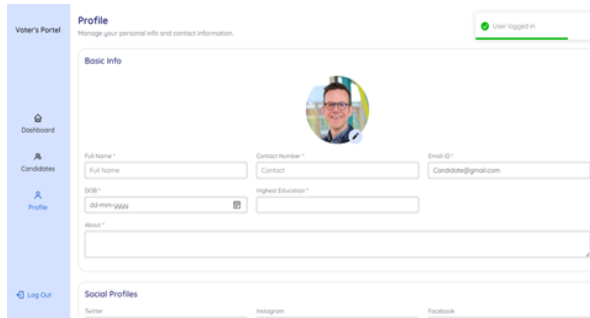
Figure 8. Voter Dashboard

The voter can view all the candidates standing in the elections as shown in Fig 9. They can also click on each candidate and see detailed information about them, view their campaigns and agendas in order to decide who to vote.
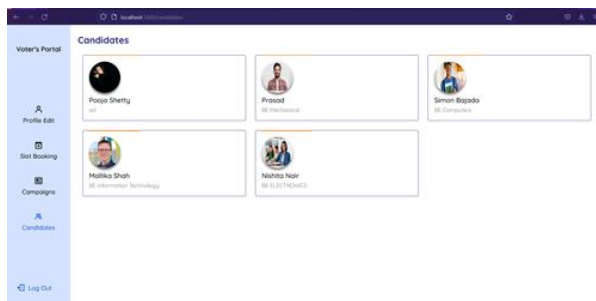

Figure 9. Viewing Candidates

Figure 10. is the screenshot of the slot booking feature for the voters. The voter can book the desired slot and can go to the voting booth at that time. This helps in managing the crowd and avoiding long queues.
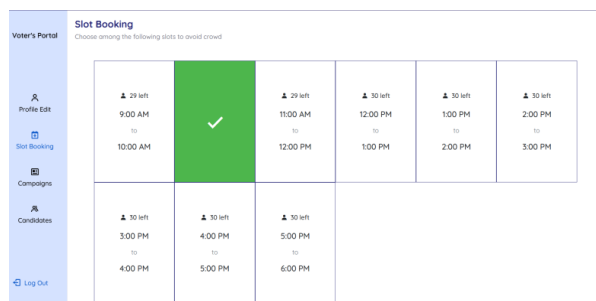

Figure 10. Slot Booking

The candidates can create their own campaigns and post it on the portal which can be viewed by all the voters. Figure 11. is the screenshot of the create campaign page.
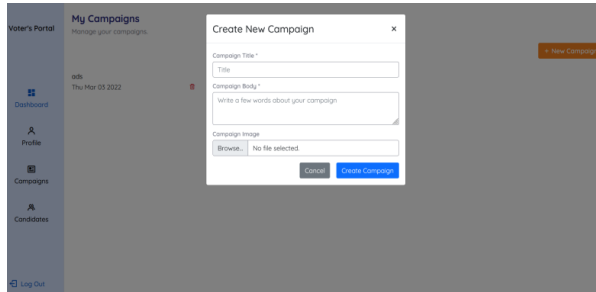
Figure 11. Create Campaigns

The admin can check the documents of the voters and the candidates in the admin dashboard as shown in Figure 12. for validation purposes.
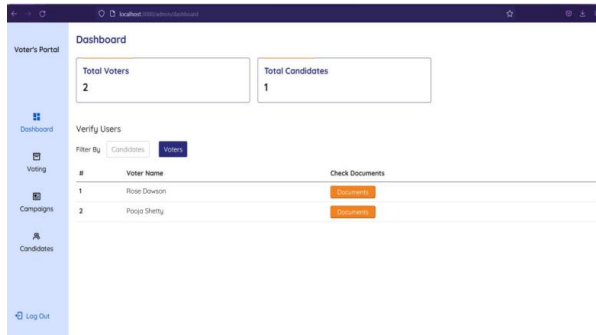

Figure 12. Admin Dashboard

After the voting process gets completed, the admin will be able to view the results of the process and the total number of votes as shown in Figure 13.
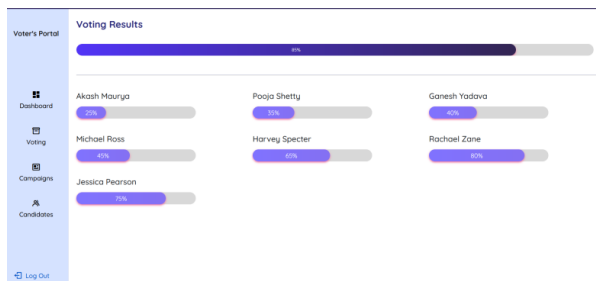

Figure 13. Voting Results

For every voter, to cast a vote, he will have to first login using his credentials as shown in Figure 14. If the credentials get matched with the ones stored in the database, then the voter can proceed to the further authentication step. If the login fails, the voter will not be allowed to the next page thus taking care of the credibility of the portal.
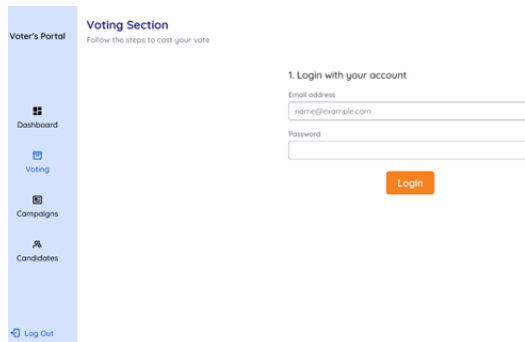
Figure 14. Voting Section

Facial Authentication Results –

After the login is completed, the voter is directed to the next page. Here, the live image of the voter is captured using the web camera as shown in Figure 15.

Figure 15. Live Image Capture

This captured image is then matched with the image that has been already stored into the database. Using the Eigen-Face algorithm the live captured image is compared with the image that has been already stored in the database. As shown in Figure 16. if the value comes true, then only the voter will be allowed to vote or else if the value comes false, the voter will not be allowed to vote.
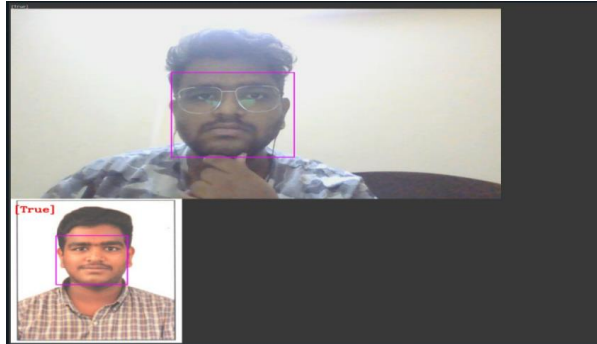
Figure 16. Face Authentication Part – 1

Once the facial authentication is complete, the voter will be directed to the voting section as shown in Figure 17. where the voter can cast his vote.
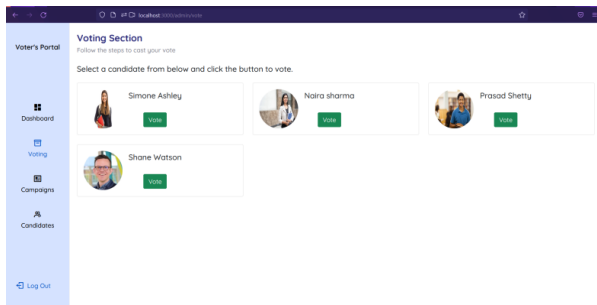

Figure 17. Voting Booth

Figure 18. shows the false result declaration when the faces don't match. In such cases, the voter will not be allowed to enter the voting booth. The voter is allowed to caste the vote only once.

Figure 18. Face Authentication Part-2

6   Conclusion

There has been an enhancement in every field today but there has been no change in the way we conduct elections in the past decade and there are many flaws in the current voting system such as improper authentication, long waiting queues and casting of false votes. To solve these issues, we have proposed this system. We have developed an online voting system embedded with facial authentication for college-level elections. The voter has to register into the portal and then login using the credentials. The voter is provided with various features like viewing the candidates, slot booking for the election day, FAQ chatbot for solving the queries and reminder feature. The candidates standing for the elections can build their profiles, do online campaigning and arrange online speeches for the voters. The admin is responsible for verifying the users and candidate registration. The admin is also responsible for starting the elections. At the end, the admin will be provided with voting results. For the facial authentication part, the Eigen-face algorithm is used and we have achieved an accuracy of 87%. The future work for this project includes developing a full-fledged voting system for general elections. Also, the accuracy could be increased further to get more accurate results.

References

[1] Ram Govindraj, P Kumareshan, K hashitha. (2020). Online Voting System using Cloud. International Conference on Emerging Trends in Information Technology and Engineering, ic-ETITE 2020. doi: 10.1109/ic-ETITE47903.2020.245.

[2] M. Jagtap, V. Kesarkar and A. Supekar, "Electronic Voting System using Biometrics, Raspberry Pi and TFT module," 2019 3rd International Conference on Trends in Electronics and Informatics (ICOEI), 2019, pp. 977-982, doi: 10.1109/ICOEI.2019.8862671.

[3] S. Agarwal, A. Haider, A. Jamwal, P. Dev and R. Chandel, "Biometric Based Secured Remote Electronic Voting System," 2020 7th International Conference on Smart Structures and Systems (ICSSS), 2020, pp. 1-5, doi: 10.1109/ICSSS49621.2020.9202212.

[4] Z. A. Usmani, K. Patanwala, M. Panigrahi and A. Nair, "Multi-purpose platform independent online voting system," 2017 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS), 2017, pp. 1-5, doi: 10.1109/ICIIECS.2017.8276077.

[5] Komatineni, Sudeepthi and Gowtham Lingala. "Secured E-voting System Using Two-factor Biometric Authentication." 2020 Fourth International Conference on Computing Methodologies and Communication (ICCMC) (2020): 245-248.

[6] E. V. Palekha et al., "Cross-Platforming Web-Application of Electronic On-line Voting System on the Elections of Any Level," 2019 IEEE East-West Design & Test Symposium (EWDTS), 2019, pp. 1-4, doi: 10.1109/EWDTS.2019.8884457.

[7] G. N. de los Santos, J. R. N. de los Santos and L. G. de los Santos, "e-voting kiosk: A Network Architecture School-based Registration and Voting System," 2020 IEEE 12th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM), 2020, pp. 1-5, doi: 10.1109/HNICEM51456.2020.9400135.

[8] S. Ganesh Prabhu, A. Nizarahammed., S. Prabu., S. Raghul., R. R. Thirrunavukkarasu and P. Jayarajan, "Smart Online Voting System," 2021 7th International Conference on Advanced Computing and Communication Systems (ICACCS), 2021, pp. 632-634, doi: 10.1109/ICACCS51430.2021.9441818.

[9] K. Hasta, A. Date, A. Shrivastava, P. Jhade and S. N. Shelke, "Fingerprint Based Secured Voting," 2019 International Conference on Advances in Computing, Communication and Control (ICAC3), 2019, pp. 1-6, doi: 10.1109/ICAC347590.2019.9036777.

[10] H. V. Purandare, A. R. Saini, F. D. Pereira, B. Mathew and P. S. Patil, "Application For Online Voting System Using Android Device," 2018 International Conference on Smart City and Emerging Technology (ICSCET), 2018, pp. 1-5, doi: 10.1109/ICSCET.2018.8537284.

[11] R. P. Prasad, S. K. N. Kumar, R. Gatti, M. Pranav, G. Rahul and M. Yatheesh, "TOUCHLESS ELECTRONIC VOTING MACHINE WITH AN AI-FACIAL RECOGNITION," 2021 International Conference on Recent Trends on Electronics, Information, Communication & Technology (RTEICT), 2021, pp. 951-955, doi: 10.1109/RTEICT52294.2021.9573760.

[12] G. Manikandan, G. Anandaraju and B. Karthikeyan, "A Candidate Aware Internet Voting System For Indian Scenario," 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS), 2020, pp. 783-786, doi: 10.1109/ICACCS48705.2020.9074158.