Electronic Voting Machine with Facial Recognition and Fingerprint Sensors

CAPSTONE PROJECT REPORT

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ABSTRACT

In this project, an attempt has been made to the development of an authenticated electronic voting system using fingerprint and facial images. The two-fold authentication system improves the security of the voting process and reduces the chances of a corrupt election process. The facial recognition process utilizes the Local Binary Pattern Histogram and Support Vector Machine process to scan, store and recognize faces efficiently. The fingerprint recognition involves the capturing of multiple 2D images and High Sensitive Pixel Amplifier to improve the quality of those images to scan the fingerprint to provide the primary form of authentication. Visual Basic is used to develop a very easy to use User Interface that enables an easy voting process. A private server is used to store both the user data and the election results separately. This reduces the chances of external manipulation of the election results**.**

Fingerprint voting, leveraging biometric identification, presents a promising approach to enhance electoral integrity and prevent fraud. By integrating machine learning algorithms with fingerprint recognition technology, this system aims to provide a secure, efficient, and user-friendly voting process. Machine learning models can optimize fingerprint recognition accuracy, minimize false positives/negatives, and handle diverse fingerprint variations across populations. The proposed system involves capturing fingerprints at the polling station, processing them through a trained machine learning model to authenticate voter identity, and recording votes securely. This method seeks to address common voting issues such as voter impersonation and ballot tampering, offering a more reliable alternative to traditional voting methods. Preliminary results indicate that machine learning-enhanced fingerprint voting could significantly improve election security and voter confidence.

Keywords: Fingerprint, Local Binary Pattern Histogram, Support Vector Machine, High Sensitive Pixel Amplifier, Histogram of Oriented Gradients.

INTRODUCTION

The simple and cold truth is that everyone hates the problems and security flaws that are glaring at everyone's face. They are so apparent to ignore, as many witnesses these flaws straight on. Some of these flaws can be easily corrected and that is the main objective of this project, to rectify the flaws that can be rectified . To list some of these so-called flaws, are a polling of proxy votes, polling of illegal votes, polling of votes under a stolen identity, external manipulation of the voting process pre and post- election, improper counting of votes Electronic voting is both electronically casting a vote and an electronic means of counting votes. In our project, we are giving importance to the authentication process of our designed voting machine. The securities that are provided will totally eliminate the fraud in the voting system. As a total number of fraudulent votes that are cast are considerably reduced, the probability of obtaining a stable and working government is increased manifold. Also, due to the implementation of immediate and Name-wise counting, there arises a possibility of finding out the number and the names of the non-voters who failed to cast their votes. When this data is utilized properly to penalize the non-voters, a future where almost a hundred percent or the complete casting of votes can be achieved which also increases the chance of a proper government. Also due to this, there is very minimal possibility of manipulation by external forces pre and post-election. When these elements are considered together, a nearly working voting system can be developed. Upon the elimination of these flaws, we can safely entail a safe and secure voting process, which results in the establishment of a stable and working government. The main objectives that are encompassed within this project are listed as, Fingerprint Confirmation as the Primary form of Verification, facial Recognition as the Secondary and Final form of Verification, two memory implementation for the prevention of manipulation, easy to use and an inviting UI for the better understanding of the voting process.

METHODOLOGY

- The order of execution of the project requirements is done so as to achieve an optimal solution within the shortest possible timeframe. The overall workflow is such that the most difficult to execute is done first and foremost, and the easiest is done at the last. This is so that, enough time is available for the testing process and some additional time, in the case of sudden, unprecedented emergencies . The overall workflow can be classified into two phases; they are the Development Phase and the Testing Phase.
- In the development phase, the design of the circuit, purchasing of the components, developing the security detail, final integration of all the details into one and fabrication of components to make the final product look appealing is completed. Secondly, the testing phase involves the testing of the final, finished product for the various contingencies and areas of problems. When these tests are carried out,faults and defects are found out and they are rightly corrected

ALGORITHM

USING CNN

- One common algorithm used in machine learning for fingerprint recognition is the Convolutional Neural Network (CNN). CNNs are particularly effective for image-based tasks due to their ability to automatically extract and learn features from image data.

- How CNNs Work for Fingerprint Recognition:

- Preprocessing: The fingerprint image is preprocessed to enhance features and normalize the image size.

- Feature Extraction: CNNs use convolutional layers to detect and extract features from the fingerprint image, such as ridge patterns and minutiae points. These layers apply various filters to capture different aspects of the fingerprint.

- Pooling: Pooling layers reduce the dimensionality of the feature maps and retain the most critical features while reducing computational complexity.

- Classification: Fully connected layers at the end of the CNN classify the extracted features to identify or verify the fingerprint against a database.

- Output: The system outputs a match or non-match result based on the classification.

Advantages of cnn in fingerprint voting system

- In a fingerprint voting system, Convolutional Neural Networks (CNNs) offer several advantages:

- Accurate Fingerprint Recognition: CNNs excel at extracting and learning complex features from fingerprint images, such as minutiae points and ridge patterns, which are crucial for accurate identification and verification.

- Robustness to Variations: CNNs can handle variations in fingerprint images due to factors like angle, pressure, and partial prints. They are capable of recognizing fingerprints even when there are distortions or partial occlusions.

- Automatic Feature Extraction: CNNs automatically identify and learn relevant features from fingerprint images without requiring manual feature extraction, simplifying the design and implementation of the system.

- Enhanced Security: The ability of CNNs to distinguish between genuine and fake fingerprints (e.g., from silicon or gelatin molds) can help improve the security of the voting system.

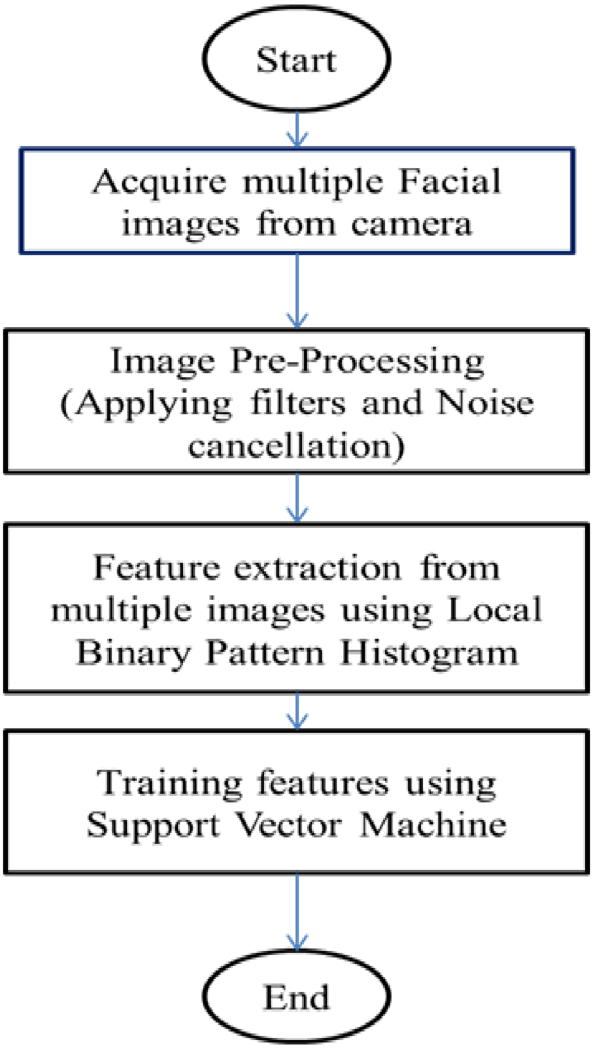
- Scalability: CNNs can efficiently process and analyze large volumes of fingerprint data, making them suitable for systems with numerous voters or large databases.

- Real-time Processing: With the computational power of modern hardware, CNNs can provide real-time fingerprint recognition, ensuring quick and efficient voter verification during the voting process.

FLOWCHART

The overall flow of the project can be illustrated and understood from the below flowchart

ACQUISITIO **Figure 1.1**


Start
Acquire multiple Facial images from camera
Image Pre-Processing (Applying filters and Noise cancellation)
Feature extraction from multiple images using Local Binary Pattern Histogram
Training features using Support Vector Machine
End

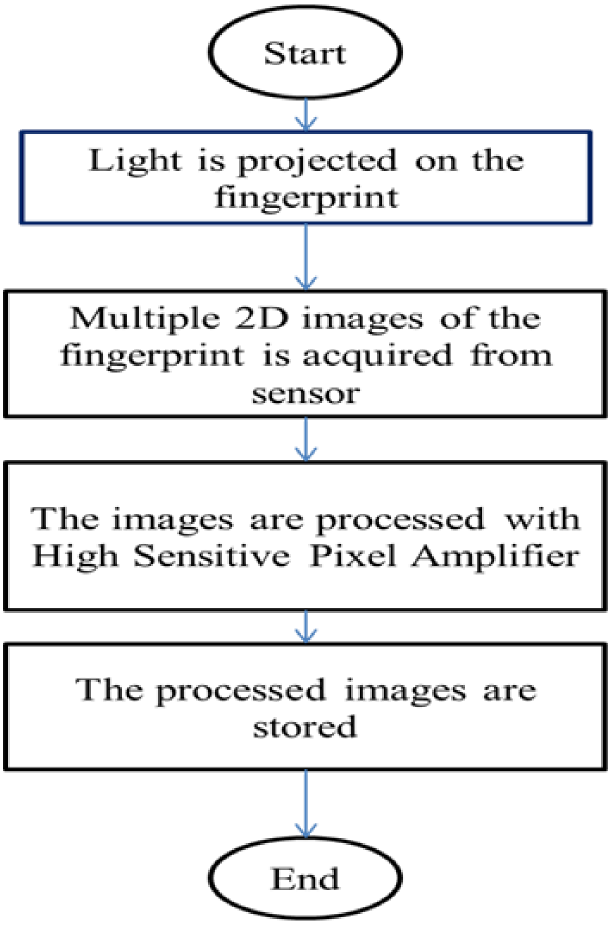
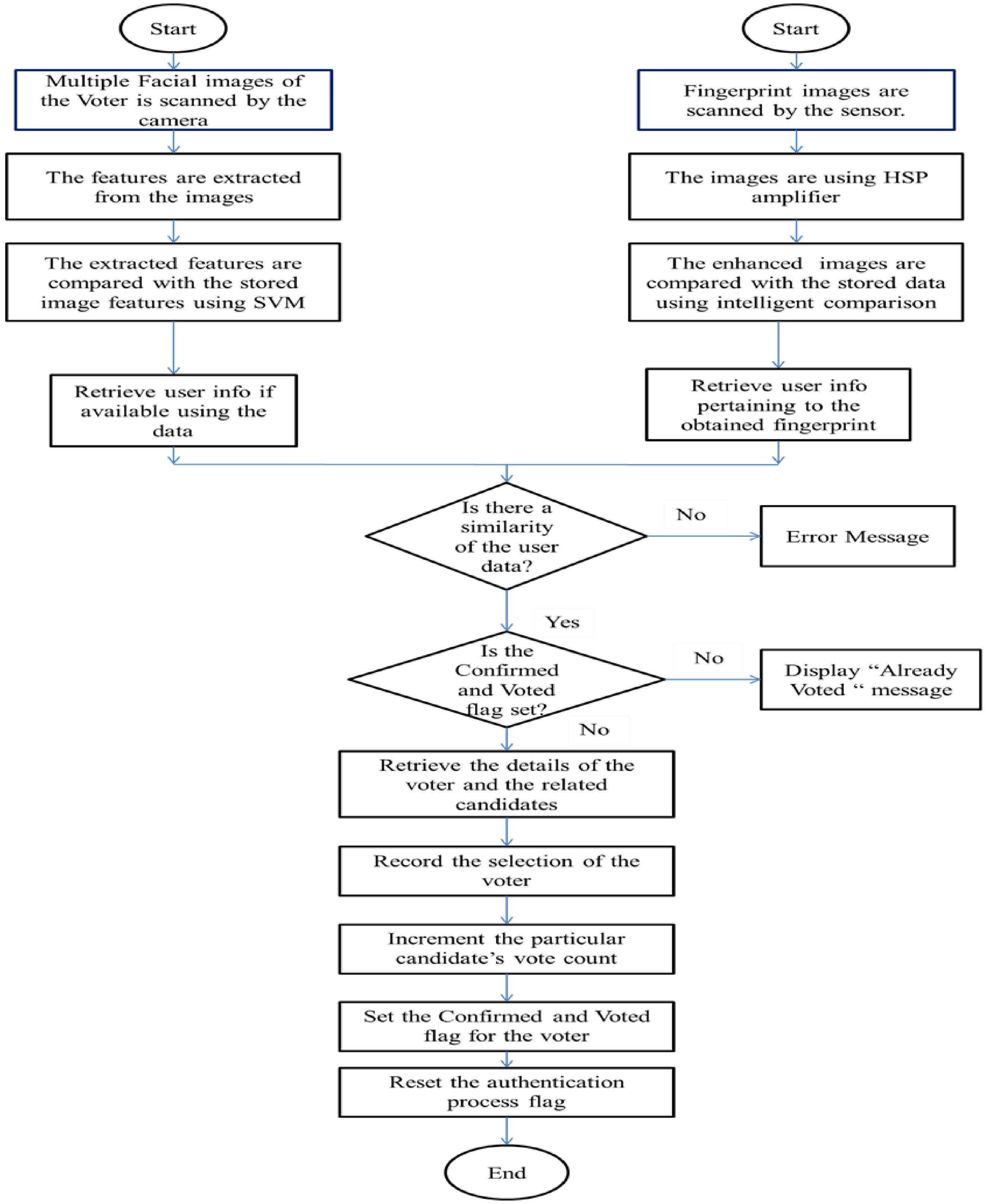

Start
Light is projected on the fingerprint
Multiple 2D images of the fingerprint is acquired from sensor
The images are processed with High Sensitive Pixel Amplifier
The processed images are stored
End

FIGURE 1.2

AUTHENTICATION

Figure 1.3


Start
Multiple Facial images of the Voter is scanned by the camera
The features are extracted from the images
The extracted features are compared with the stored image features using SVM
Retrieve user info if available using the data
Start
Fingerprint images are scanned by the sensor.
The images are using HSP amplifier
The enhanced images are compared with the stored data using intelligent comparison
Retrieve user info pertaining to the obtained fingerprint
Is there a similarity of the user data?
No
Error Message
Yes
Is the Confirmed and Voted flag set?
No
Display "Already Voted " message
No
Retrieve the details of the voter and the related candidates
Record the selection of the voter
Increment the particular candidate's vote count
Set the Confirmed and Voted flag for the voter
Reset the authentication process flag
End

WORKFLOW

- From the above flowchart, the work flow can be easily understood. First, the entire workflow is classified into two stages. The first being the acquisition phase, and the second being the authentication stage. Figure 1.1 and Figure 1.2 represent the two parts of the acquisition stage. When we look at the first figure, here the multiple images of the user's face is collected and they are pre-processed. This pre-processing stage involves removal of unwanted noise and filtering out the background noise, so as to improve the overall quality of the image. Then using LBPH, a technique that processes data or images into tiny cells that contain some information, the features are extracted . SVM, a technique that points the information of each cell in a specific point in space, is used to pre- position the points of the features information. The second figure is the acquisition stage of the fingerprint sensing . Here, first, the fingerprint of the user is illuminated. Then a series of multiple images of the fingerprint is captured as in the face recognition. But instead of LBP, here the images are further enhanced in details by passing them through a High Sensitive Pixel Amplifier (HSPA) .

- Then these processed images are stored for later retrieval. Now, the third and final figure, Figure 1.3 represents the second phase that is the Authentication Phase. In this phase, the primary authentication process, i.e., fingerprint verification is done by capturing new images of the user's fingerprint and comparing them with the stored data in the memory. Here too, the images are enhanced using HSPA. If the fingerprint is available in the database, then the corresponding user data is retrieved. The secondary authentication, i.e., facial recognition is done by capturing a series of images and then training the features via SVM after their extraction. The trained feature details are compared with the SVM data in the database.

- If a face with the similar facial features exists, the user data corresponding to that face is retrieved. Now user data retrieved from both the primary and the secondary authentication processes are compared. If they are similar, then the next step proceeds as planned, else the system is programmed to throw out an error message, stating that there is a mismatch of user data. In the next step, the system checks if the Confirmed and Voted flag are set for the user. If the flag is set, it means that the user has already voted and therefore the application exits and resets while throwing out an error message . If it is not set, it means that the voter has not yet cast their vote and so they are allowed to cast their vote. In the next step, the candidate information related to that particular voter is retrieved and they are displayed on the screen..

TECHNOLOGIES AND TOOLS USED

- The various technologies used are selected such that they are compatible with one other and have no interfacing problems. Also, they must fall within the budget limit such that compromises shall not be made. The different technologies and tools used are listed below Python Development Environment, Linux Interfacing Engine and, Visual Basic. The PDE is used to develop the working program for the verification devices and the LIE is used to convert it to Linux compatible code. Here, a development environment is a combination of a text editor and the Python interpreter.

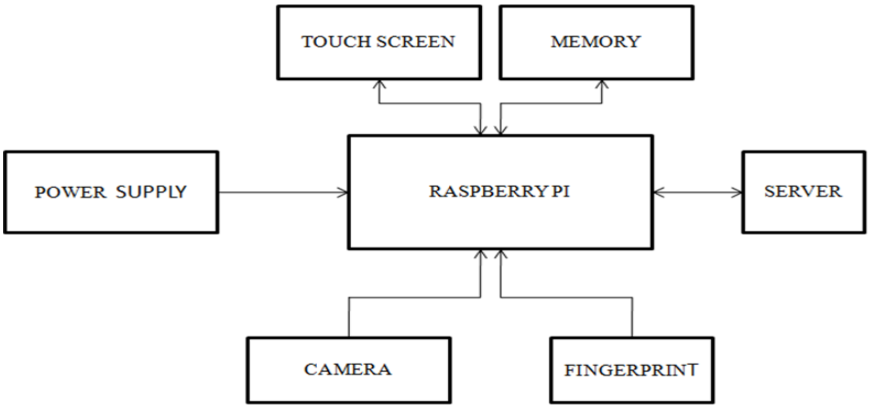
- The text editor allows you to write the code. The interpreter provides a way to execute the code you've written. A text editor can be as simple as Notepad on Windows or more complicated as a complete integrated development environment (IDE) such as PyCharm which runs on any major operating system . An application programming interface (API) is a set of specifications that define how one piece of software interacts with another, particularly an application program with an operating system.

- A primary purpose is to provide a set of commonly-used functions, such as to draw windows or icons on the screen, thereby saving programmers from the tedium of having to write code for everything from scratch . The PDE is used to develop the working program for the verification devices and the LIE is used to convert it to Linux compatible code. The capacitive fingerprint sensing is the type of fingerprint sensor used in the project. Instead of creating a traditional image of a fingerprint, capacitive fingerprint scanners use arrays tiny capacitor circuits to collect data about a fingerprint.

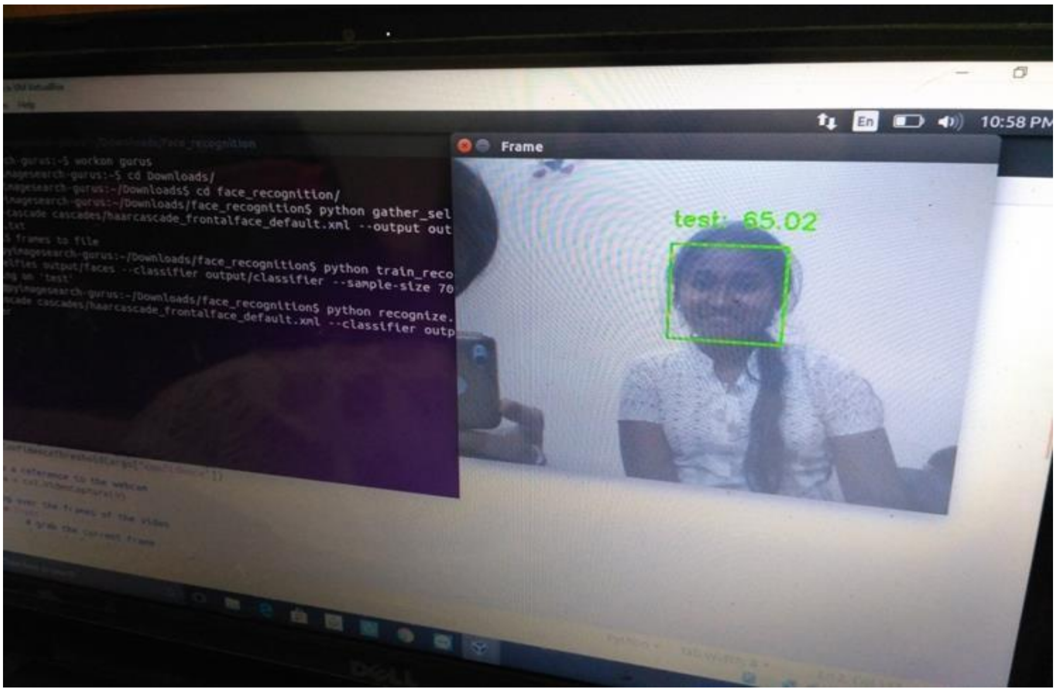
- As capacitors can store electrical charge, connecting them up to conductive plates on the surface of the scanner allows them to be used to track the details of a fingerprint. The charge stored in the capacitor will be changed slightly when a finger’s ridge is placed over the conductive plates, while an air gap will leave the charge at the capacitor relatively unchanged. An op-amp integrator circuit is used to track these changes, which can then be recorded by an analogue-to-digital converter . Local binary patterns is a type of visual descriptor used for classification in computer vision. LBP is the particular case of the Texture Spectrum model proposed in 1990. LBP was first described in 1994.

RESULT AND DISCUSSION

The working of this model is very straightforward and very easy to understand. First, the fingerprint reader scans the fingerprint of the voter and sends the output to the microcontroller. The microcontroller then pairs the scanned data with the data in the database and retrieves the information about the voter.

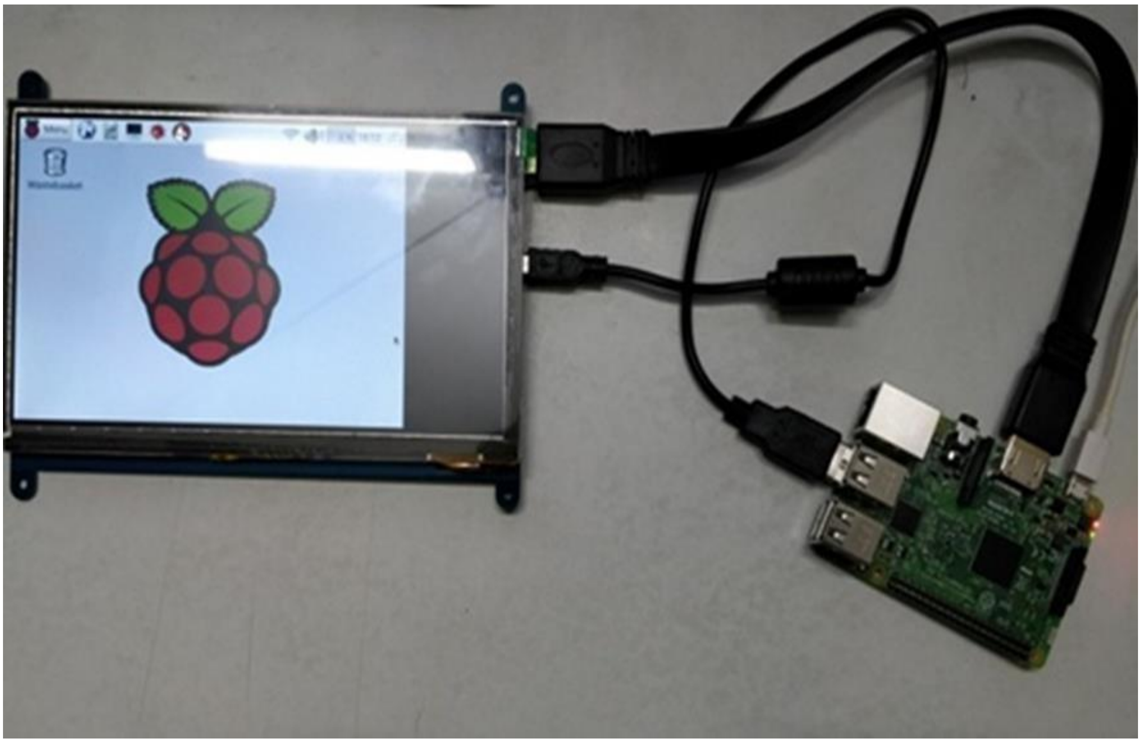


Now, the camera scans the face of the voter and checks whether it is similar to the face of the voter's face data that is paired with the fingerprint [11].



```
ch-gurus:~$ workon gurus
imagesearch-gurus:~$ cd Downloads/
imagesearch-gurus:~/Downloads$ cd face_recognition/
imagesearch-gurus:~/Downloads/face_recognition$ python gather_sel
cascade cascades/haarcascade_frontalface_default.xml --output out
.txt
5 frames to file
pyimagesearch-gurus:~/Downloads/face_recognition$ python train_reco
elfies output/faces --classifier output/classifier --sample-size 70
ng on 'test'
pyimagesearch-gurus:~/Downloads/face_recognition$ python recognize.
scade cascades/haarcascade_frontalface_default.xml --classifier outp
```

If it does not hold true, the process ends there with an error message but if it checks out, then the next step is carried out. Now the CPU displays the candidate details, in the area that is related to the voter, in a touch display. The voter then goes through the details and when he finalizes the candidate he want to cast his on, he then makes the selection on the display. Now is when the server comes into the picture. Now the voter has a verified and completed status on his ID and the vote count of the candidate is incremented by one.



This data is stored both on a local memory and is also sent to another separate memory through an external server [20]. When the counting process begins, both the local data and the server data are compared to check for any manipulations. If the data don’t match, then that shows signs of external manipulations and necessary actions can be taken on that [24]. Also, after the election is over, the overall voter - database can be retrieved and the persons without the verified and completed badge can be penalised and shown some tough love o encourage them to vote in the next election. This increases the number of voters gradually.

CONCLUSION

- There are many fraudulent and illegal activities that are happening in regards to the current voting process. With these problems in mind, the electronic voting machine is developed with fingerprint and facial recognition. This dual authentication system reduces the chances of the above mentioned problems and so it has improves the security and efficiency of the voting process.
- A fingerprint voting system offers several advantages, including enhanced security, reduced fraud, and streamlined voter identification.
- By using biometric data, it ensures that only eligible voters can cast a ballot and helps maintain the integrity of the electoral process. However, challenges such as the potential for technical issues, privacy concerns, and the need for robust data protection must be addressed to ensure its effectiveness.
- Overall, while promising, the implementation of such systems requires careful planning and robust safeguards to address these concerns and ensure a fair and efficient voting process.

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