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Electronic Voting Machine with Face Recognition

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Abstract: Electronic Voting Machines (EVMs) have improved the efficiency of elections; however, voter impersonation and duplicate voting remain critical challenges. This paper proposes) using real-time face recognition for voter authentication. The system integrates a webcam-based face capture module, facial encoding storage in a secure database, and a graphical user interface for vote casting and administration.

The framework ensures that only registered voters can vote and prevents multiple voting attempts using biometric verification and database validation. The proposed system is suitable for academic institutions, organizational elections, and prototype-level secure voting research. Experimental evaluation demonstrates reliable face recognition accuracy under controlled lighting conditions with prevention of duplicate voting.

Keywords: Electronic Voting Machine, Face Recognition, Biometric Authentication, SQLite Database, Python, Secure Voting System

I. INTRODUCTION

Elections are fundamental to democratic governance and institutional decision-making processes. The integrity, transparency, and reliability of voting systems directly influence public trust. Traditional paper-based voting systems, while simple, are prone to challenges such as ballot tampering, impersonation, delayed counting, and human error. Electronic Voting Machines (EVMs) were introduced to overcome many of these limitations by improving counting speed, reducing manual errors, and minimizing logistical complexity.

However, even conventional EVMs remain vulnerable to issues such as voter impersonation, duplicate voting, and inadequate authentication mechanisms.

Biometric authentication has emerged as a promising solution to enhance voting security. Biometric traits such as fingerprints, iris patterns, and facial features provide unique identifiers for individuals. Among these, facial recognition offers several advantages, including contactless operation, ease of deployment, user convenience, and integration with low-cost camera systems. Advances in computer vision and deep learning have significantly improved the accuracy and speed of facial recognition algorithms, making them suitable for real-time authentication applications.

II. LITERATURE SURVEY

A literature survey provides insight into existing research and technological developments related to biometric authentication in voting systems, particularly systems that use facial recognition. This section explores prior work in electronic voting mechanisms, biometric security, face recognition algorithms, and hybrid systems combining machine learning with electoral processes.

Traditional electronic voting systems were introduced to replace manual ballot counting and mitigate human error. Early implementations, such as Direct Recording Electronic (DRE) systems, improved operational efficiency but often lacked advanced security measures beyond PINs or passwords, making them susceptible to impersonation and tampering (Smith & Jenkins, 2010). The demand for more secure and verifiable voting architectures led to the adoption of cryptographic and biometric methods to authenticate voter identity reliably[1].

Biometric-based voting systems incorporate physiological or behavioral characteristics to identify individuals uniquely. Fingerprint recognition has been the most widely studied modality due to its high distinctiveness and ease of capture (Jain, Ross, & Prabhakar, 2004). In electoral applications, fingerprint authentication has been deployed in countries such as India and Brazil to prevent duplicate voting and impersonation[2].

However, fingerprint-based systems face limitations, including hygiene concerns, sensor degradation, and usability difficulties for individuals with worn or damaged fingerprints (Maltoni et al., 2009). These challenges motivated researchers to explore alternative biometric modalities that are non-contact and user-friendly[3].

Face recognition has emerged as a leading biometric due to its non-invasive nature and mature algorithmic support through computer vision libraries.

Algorithms such as Eigenfaces (Turk & Pentland, 1991), Fisherfaces (Belhumeur et al., 1997), and more recent deep learning-based embeddings (Schroff et al., 2015) have significantly improved the accuracy and robustness of face recognition in unconstrained environments[4].

The availability of open-source frameworks such as OpenCV and Dlib has enabled efficient implementation of face detection and encoding techniques without the need for dedicated hardware.

For example, face recognition libraries using deep metric learning generate a 128-dimensional vector representation for each face, enabling reliable similarity comparison and subject verification.

Several studies have investigated the integration of facial recognition into biometric voting systems. Lwin and Aung (2016) proposed a smart voting framework using PCA-based face recognition for small-scale elections, demonstrating acceptable recognition rates under controlled lighting conditions. Similarly, Rahman et al. (2018) developed a hybrid biometric model using both face and fingerprint to enhance voter verification accuracy[5].

Most prototype systems employ a two-stage process: *face detection* followed by *face matching* against a registered database, similar to the approach used in this work. Distance metrics like Euclidean distance and cosine similarity are commonly used for matching face embeddings (Guo et al., 2016). Threshold-based decision rules ensure that only sufficiently similar faces are considered matches[6].

Secure and efficient database management is crucial for storing and retrieving biometric data. Studies by Kumar & Singh (2017) investigated cryptographically secured databases for biometric identifiers to prevent unauthorized access or tampering. For prototype systems, lightweight databases like SQLite offer simplicity and reliability without requiring complex server infrastructure, as shown in implementations by Sharma & Verma (2020)[7].

III. METHODOLOGY

The proposed integrates biometric authentication, database management, and hardware interfacing using Arduino Uno. The methodology is divided into five major phases: System Initialization, Voter Registration, Face Authentication, Voting Process, and Result Management.

1) Face recognition is performed on the computer using Python.

2) If a valid voter is detected:
- Python sends a serial command to Arduino (e.g., "ENABLE").

3) Arduino:
- Activates LCD: “Select Candidate”
- Enables push buttons.

4) When a button is pressed:
- Arduino lights corresponding LED.
- Sends vote data back to PC.
-

5) PC updates SQLite database.
6) LCD displays “Vote Cast Successfully”.
7) Voting disabled for that voter.

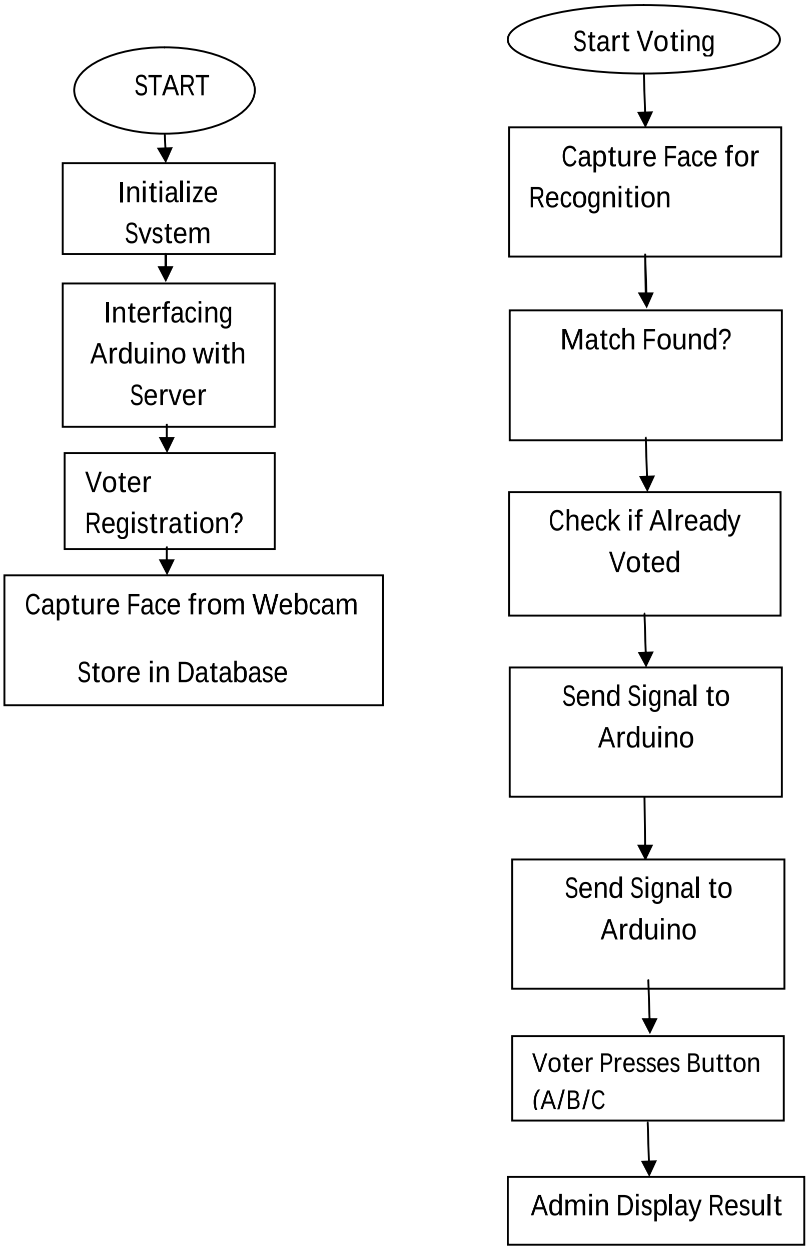


Fig 1. System Flow

A. Advantages of Proposed Methodology

- Contactless authentication
- Low-cost implementation
- Scalable for institutional elections
- Real-time verification
- Reduced impersonation.

IV. RESULT AND DISCUSSION

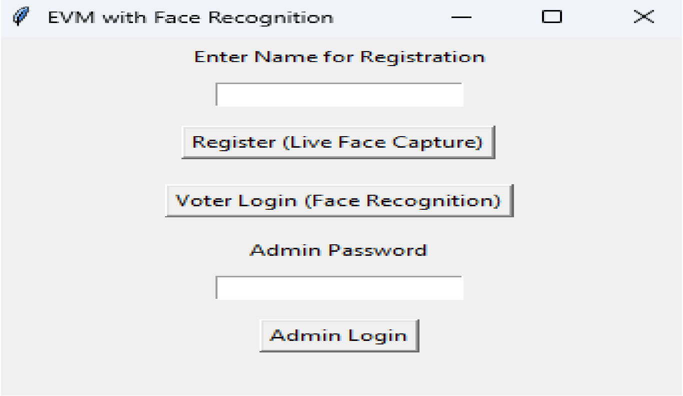
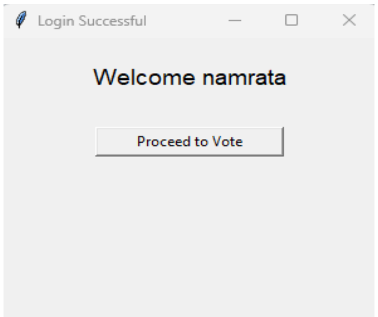

EVM with Face Recognition
Enter Name for Registration
Register (Live Face Capture)
Voter Login (Face Recognition)
Admin Password
Admin Login

Fig 2. Main Dashboard



Welcome namrata

Fig 3. Login

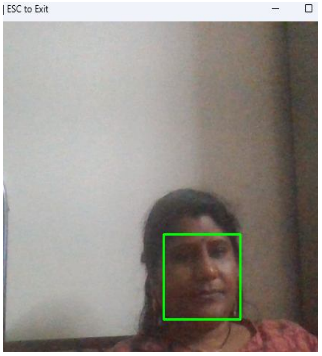
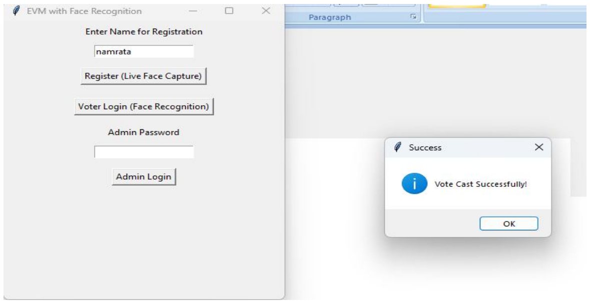


Fig 4. Face Detection


EVM with Face Recognition
Enter Name for Registration
Register (Live Face Capture)
Voter Login (Face Recognition)
Admin Password
Admin Login
Paragraph
Success
OK

namrata

Vote Cast Successfully!

Fig 5. Voting System

□ Achieves high recognition accuracy
□ Prevents duplicate voting
□ Provides real-time hardware feedback
□ Maintains efficient processing time

V. CONCLUSION

This paper presented the design and implementation of a integrated with an Arduino Uno hardware interface. The proposed system combines biometric authentication, real-time facial recognition, database management, and hardware-controlled voting mechanisms to enhance the security and reliability of electronic voting processes in small-scale institutional environments.

The system successfully demonstrated:

1) Accurate real-time face recognition using 128-dimensional facial embeddings
2) Secure voter registration with biometric storage in a local database
3) Prevention of duplicate voting through status flag validation
4) Reliable hardware interaction using push buttons, LCD display, and LED indicators
5) Seamless communication between Python software and Arduino via serial interface

Experimental evaluation showed high recognition accuracy 95–97% under controlled lighting conditions, with an average total voting time of 6–8 seconds per voter. The integration of biometric verification with hardware-level vote capture significantly reduces the risk of impersonation and unauthorized voting.

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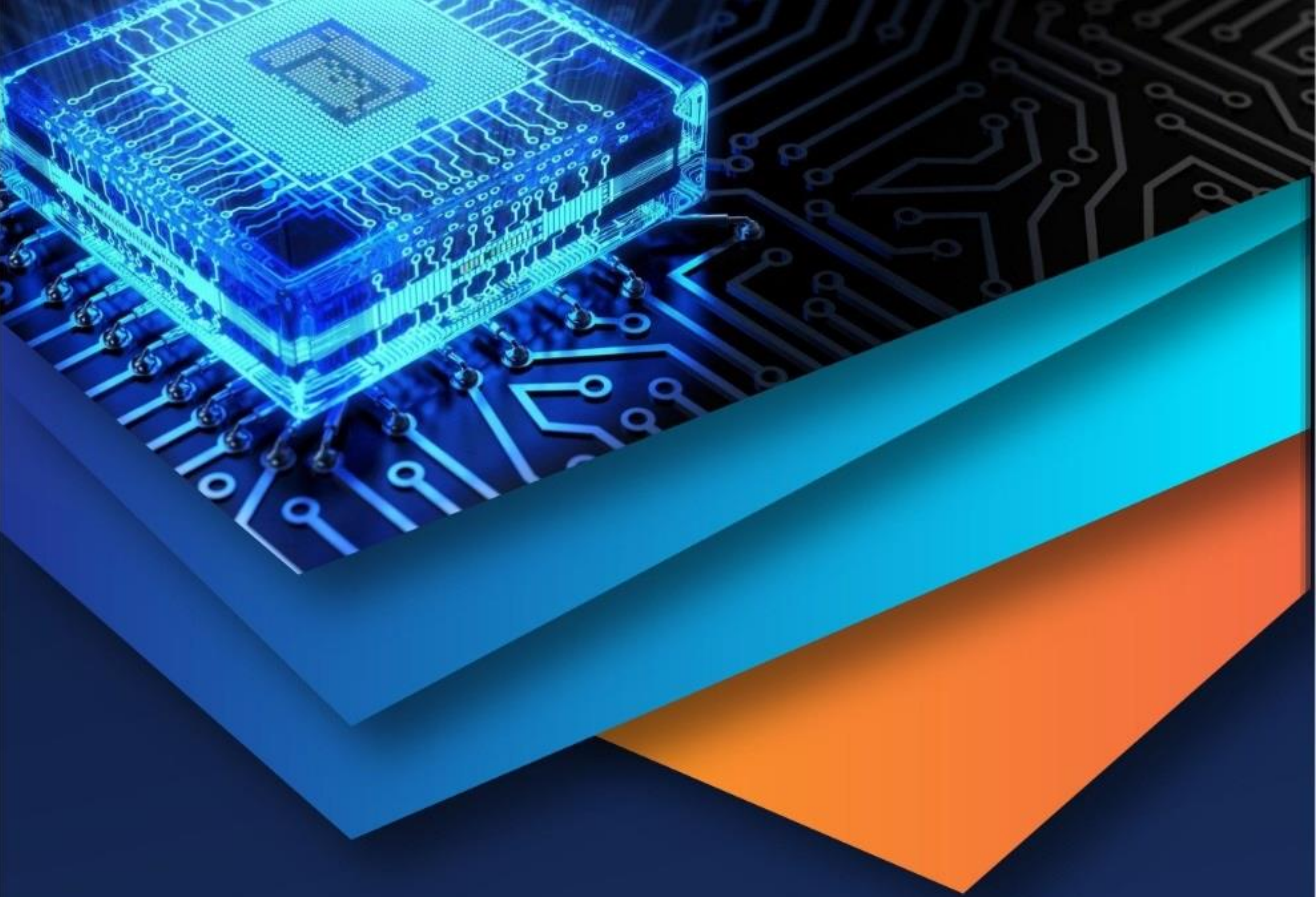

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