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AUTOMATIC CAR DOOR LOCK SYSTEM BY FACE RECOGNITION USING HASH CASCADE ALGORITHM

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Abstract*— The "Automatic Car Door Lock System by Face Recognition Using Hashcascade Algorithm" is a cutting-edge solution addressing limitations in traditional car security systems. Existing systems primarily rely on physical keys, remote controls, or password-based mechanisms, which are prone to theft, loss, duplication, or unauthorized access. These vulnerabilities compromise vehicle security and pose risks to owners. Additionally, existing biometric systems often suffer from inefficiencies, high costs, or lack of user-friendliness, making them less accessible for practical use. To address these issues, this system leverages advanced face recognition technology using the Hashcascade Algorithm, providing a more secure, efficient, and user-friendly solution. The system begins by allowing users to capture and store facial images of authorized car owners in an organized format. These images undergo a training process using OpenCV to generate a .yml file, which acts as a robust model for future identification. During the detection process, live user images are captured, converted to grayscale, and matched against the trained model. If a match is detected, the system confirms the car owner's identity and automatically provides options to lock or unlock the car. For unrecognized faces, the user can manually override the process. By automating the car locking mechanism and eliminating the need for physical keys, this system resolves the security challenges of traditional methods. It provides a seamless and secure user experience, minimizing the risk of unauthorized access while enhancing convenience through intelligent face recognition and real-time decision-making.

***Index Terms*— Artificial Intelligence, vehicle security**

I. INTRODUCTION

The automobile business has seen a considerable transformation due to recent technological breakthroughs that have introduced new innovations that improve vehicle users' comfort and safety. The use of biometric technology, such facial recognition, into car safety features is one of these developments. The Hashcascade Algorithm-powered "Automatic Car Door Lock System by Face Recognition" uses facial recognition technology to automatically lock and unlock car doors depending on the identity of the person approaching. This technology offers a seamless and safe solution for vehicle access management by fusing the powers of machine learning and computer vision Conventional car locking systems that rely on actual keys or remote key fobs are vulnerable to loss, theft, or illegal copying. By removing the need for physical keys and improving security in general and user comfort, a facial recognition-based solution, on the other hand, provides a more sophisticated and safe means of identification. The vehicle's onboard camera is utilized for real-time face detection using the Hashcascade Algorithm, an effective variant of the Haar Cascade Algorithm. This algorithm, which is well-known for its effectiveness and precision, allows the system to accurately and swiftly identify faces in real-time video feeds. After a face is identified, the system uses sophisticated identification techniques to compare it to had previously registered profiles that are kept in its database. The device automatically unlocks the automobile doors if a match is verified,

giving easy access to those who are authorized. In order to develop a sophisticated and reliable vehicle access control system, this project integrates state-of-the-art technologies such as machine learning, image recognition, and fingerprint authentication. The technology guarantees enhanced security, convenience, and user satisfaction by employing the Hashcascade Algorithm for facial recognition, marking a substantial advancement in the development of automobile access systems. Integrating biometric verification technologies has become a cutting-edge approach to improving vehicle safety and ease in the field of automotive innovation. The Face Recognition Automatic Car Door Lock System is one such invention. Physical keys and wireless key fobs are examples of conventional car access techniques that have drawbacks in terms of user experience and security. More advanced and dependable alternatives are required because these techniques may be vulnerable to theft, loss, or illegal replication. These issues are addressed by the Automatic Car Door Lock System by Face Recognition, which uses state-of-the-art facial recognition systems to verify anyone attempting to enter the car. Based on face traits, this system correctly recognizes authorized individuals using onboard cameras and advanced algorithms.

II. LITERATURE REVIEW

1. **RFID-Based Car Security System.**

   This study explores a car security system using RFID (Radio Frequency Identification) technology. Authorized users are equipped with RFID tags, which are scanned by an onboard reader to unlock the vehicle. The system ensures secure access by verifying the unique RFID code against a stored database. Its simplicity and cost-effectiveness make it suitable for practical use. However, the system is vulnerable to RFID tag cloning or theft.

2. **Fingerprint-Based Vehicle Security System**

   This paper discusses a vehicle access control system using fingerprint authentication. A fingerprint scanner captures and verifies the unique biometric data of users, stored in an onboard database. The system offers high accuracy and reliability, reducing the risk of unauthorized access. It also eliminates the need for physical keys or passwords. However, environmental conditions or dirty sensors can affect performance.

3. **Voice Recognition for Vehicle Access**

   This research introduces a voice-based authentication system for car access. Users speak predefined commands, which are analyzed using voice recognition algorithms to authenticate identity. The system emphasizes hands-free convenience and personalization. Despite its usability, background noise and voice imitation remain challenges. It is well-suited for integration with smart vehicle systems.

4. **Bluetooth-Based Keyless Entry System**

   This study presents a keyless car access system using Bluetooth connectivity. Smartphones with

authorized Bluetooth credentials can automatically unlock or lock the car upon proximity detection. The system enhances convenience and eliminates the need for physical keys. It also supports remote locking via a mobile application. Security concerns arise from potential Bluetooth vulnerabilities and signal interception.

5. **Password-Protected Car Security System**

   This paper discusses a vehicle security system that requires users to input a secure password on a keypad. The system verifies the entered password against stored credentials to unlock the car. It provides a simple and cost-effective security solution. However, the approach is prone to password theft or brute-force attacks. Advanced encryption can mitigate these risks.

6. **Gesture Recognition-Based Car Control System**

   This study explores a gesture recognition system that uses cameras and motion sensors to detect predefined hand gestures for unlocking and locking vehicles. The system analyzes real-time hand movements using machine learning algorithms. It offers a touchless and intuitive access method. However, lighting conditions and similar gestures can impact accuracy. Its usability is ideal for futuristic car interfaces.

7. **Number Plate Recognition for Vehicle Access**

   This research investigates a car access system that uses automatic license plate recognition (ALPR). Cameras capture the vehicle's number plate, which is matched against an authorized database for access control. The system is suitable for fleet management and parking lot security. It offers high accuracy in controlled environments but may struggle with dirt-covered or damaged plates.

8. **Smart Card-Based Vehicle Security System**

   This paper proposes a car security solution using smart cards embedded with encrypted credentials. Users insert the smart card into a reader to unlock the car. The system ensures secure and reliable access through advanced encryption techniques. It is user-friendly but may face issues with lost or stolen cards. Integration with additional security layers can enhance its effectiveness.

9. **NFC-Based Vehicle Access System**

   This study examines a car access system utilizing NFC (Near Field Communication) technology. Authorized users can unlock vehicles by tapping their NFC-enabled smartphones or cards on a reader. The system offers convenience and fast authentication. However, it may be vulnerable to relay attacks if proper security measures are not implemented. It is well-suited for modern smart vehicles.

10. **Biometric Iris Recognition for Vehicle Access**

    This paper explores a car security system employing iris recognition technology. An onboard

scanner captures the iris pattern, which is matched against pre-stored profiles for authentication. The system provides high accuracy and resistance to spoofing compared to other biometric methods. Its implementation ensures robust security but may involve higher costs and require precise positioning during scanning.

III. EXISTING METHODS:

Automatic car door lock systems have been traditionally implemented using various technologies, excluding face recognition. One common method involves key fobs that communicate with the car via radio frequency signals, allowing users to lock or unlock doors wirelessly. Remote locking systems extend this functionality with dedicated buttons or smartphone apps, enabling users to control door locks conveniently. Proximity sensors are another approach, automatically locking or unlocking the doors when the authorized key or device is within a certain range of the vehicle. Biometric systems such as fingerprint recognition have also been utilized to grant access, providing enhanced security. Some systems use PIN or password entry via keypads, offering an alternative to physical keys. In other cases, automatic locking is triggered by vehicle speed, ensuring doors lock once the car reaches a certain velocity, enhancing passenger safety. Pressure sensors in seats can detect occupancy and automatically lock the doors when the car is occupied. RFID-based systems rely on the detection of RFID tags or cards to manage door access. Additionally, time-based locking mechanisms lock the doors after a set period of inactivity, ensuring the vehicle remains secure even if the user forgets. These methods highlight the versatility and evolution of automatic locking systems before the advent of face recognition technologies.

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IV. PROPOSED SYSTEM:

The proposed system introduces an advanced automatic car door lock mechanism using face recognition powered by the Hash Cascade Algorithm. This system aims to enhance vehicle security and user convenience by replacing traditional key-based methods with biometric authentication. In this system, the car is equipped with a high-resolution camera integrated into its door locking mechanism. When a user approaches the vehicle, the camera captures their facial image in real time. The captured image is processed using the Hash Cascade Algorithm, which efficiently detects and recognizes the face by breaking down the recognition process into a hierarchical hash structure. This method ensures high-speed processing while maintaining accuracy, making it suitable for real-time applications. Once the face is recognized, the system cross-verifies the facial data with a pre-registered database of authorized users. If a match is found, the car doors unlock automatically. In cases of mismatched or unregistered faces, the system denies access and can optionally trigger an alert for security purposes. Additionally, the Hash Cascade Algorithm optimizes computational resources, ensuring the system performs well even under varying environmental conditions such as low light or partial occlusion. This proposed system eliminates the need for physical keys or key fobs, reducing the risk of theft or unauthorized access. Its seamless integration with advanced biometric technology provides a secure, efficient, and user-friendly solution for modern car locking mechanisms.

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METHODOLOGY:

The methodology involves the development of a robust system with a user-friendly graphical interface (GUI) designed using Python's Tkinter library. The system is divided into four key modules, each serving a specific purpose in the car door lock process.

1. Image Capture Module

Functionality: This module allows users to capture images for face recognition registration.

Process:

Users input their name and car number into the GUI.

Clicking the "Capture Images" button activates the camera using OpenCV.

The system captures multiple images of the user's face and saves them into a designated folder.

User details, including name and car number, are stored in an Excel sheet for reference.

Output: Captured face images stored in a local directory and corresponding user details saved in an Excel sheet.

2. Training Module

Functionality: Trains the face recognition model using the saved images from the Image Capture Module.

Process:

- The module uses the Local Binary Patterns Histogram (LBPH) and Hash Cascade Algorithm for training.
- The face data is processed, and a recognition model is created and saved in a .yml file for later use.
- Training ensures that multiple users' facial data can be handled efficiently.

Output: A trained model stored as a .yml file, ready for real-time recognition.

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3. Tracking Module

Functionality: Detects and verifies live faces against the trained model.

Process:

- The module opens the camera and starts real-time face detection using OpenCV.
- Detected faces are matched with the trained model.
- If a match is found, a pop-up message appears indicating "Face Detected" and the car door lock is opened.

Output: Real-time detection and verification of faces, with successful authentication unlocking the car door.

4. Quit Module

- **Functionality**: Logs user interactions and terminates the system.
- **Process**:
  - Details of successfully detected users (name and car number) are logged into an

Excel sheet for record-keeping.

- The module allows the user to safely exit the system.

- **Output**: User access logs stored in an Excel sheet and the system shut down securely.

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ARCHITECTURE:

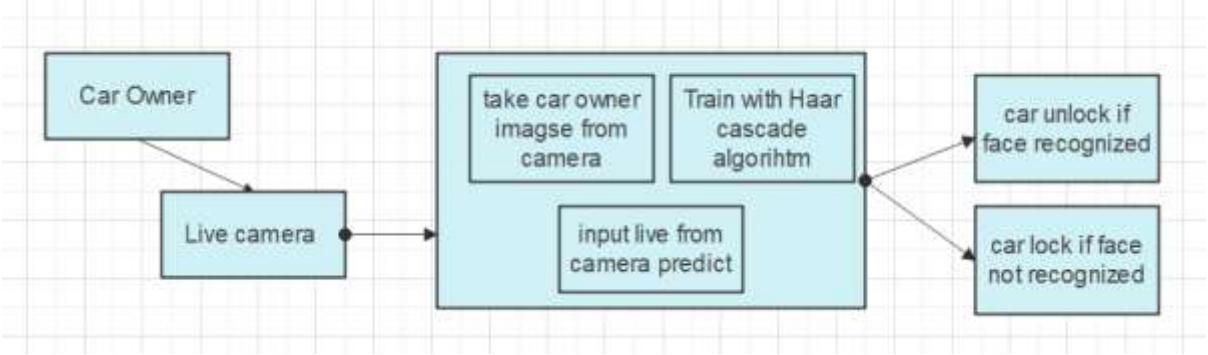

Figure 1. System Architecture

The User Interface is developed using Tkinter, providing a graphical interface for interaction with the system. The Image Capture Interface allows users to capture images with card ID, owner name, and multiple pictures for each user. This interface facilitates the collection of training data. The Authentication Module is responsible for training the data using the Haar cascade algorithm and testing it with live camera feed for face detection. If the detected person's name matches the owner's name associated with the card ID, the system sends a signal to unlock the car; otherwise, it locks the car. Please note that this is a simplified textual representation of the architecture. In practice, each component would involve several sub-components and interactions. Additionally, graphical diagrams are often used to depict architectural designs more effectively.

LBPH Model:

The **Local Binary Patterns Histogram (LBPH)** algorithm is a popular and efficient method for facial recognition. It works by analysing the local features of an image and creating a histogram-based representation of the face. The algorithm divides the image into small grids and computes a binary pattern for each pixel by comparing it with its neighbouring pixels. These patterns are then used to form a histogram, which represents the unique texture of the face.

LBPH is highly effective for recognizing faces in controlled environments, as it is robust to changes in lighting and can work with grayscale images. Its simplicity and low computational cost make it a preferred choice for real-time face recognition applications.

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V. EVALUATION METRICS

RESULTS:

DATASET:

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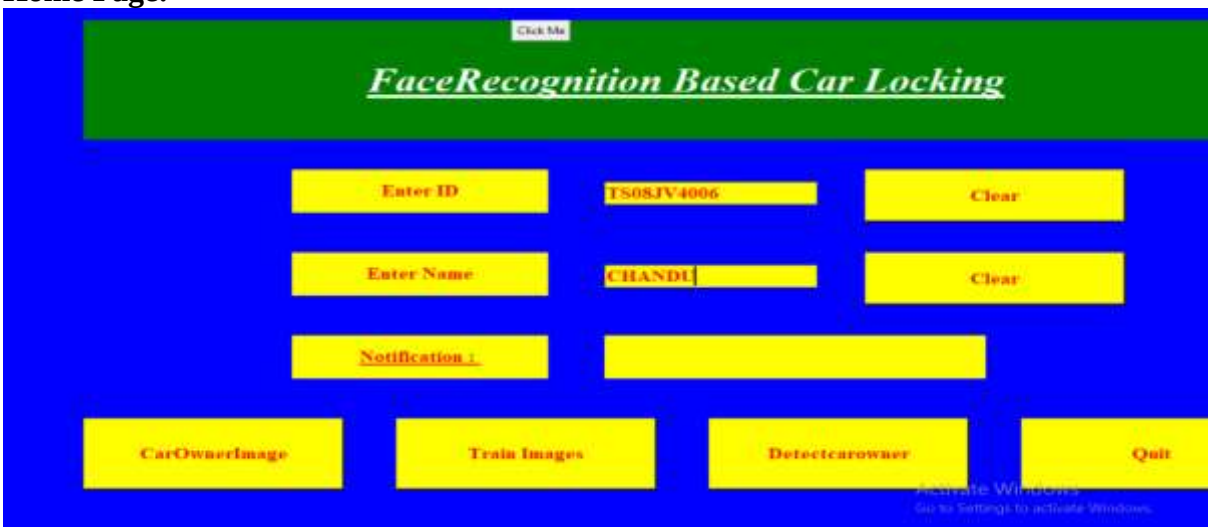
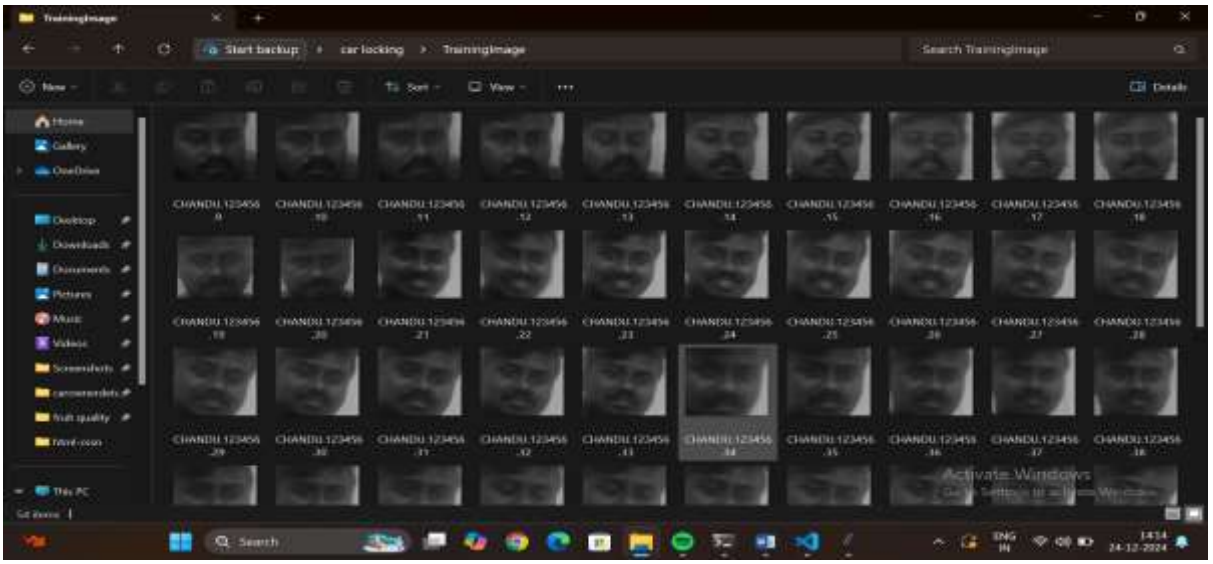
Home Page:



Take Images Page:

Stored Images:



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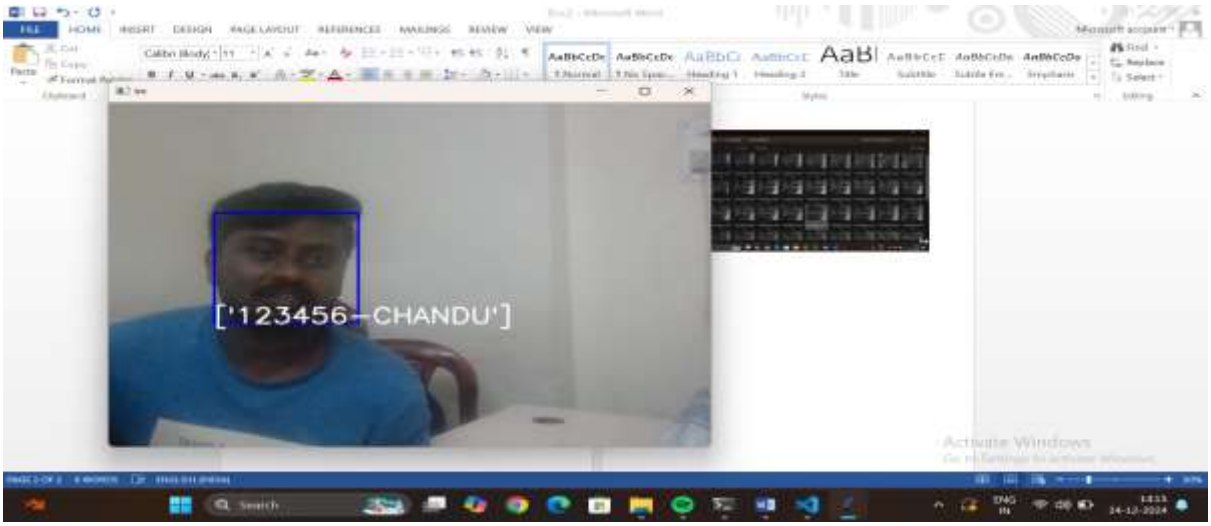
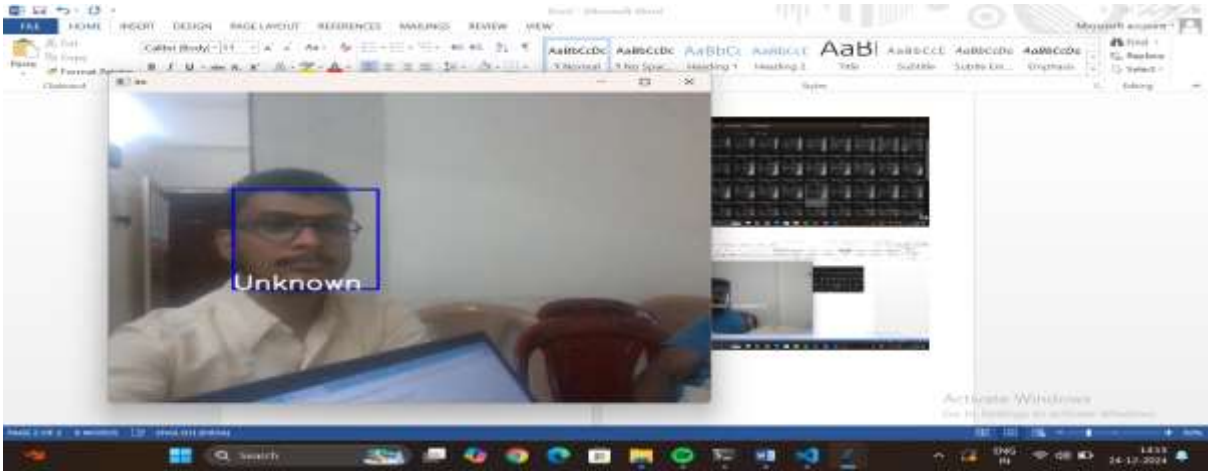
Predicted Result:



Prediction Result:



VI. CONCLUSION

The proposed Automatic Car Door Lock System using Face Recognition with the Hash Cascade Algorithm provides a secure and convenient solution for vehicle access. By leveraging biometric authentication, it eliminates the need for traditional keys, reducing the risk of theft or unauthorized entry. The integration of LBPH and Hash Cascade ensures efficient and accurate face recognition, even under challenging conditions such as varying lighting or partial occlusion. The system's modular design allows for easy scalability, enabling multiple users to register and use the system seamlessly. With a user-friendly GUI, the system is accessible and practical for everyday use, combining cutting-edge technology with reliability. This project demonstrates the potential of face recognition in enhancing automotive security and user convenience.

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VII. FUTURE SCOPE

Future enhancements could include integrating additional biometric features like iris or voice recognition to improve security further. Cloud-based storage and synchronization can be explored to make the system accessible across multiple vehicles. Incorporating advanced deep learning models could enhance recognition accuracy in dynamic environments. Additionally, expanding the system to include mobile app integration for remote access and notifications can increase user convenience and control.

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