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FACIAL RECOGNITION BASED VEHICLE AUTHENTICATION SYSTEM

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Abstract: The "Facial Recognition-Based Vehicle Authentication System" uses facial recognition to improve vehicle security. It works by scanning the face of the person trying to start the vehicle and only allows ignition if the face matches that of an authorized user, like the owner. This system aims to prevent vehicle theft by blocking unauthorized users from starting the vehicle. If an unauthorized face is detected, it triggers an alert to notify the owner, enhancing overall security and reducing theft risks. Although significant progress has been made in using facial recognition and detection techniques for authentication purposes, including security and identity verification, some lingering issues still need to be addressed to reach outstanding precision on par with human-level performance. The proposed system uses face detection for Identity Verification and gives full access to authorized vehicle drivers based on the interface of Raspberry Pi 4B development board, pi-camera. In an era where security and convenience are paramount, facial recognition technology has emerged as a powerful tool in various applications, including vehicle authentication.

Keywords: Open cv, Face recognition, Raspberry pi, Servo motor

I. INTRODUCTION

The proposed system uses face detection for Identity Verification and gives full access to authorized vehicle drivers based on the interface of Raspberry Pi 4B development board, pi-camera. In an era where security and convenience are paramount, facial recognition technology has emerged as a powerful tool in various applications, including vehicle authentication. A facial recognition-based vehicle authentication system leverages advanced imaging and artificial intelligence to verify the identity of drivers before granting access to vehicles or secure areas. This innovative approach not only enhances security but also streamlines the user experience, making vehicle access faster and more efficient. These systems utilize high-resolution cameras and sophisticated algorithms to capture and analyze facial features, creating a seamless interaction between users and their vehicles. By replacing traditional methods of authentication—such as keys or access cards—with biometric data, organizations can significantly reduce the risk of unauthorized access and improve overall safety.

As the demand for smart technology grows, integrating facial recognition into vehicle authentication systems presents a compelling solution for a wide range of applications, including parking facilities, fleet management, and toll collection. This introduction sets the stage for exploring the components, functionality, and potential impact of such systems in enhancing security and operational efficiency.

The system will stop immediately if the recently scanned image does not match the previously submitted image to the database. The Raspberry PI is in charge of running everything here. In today's systems, various sensors are used, such as doors, lights, engines, etc., where the door sensors are used for locking and unlocking the car doors through suitable keys.

- The sensors will alert if someone tries to unlock the vehicle using duplicate keys.
- But if the key is made precisely as the original one, the sensor might be unable to differentiate the changes.

The other technique used is a surveillance pad to monitor the vehicle. It consists of an RF receiver, processing unit alarm, and display. But the drawback here is surveillance pad must be carried by the user everywhere. The engine and door sensors here are not reliable. The vehicle will have an alarm system, which makes a sound as soon as someone enters it, but once they steal the vehicle, they cannot get it back. The alarm sometimes gets unnoticed, which is also a major drawback of the existing system. So, the face recognition system is easier to use, and people can be identified without their knowledge. Some of the advantages of the face recognition method for vehicle security are:

- It is convenient, efficient, and senses as soon as one is seated.
- It can be used in addition to the existing methods and is low-cost.

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II. LITERATURE SURVEY

1) Title: "Artificial Intelligence and Computer Vision-based Technique for Effective Facial Recognition System"
Year:2020
Authors: Sarah Ali Abdulkareem, Ahmed Hussian, Hassan M. Al-Jawahry
Description: In the paper, "Artificial Intelligence and Computer Vision-based Technique for Effective Facial Recognition System," the authors focus on building a more accurate and efficient facial recognition system. They use artificial intelligence (AI) and computer vision to detect and recognize faces in images. Specifically, the system employs deep neural networks (DNN) to analyze and learn facial features, making it better at handling different conditions like changes in lighting, facial expressions, and obstructions (e.g., glasses or hats).

2)Title: "Vehicle Anti-theft Face Recognition System, Speed Control and Obstacle Detection using Raspberry Pi"
Year:2020
Authors: Biju Balakrishnan, Punit Suryarao, Rashmi Singh
Description: In the paper "Vehicle Anti-theft Face Recognition System, Speed Control, and Obstacle Detection using Raspberry Pi," the authors introduce a system aimed at enhancing vehicle security and safety. The system uses facial recognition to identify the driver; only authorized users are allowed to start the vehicle, which helps prevent theft.

3)Title: "Improved Authentication and Drowsiness Detection from Facial Features using Deep Learning Framework in Real-Time Environments"
Year: 2021
Authors: Santhiya S, Divyabharathi T, Jeno J
Description: In the paper "Improved Authentication and Drowsiness Detection from Facial Features using Deep Learning Framework in Real-Time Environments," the authors developed a system that uses face recognition to authenticate drivers and monitor their alertness. It identifies the driver through facial recognition, ensuring only authorized individuals can access the vehicle. Additionally, it tracks the driver's eyes to detect signs of drowsiness.

4)Title: "Auto Safety Technology with Enhanced Facial Recognition to Prevent Replay Attacks"
Year: 2023
Authors: Smita Khairnar, Shrutee Dahake, Radhika Gaikwad **Description:** In the paper "Auto Safety Technology with Enhanced Facial Recognition to Prevent Replay Attacks," the authors propose a
security system for vehicles that uses advanced facial recognition to allow only authorized users access to the car. The system is designed to stop replay attacks, where someone might use a photo or video to trick the system.

III. METHODOLOGY

The development of the Facial Recognition-Based Vehicle Authentication System follows a structured approach**:**

1. **Requirements Gathering** – Identifying user needs, functional (e.g., real-time authentication) and nonfunctional (e.g., accuracy, speed) requirements.
2. **System Design** – Creating architecture, database schema, and user interface mockups.
3. **Technology Selection** – Choosing appropriate hardware (cameras, processors)
4. **Implementation** – Developing and integrating system components, including facial recognition algorithms, database, and user interface

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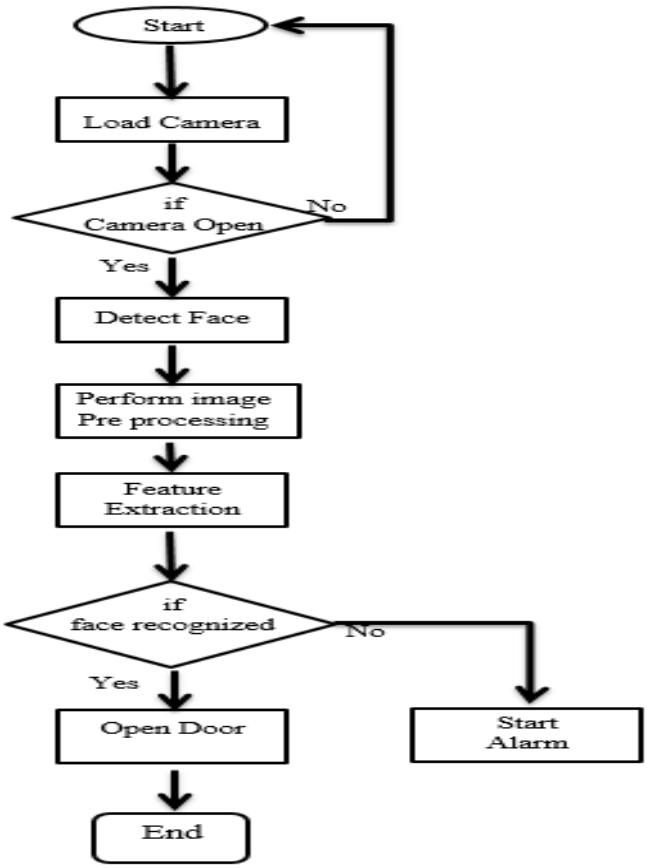

The system follows a step-by-step process to authenticate users and grant or deny access to the vehicle:

1. System Initialization

The process begins with initializing the **camera module** connected to the Raspberry Pi. The system ensures that the camera is functional before proceeding.

2. Face Detection

Once the camera is successfully loaded, the system continuously monitors for a face in the camera's field of view. When a face is detected, the system captures an image.

3. Image Pre-processing

The captured image undergoes pre-processing techniques such as:
Grayscale conversion to reduce computational complexity.
Noise reduction for improving image quality.
Histogram equalization for better contrast and feature extraction.

4. Feature Extraction

The system extracts unique facial features using algorithms such as:
Local Binary Patterns Histogram (LBPH)
Eigenfaces
Convolutional Neural Networks (CNNs) (if deep learning is used)

5. Face Recognition and Authentication

The extracted features are compared with a stored database of authorized faces.
If the **face is recognized**, the system **grants access** and opens the vehicle door.
If the **face is not recognized**, an **alarm is triggered** to alert unauthorized access attempts
.

6. System Response

If authentication is successful → **Door unlocks**
If authentication fails → **Security alarm activates**

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IV. SYSTEM DESIGN

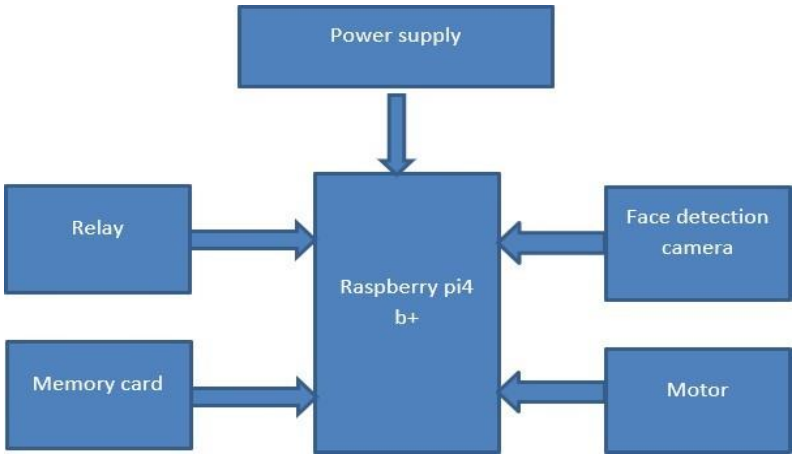

FIG: SYSTEM DIAGRAM

Working of the Facial Recognition-Based Vehicle Authentication System

The system employs a **Raspberry Pi 4 B+** as the core processing unit, interfacing with multiple hardware components to implement a secure and automated vehicle authentication mechanism. The major components and their roles are as follows:

1. **Power Supply**:
   - Provides the necessary voltage and current to power the Raspberry Pi and other connected modules.
2. **Face Detection Camera**:
   - Captures images or video streams of individuals attempting to access the vehicle.
   - Runs facial recognition algorithms to compare the captured face with authorized personnel stored in the system's database.
3. **Memory Card**:
   - Stores the face recognition dataset and processed images.
   - Contains the authentication records and system logs.
4. **Relay Module**:
   - Acts as a switch to control the vehicle's locking mechanism.
   - If authentication is successful, the relay triggers the unlocking mechanism.
5. **Motor**:
   - Represents the vehicle's locking/unlocking system.
   - The relay activates the motor to unlock the vehicle when a recognized face is detected.

IV. RESULT AND ANALYSIS

The proposed vehicle security system is trained with the person who has a driving license.by collecting photos for each authorized driver that is taught as Eigen faces. Then each approved driver was put through a series of tests. the tests are also done on unapproved person All tests were carried out on Raspberry Pi model 4 Series B+ microcontroller. If the system identifies the authorized person the DC motor will turn ON. Else the motor will turn OFF and with SMTP an email alert is sent and buzzer will ring.

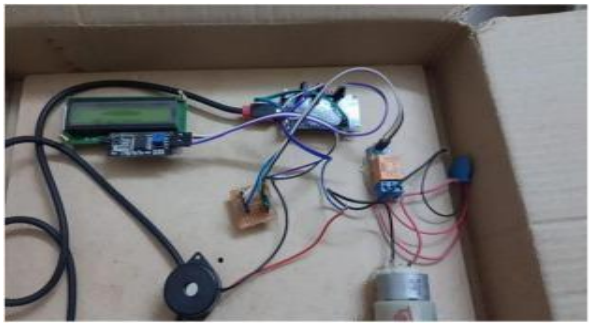

FIG: HARDWARE TEST SETUP

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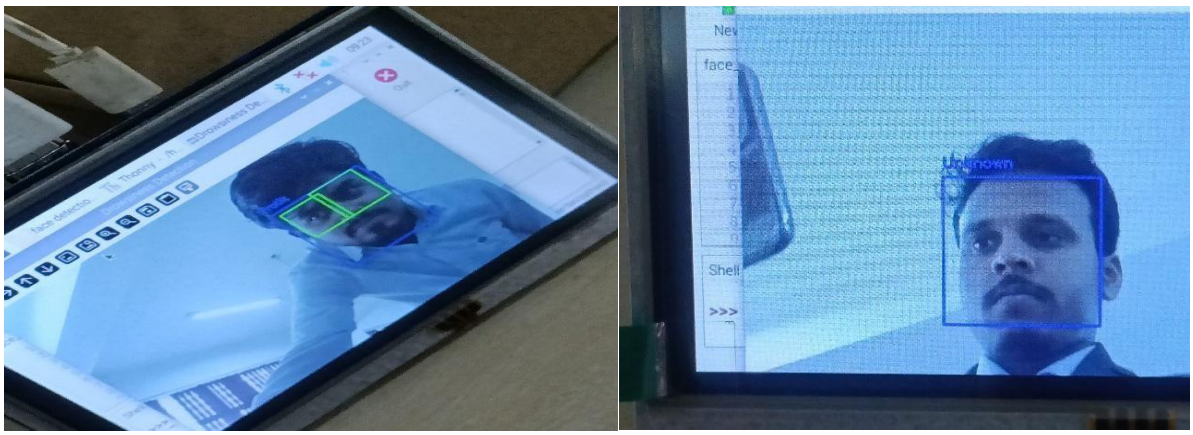

FIG: AUTHORIZED PERSON & UNAUTHORIZED PERSON

The accuracy of the proposed system is identified as shown in below:

$$\text{Accuracy}=\frac{TP+TN}{TP+TN+FP+FN}$$

$$\text{Precision}=\frac{TP}{TP+FP}$$

Where, True negatives (TN): shows the number of normal events is successfully labeled as normal. False positives (FP): refer to the number of normal events being predicted as abnormal. False negatives (FN): Represent the number of abnormal events is incorrectly predicted as normal. True positives (TP): refer to the number of abnormal events is correctly predicted as abnormal This proposed vehicle security system accuracy is 98% in brighter illumination and the precision is 0.973 of the system in the proposed vehicle security system.

V. CONCLUSION

In conclusion, facial recognition-based vehicle authentication systems represent a significant advancement in access control technology. By leveraging biometric data, these systems enhance security, streamline user access, and improve operational efficiency across various applications, from residential communities to corporate environments and public facilities

VI. FUTURE SCOPE

The Facial Recognition-Based Vehicle Authentication System has significant potential for expansion and improvement. Future advancements may include:

• Integration with IoT and Smart Vehicles: Connecting the authentication system with IoTenabled vehicles for seamless access control.

• Multi-Factor Authentication: Combining facial recognition with other authentication methods such as voice recognition or fingerprint scanning to enhance security.

• Cloud-Based Access Control: Storing facial data securely in cloud databases, allowing real-time synchronization and authentication from different locations.

• AI-Powered Anti-Spoofing Mechanisms: Implementing liveness detection and AI-based antispoofing techniques to prevent unauthorized access using photos or videos.

• Wider Environmental Adaptability: Improving the system's performance under extreme lighting conditions, weather variations, and dynamic facial changes.

• Automated Law Enforcement Assistance: Integrating with law enforcement databases to flag unauthorized access attempts and stolen vehicles

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