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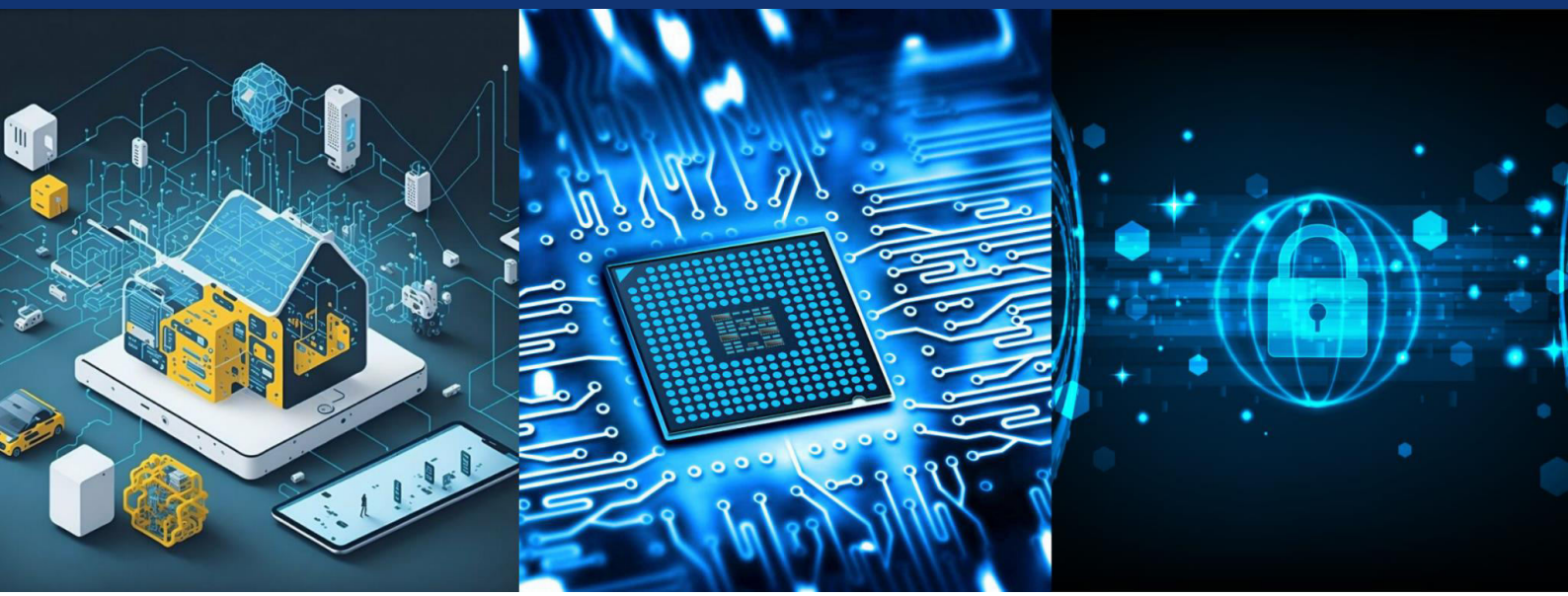

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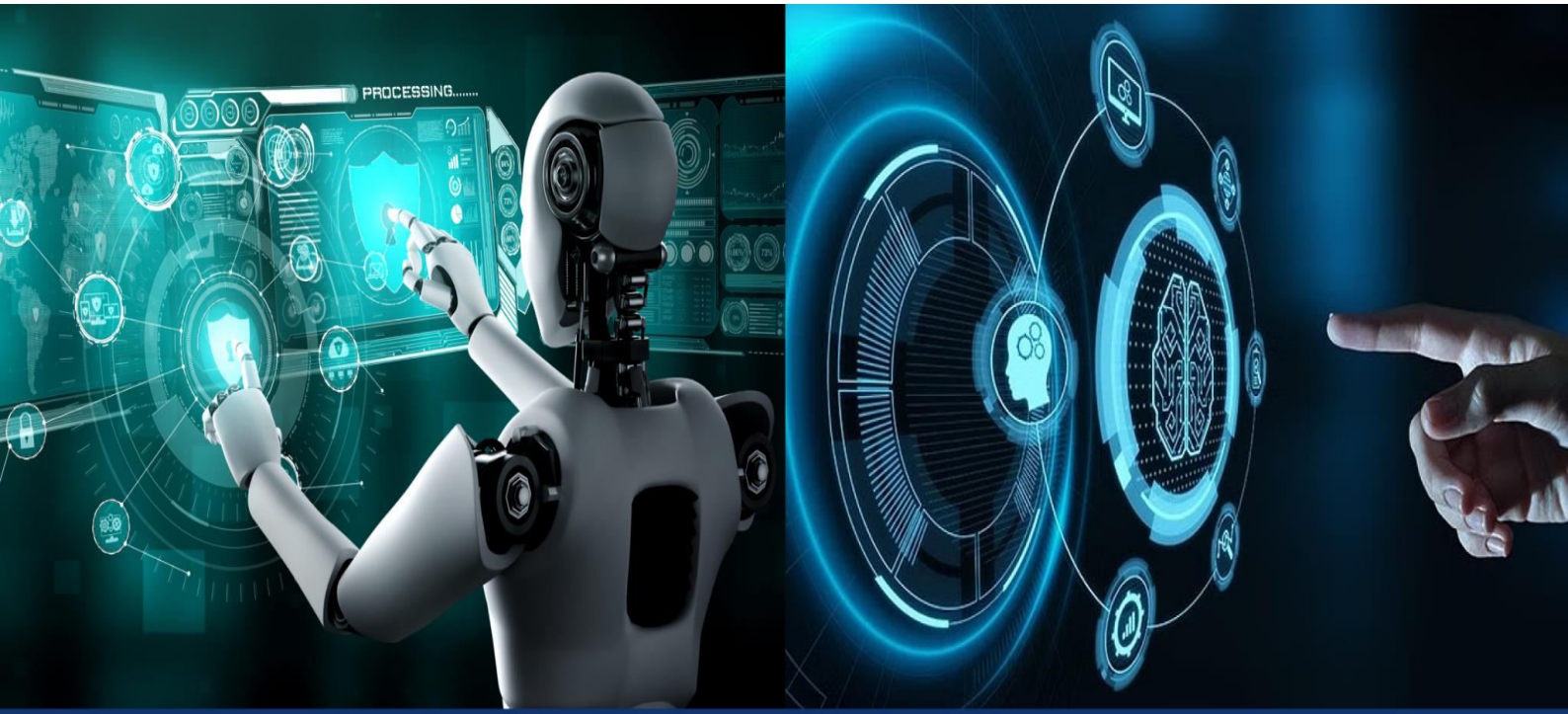

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To Design an Automotive User Identification Using Multimodal Face Gait Fusion Techniques

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ABSTRACT: This project, titled "**Automotive User Identification Using Multimodal Face–Gait Fusion Techniques,"** presents a robust biometric authentication system designed to enhance vehicle security and personalization. The proposed system integrates both facial recognition and gait analysis to accurately identify authorized users, overcoming limitations of unimodal biometric systems. A camera-based setup captures facial features and walking patterns, which are processed using computer vision and deep learning techniques. Feature-level fusion is employed to combine face and gait data, improving recognition accuracy under varying environmental conditions such as low lighting or partial occlusion. The system is implemented using a modular architecture, enabling real-time identification and seamless integration with automotive access control systems. Experimental results demonstrate improved reliability, accuracy, and resistance to spoofing compared to traditional single-modal approaches. This solution offers a scalable and efficient method for next-generation intelligent vehicle systems, ensuring enhanced security, user convenience, and adaptive personalization within modern automotive environments.

KEYWORDS: Multimodal Biometrics, Face Recognition, Gait Recognition, Automotive Security, Biometric Authentication, Feature Fusion, Deep Learning.

I. INTRODUCTION

In recent years, the rapid advancement of intelligent transportation systems has increased the demand for secure and reliable user identification methods in automotive environments. Traditional vehicle access mechanisms such as keys, key fobs, and password-based systems are increasingly vulnerable to theft, duplication, and unauthorized access. As a result, biometric-based authentication has emerged as a promising solution for enhancing vehicle security and user convenience.

Among various biometric techniques, face recognition has gained widespread adoption due to its non-intrusive nature and ease of implementation. However, it is sensitive to variations in lighting conditions, facial expressions, and occlusions. On the other hand, gait recognition, which analyzes an individual's walking pattern, offers a complementary advantage as it can identify users from a distance without requiring direct interaction. Nevertheless, gait recognition alone may be affected by changes in clothing, carrying conditions, or walking speed.

To overcome the limitations of unimodal systems, this work proposes a multimodal biometric approach that integrates both face and gait recognition techniques. By employing feature fusion strategies and deep learning-based models, the system enhances identification accuracy and robustness under diverse real-world conditions. The proposed system is specifically designed for automotive applications, enabling secure vehicle access, driver authentication, and personalized in-vehicle experiences.

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This study aims to develop an efficient, scalable, and real-time user identification system that not only strengthens automotive security but also aligns with the evolving requirements of smart and connected vehicles.

II. LITERATURE REVIEW

"FACE RECOGNITION SYSTEMS" This study explores face recognition techniques used for identifying individuals based on facial features. Traditional methods rely on feature extraction and machine learning algorithms, while recent approaches utilize deep learning models such as convolutional neural networks (CNNs) to improve accuracy and robustness. Face recognition systems are widely used due to their non-intrusive nature and ease of deployment. Experimental results show high accuracy under controlled conditions. However, performance degrades in the presence of poor lighting, occlusions, and variations in pose and expression, indicating the need for complementary biometric modalities.

"GAIT RECOGNITION SYSTEMS" This study focuses on gait recognition methods that identify individuals based on their walking patterns. Both model-based and appearance-based techniques have been proposed to extract gait features from video sequences. Gait recognition offers the advantage of distance-based identification without user cooperation, making it suitable for surveillance and automotive applications. Results demonstrate effectiveness in unconstrained environments. However, accuracy is affected by factors such as clothing variations, carrying conditions, and walking speed, highlighting limitations in standalone usage.

"MULTIMODAL BIOMETRIC SYSTEMS" This study presents multimodal biometric approaches that combine multiple identification traits such as face and gait to enhance system performance. Fusion techniques at feature-level, score-level, and decision-level are employed to integrate data from different modalities. The combined system improves recognition accuracy, robustness, and resistance to spoofing attacks. Experimental results indicate that multimodal systems outperform unimodal approaches in diverse environmental conditions. However, challenges remain in terms of computational complexity and real-time implementation.

"AUTOMOTIVE USER IDENTIFICATION SYSTEMS" This study examines the application of biometric authentication in automotive environments for secure vehicle access and driver identification. Systems integrate sensors and cameras to capture user data and provide personalized vehicle settings. The results show improved security and user convenience compared to traditional methods. However, issues such as environmental variability, real-time processing, and system scalability require further research for practical deployment.

III. METHODOLOGY

A. EXISTING SYSTEM

The existing automotive user identification systems primarily rely on traditional authentication methods such as keys, key fobs, PIN-based access, and single-modal biometric techniques like face recognition or fingerprint scanning. Face recognition systems are widely used due to their ease of implementation and non-intrusive nature. However, their performance is significantly affected by environmental factors such as poor lighting, occlusion, and variations in facial expressions. Similarly, other biometric approaches like fingerprint recognition require direct user interaction, making them less convenient in real-time automotive scenarios.

B. DISADVANTAGES

1. Reliance on unimodal biometrics reduces accuracy and robustness.
2. Sensitive to environmental conditions like lighting, pose, and occlusion.
3. Gait recognition affected by clothing and walking variations.
4. Traditional methods (keys/PINs) are vulnerable to theft and misuse.
5. Limited real-time performance and poor adaptability in dynamic environments.

C. PROPOSED SYSTEM

The proposed system introduces an advanced automotive user identification approach using multimodal biometric techniques that combine face recognition and gait recognition. By integrating these two complementary modalities, the system overcomes the limitations of unimodal methods and improves overall accuracy and reliability. A camera-based

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system captures both facial features and walking patterns of the user in real time. These inputs are processed using computer vision and deep learning algorithms to extract distinctive features.

Feature-level fusion is employed to combine the extracted face and gait features, enabling more robust identification even under challenging environmental conditions such as low lighting, occlusion, or variations in appearance. The system is designed with a modular architecture to support real-time processing and seamless integration with automotive systems for secure vehicle access and driver authentication.

D. ADVANTAGES

1. Increased system complexity due to integration of multiple biometric modalities.
2. Higher computational cost requiring powerful hardware for real-time processing.
3. Dependency on camera quality and proper positioning for accurate data capture.
4. Possible privacy concerns related to continuous biometric monitoring.
5. Performance may still be affected in extreme conditions (very low light or heavy occlusion)..

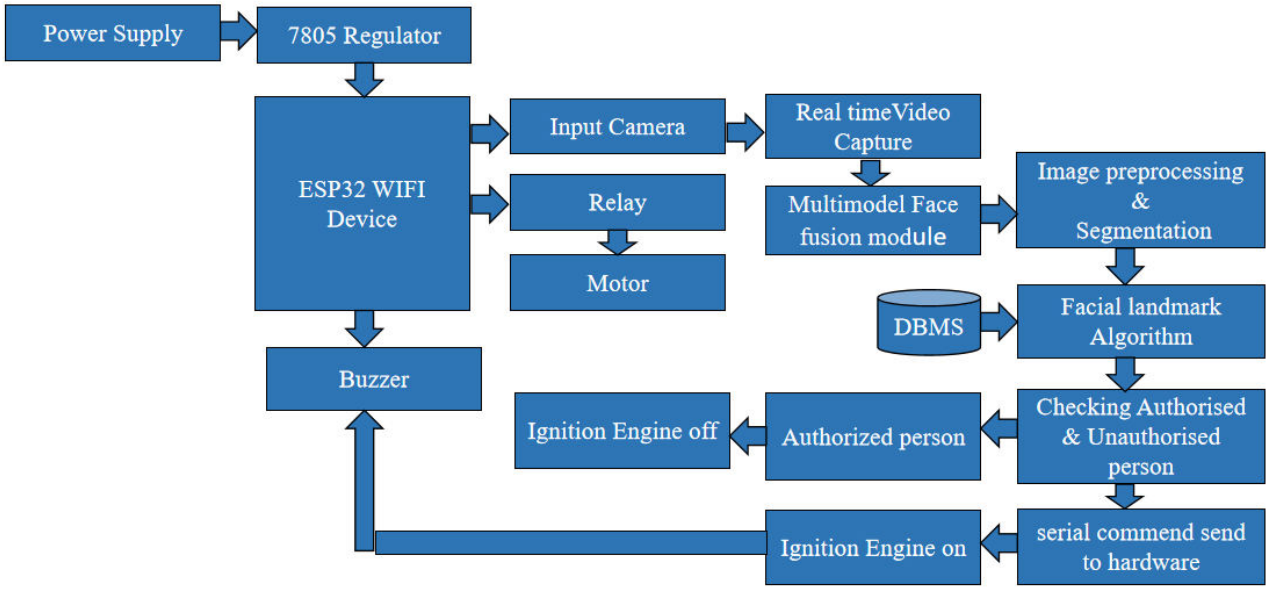
E. DESIGN OF THE SYSTEM

The proposed system is designed using a modular architecture that integrates face recognition and gait recognition for automotive user identification. The system begins with a data acquisition module, where cameras capture real-time video of the user's face and walking pattern. The captured data is then passed to the preprocessing module, where noise reduction, frame extraction, and normalization techniques are applied to improve data quality.

In the feature extraction stage, deep learning models are used to extract distinctive facial features and gait patterns. For face recognition, convolutional neural networks are employed to identify unique facial characteristics, while gait recognition analyzes body movement patterns across sequential frames. These extracted features are then combined using a feature-level fusion technique to enhance identification accuracy and robustness.

The fused features are fed into a classification module, where the system compares them with stored biometric data in the database to verify the user's identity. Based on the result, the system either grants or denies access to the vehicle. The entire process is designed to operate in real time, ensuring quick and efficient user authentication.

Additionally, the system supports scalability and integration with automotive control units, enabling personalized settings such as seat adjustment and infotainment preferences. The overall design ensures improved security, reliability, and user convenience in modern automotive environments.



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IV. IMPLEMENTATION

MODULE DESCRIPTION

1. DATA ACQUISITION MODULE

This module captures real-time data of the user using camera sensors. It collects both facial images and walking patterns (gait) required for identification. The module ensures continuous and accurate data capture under different environmental conditions for further processing.

2. PREPROCESSING MODULE

This module improves the quality of captured data through noise reduction and normalization. It extracts relevant frames from video sequences for analysis. Background removal and resizing are also performed. These steps help in improving system accuracy and efficiency.

3. FACE DETECTION MODULE

This module detects and extracts the face region from the captured images. It eliminates unnecessary background information. The detected face is aligned and prepared for feature extraction. This ensures accurate facial recognition.

4. GAIT DETECTION MODULE

This module identifies human walking patterns from video sequences. It tracks body movement across multiple frames. The system focuses on posture and motion details. This helps in recognizing individuals based on their gait.

5. FEATURE EXTRACTION MODULE

This module extracts unique features from both face and gait data. Deep learning models are used to identify important patterns. These features represent the identity of the user. It plays a key role in accurate recognition.

6. FEATURE FUSION MODULE

This module combines face and gait features into a single representation. It uses feature-level fusion techniques for integration. This improves overall system robustness and accuracy. It helps overcome limitations of individual modalities.

7. DATABASE MANAGEMENT MODULE

This module securely stores user biometric data and related information. It maintains organized records for easy access and retrieval. The system ensures data consistency and integrity. It supports efficient comparison during identification.

8. IDENTIFICATION MODULE

This module compares input features with stored database records. It finds the best match for the given user data. The system determines the identity based on similarity scores. This ensures reliable recognition.

9. AUTHENTICATION MODULE

This module verifies whether the identified user is authorized. It grants or denies access to the vehicle accordingly. Security measures are applied to prevent unauthorized entry. It ensures safe and controlled access.

10. SYSTEM INTEGRATION MODULE

This module connects the identification system with vehicle components. It enables functionalities like door unlocking and personalized settings. The system interacts with automotive control units. It ensures smooth and real-time operation.

V. RESULT

The proposed multimodal face–gait fusion system demonstrates improved accuracy and reliability in user identification compared to traditional unimodal methods. The integration of facial and gait features enhances recognition performance under varying environmental conditions. The system effectively identifies users even in cases of partial occlusion or lighting variations. Real-time processing ensures quick and efficient authentication for automotive applications. Experimental results indicate reduced false acceptance and rejection rates. Overall, the system provides a secure, robust, and efficient solution for modern vehicle user identification.

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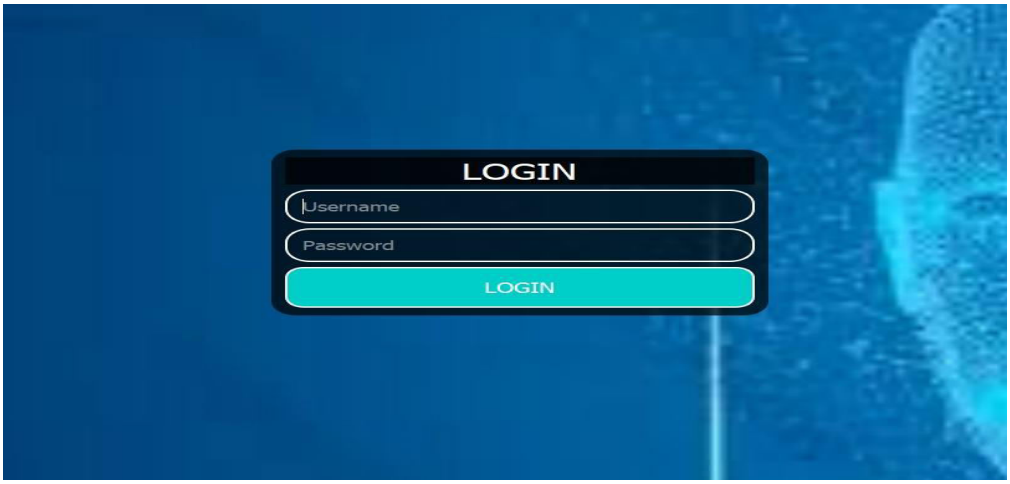

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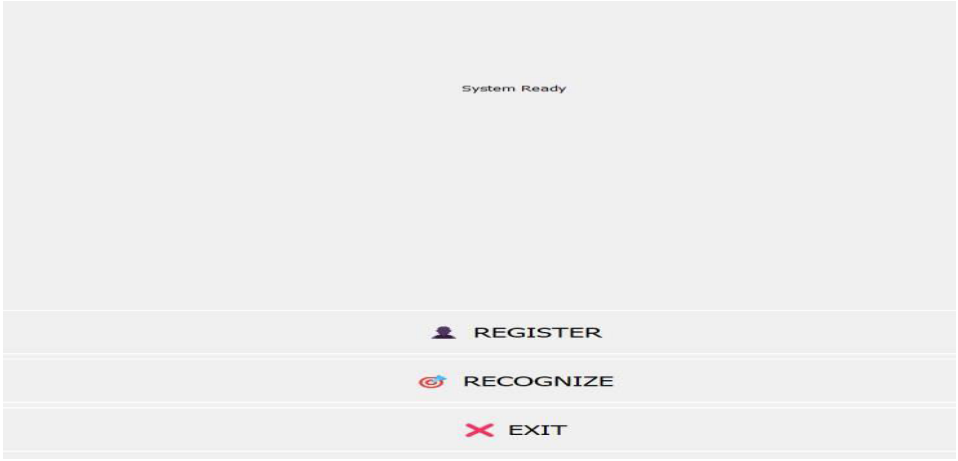

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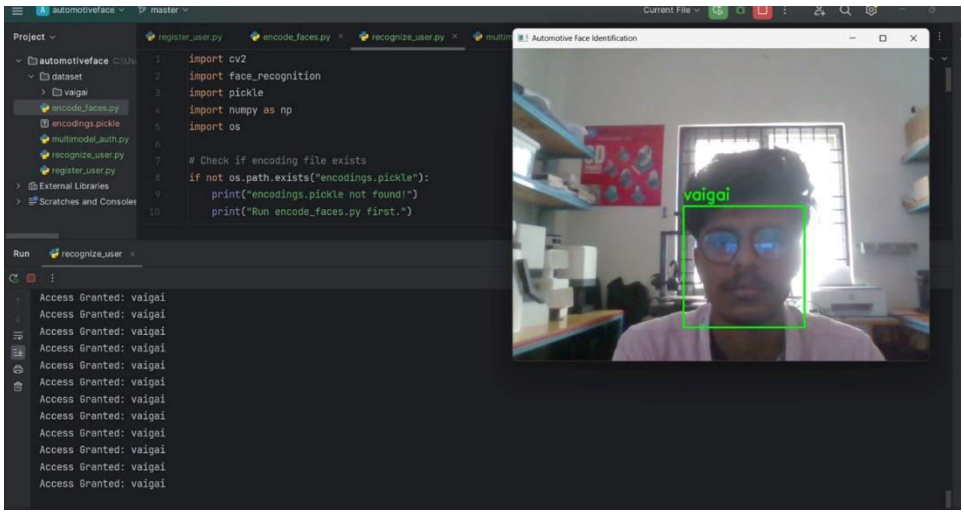

Scr. No.3:Verification Page

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VI. CONCLUSION

the project titled "Automotive User Identification Using Multimodal Face–Gait Fusion Techniques" presents an efficient and secure solution for modern vehicle authentication. The system integrates both face recognition and gait analysis to overcome the limitations of traditional and unimodal methods. By utilizing feature-level fusion and deep learning techniques, the system achieves improved accuracy and robustness under varying environmental conditions. It enables real-time user identification, ensuring quick and reliable access control in automotive environments. The proposed approach enhances security, reduces unauthorized access, and supports personalized user experiences within vehicles. Overall, the system provides a scalable and effective solution for next-generation intelligent automotive systems.

VII. FUTURE ENHANCEMENT

The proposed system can be further enhanced to improve performance, scalability, and user experience. Future developments may include the integration of additional biometric modalities such as voice recognition or fingerprint authentication to further strengthen security. Advanced deep learning models can be implemented to improve accuracy under extreme conditions like very low lighting or heavy occlusion. The system can be optimized for deployment on embedded automotive hardware to ensure faster real-time processing. Cloud integration can be introduced for centralized data storage and remote access. Additionally, privacy-preserving techniques and encryption methods can be enhanced to ensure secure handling of biometric data. Future versions may also include adaptive learning mechanisms to continuously update user profiles and improve system performance over time..

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