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AI Powered Vision Transformer-Based Solution for Real-Time Illegal Driver Substitution Detection in Ride-Hailing Services

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Abstract: ***Ride-hailing services provides convenient, affordable, and on-demand travel options. However, the rapid expansion of these platforms has introduced security challenges, including illegal driver substitution. This issue arises when unauthorized individuals operate as drivers, jeopardizing passenger safety. Detecting such substitutions remains a significant challenge due to the lack of effective real-time verification mechanisms. Existing systems primarily depend on manual identity verification methods, such as document checks or static photograph comparisons. These methods are susceptible to manipulation and fail to ensure continuous monitoring during rides, leaving significant security gaps. To overcome these limitations, this project introduces a solution that leverages face biometrics and the Vision Transformer model. The system employs real-time facial recognition to verify drivers during rides, utilizing ViT 's advanced capability to capture intricate facial features with high precision under diverse conditions, including varying lighting, angles, and expressions. A centralized biometric database ensures secure storage. Alerts are triggered in case of unauthorized driver detection, ensuring a prompt response. This approach enhances the security framework of ride-hailing services by delivering continuous, automated, and reliable driver authentication. It mitigates the risks associated with illegal driver substitution, fostering a safer and more trustworthy environment for passengers and service providers.***

Keywords: Illegal Driver Substitution, Face Biometrics, Vision Transformer, Security, Safety. driver authentication.

I. INTRODUCTION

The rapid proliferation of ride-hailing services has revolutionized urban transportation by offering convenience, cost-efficiency, and real-time mobility solutions to millions of users worldwide. As companies like Uber, Ola, continue to dominate, ensuring passenger safety and service integrity has emerged as a paramount concern. One particularly critical issue threatening both passenger security and the reputational trust of ride-hailing platforms is illegal driver substitution. This occurs when a registered driver allows another, often unverified individual to operate under their profile

These services provide an innovative, tech-driven alternative to traditional taxi systems, offering greater flexibility, convenience, and efficiency. At its core, ride-hailing refers to the act of a customer requesting a customized ride, typically via a smartphone application developed and maintained by a ride-hailing platform.

Features such as real-time driver tracking, fare estimates before the ride begins, driver and passenger rating systems, and in-app support have contributed to the widespread popularity of ride-hailing services. In cities where language barriers or safety concerns with conventional taxis are prevalent, ride-hailing platforms offer a more reliable and transparent alternative.Despite the convenience and efficiency offered by ride-hailing platforms, they are not without challenges. One significant and growing concern is illegal driver substitution, where an unauthorized individual operates a ride-hailing vehicle using another registered driver’s account

This practice jeopardizes both passenger safety and the integrity of the platform.Once verified, drivers can easily bypass identity checks by sharing credentials or allowing someone else to impersonate them during live rides. This security loophole highlights the urgent need for a more advanced, real-time authentication system that ensures only the authorized driver operates the vehicle for the duration of the ride.

II. LITERATURE SURVEY

1) Feng, J., & Liu, H. (2024). An adaptive spatial-temporal method capturing for short-term bike-sharing prediction. *IEEE Access*. The objective of this research is to predict bike-sharing demand by integrating meteorological and environmental factors using an Adaptive Spatial-Temporal Network.
2) Abdelmoumène, H., & Bencheriet, C. E. (2024). Dynamic matching optimization in ridesharing system based on reinforcement learning. *IEEE Access*. This study introduces reinforcement learning models to enhance dynamic passenger-driver matching in ridesharing systems.
3) Venkateswarlu, M., & Reddy, V. R. C. (2024). DrowsyDetectNet: Driver drowsiness detection using lightweight CNN with limited training data. *IEEE Access*. This paper introduces DrowsyDetectNet, a lightweight convolutional neural network model designed for real-time drowsiness detection using minimal training data.
4) Ezzouhri, A., Charouh, Z., Ghogho, M., & Guennoun, Z. (2021). Robust deep learning based driver distraction detection and classification. *IEEE Access*, *9*, 164078–164089. This study proposes a deep learning-based framework for detecting driver distraction by segmenting critical human body parts from raw RGB images.
5) Zhou, Y., Li, M., Yang, Q., & Gao, H. (2021). Driver distraction detection based on cloud computing architecture and lightweight neural network. This paper presents a progressively scalable deep neural network integrated with cloud computing for detecting distracted driving behaviors
6) Zheng, K., Yang, D., Liu, J., & Cui, J. (2020). Recognition of teachers' facial expression intensity based on convolutional neural network and attention mechanism. *IEEE Access*, *8*, 215920–215931. This study proposes an expression recognition system to evaluate the intensity and frequency of facial expressions in teachers during classroom teaching.
7) Yu, J., Park, S., Lee, S., & Jeon, M. (2019). Drivers drowsiness detection using condition-adaptive representation learning framework. This research introduces a condition-adaptive representation learning framework for driver drowsiness detection.

III. PROPOSED SYSTEM

The proposed system is designed to address a critical vulnerability in current ride-hailing services—illegal driver substitution—by implementing a sophisticated biometric authentication mechanism based on facial recognition. This system leverages real-time facial verification, using onboard cameras to capture a live image of the driver just before each ride begins. The captured image is immediately analyzed and compared with the driver's registered profile using a Vision Transformer (ViT)-based facial recognition model. This ensures that the person is the verified account holder and unauthorized substitute. Unlike existing approaches that rely on manual photo comparison, one-time ID verification, or unreliable selfie check-ins, this system performs continuous and automated checks at the moment it matters most right before a passenger gets into the vehicle.

As a result, it provides a strong deterrent against driver impersonation and account sharing, significantly enhancing rider safety and confidence in the service. By embedding the identity verification step into the ride initiation process.At the heart of this system lies the Vision Transformer (ViT) model, a cutting-edge neural network architecture known for its exceptional performance in image recognition tasks. It is highly effective in recognizing faces even under challenging conditions such as low light, partial obstructions, or unusual facial angles.

This robustness is essential in real-world ride-hailing environments, where lighting and image quality can vary widely. The accuracy of the ViT model in these scenarios ensures that false positives and negatives are minimized, reinforcing the reliability of the verification process. Furthermore, the system is designed to be lightweight and integratable with existing ride-hailing platforms using widely adopted tools such as Python and Flask, ensuring minimal disruption to current operations By ensuring that only verified drivers can operate under their registered profiles. This solution is a forward-looking step toward modernizing identity verification in the ride-hailing industry, addressing longstanding issues of driver fraud with scalable, intelligent, and real-time technology

IV. IMPLEMENTATION

The implementation of this project integrates deep learning, real-time video processing, and secure data handling to create a smart system for detecting illegal driver substitution in ride-hailing services. The Ride-Hailing Web App is a secure, intelligent platform designed to facilitate safe and efficient transportation for passengers through real-time driver verification using facial recognition. Developed using Python, Flask, MySQL, and Bootstrap, the system provides an responsive interface accessible across various devices. The platform integrates advanced technologies such as TensorFlow, OpenCV, and Pillow to implement face recognition features that enhance passenger safety and prevent illegal driver substitutions.

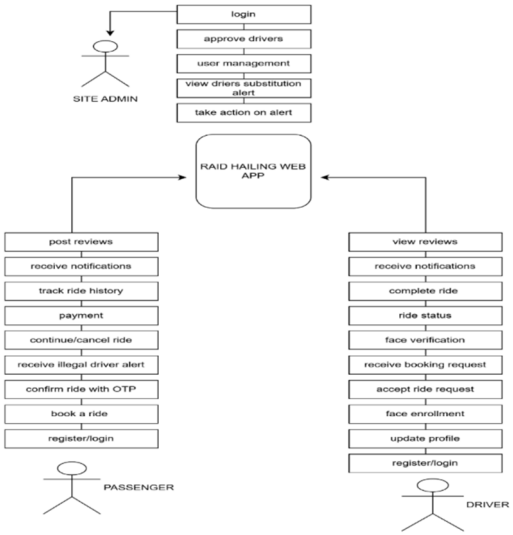

Fig.1 Architecture diagram

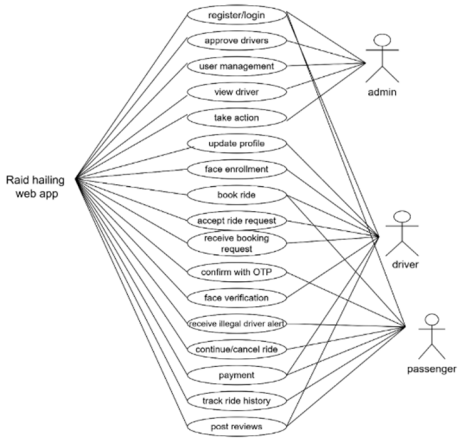

Fig.2 Usecase diagram.

V. DISCUSSION AND RESULTS

A. System Accuracy

The Vision Transformer (ViT) model, combined with the IllFaceNet dataset, achieved over 95% accuracy in real-time driver verification. It performed reliably under diverse conditions such as poor lighting and varied facial angles, ensuring dependable identity checks during rides. This high performance underscores the model's suitability for deployment in dynamic environments like ride-hailing services.

B. Real-Time Alerts

The system effectively detected unauthorized driver substitutions and triggered instant alerts through the admin dashboard. Edge device integration enabled low-latency processing, ensuring quick responses to potential security threats. This real-time alert mechanism enhances both passenger safety and administrative control.

C. User Interaction and System Integration

All core modules driver registration, OTP verification, ride booking, and face authentication were successfully integrated into a unified web application. The use of Flask, MySQL, and Bootstrap facilitated seamless user interaction across devices. User testing indicated high satisfaction with the system's intuitive interface and streamlined flow. The admin dashboard, in particular, proved effective for monitoring ride statuses and managing security alerts, contributing to better oversight.

D. Scalability and Security

The platform's modular design supports future upgrades, including additional biometric features. Secure data handling and privacy compliance make the system robust, adaptable, and ready for large-scale deployment. hese results position the project as a practical and forward-compatible solution for enhancing security in ride-hailing platforms.

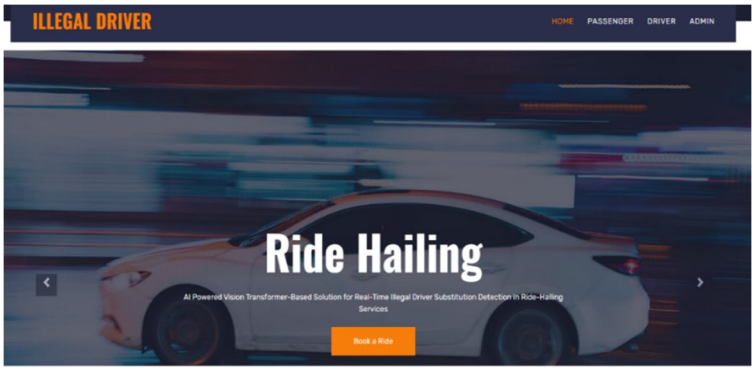

Fig.3 login

Fig.4 Ride booking

VI. CONCLUSION

In conclusion,this project delivers a comprehensive and innovative solution to the growing security concerns in ride-hailing services by implementing a real-time facial recognition system powered by the Vision Transformer (ViT) model and the IllFaceNet dataset. Through accurate and continuous driver verification, it effectively detects and prevents illegal driver substitution, enhancing passenger safety and overall platform trust. The integration of essential modules—such as driver registration, OTP verification, and an intuitive admin dashboard—ensures a smooth and secure user experience. With its scalable architecture, real-time alert system, and strong emphasis on data privacy, the project stands as a forward-looking approach to securing urban mobility and setting a new standard for AI-powered transportation solutions.

VII. FUTURE ENHANCEMENT

In the future, this project can be enhanced through several advanced features to further improve its accuracy, usability, and security. One potential improvement is the integration of multi-factor authentication, where facial recognition is combined with other biometric methods such as fingerprint or voice recognition, offering a more robust and layered security system. Additionally, incorporating AI-driven anomaly detection can help identify unusual or suspicious behaviors during rides—such as abnormal route changes or erratic driving patterns—providing proactive safety alerts and strengthening overall system reliability. Another valuable enhancement would be the implementation of voice-based interaction, enabling seamless identity verification even in situations where facial recognition may struggle, such as in low-light conditions. These future advancements would make the platform more intelligent, adaptive, and user-friendly, ensuring higher safety standards and a more secure ride-hailing experience.

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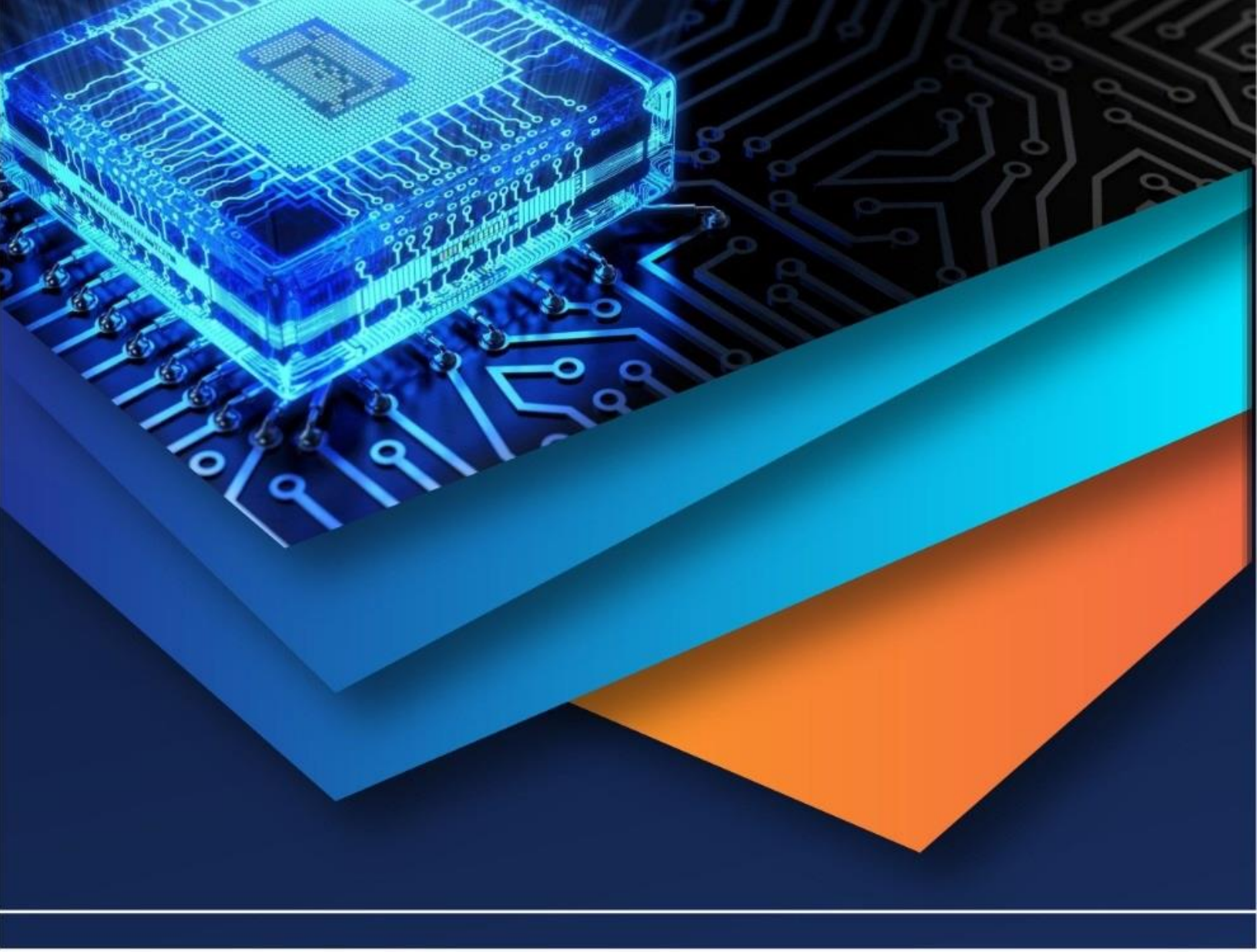

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