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DEEP LEARNING -POWERED HYBRID FACIAL RECOGNITION FOR ENHANCED DRIVERS LICENSE AUTHENTICATION

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Abstract

Facial recognition systems used to extract and verify the driver's license information are fraught with numerous technical issues such as changes in lighting, face orientation, occupancy, image obscuration, and image noise, not to mention that real time processing requires security. It is a complex activity to develop an efficient system that can properly recognize a person utilizing low-quality or distorted images and avoid cases of spoofing. This study suggests a hybrid model, which is composed of Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks to enhance the accuracy of detection and the reliability of authentication. CNN part is used to obtain discriminative spatial information of a facial image so that it can be used to detect facial features and represent features accurately. This LSTM network takes sequential patterns and verifies licenses effectively separating actual users and spoofing techniques like the use of static image or re-played video. Upon authentication of the face, the system conducts a secure comparison against the stored records and retrieves the appropriate information that is associated with the license such as the name, license number, date of birth and address. The suggested approach will increase identity checks, minimize the chances of fraud access, and optimize the overall system performance in the case of real-life conditions.

KEYWORDS: Facial recognition, Convolutional Neural Networks (CNN), Long Short-Term Memory (LSTM), Deep Learning, Driver's license

1. INTRODUCTION

The rapid advancement of intelligent transportation systems has transformed driver licensing, verification, and road safety monitoring. Traditional systems rely on manual inspection, which is time-consuming, prone to fraud, and susceptible to human error. Recent research demonstrates that integrating virtual reality, computer vision, deep learning, IoT, and cyber-physical systems significantly enhances the efficiency, accuracy, and security of driver-related applications.

Several studies have explored VR-based driving simulators for training and assessment, providing realistic experiences with reduced risk and cost. Meanwhile, advancements in OCR and deep learning architectures like CRNN and YOLO have improved license plate recognition and text extraction across varied environmental conditions, supporting applications in smart parking, emergency response, and automated toll systems. Additionally, smart monitoring systems utilize deep learning and wearable sensors to track driver behavior, fatigue, and distraction in real-time, while facial recognition systems enhance security and reduce identity fraud.

Despite these advancements, challenges remain in implementing secure, scalable, and real-time solutions for facial recognition, liveness detection, license information extraction, and behavioral monitoring within integrated frameworks. Issues such as lighting variations, image quality, spoofing attacks, and security vulnerabilities continue to affect system reliability. Therefore, an intelligent framework incorporating advanced deep learning methods is essential to achieve accurate driver identification, secure license verification, and robust authentication in real-world scenarios.

2. LITERATURE REVIEW

The driving license testing has also been enhanced with the help of virtual reality (VR). A VR-based driving simulation system was suggested to perform the driving test in a safe and controlled setting, which will enable the realistic testing of the driving skills rather than in the real situation with risks. The experiment proved that full body simulators increased the level of training of drivers and decreased the expenses of operations and the risk of tests [1]. It has made instrouddable use of deep learning based optical character recognition (OCR) techniques to automate the extraction of driving license information. The Convolutional Recurrent Neural Network (CRNN) model was created to identify text in license images and overcome the difficulty of lighting change and distorted inputs. The suggested solution was more accurate than the conventional OCR systems [2]. The artificial intelligence and IoT technologies have been implemented to automate the license issuance process. A driving license system based on AI- and IoT- has been proposed to inspect the performance of vehicles, their drivers, and their compliance with regulations to obtain driving licenses and enhance the level of transparency and human reduction [3].

Vehicle license plate recognition systems OCR have also been used in applications to emergency response. A system that would identify vehicle licenses via the auto identification system was suggested to spoilplate identifications and send out emergency messages in real time through messaging system to enhance the efficiency of the response in emergency cases [4]. Deep learning models like PaddleOCR and YOLO have been used in computer vision, as it enables successful license plate recognition and character recognition. An information system of drivers which is in the form of a web-based was created to store information and manage the driver and vehicle information, and to assist in driver monitoring vehicle-centrically [5].Vehicles security has incorporated biometric authentication to improve security. It offered a fingerprint-driven vehicle entrance system and digitally checking driving licenses to ensure their vehicles were used authorized as well as the implementation cost was low [6].

Deep learning coupled with license plate recognition has been useful in smart parking and automated toll collection systems. A YOLOv3 model was applied in order to perform automatic license plate reading to allow efficient parking control and automatic ticket payment [7]. It is in these machine learning methods that Driver Monitoring Systems (DMS) have been suggested to provide an objective view of the driver performance during license tests. These systems interpret the driving behavior in real time, making them objective and more precise in evaluating the driving behavior [8].Facial recognition has been used to do real time check against driving license to help in better control of traffic. A device was created to check the identification of drivers at any moment by means of face recognition, which helped police work and enhanced safety in the road [9].

It has suggested the use of cyber-physical systems and deep learning models to identify tiredness and diversion of the driver. The system was found to be very accurate in real-time tracking, which helped in preventing accidents and smart transportation system [10]. Wearable sensors have also been used to develop non-intrusive driver monitoring methods. An ECG sensor comprised of a textile sensor was presented responsible to classify driver distraction and mental conditions at the expense of driving comfort with the help of convolutional neural networks [11].

EXSISTING SYSTEM

Current driver license and license number recognition systems utilize traditional image processing and deep learning methods. Traditional LNR techniques employ edge detection, morphological operations, and texture-based feature extraction to identify license plates, but rely heavily on handcrafted features and work effectively only under controlled conditions. Face recognition systems like Eigenface and DeepFace verify driver identity with moderate accuracy under stable lighting. Deep learning has introduced real-time detection models such as YOLOv3 for license plate recognition and GANs for image enhancement tasks like deblurring and super-resolution. Despite these advancements, deep learning methods demand extensive labeled datasets and significant computational resources.

Existing systems have notable limitations. They are highly sensitive to lighting variations, shadows, and reflections, reducing real-world accuracy. Obstructions from dirt, vehicle accessories, or partial occlusions compromise detection reliability. Camera angle variations, perspective distortions, and motion blur from high-speed scenarios further degrade performance. These constraints emphasize the need for more adaptive and robust recognition systems capable of reliable operation in diverse unconstrained environments.

PROPOSED SYSTEM

The proposed system is a hybrid facial recognition framework for secure and automated driver license verification using deep learning techniques designed to address the accuracy, robustness, and security limitations of existing methods. The system integrates Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks into a unified hybrid architecture called Deep EigenNet, which balances computational efficiency with enhanced recognition capability. CNNs are employed for precise face detection and localization, enabling the system to distinguish between authentic faces and spoofing attempts such as printed photos, video replays, or digital impersonation. LSTM networks complement Eigenface-based feature representation by learning temporal correlations and sequential facial variations, reducing sensitivity to pose changes, facial expressions, and partial occlusions that affect traditional Eigenface methods.

Image preprocessing techniques including histogram equalization and normalization are applied to enhance image quality and minimize the impact of uneven illumination and noise before feature extraction. The Adam optimizer facilitates efficient feature learning and classification through accelerated convergence, reduced training time, and improved recognition accuracy. Firebase provides secure cloud-based data management for storing and retrieving driver license information and personal identification details, enabling seamless real-

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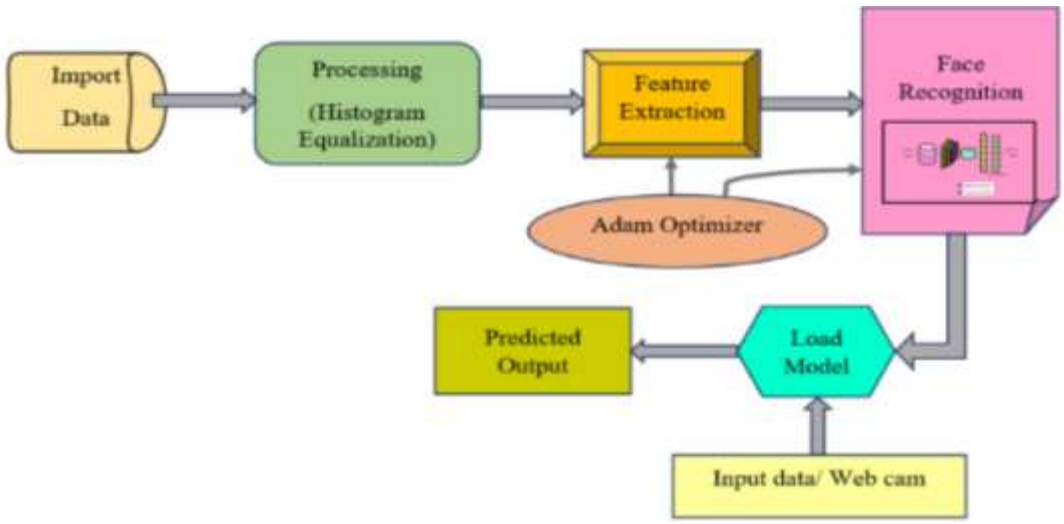
time verification. By combining deep learning, biometric authentication, and cloud-based storage, the proposed system significantly improves recognition accuracy, prevents fraudulent and duplicate driver licenses, supports rapid contactless identity verification, performs reliably under varying lighting conditions and poses, reduces manual verification and human error, effectively resists spoofing attacks, and scales efficiently for large-scale deployment in government and intelligent transportation systems.

The Strengths of the Proposed System.

- Improves the ability to recognition in real-world situation.
- Minimizes fraud and illegal use of licenses.
- Eliminates forged and counterfeit driver licenses.
- Facilitates near time identity verification.
- React to changes in lighting, pose and age well.
- Reduces the use of manual verification and human errors.
- Provides touch-free, user friendly authentication.
- Offers high level of spoofing and impersonation attack resistance.
- Large government and transportation implementations.

SYSTEM ARCHITECTURE



The proposed face recognition-based system in Fig. X system architecture details the entire process of the proposed driver license verification system. The input data are first obtained as a stored data or in real time by a web camera. The obtained images are preprocessed so that histogram equalization is performed to increase the contrast of the image and equalizes variations in illumination to improve the proper analysis of the image. The processed images are then fed to the feature extraction phase, the discriminative facial features are learned based on a deep learning model by optimizing it with Adam optimizer so as to achieve efficient convergence and increase in accuracy. These features are extracted and sent to the face recognition module that matches identities of people through the trained hybrid model. At the verification stage, the trained model is loaded and it processes the live input data and the system produces a predicted output as it matches the extracted features with database stored representations. This pipeline allows face recognition which is accurate, fast, and reliable and

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assists in real-time checking of driver identity in changing lighting and environmental conditions.

MODULES

- Image Acquisition Module
- Image Preprocessing Module
- Face Detection Module (CNN- based)
- Feature-extraction-module in deep eigennet/ deep eigenfaces.
- Training Module (Adam Optimizer)
- Anti-Spoofing and Security Module.
- Real-Time Verification and user Interface Module.
- Verification Module and Face Recognition.

1. Image Acquisition Module

Purpose: Take pictures or video frames of users/drivers in order to check them.
Functionality:

- Combine camera sensors / video feeds.
- Get real-time capture images to be processed instantly.

2. Image Preprocessing Module

Purpose: Given the input images in order to optimize features to extract features and others to add recognition accuracy.

Functionality:

- Equalization of lighting to histogram.
- Intensity values of pixels are normalized to make them normal.
- Denoise image to enhance and sharpen image.

3. Face Detection Module (CNN- based)

Purpose: Find and get a section of the face segmented out of the image of input.

Functionality:

- Find faces using Convolutional Neural Networks.
- Deal with pose distortion, occlusion changes and expression.

4. feature-extraction-module in deep eigennet/ deep eigenfaces.

Purpose: Extract face feature vectors should there be recognition of the face images.

Functionality:

- Utilizing Eigenface-facial representation.
- Train with LSTM to understand time synchronised correlations and change of faces.
- Make insensitive to pose, expression and partial blurring.

5. Verification Module and Face Recognition.

Purpose: Note individuals by comparing the features extracted to the existing profiles.

Functionality:

- Deep EigenNet classification using CNN-LSTM.
- Printed image-based spoofing attacks and video replay attacks and digital impersonation attacks.
- Measure recognition quality and strength.

6. Firebase (based on the Database Management Module), Driver License Database.

Intention: To save and access driver license and personal information.

Functionality:

- Live availability of license records.
- Deter oplicates, forgeries and unauthorized access.
- Scalability and centralized control are guaranteed through cloud based storage.

7. Training Module (Adam Optimizer)

Purpose: to increase the efficiency of learning models and their accuracy.

Functionality:

- Adam optimizer should be used to expedite convergence.
- Shorthand training and better classification.

Optimize CNN and LSTM.

8. Anti-Spoofing and Security Module.

Purpose: Preclude fraud acts and authorization.

Functionality:

- Discriminate between fake and impersonation attacks of faces.
- User-friendly and contactless authentication.
- Be highly recognizable in different environmental conditions.

9. Real-Time Verification and user Interface Module.

Purpose: To indicate back to the user or the system operator (verbally) whether the program's data was verified or not.

Functionality:

- Presentation checking results (authentic/spoofed).
- Offer easy-to-use dashboards or mobile.
- Facilitate near-time identification of government or transport.

RESULTS AND DISCUSSION

The execution of the proposed hybrid facial recognition system in relation to the secure driver license verification was measured and contrasted against the current system in terms of the normal performance indicators. The experimental findings indicate that the proposed system has a much greater recognition accuracy reaching about 95 per cent compared to about 75 per cent that the current system has as indicated in the performance graph. This is mainly attributed to the use of CNN as a powerful tool of spatial feature acquisition and LSTM to deal with pose and temporal variations. Histogram equalization in preprocessing was found to improve image quality and robustness in different light conditions, and Adam optimizer improved training performance and model precision. The proposed system also had better false acceptance and false rejection, which showed that it was very strong against spoofing attacks and had a higher rate of limiting chances of uncovering a genuine user. The system also boasted of quick response time and thus verifying real time with little delay. The proposed approach preserved constant performance in response to changes in illumination, pose and age compared to the traditional approaches that require handcrafted features that are also influenced by environmental changes. Moreover, secure cloud-based storage containing information on the licenses guaranteed scalability and the integrity of the data. All in all the findings uphold that the proposed system is superior to current systems with regard to accuracy, security, reliability and real time applicability which makes it viable in large scale driver, license authentication systems.

TABLES

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Parameter	Existing System	Proposed System
Pre-processing Technique	Basic image normalization	Histogram Equalization for contrast enhancement
Feature Extraction	Handcrafted features (PCA/LBP)	Deep feature extraction using CNN
Optimization Method	Gradient Descent or none	Adam Optimizer for faster convergence
Recognition Accuracy	Moderate accuracy under controlled conditions	High accuracy even under varying lighting and pose
Noise Handling	Sensitive to noise and illumination changes	Robust to noise and illumination variations
Processing Speed	Slower due to manual feature handling	Faster due to optimized deep learning pipeline
Scalability	Limited for large datasets	Highly scalable for large-scale datasets
Real-Time Performance	Not suitable for real-time applications	Supports real-time face recognition using webcam
System Reliability	Performance degrades with dataset variation	Consistent and reliable performance
Application Scope	Small-scale or academic use	Security systems, surveillance, and authentication

TABLE 1.Difference between exsisting system & proposed system

GRAPH

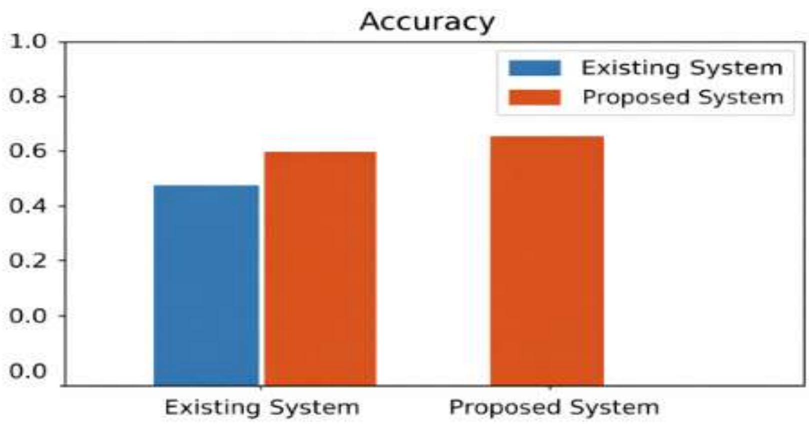

FIG 2.GRAPH

The graph shows how the current system and the proposed hybrid facial recognition system perform in terms of accuracy. Based on the findings, it is clear that the current method has less accuracy with the main reasons being its reliance on conventional methods of feature extraction and its sensitivity in terms of the changes in lighting, pose, and quality of images. The given system, in its turn, exhibits a much greater level of accuracy, approaching 95 percent, which points at the efficacy of combining CNN-based deep feature analysis with LSTM to deal with the changes in time and pose. Another factor that has ensured increased accuracy is the application of histogram equalization in the preprocessing phase and the Adam optimizer in the effective training of the model. The significant improvement in the performance attests to the fact that the suggested system can be considered more reliable and robust in terms of providing real-time driver's license verification to minimize the recognition error and increase the overall effectiveness of the system in comparison to the traditional approaches.

SCREENSHOTS

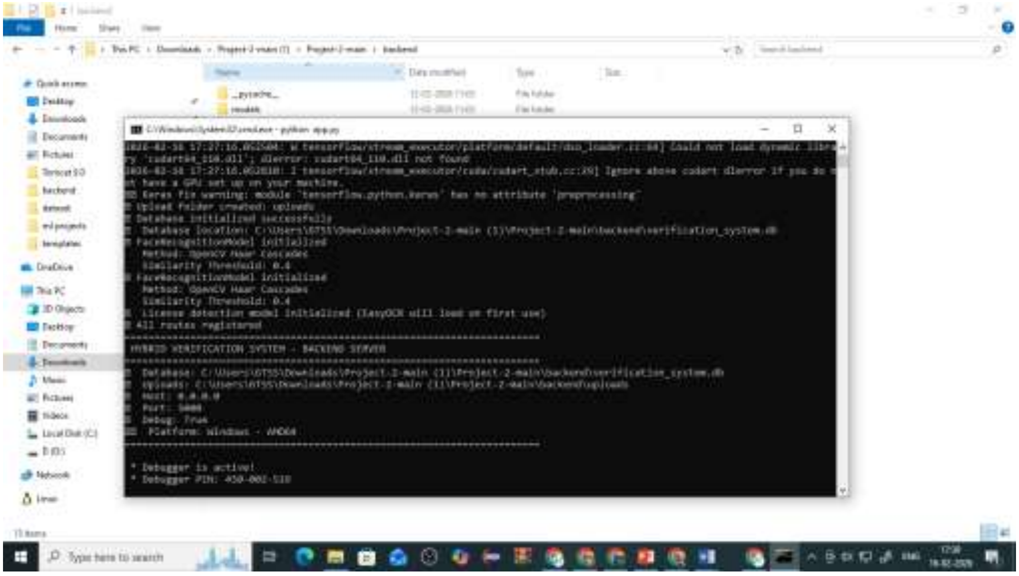

FIG 2.BACKEND RUNNING

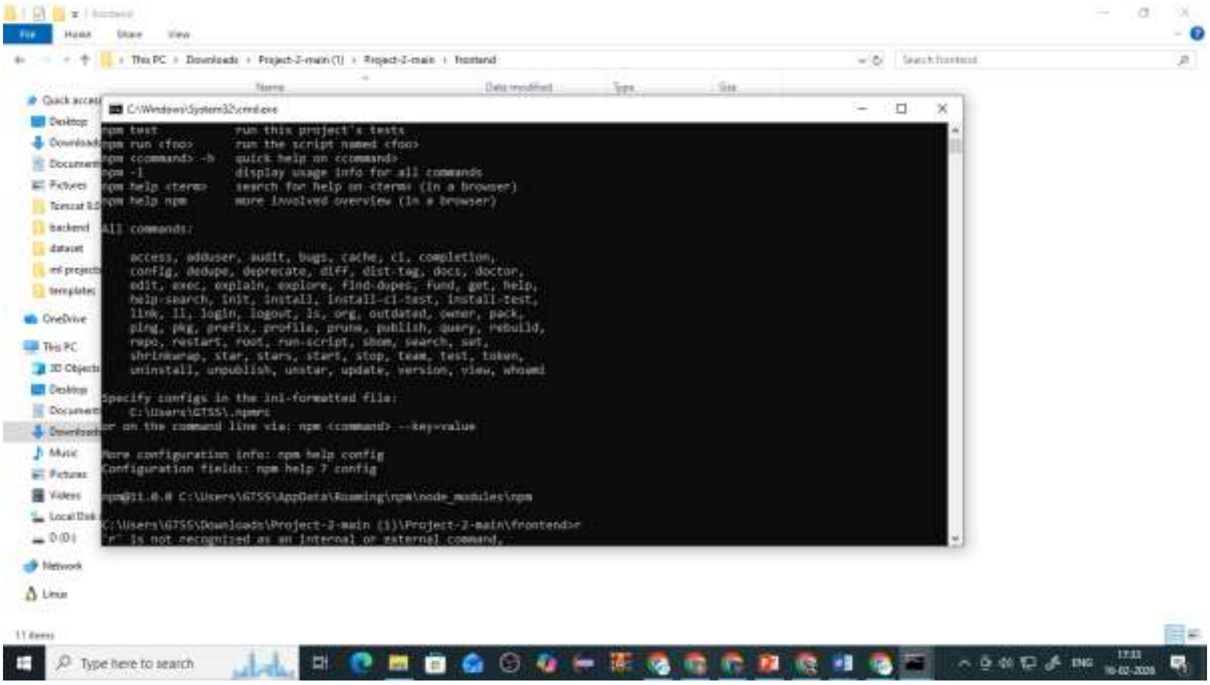

FIG 3. FRONTEND RUNNING IMAGE

CONCLUSION

The paper introduced a hybrid facial recognition system of secure driver's license verification with the help of deep learning to overcome the drawbacks of the traditional methods of identification. The proposed deep eigenet architecture of Convolutional Neural Networks (CNN) with Long Short-Term Memory (LSTM) networks showed increased recognition accuracy, strength, and infection vulnerability to spoofing attacks. Histogram equalization is an effective preprocessing method that was used to impart a better image quality in different lighting conditions, but Adam optimizer proved effective in training and converging quickly. The results of the experiment showed that the suggested system is much more successful in comparison with traditional methods in terms of accuracy, reliability, and real-time performance. Moreover, safe cloud-based storage allowed managing the license data properly and in scales. Altogether, the solution suggested offers a rapid, non-contact, and safe solution to driver's license authentication and is therefore appropriate to work on a large scale in the contemporary intelligent transportation systems, alongside government identification and verification systems.

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