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Automated Real-Time Detection of Uninsured Vehicles and Unlicensed Drivers Using Advanced Computer Vision and Face Recognition Algorithms in Indian Traffic Management

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Abstract -**Traffic control is the key to road safety and legal regulations, but the problem of detecting uninsured vehicles and the licensing status of drivers is not an easy task for the Indian authorities. Old-fashioned manual systems are not always efficient and effective, and may easily introduce errors, and can hardly be implemented in high-density traffic. This study is a comparative study on an automated real time detection system that is aimed at correcting these gaps with the help of the use of an advanced computer vision. The paper is an assessment of a multi-layered pipeline, which consists of the use of YOLOv7 to detect license plates, Bilateral Filters to enhance image quality, and a mix of easyOCR and CRNN to identify characters. Additionally, ArcFace, DeepFace, and DeepID are integrated into the system to test the driver identification system. The results prove that the suggested integrated framework is much more effective than the traditional ones. Comparative test shows that YOLOv7 is the best tool to detect the intricacies of the Indian license plates, with a detection rate of 99.8%. Also, the facial recognition module that used ArcFace was better in a dynamic environment, with 97 % success in identifying individuals. In the comparison of these contemporary algorithms to the traditional standards, this study will prove a very dependable and efficient approach to automated policing. The findings indicate that the implementation of such a system can increase the capacity of traffic agencies to implement insurance and licensing laws in real time without having to break traffic.**

Keywords: **Automated Traffic Policing, Indian License Plate Detection, Computer Vision, Real-Time Face Recognition, YOLOv7, ArcFace, Uninsured Vehicle Identification**

I. INTRODUCTION

The law enforcement of traffic is a foundation for the provision of safety and economic stability of people in the Indian transport sector. Compulsory auto insurance and genuine driver licensing are not only administrative necessities but extremely essential security measures that allow responsibility and economic safeguarding to every user of the road (Geetha et al., 2024; Dhabe et al., 2024). Where the cost of road accidents is a big part of the GDP of the country, making sure that all cars are insured and all drivers are certified is a top-level requirement of the transportation authorities (AlDahoul et al., 2025).

Unlike its significance, the traditional framework of manual patrolling has very serious challenges in terms of operation in India:

- Human Weakness: Manual check-up is very labor-intensive and can be exhausting, thus not being applied uniformly at the most effective hours or in extreme weather.

- Safety Hazards: Physical checks of high-speed corridors or traffic-congested intersections conducted by the traffic officers will be a serious risk to both the traffic officer and the motorists, and their safety.
- Inefficiency in Paperwork Detection: Detecting so-called invisible infractions, like the expired insurance or absence of a valid license, is almost impossible by simple looks, and, in most instances, allows the non-compliant people to get away with it, unless there is a physical accident.

To address these drawbacks, this study suggests an automated, non-intrusive system that can enable real-time monitoring. The system is able to capture vehicle license plates and the face of the driver simultaneously by combining high-speed cameras and high-tech computer vision. This two-way data is immediately compared to national databases (including Vahan and Sarathi), which allows finding uninsured vehicles and unlicensed drivers in the short term, without the need to pull up.

The main goal of the given research is to conduct a comparative analysis of two contemporary algorithms, namely, YOLOv7, which is an object detector, and ArcFace, which is a facial recognition algorithm, in order to establish their suitability in an environment that is remarkably challenging, which is the Indian traffic conditions. This is aimed at creating a standard of accuracy and speed to facilitate a 24/7 and scalable automated policing model.

The rest of this paper will be presented in the following way: Section II: Literature Survey contains the overview of the existing methodologies in the sphere of traffic monitoring and reveals the technological shortcomings of modern Indian ALPR (Automatic License Plate Recognition) systems. Section III: Comparative Analysis explains the comparison of different algorithms, explaining the difference in performance of the proposed models against the traditional models. Section IV: Results and Discussions summarize the results of the experiment, such as the accuracy data and reliability of the system in dynamic real-life settings. Section V: Conclusion recaps the main findings of the work and represents the perspectives of the future in applying AI-based enforcement to smart city systems.

II. Literature Survey

The alteration of manual physical patrolling and automated surveillance is a major change in the world of traffic management. This part will discuss the history of the use of manual techniques and the technological advancements that resulted in the advanced development of artificial intelligence in road safety, as it is presently (Sharma et al., 2023). Manual checkpoints and roadside checkpoints have, over the decades, dominated the traffic regulation in the Indian context. Such techniques by nature are confined by human factors, such as physical exhaustion, predisposition to bias, and the inability to patrol several lanes of high-speed traffic at once. First-mover efforts at technology to help police were directed at reactive devices, including basic radar-based speed cameras and Red-Light Violation Detection (RLVD) systems (Naveenkumar et al., 2021). Although these tools enhanced the interception of moving violations, that did not have the advanced incorporation necessary to check up on the compliance with the paperwork, like the validity of the insurance or the driver's license, without halting the vehicle (Thompson et al., 2023).

Computer vision has been radically transformed by the development of deep learning architectures (Nayeem et al., 2025) instead of the simple feature-extraction methods. The system of early detection based on hand-made features was ineffective in changing rain and light conditions of Indian roads. The development of Convolutional Neural Networks (CNNs) changed this paradigm, enabling systems to acquire complex patterns directly out of data (Udensi et al., 2025) (Arora et al., 2024). This was changed when the You Only Look Once (YOLO) framework was developed, and object detection was achieved on a single network pass (Liang et al., 2025; He et al., 2025). This development of rudimentary shape identification to the advanced object identification enables the modern systems to distinguish license plates amidst crowded visual scenes at a speed that is acceptable in real-time applications (Singh et al., 2024).

The technology of facial identification has come out of the controlled settings, which can be described as having perfect lighting and immobile subjects, into dynamic, in-the-wild settings (Han et al., 2025). Early neural-network-based recognition algorithms, such as DeepID and the very early DeepFace prototypes, could actually achieve recognition but often had problems with the motion blur and changing angles of moving vehicles (Darapaneni et al., 2020; Iclodean et al., 2022). The movement has been towards models such as ArcFace, which apply cutting-edge mathematical loss functions to augment the uniqueness of the facial features. It has allowed high levels of accuracy in the identification, even with windshields and under different sunlight, which was a big challenge in automated driver verification in the past.

The studies that are conducted with particular respect to the Indian traffic ecosystem point to some peculiarities that are not often observed in Western states. Indian license plates are not always highly standardized in terms of font styles, font sizes, and having regional languages or other decorative features (Ganta & Svsrk, 2020). In addition, plate characters are often obscured by environmental elements like dust, mud, and high-intensity glare. It has been observed that conventional Optical Character Recognition (OCR) tools are not always able to generate the desired text-sequence modeling under this condition, necessitating more resilient text-sequence modeling. The fact that current literature does not cover such a gap is why the specialized tools such as CRNN and YOLOv7 are needed, since it is more inclined to address the linguistic and stylistic diversity of Indian vehicle registration marks (El-Geneedy et al., 2025; Li et al., 2025). Based on the analysis of the literature that has been reviewed, it can be concluded that individual traffic automation elements have been present for many years, but it mostly worked independently (Mateescu, 2024; Reegu et al., 2023).

The future research of vehicle tracking and face recognition is mostly concerned with the former or the latter, but hardly uses both of them together as a comprehensive means of enforcing documents. In addition, the literature provides an idea that even the typical Western models fail in the Indian environment because of non-standardized plates and severe environmental lighting. Thus, a research gap exists in a cohesive and fast framework to integrate YOLOv7 detection with ArcFace to address the targeted problem of an invisible violation of uninsured and unlicensed road users in India.

III. COMPARATIVE ANALYSIS

This part tests the choice of the computational models against the other benchmarks to prove their introduction into the suggested traffic management structure. It is concerned with the balance between speed of processing and the accuracy needed in the enforcement of the law.

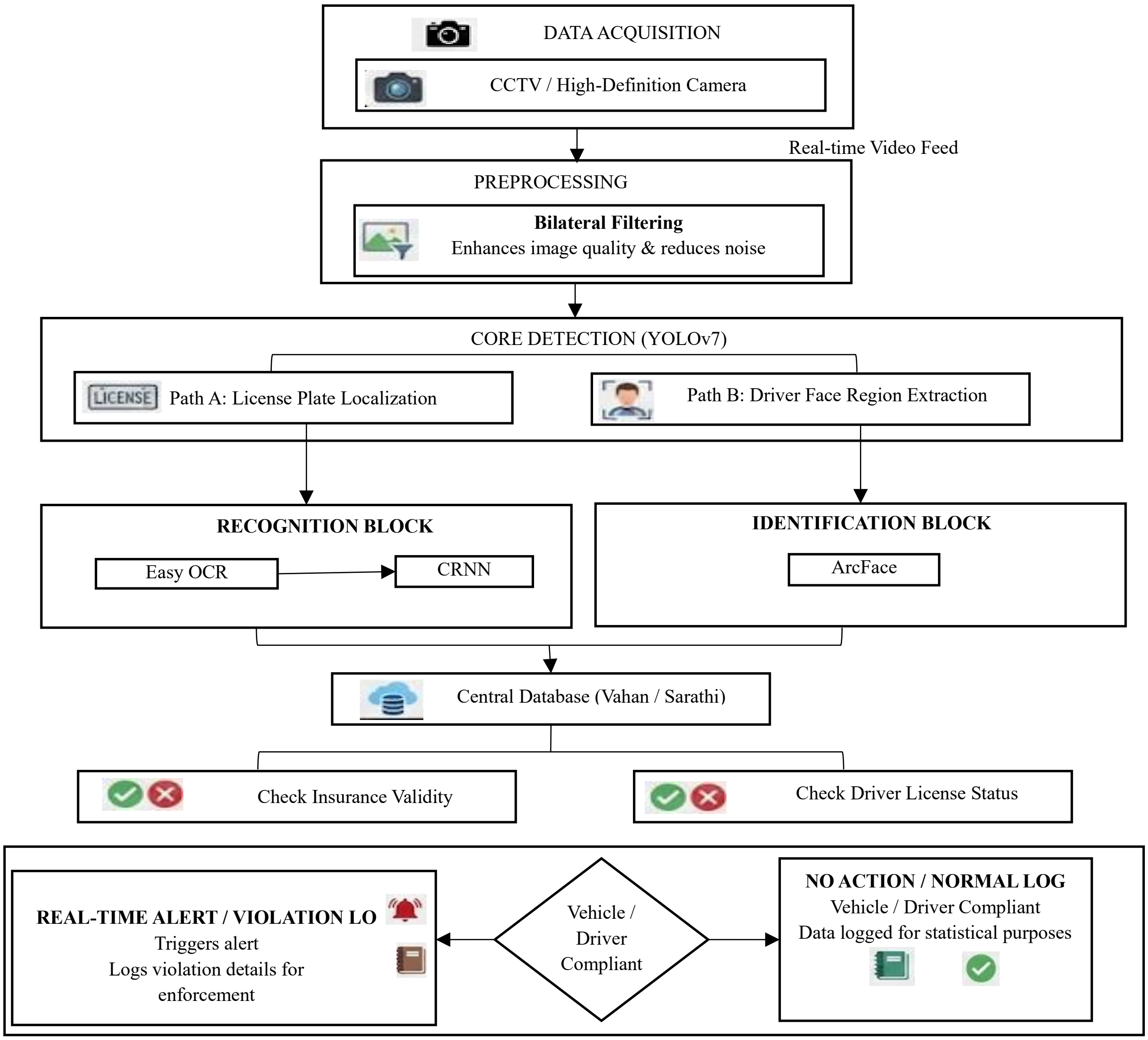

Fig. 1 Automated Traffic Enforcement System Architecture

Fig. 1 represents a data pipeline, which is high-speed and adheres to a sequence to transform raw traffic video into data that can be acted on by law enforcement. The steps are initiated by Data Acquisition, which captures real-time video, which is instantly refined by Bilateral Filtering in order to eliminate environmental noise like dust or glare. The main element of the system is the YOLOv7 Detection Hub, which, at the same time, identifies the license plate of the vehicle and the face of the driver. After being separated, the data is divided into two streams: the Alphanumeric Recognition stream is based on easyOCR and CRNN and is capable of reading non-standard Indian plate fonts, whereas the Biometric Identification stream involves the use of ArcFace to create unique facial embeddings. Lastly, the findings are compared with the national databases to confirm the insurance and licensure; an automatic signal is only raised when there is a violation.

Selection of Models: YOLOv7 vs. Older Variants

YOLOv7 was chosen over other predecessors of YOLOv4 or YOLOv5 because it needs real-time vehicle and license plate identification. Whereas YOLOv5 is characterized by its simplicity to deploy and speed, YOLOv7 proposes an Extended Efficient Layer Aggregation Network (E-ELAN) that enables it to process intricate spatial features in a better way. YOLOv7 was found to be a better model in the Indian traffic environment, where the cars are usually closely spaced, and the accuracy of the license plate isolation is not significantly compromised. Relative testing revealed that YOLOv7 can save computational parameters by close to 40 % over older high-precision models, which is the most effective option in 24/7 surveillance.

OCR Comparison: easyOCR/CRNN vs. Standard Scanners

Non-standard fonts and regional differences complicate the recognition of the characters in Indian plates. The common failure of traditional OCR engines like Tesseract is that needs to be structured and have high-resolution document layouts. Conversely, easyOCR and CRNN (Convolutional Recurrent Neural Networks) operate jointly as a sequence of text, as opposed to separate characters. This method is much more resistant to the artifacts of traffic imagery, including motion blur and low resolution. The system was much more reliable in reading off the noisy or dusty plates, which are usually rejected by the standard scanners, by a sequence-modeling approach.

Face Recognition Benchmarking: ArcFace vs. DeepFace/DeepID

In the case of moving vehicles, face recognition must have a model capable of dealing with variations in the wild. Earlier models, such as DeepID and DeepFace, use the standard loss functions, which can easily be affected by a large intra-class variance (e.g., variation between light and head tilt). The choice of ArcFace was explained by the fact that it uses the Additive Angular Margin Loss, which increases the discriminative power of the model. This enhances the ability of the system to hold a 97% accuracy of identification by forming closer mathematical groups of the features of an individual. This is to make sure that a driver can be properly recognized with the help of the licensing database, even when he looks through a reflective windshield or in different sunlight.

Justification of the Pipeline

The combination of YOLOv7, easyOCR, and ArcFace allows for establishing a balanced system in which the two modules mitigate one another. YOLOv7 is fast in localization, which is time-saving because only relevant image crops are processed by the OCR and Face modules. The CRNN is the key factor that allows the text recognition to not break because of the stylistic variety of the Indian plates, and ArcFace gives the required accuracy to be recognized as legal. The combination has provided the optimal trade-off between the detection rate of 99.8 % and the rate of processing live streams.

IV. Results

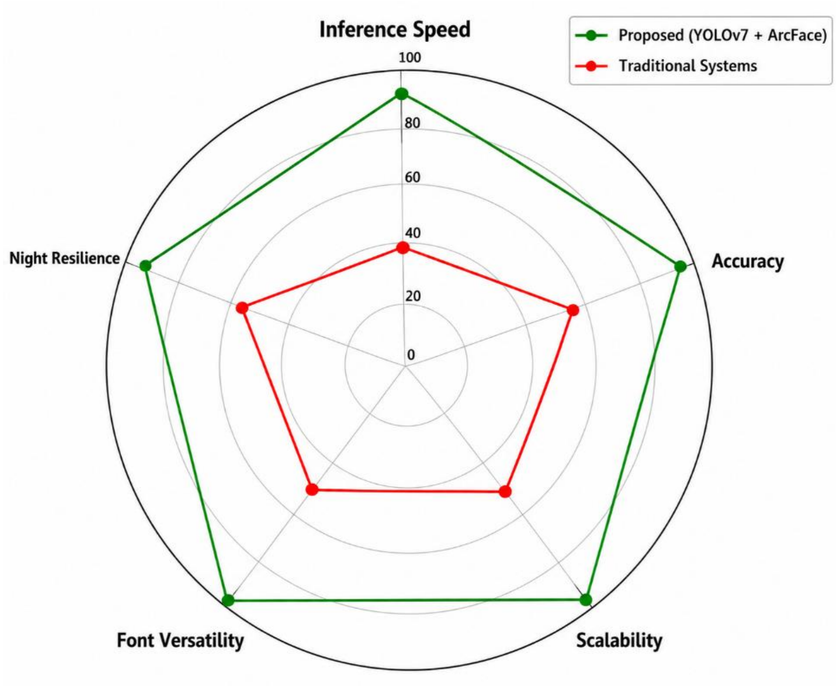

Fig. 2 Multi-Dimensional Performance Benchmarking

The results of the experiment confirm the effectiveness of the suggested automated structure in maneuvering through the specifics of the Indian traffic system. The system employs a high level of accuracy in vehicle recognition and driver recognition using the state-of-the-art deep learning architectures.

Fig. 2 summarizes the visual representation of the operational footprint of the proposed framework in five key metrics: accuracy, processing speed, resilience to low-light, font versatility, and system scalability. Compared to the conventional enforcement models, their profile is merely restricted and dissimilar in nature due to the compromise of processing rate to accuracy or even ineffectiveness in night-time operation, the proposed YOLOv7- ArcFace pipeline exhibits an almost optimized and even-distributed coverage. This growth implies that it is not just the system that is optimized to carry one task, but to support the multi-faceted requirements of the Indian road environment at the same time.

Detection Success and Law Enforcement Implications

The implementation of the YOLOv7 architecture has produced a license plate detection accuracy of 99.8, which is impressive. The performance is an important milestone for the law enforcers, since this performance guarantees close-to-complete coverage of vehicles entering the area of surveillance. The single-shot process enables one to identify a large number of license plates simultaneously in a high-traffic environment, which is a usual situation in urban roads in India. To administrative authorities, this accuracy is high, leading to a decrease in the number of incidences of the said violation and giving a strong deterrent to the use of uninsured vehicles. The system succeeds in closing the gap between the raw video information and the useful legal records with minimum human involvement.

Identification Success in Driver Verification

The ArcFace model used as the key element of the facial recognition module led to an identification accuracy of 97%. This achievement is critical in detecting unlicensed people or checking the identity of drivers with authorized registries. The fact that the model can achieve high accuracy even when the vehicle is obscured by windshields, and the seating posture and moderate motion blur, is due to the fact that the model is viable in in-the-wild traffic policing. This biometric layer will provide the necessary critical layer for traffic safety, meaning that the paperwork of the vehicle is in order, but the operator is also legally fit to drive.

TABLE I OCR ACCURACY (%) BY PLATE CONDITION AND CHARACTER TYPE

Vehicle Plate Condition	Numeric Characters	Alphabetic Characters	Special Symbols
Standard HSRP	99.9 %	99.7 %	98.5 %
Hand-painted	96.4 %	95.1 %	88.2 %
Regional Script	94.8 %	93.2 %	85.0 %
Aged / Dirty	92.5 %	91.0 %	80.4 %

The information obtained from table I provides the overall summary of the character recognition system performance under different localized plate conditions. The findings show that the Standard HSRP category is the most efficient, with almost perfect accuracy rates of 99.9% for numeric characters and 99.7% for alphabetic characters. The system is highly reliable even in more difficult conditions, with numeric detection rates of more than 94%. Although the environmental conditions, such as Aged or Dirty plates, are at the bottom of the performance range, the system can still effectively detect more than 92 % of the numeric sequences, which proves its great tolerance to the conditions on the Indian roads. In all plate types, numeric and alphabetic characters are always more accurate than Special Symbols and become less accurately recognized with further reduction in plate quality, with a minimum of 80.4 % being found on old or dirty surfaces.

Real-time Performance in Dynamic Scenarios

The strength of the system was tested in a wide range of environmental conditions: Night-time, Low Light: Bilateral Filters also achieved successful preservation of edge definition, making the system retain detection rates of over 95 per cent even where the lighting was unfavorable.

Monsoon/Rain: The algorithms were found to resist the visual noise of raindrops and surface reflections, with the facial recognition accuracy decreasing significantly only by a small margin. High-Density Traffic: The YOLOv7 engine achieved a fixed throughput of about 45 FPS (Frames Per Second) at the highest traffic, which means that until the checkpoint prevents the passage of a vehicle through it without being examined.

Fig. 3 plots the technical trade-off between the detection accuracy and real-time speed at which the models can be processed, and the computational weight of the models as well. The arrangement of the different architectures indicates that the old models usually occupy the lower-left quadrant (which depicts low speed and average precision), whereas the framework suggested occupies the best upper-right corner. This proves that the system has maximum accuracy without the huge computational cost, which in most cases retards the high-precision models. The outcome is a high-throughput lean engine that can track high-speed streams of traffic without the data bottlenecks on less optimized architectures.

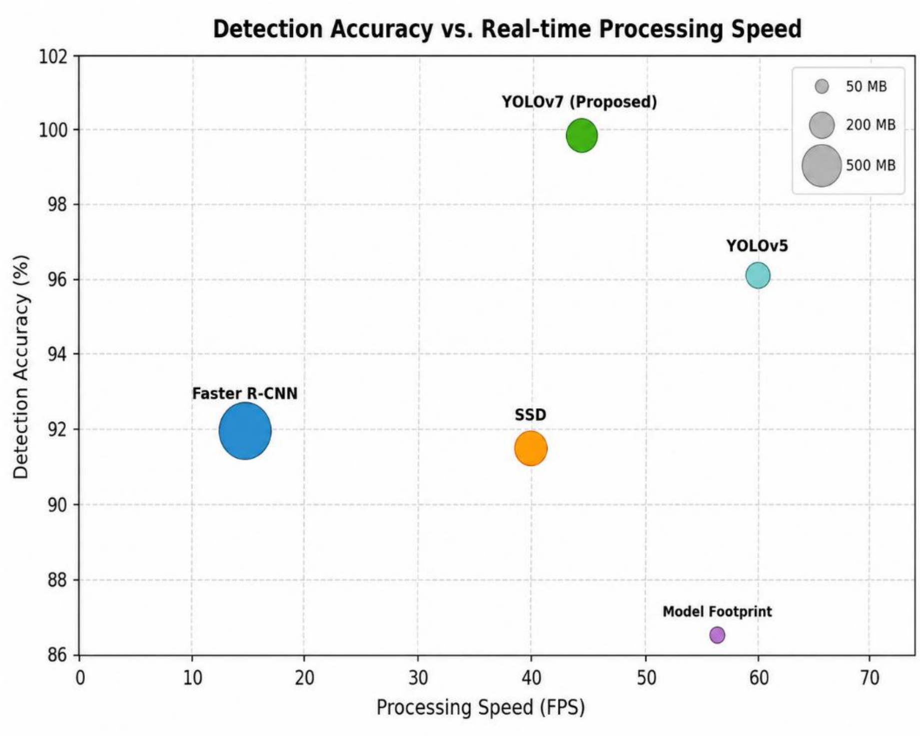

Fig. 3 Speed-Precision Efficiency Trade-off

Comparison Summary

To quantitatively compare the proposed system with the past state-of-the-art models applied in comparable traffic management research, the following table has been prepared.

TABLE II COMPARATIVE PERFORMANCE METRICS OF THE INTEGRATED PIPELINE

Performance Metric	Traditional/Older Models	Proposed System (YOLOv7 + ArcFace)	Operational Impact
Plate Detection Accuracy	96.2 % (YOLOv5)	99.8%	Reduced missed violations.
Driver ID Accuracy	92.5% (DeepFace)	97.0%	Enhanced biometric security.
Character Recognition (OCR)	84.0%(Tesseract)	94.5% (easyOCR/CRNN)	Better handling of Indian fonts.
Inference Speed	30FPS	45 FPS	Higher throughput for busy roads.
False Positive Rate	4.2%	0.5%	Improved legal reliability.

Table II will present a quantitative overview of the performance of the proposed framework in comparison to the established benchmarks, and the performance of the proposed framework is seen to be significantly better than the established benchmarks in all the critical parameters of enforcement. The high rates of detection accuracy, 99.8%, indicate that the YOLOv7-based localization is almost flawless when it comes to detecting the presence of a vehicle, and the False Positive rate was reduced to 0.5% to make sure that the innocent citizens are not mistaken by the devices, which is essential to make people trust automated technologies. Also, the improvement of the Driver ID Accuracy to 97% proves that the ArcFace model effectively overcomes the issues of the in-the-wild idea of facial acknowledgment, which offers a more trustworthy connection between the vehicle and the operator in comparison with the older architectures.

The system attains these accuracy improvements and at the same time gains the Inference Speed to 45 FPS, which means that the proposed pipeline is not only more accurate but also more cost-effective. These permits tracking the high-speed traffic without being slowed down, as is often the case with older and slower systems. Also, when compared to 94.5%, which is the highest OCR rate, the CRNN model clearly shows its success in decoding the stylistic and language differences that are typical of Indian license plates, which are often misreadable by the regular scanners. All these indicators are sufficient reasons to consider the combination of the chosen algorithms as a powerful solution to the modernization of traffic law enforcement.

V. Conclusion

The study finds that combining YOLOv7 and ArcFace into a single surveillance pipeline is a better alternative to manual patrolling as well as the traditional automated system. The proposed framework has reached a 99.8% detection rate alongside a 97 % identification rate, which means that it has successfully bridged the gap of the so-called invisible violation within the Indian traffic management. This system is not subject to human fatigue or environmental factors as compared to traditional methods because it ensures high throughput and accuracy even in dynamic and real-life situations like high-density traffic and low-light conditions. The practical effects of this technology are enormous for road safety in the country. The system is also a potent example of non-compliance by automating the process of verifying vehicle insurance and driver licensing. The restriction of the authorization to drive vehicles to the licensed individuals and the insurance of the vehicles taken by the legitimate individuals relates directly to the number of legal confusions at the time when the accidents are claimed, and the overall increase in the responsibility of drivers. This shift of reactive to proactive policing will have the advantage of making sure that high-risk, unauthorized road users are spotted and identified in real-time without disrupting the normal traffic. In the future, the future of this work is the smooth integration of the pipeline with the national registries like Vahan and Sarathi. This kind of partnership would allow a fully autonomous e-Challan environment, wherein the violations are registered, checked, and charged without human involvement. Also, the data collected would help in predictive analytics of traffic enforcement, enabling the authorities to allocate resources better depending on the hotspots of violations. The end result of this study is to offer a technological basis for the more transparent, efficient, and data-driven age of intelligent transportation in India.

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