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Advanced Vehicle Tracking System With Number Plate Detection Using Deep Learning And Computer Vision

[1]Dr. Vidhya R, [2]Kirthik R, [3]Kaushikk B, [4]Kamalesh P

ABSTRACT

In recent years there has been a huge increase in the population of vehicles. Tracking a particular vehicle among the traffic is done manually and it is a very time-consuming process. Manual tracking can sometimes miss the subject due to various reasons like human error. Tracking the vehicle in real-time becomes almost impossible due to the large number of vehicles passing through a particular area. This article introduces a breakthrough solution that integrates computer vision, deep learning and object tracking to revolutionize vehicle monitoring and tracking system. The Solution leverages footages from surveillance cameras which are placed throughout the landscape. Our advanced vehicle tracking system aims to overcome the limitations of tradition manual tracking methods. It does it by analyzing the footages and gathering the data from it, then the data is processed to track the vehicle across various locations. The system can get data from already existing AI cameras directly or process the footages and use the data from it. The project aims to use YOLO V8 and Optical character recognition (OCR) System to extract data from the footages. The System will not only dynamically track vehicles, but also map vehicle trajectories on a map, providing valuable insights into traffic patterns. This article details the project's objectives, methodology and expected outcomes of an innovative approach to transport management and tracking.

Keywords: *Computer Vision, License Plate Detection, Optical Character Recognition.*

1. INTRODUCTION

The huge increase in vehicle ownership around the world, which has caused traffic management and surveillance to become more complex. In India alone, there are 326.3 million vehicles on the roads.[1] This has led to a need for more advanced systems to monitor and manage traffic efficiently. In case of theft or any situation manually tracking a vehicle is a labor-intensive process that requires a lot of time and can lead to human errors. The large movement of vehicles in urban areas makes real-time tracking a challenge. Our project aims to address this issue by bringing innovation to already available number plate detection methods and satisfy the growing need for efficient vehicle tracking.

1.1 COMPUTER VISION

Computer vision is a multidisciplinary area of study that can gather information from visual data. It is achieved by combining complex algorithms, neural networks, image processing techniques which allows to mimic the human visual system. This technology has a very wide range of applications like facial recognition, object detection, image classification and much more. In the project various techniques of computer vision is used to analyze surveillance footage and extract information for tracking of vehicles.

1.2 LICENSE PLATE DETECTION

[1, 2,3,4] Computer Science and Engineering, Sri Krishna College of Technology, Coimbatore, India.

License plate detection is process identification and extraction of license plate information from the footages. License Plate detection involves multi stage process in which the video is provided as input and the list of number plates appeared in the video is the output. Sophisticated image processing algorithms are utilized to precisely recognize the number plates and OCR techniques are used convert the visual information to text-based format.

1.3 OPTICAL CHARACTER RECOGNITION

An Optical Character Recognition is technique used to identify alphanumeric characters in images and the interpret them to actual characters. OCR works by analyzing visual pattern and then translates into actual text. In this project OCR is used in the extraction of alphanumeric details from the vehicle's number plates in the surveillance footage. OCR allows to efficiently and accurately retrieve information from the received visual information.

2. LITRATURE SURVEY

2.1 PROCESS OVERVIEW OF AUTOMATIC NUMBER PLATE RECOGNITION SYSTEM

Ibrahim and others have provided the overview of the methods involved in automatic number plate recognition system. They covered challenges, variations in license plate, environmental conditions and other important aspects of number plate detection and extraction. It also provides the fundamental processes involved in number plate detection system. [3] The paper comes to the conclusion that future of ALPR should be more concentrated on multi-style plate recognition and it is used on this project.

2.2 DEEP LEARNING METHODS FOR AUTOMATIC LICENSE PLATE RECOGNITION

Jithmi Shashirangana and others has made a survey on comparing various techniques available for Automated License Plate Recognition. The paper establishes the fact that statistical methods have been replaced by deep learning neural networks due to their high accuracy in object detection [2].

2.3 EFFECTIVENESS OF YOLO ALGORITHMS

A lot of studies have used YOLO object detector for license plate detection process [2]. Yolo provides an efficient and robust system for object detection. Yolo has way better performance when compared to other detection methods including DPM and R-CNN [4].

3. RELATED WORK

Although numerous studies have extensively investigated the field of license plate recognition using various techniques and methods, a notable gap exists in the field of using all the data from different points to provide a comprehensive vehicle tracking via camera systems.

4. METHODOLOGY

In conventional settings, tracking the movement of a vehicle is often a very labor-intensive process of manually going through surveillance footages one by one. This manual approach requires extensive human effort, going through each frame until the vehicle is found and repeat the same in adjacent footages iteratively until the vehicle is no longer detected. After that the trajectory is traced to understand its path. In this project, we revolutionize and automate this tracking process by leveraging cutting-edge techniques in vehicle detection and number plate extraction.

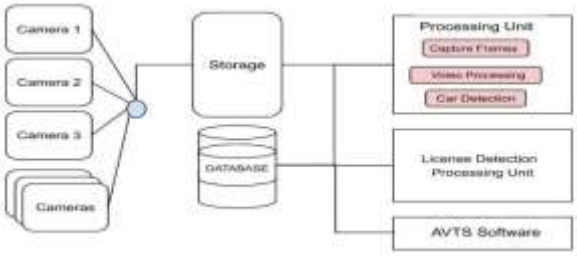

Figure 1. Block diagram of Advanced Vehicle Tracking System

4.1 VEHICLE DETECTION

Vehicle Detection is the foundation for extracting number plate from the footage. In this system YOLOv8 (You Only Look Once) deep learning algorithm is used to detect the vehicles. YOLOv8 is a deep convolutional neural network-based architecture which provides accurate and real-time detections. YOLOv8 has pre-trained models for detecting various types of vehicles. YOLOv8 nano is used to reduce the need of processing power which in future can be used in edge computing configuration. Utilizing the YOLOv8 model, the Vehicle Detection Module performs real-time vehicle tracking in surveillance camera footage. It converts the video into frames and analyzes each frame comprehensively, identifying and bounding boxes around vehicle present in the scene.

4.2 LICENSE PLATE DETECTION MODULE

To detect number plates a customized YOLOv8 deep learning model is trained using a diverse and extensive dataset from Kaggle. The dataset has a total of 22,000 images after applying preprocessing techniques. The dataset includes a wide variety of license plate images. The training is done using Google Colab and from the validation the accuracy is about 98%. The obtained model is customized to focus specifically on the unique features and patterns associated with license plates, enhancing its accuracy.

4.3 LICENSE PLATE NUMBER EXTRACTION USING OCR

The License Plate Number Extraction Module employs the EasyOCR module to extract alphanumeric information from the identified license plates. After the license plate is localized through the License Plate Detection Module, EasyOCR is utilized to perform Optical Character Recognition (OCR). This process involves translating the visual representation of characters on the license plate into machine-readable text. To ensure the accuracy and reliability of the extracted data, a data filtering mechanism is implemented. This filtering step is crucial for refining the OCR output, ensuring that the extracted license plate numbers adhere to the expected format. By integrating EasyOCR and implementing data filtering, the AVTS can reliably capture and process license plate information, forming a vital component in the overall vehicle tracking and monitoring system.

4.4 DATABASE INTEGRATION

Following the extraction of the number plate from surveillance footage, the system seamlessly Following the extraction of the number plate from surveillance footage, the system seamlessly integrates with a Relational Database Management System (RDBMS) to store and manage the captured information. The extracted number plate data is enriched with additional details such as date, time, and camera specifics before being transmitted to the database. Our RDBMS is designed with a normalized structure, ensuring efficient data organization and scalability. It serves as a comprehensive repository, housing crucial information about each tracked vehicle. By incorporating database integration into the workflow, the AVTS ensures robust data storage, retrieval, and management capabilities, facilitating a systematic approach to vehicle tracking.

4.5 AVTS SOFTWARE

The AVTS Software servers as the user interface and control center of this tracking system. The Software harnesses the stored information in the database to provide a wide range of useful functionalities. The Software include various features like query Interface, path tracer, vehicle tracker, alert system and statistics features like heatmap.

4.5.1 AVTS SEARCH

AVTS provides with search functionality which provides instant access to targeted vehicle's data. In addition to the quick search, it also has date range which enables the users to track the vehicle on a particular date or a series of date.

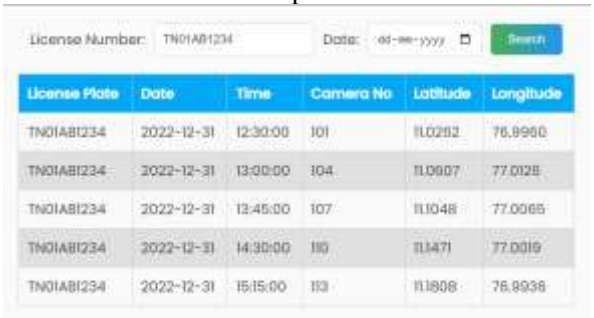

Figure 2. AVTS Search

4.5.2 ROUTE MASTER

The Route Master uses mapping tools to visually represent the movement pattern of the tracking vehicle on real-world map. Users can choose to visualize the path on both map and satellite views. It also allows to see the path day-wise.

Figure 3. Route Master

4.5.3 ALERT SYSTEM

The Alert module in AVTS acts as a vigilant system which provide real-time alerts in different forms for marked vehicles. This module alerts the officials promptly when a tracked vehicle is detected on any surveillance camera. Users can mark a any number plate as tracking and once the purpose is over, we can mark it as closed.

Figure 4. Alert System

4.5.4 HEATMAP ANALYSER

Heatmap Analyzer is an intelligent visualization tool which provides insights on vehicle theft. The module generates heat map that highlight areas with more thefts and helps the officials to make decisions about security allocation and surveillance placement. It allows user to customize the heat map providing different types of optical visualization.

Figure 5. Heatmap Analyzer

5. RESULT ANALYSIS

By implementing the Advanced Vehicle Tracking System Software Module we have achieved remarkable efficiency gains compared to traditional manual tacking methods. In direct comparisons, our system demonstrated an impressive reduction in tracking time, saving up to 70% of the time for manual tracking. This huge time-saving advantage becomes very important in dense traffic areas where manual tracking is very difficult. In addition to time savings, the AVTS system provides an overall higher accuracy as it is less prone to human errors. It allows for real-time tracking and it reduces the response times and it will be very help full in critical situations. The Integrated alert system which can be set to trigger alerts if a particular number plate is detected is very important when there is missing or chasing vehicle and it allows the department to make quick decisions to capture the particular vehicle. The heatmap functionality of the AVTS allows the officials to identify the areas where more focus should be taken for security purposes. The Software can also leverage already present ai cameras and use their data to do the same. In summary AVTS system is highly beneficial.

Method	**Efficiency**	**Error rate**
Conventional Method	40%	~30%
AVTS	85%	~8%

Table 1. Comparison Table

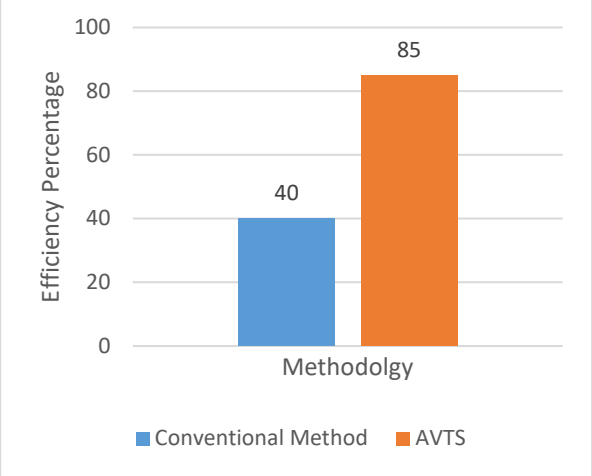

Figure 6. Efficiency Comparison

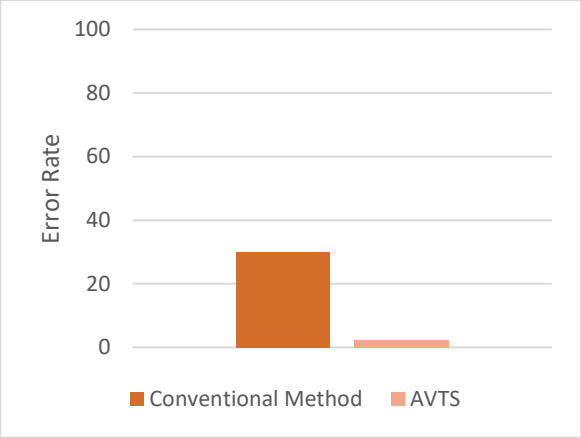

Figure 7. Error Rate Comparison

6. CONCLUSION AND FUTURE WORK

In conclusion, the implementation of Advanced Vehicle Tracking System is significant leap in the domain of vehicle monitoring and surveillance. AVTS provides a great foundation for analyzing data and provides insights in a user-friendly software module which can used by anyone with minimal to no training. The Future for the AVTS involves using an even more accurate and efficient algorithms. We also have a vision to add a advanced neural network identification technique to gather details about the vehicle profile. By implementing the technology capable of identifying the make, model and color of a vehicle and associates with the RC details of the number plate and ensures whether the number plate corresponds to the same vehicle and additionally will check the database for changes in the registered information. Also, we will be focusing on adding predictive path by using patterns. The future for this is very exciting and promising.

8. REFERENCES

[1] S. Luo and J. Liu, "Research on Car License Plate Recognition Based on Improved YOLOv5m and LPRNet," in IEEE Access, vol. 10, pp. 93692-93700, 2022, doi: 10.1109/ACCESS.2022.3203388.

[2] J. Shashirangana, H. Padmasiri, D. Meedeniya and C. Perera, "Automated License Plate Recognition: A Survey on Methods and Techniques," in IEEE Access, vol. 9, pp. 11203-11225, 2021, doi: 10.1109/ACCESS.2020.3047929.

[3] S. Du, M. Ibrahim, M. Shehata and W. Badawy, "Automatic license plate recognition (ALPR): A state-of-the-art review", IEEE Trans. Circuits Syst. Video Technol., vol. 23, no. 2, pp. 311-325, Feb. 2013.

[4] J. Redmon, S. Divvala, R. Girshick and A. Farhadi, "You Only Look Once: Unified, Real-Time Object Detection," 2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Las Vegas, NV, USA, 2016, pp. 779-788, doi: 10.1109/CVPR.2016.91.
[5] R. Laroca, E. Severo, L. A. Zanlorensi, L. S. Oliveira, G. R. Goncalves, W. R. Schwartz, et al., "A robust real-time automatic license plate recognition based on the YOLO detector", Proc. Int. Joint Conf. Neural Netw. (IJCNN), pp. 1-10, Jul. 2018.
[6] A. M. Al-Ghaili, S. Mashohor, A. Ismail and A. R. Ramli, "A new vertical edge detection algorithm and its application", Proc. Int. Conf. Comput. Eng. Syst., pp. 204-209, Nov. 2008.
[7] Y. Wen, Y. Lu, J. Yan, Z. Zhou, K. M. von Deneen and P. Shi, "An algorithm for license plate recognition applied to intelligent transportation system", IEEE Trans. Intell. Transp. Syst., vol. 12, no. 3, pp. 830-845, Sep. 2011.
[8] L. Luo, H. Sun, W. Zhou and L. Luo, "An efficient method of license plate location", Proc. 1st Int. Conf. Inf. Sci. Eng., pp. 770-773, 2009.
[9] K. Kanayama, Y. Fujikawa, K. Fujimoto, and M. Horino, “Development of vehicle-license number recognition system using real-time image processing and its application to travel-time measurement,” in IEEE Vehicular Technology Conference, 1991, pp. 798–804.
[10] J. W. Shi and Y. Zhang, "License plate recognition system based on improved YOLOv3 and BGRU", Comput. Eng. Des., vol. 41, no. 8, pp. 2345-2351, 2020.
[11] S. M. Silva and C. R. Jung, "Real-time license plate detection and recognition using deep convolutional neural networks", J. Vis. Commun. Image Represent., vol. 71, Aug. 2020.
[12] C. X. Fu and R. H. Qiu, "A license plate recognition system based on YOLOv3 algorithm", Sci. Technol. Innov., vol. 3, no. 3, pp. 42-44, 2020.
[13] C. Henry, S. Y. Ahn and S. -W. Lee, "Multinational License Plate Recognition Using Generalized Character Sequence Detection," in IEEE Access, vol. 8, pp. 35185-35199, 2020, doi: 10.1109/ACCESS.2020.2974973.
[14] J. Redmon, S. Divvala and R. Girshick, "You only look once: Unified real-time object detection", Proc. IEEE Conf. Comput. Vis. Pattern Recognit., pp. 779-788, Jun. 2016
[15] P.Shivakumara, D. Tang, M. Asadzadehkaljahi, T. Lu, U. Pal and M. H. Anisi, "CNN-RNN based method for license plate recognition", CAAI Trans. Intell. Technol., vol. 3, no. 3, pp. 169-175, 2018.
[16] Z. TangYushun, "Color-based license plate recognition research", Mod. Comput., vol. 32, no. 71, pp. 63-66, 2020.