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A Systematic Review of Intelligent Smart Traffic Control Systems (ITCs) using Image Processing Techniques

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ABSTRACT

Automatic number plate recognition (ANPR) is a technology to control traffic in smart cities. The ANPR technology has become very important in daily life with the addition of vehicles, traffic violations, and controlling traffic issues. This article aims to review different smart traffic control methodologies used to develop better results in the past few years. This paper presents a comprehensive review of intelligent smart traffic control systems (ITCs) using image processing techniques. We first investigate the major challenges, including the detection of number plate formats and the recognition of characters. We specifically investigate different ANPR techniques that include the acquisition, segmentation, classification, detection, and recognition of number plates. The paper determined that utilizing additional image processing techniques resulted in successful outcomes. Finally, the paper suggests potential areas for future study to improve the accuracy and correctness of image processing methods.

Keywords: Intelligent smart traffic control systems (ITCs), automatic number plate recognition (ANPR), image processing (IP); recognize characters.

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INTRODUCTION

Background

In the last few years, the increasing traffic on roads has led to the development of new technologies for traffic [1] monitoring and control. Automatic identification and recognition [2] of traffic systems is important for various applications such as monitoring stolen vehicles and ensuring [3] safety on the road.

Objective

The basic objective of purposed system is developed an Intelligent Traffic Control Systems (ITCs) use image processing techniques and machine learning to perform tasks such as vehicle counting [5], fake number plate detection, and maintaining databases of alerts and stolen vehicles [6]. These systems can quickly and accurately manage, control, check, and track traffic, reducing errors [7] and difficulties associated with manual management.

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The main objectives of ITCs technology are to find solutions for real-world increasing traffic problems. Some image processing and machine learning techniques are:

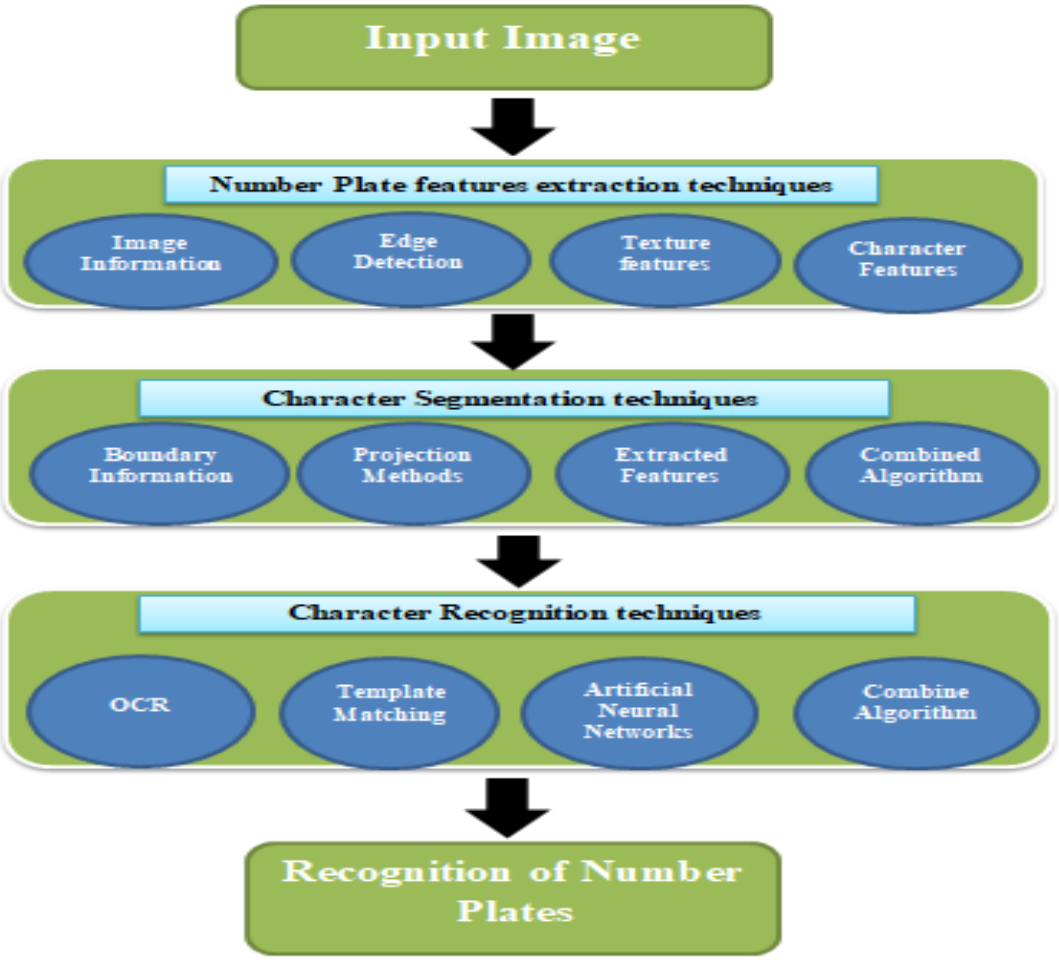

Figure 1. ITCs different image processing techniques

IMAGE PRE-PROCESSING TECHNIQUES

Image processing applications are very interesting in an intelligent traffic control system through number plate detection [8], and an image capturing framework uses them to detect number plates and differentiate between fake and original through the database management system. Image processing designs play a small part in the era of machine learning and computer vision application systems [9]. The field of digital image processing helps the computer view its environment. An image captured by the digital camera and processed by the techniques of image processing via algorithm makes it easy to detect and recognized number plates, objects, features, [10] etc. An image processing technique supporting classifying, segmentation, augmentation, and removal of noise in an image, feature extractions from the captured image, like clustering, edge detection, average pooling, segmentation, etc. [11]. The captured image feature extraction can be divided into patches and further processed with the help of image processing algorithms. The change in technologies like processing power, storage (RAM, ROM), etc. used in image processing will also change the requirements of the image processing algorithm [12]. Open-CV is an open-source library available online used for the processing of machine learning models [13]. In it, a very large number of optimized algorithms exist for the recognition of number plates.

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ACQUISITION

Acquisition in the context of Automatic Number Plate Recognition (ANPR) [13] or license plate recognition (LPR) refers to the process of capturing images of vehicles. This includes acquiring an image of the vehicle and its license plate in real-time, [14] as the vehicle is moving.

The image acquisition process is a challenging task as it is difficult to capture a clear image of a moving vehicle without missing any important components, such as the license plate [15]. The quality of the acquired image is crucial for the success of the following steps in the ANPR process such as number plate detection, character segmentation, and character recognition.

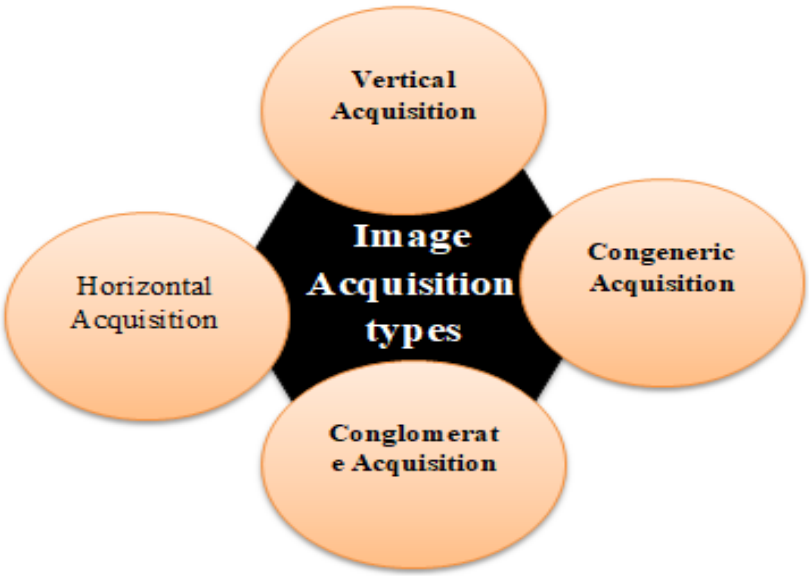

Figure 2 Types of image acquisition

SEGMENTATION

In the context of Automatic Number Plate Recognition (ANPR) or license plate recognition (LPR), segmentation refers to the process of separating the license plate from the rest of the image. This step is important for isolating the license plate from the background and other objects in the image, [16] in order to make the recognition of the characters on the plate more accurate.

Segmentation is typically achieved using image processing techniques such as thresholding, edge detection, and morphological operations [17]. These techniques are used to identify the location of the license plate in the image, and then to extract it from the rest of the image. The segmentation step [18] is important for improving the accuracy of the subsequent step, the character recognition,[19] as it helps to reduce the complexity of the image being analyzed and improves the overall performance of the ANPR system.

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Volume-04 | Issue-01 | March-2023

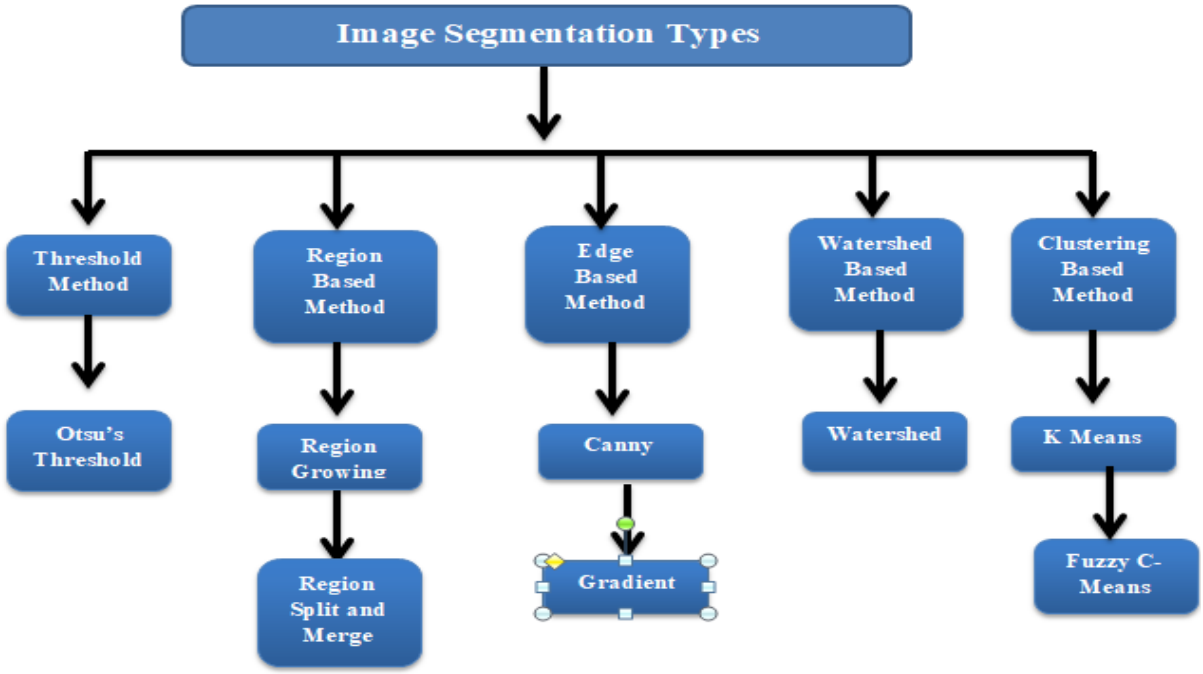

Figure 3 types of image segment

CLASSIFICATION

In the context of Automatic Number Plate Recognition (ANPR) or license plate recognition (LPR), classification refers to the process of identifying and classifying the characters on a license plate. This step is typically done after the image has been captured, segmented, and pre-processed [19] in order to improve the visibility of the characters.

Classification is typically done using machine learning techniques such as neural networks and support vector machines. These techniques are trained on a dataset of license plate images and the corresponding character labels [20]. The trained model is then used to classify the characters on new license plate images. The classification step is important for the final step, the recognition of the license plate number, as it helps to identify the individual characters on the license plate.

In some cases, Optical Character Recognition (OCR) is used to classify the characters, which is a process that converts the scanned or digital images of typewritten or printed text into machine-encoded [21].

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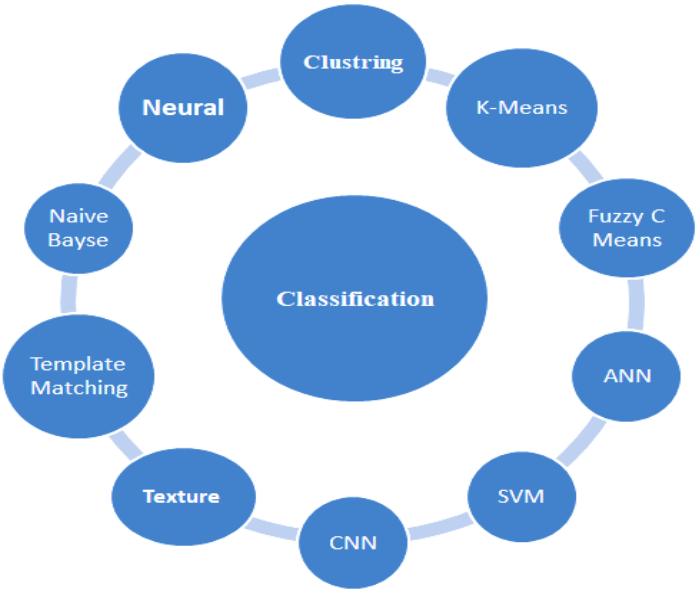

Figure 4 different type of classification

DETECTION

In the context of Automatic Number Plate Recognition (ANPR) or license plate recognition (LPR), detection refers to the process of identifying and locating the license plate in an image. This step is important for isolating the license plate [22] from the background and other objects in the image, in order to make the recognition of the characters on the plate more accurate.

Detection is typically achieved using image processing techniques such as edge detection, blob analysis, and template matching [23]. These techniques are used to identify the location of the license plate in the image, by analyzing the edges, shapes, and other features of the plate. The detection step is crucial for the success of the subsequent steps, such as segmentation and classification of the characters on the plate, as it helps to locate the plate in the image and extract it from the rest of the image [32].

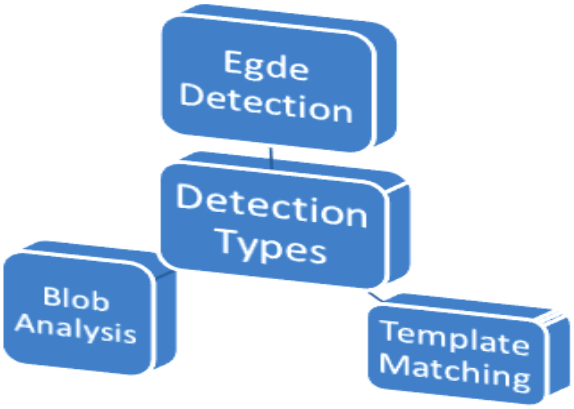

Figure 5 Different types of detection

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Volume-04 | Issue-01 | March-2023

RECOGNITION

In the context of Automatic Number Plate Recognition (ANPR) or license plate recognition (LPR), recognition refers to the process of identifying and extracting the license plate number from the image. This step is typically done after the image has been captured, segmented, and pre-processed in order to improve the visibility of the characters [25].

Recognition is typically done using machine learning techniques such as neural networks and support vector machines. These techniques are trained on a dataset of license plate images and the corresponding license plate number labels [26]. The trained model is then used to recognize the license plate number on new images.

Optical Character Recognition (OCR) [27] is also commonly used for recognition. It is a process that converts the scanned or digital images of typewritten or printed text into machine-encoded text. OCR is used to recognize the characters on the plate and extract the license plate number [27].

Recognition step is the final step of the ANPR process; it allows to extract the license plate number and to use it for various purposes like traffic monitoring, toll collection, and vehicle identification [28].

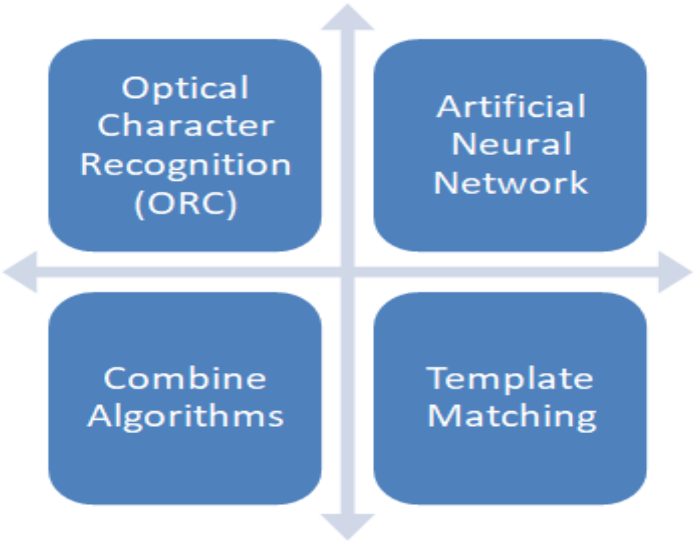

Figure 6 different types of image recognition

LITERATURE REVIEW

Lei M et al. proposed article explains the working of a video-based model that can solve a real-time problem based on vehicle detection and vehicle classification and that uses a surveillance video base camera with high definition to capture the quality of pixels and maintain the traffic video frames. There are two methods developed in this article: Gaussian shadow elimination and background estimation [1].

Miss. Shraddha S. Garage et al. describe character recognition (CR) techniques to detect number plates based on the aforesaid method that can be recognized as the original and a fake. In the character recognition technique, characters can be recognized using feature extraction techniques similar to those used to detect and recognized original and fake number plates [2].

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Zang, D., Chai, Z et al. in the proposed paper, present recognized Chinese car license plates. The camera captured traffic video using a modified visual attention model to detect and capture license plates, and then license plate characters were separated with an OCR technique, finally recognized license plate with database images. [3]

O' Mahony N. And colleagues' proposed this paper, which also explains the hybrid method's combination. The hybrid method improves the performance of computer vision and also enhances the performance of problems that are not suitable for deep learning. Conventional computer vision with combined deep learning, for example, has been explained in computer vision and 3D vision. That is not only implemented with deep learning techniques. [4]

In this article, Kato, S., Takeuchi, E., et al. discovered an open platform using export vehicles and sensors. The authors of the paper explain the algorithm, software, dataset, and different libraries required for detection, recognition, vehicle control, path planning, etc. The success of the model relies on open-source platform vehicles and sensors. [5]

Ojha, S., &Sakhare, S. et al. represent tracking methods and their classification with different methodologies. These methods include important tracking method and also consist of their advantages and disadvantages features. It is useful for many researchers to adopt this method for the tracking of objects and classification, which are the most important application and latest research topics of image processing can be described.[6]

Kaushik Deb et al. in this paper the author explains the sliding concentric window (SCW) segmentation method. This method works on the base of the adaptive image segmentation method for detecting regions of the images. The image can be captured by a digital video camera (canon 570) under different lighting conditions and scenes in real-time. This method works better in different vehicles and weather conditions. The important comparisons are on the bases of performance LSFPO, LSFVO, and the principal axis. [7]

Liu F, Koenig H, et al. In this article, the Author represents various video encryption algorithms. The purposed video encryption algorithm encrypts video communication. The video encryption algorithm can be categorized with its video compression features and adjacent video compression. The most important algorithm includes independent encryption and dependent encryption algorithms. [8]

Culjak I, Abram D, et al. In this paper the authors present and display fast make the reader familiar with Open-CV basic references manuals and books referenced. Professional software developers and C++ programmers are using knowing of Open-CV's important library useful for graduate students and beginner of a new researcher in the field of image processing and computer machine learning areas. [9]

A Roy and D.P Ghoshal, in this paper expressed the system's performance and build the system more efficiently. The author built a new Automatic number plate recognition system that can find out the character form given images for recognition of license plates. The system examined 150 different images that can be captured from various cities and the system accuracy was 91.59%. [10]

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Volume-04 | Issue-01 | March-2023

Sr. No	Different Research paper	Method	Accuracy
1	Object detection and recognition in images	1.RCNN 2. Faster RCNN 3. Easy-net Model	66.1% 73.2% 69.4%
2	A video based vehicle detection, counting and classification system	1.Result of Contour Comparison 2. BoF output with SVM	98.7% 97.4
3	Neural network based vehicle and pedestrian detection for vehicle analysis system	1.SSD and Mobile-Net 2.YOLOv3 =	57.204% 75.740%
4	Automatic detectors for bikers with no helmet using deep	1.VGG16 2.VGG19 3.Mobile-Net	78.09% 79.11% 85.19%
5	Pedestrian detection on Open-CV and Tensor-Flow	SVM and HOG Multi-box SSD	74% 94.77%
6	Detection of motorcyclists without helmet in videos using convolutional neural network	CNN classifier	92.87%
7	Automatic safety helmet wearing detection AUC	1.Output of a ViBc , CF, and C4 2.Output of a ViBE , SVM , CFD , and HOG,	94.13% 89.20%
8	Automated Gate System Using Number Plate Recognition (NPR)	Proteus & Micro C the recognition	98%
9	Automatic License Plate Recognition System for Bangladeshi Vehicles Using Deep Neural Network	deep-learning neural network models.	96.37%
10	A License Plate-Recognition Algorithm for Intelligent Transportation System Applications	Two layer PNN	89.1
11	Automatic Number Plate Recognition (ANPR)	Statistical feature extraction	85
12	An Algorithm for License Plate recognition Applied to Intelligent Transportation System	SVM Integration with feature extraction	93.7
13	Artificial neural netwokrs based vehicle license plate recognition	multi layered perceptron (MLP) ANN	98.17
14	An algorithm for accuracy enhancement of license recognition	Open source OCR Tesseract	98.7
15	Automatic license plate recogniton," IEEE Transactions on Intelligent Transportation	character categorization, topological sorting, and self-organizing (SO) recognition	95.6
16	A cognitive and video-based approach for multinational License Plate Recognition	Hierarchical Neural Network(HNN)	95.2
17	Chinese-style Plate Recognition Based on Artificial Neural Network and Statistics,	BP neural network	95.3

Table 1. Accuracy compression of a few research papers

Adithya.t.g et.al. in proposed research paper gives an idea of how to implement an automatic number plate recognition system using the machine learning technique Artificial neural networks (ANN), especially in crowded cities and during the moving of automobiles along with the tolls plaza in expressways through Open-CV which is a package of different functions which aimed at real-time learning of machine learning like deep learning, computer vision.[11]

In this review, the authors have discussed an automatic house gate control system through the number plate recognition. This article developed to an automatic gate control system for protection

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Volume-04 | Issue-01 | March-2023

and security of vehicle in the houses. The house or home gate control system will work automatically without human beings and also the system will be able to recognize vehicle license number plates from cars at the entrance house gate and take an action to let cars enter or not.The system work based on a PIC microcontroller and computer vision through via video camera can be capturing number plate and recognized from dataset. The developed system has been implemented using Matlab software, Proteus & Micro C the recognition of vehicle number plates is about 98%.[12]

In this survey, the author presents automatic number plate recognition (ANPR) through a real-time video camera in the city of Tehran, Iran. In this system matrix can be accessed to the congestion charge zone (CCZ) then the convex model uses user equilibrium (UE) condition for traffic control. The traffic control system creates a pattern and real-time data gathered by ANPR through a video camera and analysis data through image processing.Theauthordeveloped the OD-put together strategy concerning the outing vehicle framework to deliver for vehicle passageways exits and viewed it as acceptably exact checked to genuine circumstances, he reasoned that the UE conditions couldn't find the functional task result in 27% of cases in examination with the real world.[13]

In this article, the author argues that the AVNPR system is an important research area in the field of machine learning. Different methods and algorithms were used to develop and recognize the AVNPR system. Some problems have issues with scale, lighting situation, variation of numbers, size of number plate, and text style in different provinces and countries. In this research, the Douglas Peucker algorithm is used to check shape approximation to detect the prominent contour, which is then fetched as a number plate. The analysis phase for character segmentation is then connected through OCR to recognize the character of plates. [14]

The author has proposed a method for an image processing technique for the automatic license plate recognition system for Bangladeshi vehicles. The experiment is done with different deep-learning neural network models. The deep learning models have been trained with huge datasets of license plates for the cities of Bangladesh. In this research, an algorithm introduces the need for segmentation and generates suitable patterns for increasing results efficiently. The proposed models display 99.37% accuracy in the recognition of number plates and 96.31% accuracy for character recognition. [15]

16] This study presents a comprehensive performance comparison of several real-time tested and simulated algorithms, including those utilizing machine learning, along with a complete assessment of current approaches and developments in automatic number-plate recognition (ANPR) systems (ML). Using image processing methods, ANPR technology has the capacity to detect and identify automobiles by their license number plates. A successful ANPR system deployment may require additional hardware even with the greatest algorithms in order to maximize accuracy. By referencing pertinent earlier work, analyzing and exhibiting a survey of extraction, segmentation, and recognition while providing guidelines on future advancements in this field, this paper intends to enhance the state of knowledge in ITS (ANPR) built on CV algorithms.[16]

In this review paper, network design and urban traffic management are studied using the origin-destination (OD) matrix, which contains the necessary travel-related information. The current study makes a first step forward in urban traffic assessment by using data mining methods of real-time traffic map pictures that have been produced as a location-based dataset. The data were then analyzed by KNIME and Python open-source workspaces, and the results were compared with the traditional traffic results. It may be concluded that the UE was not able to locate the practical task in 24% of situations as compared to the reality that after origin-destination (OD) based on the trip-per-vehicle matrix was examined for automobile entry points and found to be acceptably accurate. [17]

The study of this research develops a method that uses an augmented technique for the ANPR system to detect and recognized camera images for smart cities. This model produces important

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Volume-04 | Issue-01 | March-2023

relations with passenger and vehicle stops to find out the differences between vehicle classifications. This study is developed for the cities of Mechelen Wille broek in Belgium, images dataset manage by video camera within two weeks. Increasing in the article is to car-shrink zone to check different vehicle classifications. The detection is checked with GPS data from the collected datasets. [18]

In this review paper, an author presented a different methodology and its performance in the Automatic Number plate Recognition ANPR system. The different comparison between algorithms of computer vision. These models detect and recognized license number plates using different image processing techniques. Especially, additional hardware is required to develop a successful ANPR system algorithm. Deep learning techniques are also used for better detection results. This type of article is used to develop advancement in ITS (APNR) with the help of computer vision. Different computer vision techniques are segmentation, augmentation, extraction, and detection techniques recommended for future problems. [19]

In this research paper, the author represents an automatic number plate recognition ANPR system to find out a successful solution to the problem. The proposed algorithm works with a Ghanaian vehicle license plate recognition. The algorithm code is written in C ++ language with Open-CV libraries that are uses feature and edge detection techniques. The OCR technique also performs to detect character recognition. [20]

Author	Year	Methods	Dataset	Accuracy
Hamid mirza hossein,	2022	KNIME and Python, CCZ, Data mining	images of real-time	27%
Adithya.t.g,	2022	AI-based ANNs	Video camera	Not mention
Muhammad Ayaz,	2022	Image processing Techniques	Capture Images	Not mention
Shreya anekaret,	2022	CNN, IP,OCR	Register number plate in database	100 %
Syed Afaqali shah,	2021	CV, CNN, techniques	Not mention	Not mention
Nahin Hossain.	2021	deep neural network (DNN) models, YOLO	Not mention	99.37%
Shahnaj Parvin,	2021	OCR and You Only Look Once (YOLO), CNN	Not mention	97.52%
Pusokhaiba,	2020	OKM-CNN improve Begnaon algorithm(IBA), CCA	Stanford image dataset	Not Mention
Sheida Hadavi,	2020	digital counting techniques, video cameras, Image processing	data from 122 ANPR cameras	Not Mention
Miss. Shraddha.	2019	Image processing, Machine Learning	Not mention	Not mention
SatadalSaha,	2018	Artificial Neural Network (ANN),	Not mention	Not mention

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Volume-04 | Issue-01 | March-2023

Jepthah Yankey,	2018	OpenCV, Image processing	Not mention	Not mention
Goyal A, Bhatia R,	2016	OCR, SVM	CCTV or real time video cameras	91 %
Chirag Indravadan bhai Patel ,	2013	Multilingual ANPR	Not mention	99%
Kuldeepak MK, Vashishath M,	2012	Image Acquisition, Segmentation, Recognition techniques	PC with video camera, catches video frames	98%.
Qadri MT, Asif M ,	2009	OCR techniques	Database of vehicle image	92%

Table2. Comparison between different include vehicle detection and recognition system.

Conclusion

An intelligent traffic control system is an important requirement to develop a suitable environment for the safety of valuable vehicles as well as safe cities' demands. The area of machine learning and image processing techniques has developed a major role in artificial intelligence (AI) subfields. The fake and original number plate detection and recognition systems play a big role in the smart traffic control system and smooth flow of traffic. The development of machine learning (ML) and image processing (IP) methods has influenced the rise of online software and methods with built-in models that can be applied to a variety of systems. Due to the use of machine learning, the method of identifying and detecting vehicles for traffic control has improved in the field of image processing (IP). This review study shows that although machine learning models produced improved results, utilizing image processing with a computer. This paper provides a thorough evaluation of current trends and potential developments in the detection and recognition of modern vehicle license plates, which may be useful to consider as being important in this area.

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Volume-04 | Issue-01 | March-2023

REFERENCES

[1] Adithya.t.g et.al "Automatic Number Plate Recognition Idea Development using AI-based ANNs" 2022
[2] Shreya anekaret.al Automated Gate System Using Number Plate Recognition (NPR) (February 2022)
[3] RaysonLaroca et.al "On the Cross-dataset Generalization in License Plate Recognition" 2022.
[4] Muhammad Ayaz et.al "Automatic Vehicle Number Plate Recognition Approach Using Color Detection Technique" 2022
[5] NahinHossain et.al "Automatic License Plate Recognition System for Bangladeshi Vehicles Using Deep Neural Network" 2022
[6] Syed Afaqali shah et.al "Automatic Number Plate Recognition: A Detailed Survey of Relevant Algorithms" 2021
[7] Hamid mirzahossein et.al "How realistic is static traffic assignment? Analyzing automatic number-plate recognition data and image processing of real-time traffic maps for investigation" 2021
[8] SheidaHadavi et.al "Analyzing passenger and freight vehicle movements from automatic-Number plate recognition camera data" 2020
[9] Lin, H.Y.; Dai, J.M.; Wu, L.T.; Chen, L.Q. A vision-based driver assistance system with forward collision and overtaking detection.Sensors **2020**, 20, 5139. [CrossRef] [PubMed]
[10] O'Mahony N et al (2020) Deep learning vs. traditional computer vision. In: Arai K, Kapoor S (eds) Advances in computer vision. CVC 2019.Advances in intelligent systems and computing, vol 943. Springer, Cham
[11] PlateRecognizer. Plate Recognizer ALPR. Available online: https://platerecognizer.com/ (accessed on 25 November 2020).
[12] ParkPow. a division of ParkPow. Available online: https://parkpow.com/ (accessed on 25 November 2020).
[13] Croce, A.I.; Musolino, G.; Rindone, C.; Vitetta, A. Route and Path Choices of Freight Vehicles: A Case Study with Floating Car Data. Sustainability **2020**, 12, 8557.
[14] Miss. Shraddha S. Ghadage (2019) A Review Paper on Automatic Number Plate Recognition System using Machine Learning Algorithms.Vol. 8 Issue 12, 2019.
[15] Luo, X.; Ma, D.; Jin, S.; Gong, Y.;Wang, D. Queue length estimation for signalized intersections using license plate recognition data. IEEE Intell. Transp. Syst. Mag. **2019**, 11, 209–220.
[16] Thangallapally, S.K.; Maripeddi, R.; Banoth, V.K.; Naveen, C.; Satpute, V.R. E-Security System for Vehicle Number Tracking at Parking Lot (Application for VNIT Gate Security). In Proceedings of the 2018 IEEE International Students' Conference on Electrical, Electronics and Computer Science (SCEECS), Bhopal, India, 24–25 February 2018; pp. 1–4.
[17] Negassi, I.T.; Araya, G.G.; Awawdeh, M.; Faisal, T. Smart Car plate Recognition System. In Proceedings of the 2018 1st International Conference on Advanced Research in Engineering Sciences (ARES), Dubai, United Arab Emirates, 15 June 2018; pp. 1–5.
[18] Birgillito, G.; Rindone, C.; Vitetta, A. Passenger mobility in a discontinuous space: Modelling access/egress to maritime barrier in a case study. J. Adv. Transp. 2018, 2018, 6518329.
[19] Naveed mufti et.al "Automatic Number Plate Recognition: A Detailed Survey of Relevant Algorithms" 2018.
[20] JepthahYankey et.al "Aan Automatic Number Plate Recognition System using OpenCV and Tesseract OCR Engine" 2018

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E-ISSN: 2708-7123
Web: www.lcjstem.com | Email: editor@lcjstem.com
Volume-04 | Issue-01 | March-2023

[21] Alonso, B.; Pòrtilla, Á.I.; Musolino, G.; Rindone, C.; Vitetta, A. Network Fundamental Diagram (NFD) and traffic signal control: First empirical evidences from the city of Santander. Transp. Res. Procedia2017, 27, 27–34.

[22] Kanteti, D.; Srikar, D.; Ramesh, T. Intelligent smart parking algorithm. In Proceedings of the 2017 International Conference on Smart Technologies For Smart Nation (SmartTechCon), Bengaluru, India, 17–19 August 2017 ; pp. 1018–1022.

[23] Shreyas, R.; Kumar, B.P.; Adithya, H.; Padmaja, B.; Sunil, M. Dynamic traffic rule violation monitoring system using automatic number plate recognition with SMS feedback. In Proceedings of the 2017 2nd International Conference on Telecommunication and Networks (TEL-NET), Noida, India, 10–11 August 2017; pp. 1–5.

[24] Chaithra, B.; Karthik, K.; Ramkishore, D.; Sandeep, R. Monitoring Traffic Signal Violations using ANPR and GSM. In Proceedings of the 2017 International Conference on Current Trends in Computer, Electrical, Electronics and Communication (CTCEEC), Mysore, India, 8–9 September 2017; pp. 341–346.

[25]. Felix, A.Y.; Jesudoss, A.; Mayan, J.A. Entry and exit monitoring using license plate recognition. In Proceedings of the 2017 IEEE International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (ICSTM), Chennai, India, 2–4 August 2017; pp. 227–231.

[26]. Goyal A, Bhatia R "Automated car number plate detection system to detect far number plates". 2016

[27] Zang, D., Chai, Z., Zhang, J., Zhang, D., & Cheng, J. (2015). Vehicle license plate recognition using visual attention model and deep learning. *Journal of Electronic Imaging*, *24*(3), 033001.

[28] Kato, S., Takeuchi, E., Ishiguro, Y., Ninomiya, Y., Takeda, K., & Hamada, T. (2015). An open approach to autonomous vehicles. *IEEE Micro*, *35*(6), 60-68.

[29] Ojha, S., &Sakhare, S. (2015, January). Image processing techniques for object tracking in video surveillance-A survey.In *2015 International Conference on Pervasive Computing (ICPC)* (pp. 1-6).IEEE.

[30] Sheetal Rani, Pawan Kumar Dahiya, "A comprehensive study of different techniques of automatic license platerecognition system," *TEQIP sponsored national conference on Advances in Electronics & Communication Technologies*, Jan., 2015, pp. 159-163.

[31] Jitender Kumar, Pawan Kumar Dahiya, "Automatic number plate recognition: a state-of-the-art", *the Worldcongress on Engineering 2014 (WCE 2014) London,U.K.*, july, 2014.

[32] Priya Sharma, Randhir Singh, "Survey and classification of character recognition system," *International Journalof Engineering Trends and Technology*, Volume-4, Issue3, pp. 315-318, 2013.

[33] Shan Du, Mahmoud Ibrahim, Mohamed Shehata, "Automatic license plate recognition (ALPR): a state-of the art review," *IEEE Transactions on circuits andsystems for video technology*, Vol. 23, No. 2, pp. 311- 325, February 2013.

[34] Suruchi G. Dedgaonkar, Anjali A. Chandavale, Ashok M. Sapkal, "Survey of methods for character recognition," *International Journal of Engineering andInnovative Technology (IJEIT)*, Volume 1, Issue 5, pp. 180-189, May 2012.

[35] Kaushik Deb, Ibrahim Kahn, AnikSaha, and Kang-Hyun Jo, "An Efficeint Method of Vehicle License Plate Recognition Based on Sliding Concentric Windows and Artificial Neural Network," *Procedia Technology*, vol. 4, pp. 812-819, 2012.

[36] . Kuldeepak MK, Vashishath M (2012) License plate recognition system based on image processing using labview. Int J Electron CommunComputTechnol 2(4):183

[37] Vivek Shrivastava1 and Navdeep Sharma, "Artificial neural network based optical character recognition," *International Journal (SIPIJ)* , Vol.3, No.5, pp. 73-80, October 2012.

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[38] Du, S.; Ibrahim, M.; Shehata, M.; Badawy, W. Automatic license plate recognition (ALPR): A state-of-the-art review. IEEE Trans. Circuits Syst. Video Technol. **2012**, 23, 311–325.

[39] LihongZheng, Xiangjian He, BijanSamali, and Laurence T. Yang, "An algorithm for accuracy enhancement of license recognition," Journal of Computer and System Sciences, 2012.

[40] AAlbiol, L Sanchis, and J.M Mossi, "Detection of Parked Vehicles Using Spatiotemporal Maps," *IEEE Transactions on Intelligent Transportation Systems*, vol. 12, no. 4, pp. 1277-1291, 2011.

[41] P. K. Dahiya, "Recent Trends in Evolutionary Computation," Ph. D. thesis, M. D. University, Rohtak, India, April, 2011.

[42] H. E. Kocer and K. K. Cevik, "Artificial neural networks based vehicle license plate recognition," *in proc.Comput. Sci*., vol. 3. 2011, pp. 12–137.

[43] Ying Wen et al., "An Algorithm for License Plate recognition Applied to Intelligent Transportation System," IEEE Transactions of Intelligent Transportation Systems, pp. 1-16, 2011.

[44] H. ErdincKocer and K. KursatCevik, "Artificial neural netwokrs based vehicle license plate recognition," Procedia Computer Science, vol. 3, pp. 1033-1037, 2011.

[45] Nicolas Thome, Antoine Vacavant, Lionel Robinault, and Serge Miguet, "A cognitive and video-based approach for multinational License Plate Recognition ," Machine Vision and Applications, Springer-Verlag, pp. 389-407, 2011.

[46] H. ErdincKocer and K. KursatCevik, "Artificial neural netwokrs based vehicle license plate recognition," *Procedia Computer Science*, vol. 3, pp. 1033-1037, 2011.

[47] Yifan Zhu, Han Huang, ZhenyuXu, Yiyu He, and Shiqiu Liu, "Chinese-style Plate Recognition Based on Artificaial Neural Network and Statistics," Procedia Engineering, vol. 15, pp. 3556-3561, 2011.

[48] A Roy and D.P Ghoshal, "Number Plate Recognition for use in different countries using an improved segmenation," in *2nd National Conference on Emerging Trends and Applications in Computer Science(NCETACS)*, 2011, pp. 1-5.

[49] You-Shyang Chen and Ching-Hsue Cheng, "A Delphi-based rough sets fusion model for extracting payment rules of vehicle license tax in the government sector," *Expert Systems with Applications*, vol. 37, no. 3, pp. 2161-2174, 2010.

[50]. Qadri MT, AsifM "Automatic number plate recoginization system for vehicle identification using optical character recoginization". In: 2009 international conference on education technology and computer" 2009.

[51] PrathameshKulkarni, AshishKhatri, PrateekBanga, and Kushal Shah, "Automatic Number Plate Recognition (ANPR)," in RADIOELEKTRONIKA.19th International Conference, 2009.

[52] J. Jiao, Q. Ye, and Q. Huang, "A configurable method for multistyle license plate recognition," *Pattern Recognit.*, vol. 42, no. 3, pp. 358–369, 2009.

[53] Lei M, Lefloch D, Gouton P, Madani K (2008) A video-based realtime vehicle counting system using adaptive background method. In: IEEE international conference on signal image technology and internet based systems (SITIS'08), pp 523–528

[54] Christos Nikolaos E. Anagnostopoulos, Ioannis E. Anagnostopoulos, Ioannis D. Psoroulas, VassiliLoumos, and EleftheriosKayafas, *License Plate Recognition From Still Images and Video Sequences: A Survey*, vol. 9, no. 3, pp. 377-391, 2008.

[55] Anton SatriaPrabuwono and AriffIdris, "A Study of Car Park Control System Using Optical Character Recognition ," in *International Conference on Computer and Electrical Engineering*, 2008, pp. 866-870.

[56] S. N. H. S. Abdullah, M. Khalid, R. Yusof, and K. Omar, "License plate recognition using multicluster and multilayer neural networks," *Inform. and Comm. Tech.*, vol. 1, Apr. 2006. pp. 1818–1823.

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[57] Christos Nikolaos E. Anagnostopoulos, Ioannis E. Anagnostopoulos, VassiliLoumos, and EleftheriosKayafas, "A License Plate-Recognition Algorithm for Intelligent Transportation System Applications," pp. 377-392, 2006.

[58] S. Tang and W. Li, “Number and letter character recognition of vehicle license plate based on edge Hausdorff distance,” *in Proc. Int. Conf. ParallelDistributed Comput.Applicat. Tech*., 2005, pp. 850–852.

[59] Christos Nikolaos E. Anagnostopoulos, Ioannis E. Anagnostopoulos, VassiliLoumos, and EleftheriosKayafas, "A License Plate-Recognition Algorithm for Intelligent Transportation System Applications," pp. 377- 392, 2006.

[60] Shyang-Lih Chang, Li-Shien Chen, Yun-Chung Chung, and Sei-Wan Chen, "Automatic license plate recogniton," IEEE Transactions on Intelligent Transportation Systems, vol. 5, no. 1, pp. 42-53, 2004.