A Necessary Review on Optical Character Recognition (OCR) System for Vehicular Applications

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Abstract: **The licensed number plate is used as an image processing procedure to categorize the vehicles. Optical character recognition is widely used for this character recognition. In this paper, a vehicle licensed number plate is captured as an image and stored in a database. These images will further used for the identification of a vehicle. Due to the increase in automobile-related crimes, this technique is helpful for defense and traffic applications. In dissimilar references, this knowledge is referred as Automatic automobile discovery, Automatic number plate recognition, Car number plate recognition, Car Plate Reader, or Optical Character recognition. There are several approaches used to build an Automatic Number Plate System like Artificial Neural Network-based, Cloud Computing based, Hybrid based, Template Matching based, and Histogram based, etc. By using these approaches, the accuracy of the number of plates using the OCR technique is checked. The main motive of automatic number plate recognition is to monitor the congestion, traffic control, Smart Parking system, safety and surveillance of the drivers.**

Keywords: **Automatic Number Plate System, Optical Character Recognition, Optical Character Reader, automation.**

I. INTRODUCTION

In today's development, the world is followed by the association of things and people. Today, as technology increases in every phase of life, services are also getting better using such technologies [1]. The vehicle transport system is also playing an important role in technology. As the inhabitants increase, the vehicles are also increasing speedily due to the daily desire of the citizens. The automobile transportation System plays a primary task in the traffic monitoring system [2], crime detection system, Tracking stolen vehicles, and protection applications, etc. Vehicle Number Plate Reader is an illustration Processing Technique that uses OCR (Optical Character Recognition) [5] technology to perceive the familiar terms to classify fine vehicle points. Administration of vehicle transportation is monotonous if the occurrence over the shadowing mission is not performed automatically. Accordingly, it is indispensable to build up an automatic license plate recognition system to decipher the troubles discoursed beyond which will involuntarily recognize digit from the frontage elevation image of the vehicle. Vehicle Number Plate Reader (VNPR) [16] is an

organization that consists of the equipment which can examine the character and number on the vehicle's license plate. The VNPR captures the image of a verified license plate of a vehicle. These images were taken by a digital camera/gray-scale digital camera, as well as an infrared camera [11]. An optical Character Recognition (OCR) or Optical Character Reader technique was further applied to these images to categorize the vehicles [8]. The Indian number plate mostly uses a white background and black font of letters on it or the yellow background and black font letters [12].

The automatic licensed plate system is first invented by one of the police stations in the United Kingdom [5]. This technology was used for many years in hardware and software development. This technology also works for improvement in its accuracy. But, its current accuracy [18] is still not satisfied with the traffic concerns. The issue that happened with this system was poor lighting, a large number of plates, and ghastly plates. This system also had a problem of imperfect range software and vision hardware, poor quality systems, etc. But now a days, it is reasonably enhanced via infrared imaging and high-resolution camera with high reflective background in number plates. Image Enhancement technique is used to eliminate clatter and redundant belongings of radiance and inappropriate details. Number plates are detected using an input image to identify the information regarding the particular vehicle. Figure 1 depicts the process in automatic number plate recognition.
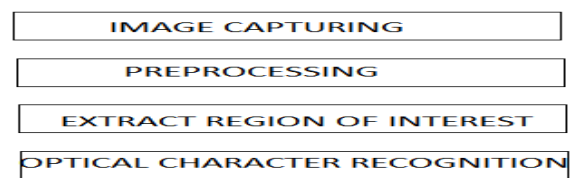
Figure 1: Procedure Followed by the Image Processing

Hence, the rest of this paper's structure is as follows. Within part II, we talk about the journalism effort correlated to Optical Character Recognition systems for vehicular applications done in the past decades by several researchers. Some other approaches also have been depicted/ discussed in appendix 'A' (in the last page), also have been discussed in section III (with a comparative study of existing Optical Character Recognition

techniques). In last, section IV concludes this work in brief with several future research directions

II. LITERATURE SURVEY

Vehicular Number Plate Reader System is the winning recognition of the automobiles. The various research journals were referred to discover noteworthy information concerning based applications. Now the work or approaches or resolution wished-for by several journals in the history decades (concerning Optical Character Recognition or number plate) is discussed as:

In [1], M. M. Rashid *et al.* examine to assemble and realize a conventional parking system that will boost convenience and precautions of the civic parking assortment as well as collect parking charges without hassles of utilizing a magnetic card. The regular parking scheme will able to have a lesser amount of dealings of humans and use no magnetic card and its diplomacy. It added extras to that. It has a parking management system that can give us a thought about and lead the user towards parking liberty. This scheme used a digital image processing of recognizing number plates for the operation of parking and billing systems. The key purpose is to formulate minimum human participation in the parking system and guarantee the right of entry control in constrained zones. This document provides a base technique for identifying license plate (i.e., withdrawal from automobile, by the segmentation of characters and reorganization). It also develops electronics parking payment (with collecting systems based on number plate information). In [1], numbers of algorithms implemented are included as autocorrelation, image processing, plate number recognition, mean square error, and structural similarity indicator.

In [2], C. Patel *et al.* works on parameters like speed, accuracy, performance, image size, and platform are reported. The algorithms used are Hough Transform, Blob detection, Connected Component Analysis, and Mathematical morphology, etc. are used for image acquisition. The algorithm is implemented on the MATLAB, and Visual C++ is also used. In this, the different country's number plates are implemented to check the accuracy of the software. The drawback of this project is that it could not be implemented on the Indian number plates because of the font is different as compared to other countries. So the accuracy is 100% for the U.S.A, China, Australia, Turkey, etc. but not for India format.

Further, in [3], S. H. Bailmare *et al.* proposed a new system for localization of the vehicle's number plate (in West Bengal: a state of India). They segmented the vehicle numbers in sorting order to each number (autonomously). This presents a loom based on uncomplicated and talented morphological function and Sobel edge detection method, a novel scheme used for the detect boundary, and fills the hole with a reduction of 8 pixels only, grouping features in each segment to identifying and recognizing car/vehicle's license plate. This process is completed in two steps, i.e., with tracing the number plate and with segmenting all vehicle's license plate numbers and letters to identify the respective number (i.e., each one automatically and independently).

In [4], A. Kumar and S. Godara describe the faster growth of the Transportation System and Automatic visual Inspection of vehicles. They provide a brief introduction about the number plate types and environment of challenges in the number plate system. In which they give the following details as- location of plate, size of the plate, the color of the plate, occlusion of plate and image background, and the different illumination all discussed during that time, and the image was captured. The motive of their project was the Number Plate Recognition System. This system mainly contains three steps- Region of Interest Extraction, Image Extraction, and Character Recognition using different techniques that facing the challenges of different weather conditions and number plate formats using MATLAB.

In [9], A. Puranic *et al.* discussed the template matching of licensed number plates, which is necessary for the identification of the vehicles to reduce the civic problems in traffic control due to the increase of vehicles and overstressed parking areas. They use the Computer vision and character recognition, algorithms for video capture by the camera during the parking of the vehicle in any specific area. They are doing this project based on their institutional parking area, where finding cars or vehicles are a big issue due to the growing number of vehicles. The vehicle can be a car, a truck or a two-wheeler motorbike, etc. They have concluded the 80% accuracy of the template matching of the different number of plates written in different fonts captured by the camera. The two layers neural network concept is applied to it for the best frame capturing. The limitation in this is they are working on the multiple numbers of plates scanning at the same time with different accuracy. Still, the identification concept does not apply to this project. This application developed using MATLAB.

In [11], G. R. Kumar and P. P. Kiran worked on the development of Android application for mobile of licensed number plate system. The main persistence of this application was to limit the hardware where most of the previous researches have used high-end desktop PC. The characteristic of an accessible system is Recognizes license plate images taken using the license plate recognition camera. An apprehension is sounded inedible when a vehicle having a license plate number not scheduled in the registered catalog is detected, and the License plate number detected by the system is recorded in the logs. It can be searched and used for short psychoanalysis. The restrictions in this are the High price tag is required for a great characterization camera, and it is obligatory to provide power supply cable to camera and space matters. The scheme is implemented, and imitation in java and its performance is experienced in an authentic image.

In [12], G. Somal *et al.* discussed the use of a license number plate system in metropolitan cities to make it a smart city by providing safety and surveillance for the drivers. They are using the Automatic Number Plate System using SVM, which provides help in working to make the city smart in transportation. They are recovering the main problem of diversity of number plate problems by using the novel algorithm for recognition of license plates in a complex scenario. They have used the

mathematical morphology and Support Vector Machine (SVM) for this useful purpose. SVM is the clarification method that is made for the concept of decision plates that can define the decision boundaries. It is the supervised learning technique used for classification and regression. They use image processing and morphological operations for extracting the License Plate from the image and search out the digits from the image. The feature vectors extracted will be used to train the SVM Classifiers and make the database, and it is a new approach for highly accurate and real-time recognition of poor quality number plates. This system is useful for both the big and small city's transportation systems. This algorithm employs a Support Vector Machine (SVM) to be up to date with numbers. Each character is renowned by SVM, which is qualified by a few progress samples. In this, the numbers are veteran one by one using the qualified sculpt. The outcomes are achieved by the judgment of the utmost value between the outputs. To trained dataset, Machine Learning is used as a GUI.

In [13], S. Kumari *et al.* discussed the main purpose of the number plate system, is to capture the image and then change the size, i.e., resize the image and region of interest is considered by eliminating edges from the image. By applying multiple image processing techniques to justify the image and the number plate text is used to identify the detail of the vehicle owner. It works on image acquisition, image segmentation, and the identification process is recognized using the number plate image. The drawback of this system is that it will not identify the position information if the situation of status information is distorted.

In [15], D. H. Kulkarni *et al.* used the cloud-based intellectual parking services in well-groomed cities using IoT (Internet of Things or Internet Connected Things) paradigm is used to develop a Number plate recognition system. This scheme includes an algorithm that increases the effectiveness of the in-progress cloud-based smart parking deal and develops a set of associations architectural plans based on the Internet of Things technology. This system helps users in finding at no cost parking liberty (automatically) at a low cost. In this software system, a smart parking sensor is used to good judgment the car for the duration of the doorway or goes out from the parking zone. The system uses ultrasonic technology to keep an eye on car parks. An ultra-sonic reader counts the proportion of without charge parking places in every car park, which helps to reduce the expenditure of time to find the liberty for a car park [21]. Using IoT services, ongoing things can make identity announcement devices. The devices could be tracked, prohibited, or monitored using far-flung computers coupled through the Internet. This project required a large amount of cost to implement in real-time and does not required for the common purpose.

In [17], G. Sharma discussed the problem related to the diversity of number plates (in Nepal). In this, the vehicle plate picture is taken by digital cameras, and these respective or captured pictures were proceeded to verify the vehicle's license number plate (in little time). Several features or techniques like Morphological operations, and boundary detection, smoothing, filtering for plate localization, segmentation for segment character are used. This segmented character was reduced into a building block of 70×70 dimension and determine correlation with the stencil of the database using template matching algorithm (using cross-correlation and phase correlation), and in last, compare these results for generating higher accuracy. They capture the image by the camera to identify the detail of the vehicle. They recognize the all single character of the number plate wording to examine the lettering and validate the outcome from the database. To progress the accurateness by using phase correlation and normalized correlation, they recognize the number plate.

III. COMPARATIVE STUDY OF OPTICAL CHARACTER RECOGNITION (OCR)

Optical Character Recognition (OCR) the technique is used to converting the printed text into editable text. By using OCR, we can check the accuracy of the text. There are some difficulties faced during check the accuracy of the text like size, orientation, type and style, and complex background of the image [20]. Hence, a comparative study of Optical Character Recognition systems is also explained in Appendix A. The next section will conclude this work in brief with some future enhancement.

IV. CONCLUSION AND FUTURE WORKS

Optical character recognition is the most used technique to extract text from images, used to read number plates of vehicles, and provide matching (checking) with the document management system. In the above discussion, we have seen efficient algorithms or methods that are yet to be proposed. As future work, this OCR can be used to identify stolen vehicles or reduce crime over the road/ highways (in a city) via identifying vehicles through its identification/ verification process. Such critical issues like stolen vehicles and crime over the road using fake/ vehicles can be reduced to a critical level through a strong and powerful OCR system.

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Appendix A

Author (s)	Technique used	Parameters used	Remarks
[19]	OCR, Neural Network, Support Vector Machine (SVM), Hierarchical Temporal Memory (HTM).	Fifteen resultant images are tested	The investigational effect demonstrates the algorithm obtains first-class recognition routine and compatibility in diverse license plates under weaker illumination and complex backgrounds. That provides a better accuracy with 97.7% and 46.1ms. Further RFID devices and Bluetooth equipment improve accuracy.
[14]	OCR, Image processing using MATLAB.	Two vehicle number plates are used to remove the noise from the number plate within the boundary box.	To produce a better result using difficulties like blurry image and different fonts, poor lighting, etc. Some of the similarities in characters like O and D; 5 And S; 8 and B, E; O and 0, etc.
[16]	Image processing, Neural Network, OCR based on Java and Android PHP.	Two number plates are tested on a multi-track app.	This is an android application that is used for limited vehicles and at a low rate.
[9]	OCR, Back Propagation Neural Network, MATLAB,	Five images are tested from different directions in eight directions.	Number plates of Multiple vehicles are detected using the best frame to check or compare the accuracy to competition the aim character on or after eight directions.
[10]	Machine learning, Image Processing, MATLAB, Artificial Neural Network	Four parametric images are tested by the software. Tilted images are tested.	Tilted images are used to test. This algorithm fails to detect the number of plates under changing illuminations.
[5]	Template Matching, Neural Network using MATLAB, and OCR.	Experimental performance of some algorithms.	The algorithms are image dependent, and if the image changes algorithm changes. So no introverted algorithm is capable of several images.
[6]	OCR, Genetic Neural Network, Feedforward Back-propagation neural network	Seven different images are tested to scan the grey level image and dark images using MATLAB R2013a to find the right characters in the image.	It is 100% resourceful in segmentation as well as recognition of characters. The permutation of the neural network and template matching is performing single-handedly.
[7]	Morphological operations using OCR,	Fifty images are detected in different positions like tilted and corrupted to show results.	It is a secured system for parking used in a highly secured building. Additionally, we can intellect theft vehicle by comparision of a stolen vehicle catalog and ring a self-control alarm. This process will enhance safety measures of the system. This processs is used in defense for many purposes like, parking system velocity detection, detection of traffic disobedience, toll assortment.