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A Review Paper on Automatic Number Plate Recognition System

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ABSTRACT

Number plate recognition brings a drastic improvement for the city traffic enhancement. It provides the direction in which the steps should be taken for working of an effective intelligent transportation system. ANPR have become necessity for traffic control management due to rapid increment of vehicles. The main aim of ANPR is to monitor traffic and for security purpose. Recognition of number plate uses image processing techniques and latest technology in detecting characters on vehicle license plates automatically. In recent years, there are many technological developments in recognizing license plate area of research. Image processing protocols like OCR technology allow the traffic surveillance to deal with several problems that occurs in criminal investigation, toll collection, monitoring traffic, controlling speed, parking management etc. For efficient management of traffic and mass surveillance in transportation system, an ANPR system is essential. With the aid of image processing algorithms and vehicle images dataset, it becomes possible to monitor traffic at a large scale. Vehicle images are helpful for recognizing characters on license plates by performing image segmentation, feature extraction and character recognition. Data collected through captured images are utilized in the commercial applications, law enforcement, traffic applications etc. The software examines the vehicle picture as an input image that results in displaying the plate numbers. The system with image processing used reliably for traffic detection where modification of the technologies enables an accurate acknowledgement of vehicle number plates. There are several ANPR systems developed, working on character recognition of LP by the help of image processing technique. This paper reviews the performance by researchers in this particular area towards meeting goals of transportation system. It also provides major issues and challenges in this field.

Keywords : Automatic Number Plate Recognition (ANPR), Optical Character Recognition (OCR), License Plate (LP)

I. INTRODUCTION

Vehicles perform a vital role in an element of traffic control structure. It creates a huge problem for traffic control area to manage this large traffic. This is due to rapid increase of population that is not easy to control vehicles traffic in present time [9]. For this purpose, ANPR becomes a key factor for a quick cognitive transportation system. In addition, in present scenario, application complexity increases which in return demands the higher requirements for an efficient license plate recognition protocol [7].

For an efficient monitoring and management on roads, an Automated Number Plate Recognition (ANPR) system plays a vital role. ANPR uses an image processing algorithms, which help to detect the conveyance license plates, and recognizing characters of number plates. In a perfunctory surveillance of pedestrians or vehicles management, an ANPR system helps to capture the vehicle possessor record by identifying there vehicle plates [9]. As ANPR is a bulk monitoring method, thus it plays an imperative role in traffic control protocol by simply recognition of number plates. Here the pictures are clicked by camera and conveyance and its possessor is identified using of number plate recognition methods [1].

In 1976, the first ANPR system was designed in United Kingdom at Police Scientific Development Branch. Although it's main prototype system started operating after 1979 in which the contracts were given to manufacture in industries. At very first contract, it was working at EMI, Electronics and later on it was given to the Computer Recognition Systems (CRS) in Workingham, UK [1].

Primary Applications of ANPR

The primary applications of number plate recognition are used in urban traffic flow monitoring, detection of vehicle seed at highway, auto transport charge, in traffic accessibility [8]. Other than this, observations were found that the ANPR has the big data applications too i.e. the recovering of stolen cars, automatic toll collections, parking management, monitoring of road traffic, traffic law violation of rules [4]. It is also utilized in several different fields like entrance admission, security control, airports, speed control, harbour cargo control and many more [5].

With the rapid growth in population, there is rapid increase in vehicles too, which in return also increase the traffic violations. When there is more public traffic, the transport management system face difficulty due to these traffic violations. This may include frauds in collecting of tolls on highways and parking lots, speeding issues, theft of cars and so on. Therefore, now a day the necessity of vehicle plate identification is in demand. The information, which is originated from the identification of vehicle numbers, can be assisted in miscellaneous purposes like dealing with several crimes, monitoring of border crossing, highway toll stations, searching for stolen vehicles, access and flow control, proper traffic management etc. [12]. ANPR also plays a vital role in smart cities for criminal investigation and traffic detection and vehicle tracking. In manifold highway toll systems observations were that there are fixed shooting angles and lightening environments, size and brightness. Therefore for this aim, ANPR is used frequently in highway toll systems [6].

Further advantages of ANPR system includes monitoring of administration, urban road monitoring, outing vehicles are tested easily, checking of illegal entries, incidents managements, various safety managements, used in surveillance of petrol posting forecourt, in an area of red light camera, customer credentials, speed enforcements, crossing of border and so on [9].

Goals of ANPR- The detection of license plate is a very good source of information for record detection and recognition. However, the traditional procedure of number plate identification is tedious [7]. The manual way of identifying the vehicle and its owner is not that applicable in detecting license plates to retrieve the secret treasures of knowledge. Automatic license plate recognition is therefore chosen as an optimal solution for extracting numeral plate information. Moreover, for this we require different recognition techniques for the extraction of information of number plates.

How Number Plates are recognized – The plate recognizing is performed in two modules:

- License plate detection
- License plate recognition

The basic steps involved in identifying vehicle number plates are image acquisition or input image, pre-processing of image involves gray scale conversion and noise reduction, segmentation of character, extraction of features, classification and identification of character.

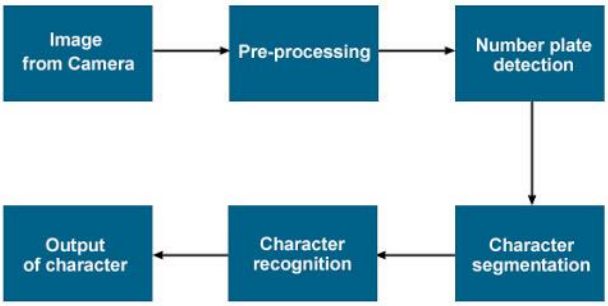

Fig 1. Basic steps in ANPR System

In this paper, the division is in 6 sections. Section 2 provides a brief introduction of features and uses of ANPR. Also, depicts advantages and disadvantages. Section 3 throws light on brief literature review of work done by other researchers. Section 4 provides comparative study and section and highlights the important issues and challenges. Finally, in Section 5 conclusion is provided.

II. FEATURES OF ANPR

License plate recognition is achieved through device program ANPR. Images taken by using cameras displays the output of vehicle plate. ANPR's basic work is reading and unfolding license plate. ANPR are also called by the name of ALPR (Automatic License Plate Recognition). The software of this system forms a record of all number plates that interpret with all the related data such as date, time and GPS location. It utilizes the OCR technology for recognizing characters of number plates.

A- Cost of ANPR System

There are various types of ANPR that are available and due to different types, component, uses and geographical areas they fall into different categories of price. It depends on the authority criteria for which they wish to purchase ANPR program system. In market of 2016 evolution, it was around USD 1.78 Billion. It is highly anticipated by the end of 2023, the price may increase up to USD 3.57 Billion.

B- Features

All the ANPR contain a camera that differs in size and quality that totally depends on the price of ANPR. The pictures taken from camera can be from infrared, colour or both mixtures. The system sometimes consists of a chain of frames that affects the accuracy rate. The cameras of ANPR are consists of IR-lamp, fast shutter and zooming control of lens for detecting images. For achieving better plate information, approximately 40 pixels of width are required. The distance of camera from the conveyance should be as minimum as possible that is approximately <35 meters. The vertical angle of camera on license plate should be < 45 degrees, and the horizontal angle of camera should be < 45 degrees. It has observed that the minimum 2MP camera required for parking lot management and collecting tolls automatically, 4MP camera for logistics or vehicle repair type works and approximately 8MP for highway traffic monitoring camera is used.

C- Powerful Source

It completely relies on the pace and camera angle of the vehicle to achieve an accurate accuracy for recognition. Camera measures this by capturing innumerable vehicle images and further re-examining those images for better accuracy.

D- Ease and Use

In this system, the images of vehicle pictures are being stored therefore, ANPR needs huge bandwidth.

Therefore, to decrease the storage, images are being converted to text and only the record of plate numbers are maintained followed by date.

Use of ANPR in smart city

The transportation in miscellaneous areas has resumed being unbelievably burdensome. Therefore, violation of regulations is common now days. There are elevated pace locating vehicles cameras that aid in detecting conveyance speed and finding traffic violation by any vehicle by keeping the record of number plate.

They are utilized in the technologies such as image processing, communication purpose, sensor, control etc. [8] These technologies provides insight and details about the vehicle regarding the vehicle owner, law enforcement etc. and hence their use provides constant, timely and effective help in transport management.

Since the manual recording of vehicle, information may be recorded wrong and the chances of information breach and misplaced data are higher. Therefore automatic software program for traffic detection is needed for the area of safety purposes and for many other traffic tasks [3].

ANPR plays a major role in the age of Big Data deployment. In a complex environment conditions like ambient lightening the program is effective to use [7].

ANPR collect vehicle images as data, displays plate numbers by the aid of algorithms, and depicts the useful information. Now-a-days plate recognition systems are a fantastic tool with the aid of cameras for capturing transport images.

Advantages of ANPR

- For helping of visitor management propagation in respect to detect outside vehicles.
- ANPR are efficiency saving by reducing manual traffic check and access permission to required members only.
- Extra security is provided by installing ANPR such as reduced human error. Unauthorized vehicles are located easily.
- Efficient way for resource management to detect the in and out time of an employee can be done by using ANPR.
- The vital role in parking management is granted by ANPR system by controlling the traffic flow.

Disadvantages ANPR

- ANPR creates problem in extreme weather conditions.
- Privacy issues are a significant element in ANPR, as sensitive information is collected in the system and can be misused further.
- Photos cannot be identified because of the blurring of the picture while the car is going by.
- The photos with low resolution often lower the accuracy rate in the ANPR method.

III. REVIEW LITERATURE

Saqib Rasheed et. al [2012] proposed “Automated number plate recognition using hough lines and template matching” proposed a robust license plate identification and recognition system based on hough lines using Hough Transformation and template matching Model. In this research license plate detection is carried out using canny detector and transformation of the hough. Additionally, the identification of license numbers is achieved using matching templates. The accuracy rate for vehicle plate extraction is 94.11 percent and the number of vehicles recognized successfully is 90.62 percent. The proposed ANPR system is a standardized number

plate for Islamabad, which are 89.70 percent overall results. [01]

Alice N Cheeran et. al [2017] proposed "Automatic Car Number Plate Recognition" have used Modified Ant Colony Optimization Algorithm in the plate localization for the edge detection. The Kohonen neural network is used to classify an individual character's location and dimensions. In addition, the connected component analysis (CCA) and the proposed hybrid network are compared using CCA, and the neural kohonen network is conducted and the accuracy is measured. Eventually, a hybrid hierarchical classification system based on inductive RULES-3 approach and SVM approach is proposed. The proposed character segmentation and extraction algorithm gives 94 percent accuracy. [2]

Sumanta Subhadhira et. al [2014] proposed "License Plate Recognition Application using Extreme Learning Machines" have developed new license plate recognition system using Extreme Learning Method (ELM). Here smartphone application is used to photograph the license plate of a vehicle. This system recognizes the Thai license plate to pre-process and extract features using ELM as a classifier and a Histogram of Oriented Gradients (HOG). For this, the program follows the same concepts as provincial license plate recognition. ELM is used for data concerning segmentation. The province part is 95.05% accurate but it has less data to process. The proposed application can recognize the whole plate which consist both the car registration identification number and it's province by 89.05% accuracy. [3]

Yoshihiro Shima [2016] proposed "Extraction of Number Plate Images Based on Image Category Classification using Deep Learning" has proposed the ANPR system on a region extraction technique combined with morphological image processing and deep learning. Edge detection and Connected Component Analysis (CCA) is used in the processing of morphological images. As a feature extractor, a pre-trained Convolution Neural Network (CNN) "Alex-Net" is used, and SVM is used as a classifier. The algorithm is implemented in morphological image processing in C++ programming language, and in pre-trained CNN and SVM sections in MATLAB. The proposed device has been checked on 126 sample images, including 113 extracted as the right number plate. It gives 89.7 per cent success rate. [4]

Dinesh Bhardwaj et. al [2014] proposed "Automated Number Plate Recognition using Machine Learning Algorithms" have proposed a technique to recognize a number plate of vehicle. In this study, the recognition of number plate was rendered in five separate steps, such as Image Acquisition with the aid of a high-resolution camera, pre-processing of image using gray scale conversion, removal of noise using median filter, edge detection using Sobel Technique, segmentation using vertical technique, character recognition using K-Star machine learning algorithm. Here dataset was collected as 320 images of various vehicles in real-times, parking etc. This work has been performed for the Indian ANPR system. [5]

Wei-chen Liu et. al [2017] proposed "A Hierarchical Plate Recognition System using Supervised K-means and Support Vector Machine" have presented a novel hierarchical character recognition scheme based on supervised K-means and SVM to recognize the blurred and tilt license plate. In this proposed work, the main aim was to reduce classes of characters in each subgroup and then further reduce the numeral of SVMs and their complexity. This system offers 98.89 percent precision for blurred license plate and tilt characters. Further on the comparison with the state-of-the-art of plate recognizing approaches, the average improvement is found to be 3.6%. [6]

Yongsheng Li et. al [2019] proposed "Vehicle License Plate Recognition Combining MSER and Support Vector Machine in a Complex Environment" have

proposed a license plate recognition algorithm based on MSER and SVM. Here the license plate recognition algorithm is contrasted with two standard license plate recognition algorithms i.e. edge detection and detection of colours. The proposed algorithm is suitable for complex surroundings. MSER extracts the character area directly. Here in MSER, license plate location and segmentation is not carried out and directly screened for the characters which is directly used for the character recognition. This composite MSER and SVM system gives more than 90 per cent accuracy. And the edge detection and color detection accuracy is poor as compared to the MSER and SVM combined. [07]

Yang Guang [2011] proposed "License Plate Character Recognition Based on Wavelet Kernel LS-SVM" has presented license plate character based on wavelet LS-SVM (least square SVM). The Mexico hat wavelet kernel is used in this work because, due to the function of multi-scale analysis, it has better generalizing potential and is approximately orthogonal. The approach based on the LS-SVM wavelet kernel consists of two key steps in character recognition which are preprocessing and multi-classifier. Here, according to BT-model, four classifiers are based on wavelet kernel LS-SVM. The experiment is performed on the BP neural network and RBF LS-SVM method proposed for this method. The system suggested has a cumulative recognition rate of 98.3 per cent. [08]

Dinesh Bhardwaj et. al [2014] proposed "Comparison of ML Algorithms for Identification of Automated Number Plate Recognition" has proposed the new methodology for number plate recognition in which there is six imperative parts. In this, the comparative analysis is carried out among the classifiers based on factors such as average accuracy, precision, recall, F-measure. Here classifiers used are the Random forest classifiers, Rep tree, IBK, K-star. Character resizing is done using universal discourser. The feature extraction is done on the basis of six zone features. For the classification of characters and numbers on the number plate region are performed in WEKA tool. Detailed accuracy is done by using K-star ML algorithms which show the accuracy on data set of 99%. All over it is observed that among all K-star algorithms performs better for recognizing number plate. [9]

Mahima Satsangi et. al [2018] proposed "License Plate Recognition: A Comparative study on Thresholding, OCR and Machine Learning Approaches" have discussed license plate recognition using Viola Jones algorithm. In this the main concentration was on the classification and the recognition of characters on the license plate. The images captured are with the aid of magnetic loop detector sensor. The identification of the license plate is performed essentially in three sequential steps such as image detection, number plate extraction and image segmentation. The ML algorithm viola Jones is used which consist of four basic concepts like Haar feature, Integral images, Ada-boost and a Cascade classifier. The output obtained from the algorithm proposed is compared with the output obtained from threshold and OCR technology. The accuracy from the all three implementations shows that the viola jones gives the best performance of the 80%. [10]

Kaili Ni et. al [2018] proposed "A Proposed License Plate Classification Method Based on Convolutional Neural Network" have proposed a novel license plate classification scheme that is based on convolutional neural network. This work uses the CNN seven layers that are four convolutional layers which are followed by max-pooling layers respectively. And then they use the fully connect layers that helps in classification with feature extraction. At last, soft-max function is performed in soft max layer. The faster-CNN is being carried out for the localization of the vehicle plate. Here, the 100% classification accuracy is achieved on the training set. It is found

that the proposed research offers the best 98.79 per cent accuracy score. [11]

Zied Selmi et. al [2017] proposed "Deep Learning System for Automatic License Plate Detection and Recognition" have discussed the automatic license plate detection and recognition based on deep learning approach. In this study, using the first CNN model for LP detection, the author uses the pre-processing steps to identify license plates and non-license plates. And for the classification and recognition purpose, the second CNN model is used. For the character segmentation the canny edge detection technique is used. Further recognizing characters is based upon tenser flow framework that uses second CNN model with 37 classes. The dataset used here are collected from the Caltech dataset and the AOLP dataset. [12]

This paper presents a survey of techniques focused on ANPR used for smart Intelligent Transportation Network. This study will help the researchers identify potential areas of research.

IV. COMPARITIVE STUDY

TABLE I. COMPARITIVE STUDY OF PREVIOUS WORK

Authors / researchers	Work	Method used	Result
Rasheed et al. (2012)	Automated number plate recognition using hough lines and template matching	Hough lines using hough transformation and template matching	The result is capable to discover and acknowledge the license plates of Islamabad. It gives out the total accuracy of 89.70 percent with over all recognition time to be as 0.9 second for one particular image.
Sasi et al. (2017)	Automatic car number plate recognition	Modified Ant colony optimization (ACO) for plate location, hierarchical grouped structure that is based on inductive RULES-3 and Support Vector Machine (SVM) approach	Result shows the segmentation and extracting image of plates in proposed algorithms gives a precision rate of 94 percent. Additionally the combined approach offers improved results for character recognition.
Subhadhira et al. (2014)	License plate recognition application using extreme learning machines	Extreme learning machines (ELM) for recognition and Histogram of oriented gradients (HOG) for feature extraction and	The result provides the acknowledgement of Thai number plates. It provides an accuracy rate of province part with 95.05 percent and to equate license plate with

		pre-processing	province both results as 89.05 percent efficient.
Shima (2016)	Extraction of number plate images based on image category classification using deep learning	Morphological image processing, pre-trained convolutional neural network (CNN) Alex-Net for extracting characteristics, Support vector machine (SVM) as classifier	The proposed device is made for the extraction of license plate which shows the output of 126 rear sample images with 89.7 percent success rate.
Bhardwaj and Gujral (2014)	Automated Number Plate Recognition System Using Machine learning algorithms (Kstar)	Kstar machine learning algorithm, sobel and vertical segmentation,	To increase the speed of number plate recognition, this method is proposed with the aid of five steps based on Indian plate character analysis.
Liu et al. (2017)	A hierarchical license plate recognition system using supervised K-means and Support Vector Machine	Hierarchical approach combining supervised K-means and support vector machine	Result is shown on the base of images taken from 1530 samples of Taiwan license plate for identifying characters. The accuracy rate of the device is observed as 98.89 percent for unfocused and inclined images. The system was observed with high accuracy rate and less computations with decreases complexity.
Li et al. (2019)	Vehicle License Plate Recognition Combing MSER and Support Vector Machine in A Complex Environment	Algorithm based on Maximum stable region extremum (MSER) and Support vector machine, Kernel method	The combined approach of MSER and SVM offers better character recognition results compared to conventional methods without the use of position of license plate and segmentation of character. The system proposed is more concise and effective, which gives 90 per cent accuracy.

Guang (2011)	License plate character recognition based on wavelet kernel LS-SVM	Mexico hat wavelet LS-SVM (least square SVM)	Result shows the accurate and quick recognition of conveyance license plate. Experiment was performed using 500 image samples for training and testing data. In addition, the findings of the proposed study were compared with the neural network BP and the LS-SVM RBF. Among which it was observed that Mexico hat wavelet LS-SVM depicts high success rate as 98.3 percent.
Bhardwaj and Kaur (2014)	Comparison of ML algorithms for identification of Automated Number Plate Recognition	Kstar ML algorithm, WEKA tool, IBK, Random Forest, REP Tree, MLP	The result is obtained to compare the several algorithms of machine learning for recognizing the license plate. Among all the algorithms compared it was observed that kstar depicts the highest accuracy on the data sample images that is 99 percent.
Satsangi et al. (2018)	License Plate Recognition: A Comparative Study on Thresholding, OCR and Machine Learning Approaches	Viola Jones ML algorithm	Recognition of characters is performed on 510 images by using Viola Jones ML algorithm. In the result the output comparison was carried out with the other traditional techniques like threshold and OCR technology. Among all three technologies the viola jones gives out the more efficient result for recognition that is 80 percent.
Ni et al. (2018)	A Proposed License Plate Classification Method Based on	Convolutional Neural Network, Faster-CNN	The result is obtained by using CNN model for the classification of number

	Convolutional Neural Network		plate. To avoid the bad quality picture that affect the successful recognizing of characters from data sample, this improved classification process is added. It was found that the designed program was more accurate as it provided 98.79 percent accuracy rate.
Selmi et al. (2017)	Deep learning system for automatic license plate detection and recognition	Second CNN model, Canny Edge Detection Technique, Tenserflow framework	Result demonstrates vehicle number plate identification by using deep learning architecture. Tenserflow framework was opted for classification and CNN for recognition. The caltech and AOLP dataset was used on 2400 dataset images. Measured with previous work, the performance was further measured, and it was found that the proposed work offers the best accuracy rate of recognition.

Issues and Challenges in using ANPR System

ANPR system has gained the attention of several people in the field of intelligent transport system in the last few years. The involvement of human activities has decreased to a greater extent, with the help of automatic license plate recognition. It can track traffic automatically by detecting and recognizing the plates on the vehicle. The highly significant factor in the metropolitan city is the management of traffic and finding out the vehicle owner. As observed, the increase in population indicates the growth in the vehicle is in many folds. So, recognizing license plate will also be needed to acquire more vehicle information and to increase the knowledge for interested vehicles in field of traffic management. The recognition of vehicles can be done by using various methods but the more efficient way in the traffic management is to utilize ANPR systems by performing image processing protocols for finding the vehicle information. Recognition systems are mainly used for monitor traffic, collecting electronic tolls and law enforcement. Other necessary area of interest and scenario for application are repossession of stolen vehicles, control on parking lots, criminal investigations etc. An open problem is the proper detection that may be due to distinct vehicle plate and bad environment conditions [4].

The images may be taken under bad lightening conditions and also camera resolutions may not be very high. Some other factors that affect the ANPR are due to inclination problems, plates not clear enough to be read and also many vehicle plates in a picture [12]. The other problems observed were that tilted or side view images and moving distance images were not recognized easily. The framework needs the implementation of appropriate image processing techniques to enhance the identification of vehicles. Creating a necessary segmentation and recognition methods for recognizing of vehicle are considered to be a big request for the mass surveillance of traffic. It should be kept in mind that the precision accuracy of recognition is higher and computational complexity to be lower in the city traffic observation to monitor traffic. Another issue includes facts that the images are noise sensitive and also sometimes the vehicle plate pictures are full of dirt. There are missing number plates and dingy license plates that also cause problem in accurate identification of vehicle. So, these, in effect, avoid attempts at using ANPR techniques in traffic management areas. Unless object detection methods and recognition methods are substantially improved, the recognition of conveyance by ANPR implementation would remain a huge problem.

V. CONCLUSION

This paper depicts a survey of recognizing vehicle plate number in traffic surveillance. System with powerful image processing technique can easily detect vehicles of interest from different angles and display information about the owner as output. This is a much more accurate way of monitoring traffic than a manual approach. And for that, with the aid of the new technology, ANPR systems are playing a major role in developing the intelligent transportation network. Recognition may use the image processing technique combining with neural networks to detect the number plates where the tilted or side view images, moving distance images, numbering scheme, and number plate style (background) can be further enhanced. Object detection and neural networks are useful for detecting side view or tilted images and moving distance images. This work opens new possibilities by using deep learning algorithms for image segmentation processes by the aid of You-Only-Look-Once (YOLO) algorithm, including convolutional neural networks for character recognition. It had also been manifested that the ANPR are light weight and a robust method. In future recognition systems have the option of using high resolution cameras with increased number of frames for high accuracies and for better recognition results.

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