Can we use Automatic License Plate Recognition (ALPR) for live tracking of vehicles?

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Abstract: **The idea of this research is to track vehicles using their number plates. For this we introduce, Automatic License Plate Recognition system (ALPR). ALPR is a technology that uses optical recognition systems to recognize images captured from CCTV cameras to recognize vehicles' registration plates. ALPR can gather the images of the number plates and store in a database along with the location, date and time. This report analyses the working of ALPR systems, the challenges and at last consider if we can use ALPR systems for live tracking of vehicles.**

Keywords – Automatic License Plate Recognition (ALPR), Optical Character Recognition (OCR), Closed Circuit Television (CCTV)

I. INTRODUCTION

In the present world the need for transportation has become a key and unavoidable. As we can see, the number of automobile users have increased drastically in the past few decades than it did for few centuries. As the number of vehicles has increased, tracking them has also become a tedious task. Tracking can be done for several reasons by various methods. Nowadays the necessity of google maps and other navigation applications have been increased wildly. These navigation applications use the Global Positioning System (GPS) service from our smart phones to show our location on a graphical map with the respective coordinates. GPS can also be used for tracking purposes. No only smart phones, GPS is also installed in devices which dedicately serves the purpose of tracking. There are so many vehicles which are tracked thrgouh GPS. Even trains and buses have GPS devices installed in them which lets the controller know the location and be updated of their ETA and time to wait at a specified stop. Now a days GPS are installed even in organizations' cars for safety purposes. However these advantages of GPS can be used in known vehicles or vehicles under one's control. But how can we track unknown vehicles or vehicles that aren't under our control. The answer is obvious- CCTV cameras. CCTVs are not only used to monitor and control traffic on roads and freeways but also used to identify the criminals. Whenever an incident happens, cops instantly check the near by CCTV camera footages and identify the criminals. With the overflowing advantages of CCTV cameras, they also serve as useful input for ALPR systems. ALPR is a technology that uses optical character recognition systems to recognize images captured by CCTV cameras to recognize the content from vehicles' registration plates. The ALPR systems use the images captured from the CCTV footages as input for its entire functionality so the quality of the images are crutial. There are several hurdles to overcome before reaching perfection in ALPR which will be discussed below.

This paper aims to provide a comprehensive survey of the working of ALPR systems and their functionalities. The paper potraits the complexities in implementation, algorithms used to overcome the complexities, and validation methods. Section II of this paper discusses the background ALPR and the working of ALPR systems. Section III provides a detailed review about the complexities in implementing a working ALPR system and actions performed to overcome the complexities. Section IV provides a detailed review of other publications on ALPR systems. Section V concludes and briefly discusses the idea of this paper.

II. BACKGROUND

Automatic License Plate Recognition (ALPR) is used widely in the areas of roads and freeway monitoring, traffic surveillance, law enforcement, parking lots, toll booth fee collection, disrupt

criminality and organized crime groups and terrorists. ALPR is used in parking lots to figure out the amount of the parking fee by calculating the in and out time using the information collected, control relay to automatically open gates or barriers when a car arrives which matches the payment information across the database. ALPR cameras are being mounted on police cars, road signs, bridges etc to photograph images of speeding cars or traffic violators. With this advancement, the cops need not figure out the license plate information manaully from the image or footage and then cross check with the database. ALPR does it in no time, it reads the information and stores the vehicles' information in a database instantly which can be retreived anytime.

In general, the ALPR systems use the images captured by surveilance cameras as input and then using character recognition the actual content in the plate is retreived. ALPR uses a set of state-of-the-art techniques in order to achieve perfection in the working model. Below are the major steps involved in the working of ALPR.

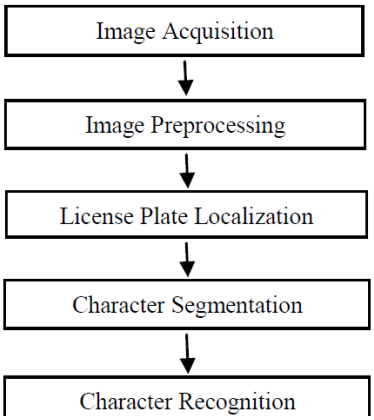

Fig 1: Working of an ALPR model [6]

- *Image Acquisition:* In this step, the raw image of the vehicle or an image from the footage is captured and sent to the ALPR system for preprocessing. Image acquisition simply menas, conversion of visual characterstics of an object into digitally encoded representation. The object might be a physical scene or the interior structure of an material. The image can contain the frame of the license plate along with the vehile itself or even along with other vehicles, road and surroundings.

- *Image Preprocessing:* In this step, the raw image is processed in order to extract more details out of it in the future steps. In terms, this is the step where an image is enhanced and made to appear more legible. Image processing literally means, a set of operations performed on an image to get an enhanced image where some useful information can be extracted out of it. This is the step where the part of the license plate is extracted from the entire image.

- *License Plate Localization:* In this step, the characters of the image are matched with close combinations and to eradicate variations in it. Localization of an image can be a huge task with many variations such as size, shape, color, texture, and spatial orientations of license plates. This is the step where the accuracy of the character image is measured/increased appropriately.

- *Character Segmentation:* In this step, the characters are segmented and extracted accordingly. Character Segmentation means, to split an image which contains a sequence of characters into few sub-images which contains the individual character in it. If a license plate containing 5 characters is given as an input to this system, the output will be 5 images have each character in it segmented from the input data.

- *Character Recognition:* The final step of ALPR is character recognition. In this step, the characters in the image are recognized and the recognized characters are extracted from that. Character Recognition is usually done by comparing the features extracted from the segmented image and a set of stored features of characters. The highest match is obtained from the comparison, from which the character in the segmented image will be matched across.

According to [1], there are several ways of License Plate Extraction, License Plate Segmentation and Character Recognition.

In [1], the existing license plate extraction methods are categorized based on the features in to the following:

- ✓ Using Boundary/Edge Information.
- ✓ Using Global Image Information.
- ✓ Using Texture Features
- ✓ Using Color Features
- ✓ Using Character Features
- ✓ Combining two or more features

Each of the above extractions are made based on shape, color, texture and background image of the license plate.

In [1], the existing license plate segmentation methods are categorized based on the features they used:

- ✓ Using Pixel Connectivity
- ✓ Using Projection Profiles
- ✓ Using Prior Knowledge of Characters
- ✓ Using Character Contours
- ✓ Using Combined Features

In [1], the existing character recognition methods are categorized based on the features they used:

- ✓ Using Raw Data
- ✓ Using Extracted Features

As we discussed, the existing categories of extraction, segmentation and recognition, why are they needed in the first place? The answer would be the complexities in capturing or reading the data from the CCTV images. Let us discuss about the issues faced in the next section.

III. COMPLEXITIES AND SOLUTIONS

According to [1] & [2] there are several common complexities that an ALPR system should overcome before attaining perfection. Let us discuss about it below:

- ➢ Quality of the plates: License plates may be out of shape, rusted or even the paint might have worn off.
- ➢ Some license plates may have been placed in different parts of the car, for example, some might have their number plates within the car on the dash, some might have it on the right or left corners.
- ➢ The extracted image might have more than one set of numbers in it, or might also have no numbers in it.
- ➢ Format of the license plate font in the image, which may include font style, font size, color etc.
- ➢ Images captured from incorrect angle or license plates being tilted by external factors.
- ➢ Natural factors affecting the image quality for example, bright or dim day light, fog, rain or snow.
- ➢ Sometime even the other vehicles' headlights may affect the image quality.
- ➢ Some license plates may have overlapping numbers.
- ➢ Not necessarily alll license plate are in English. For example, In India each state its own language and people are allowed to use plates in their native language.

In [2] there were several verifiers implemented to over come these complexities. In [5] there were several other methods used to over come these complexities. Let us take a quick look about Split and Merge Segmentation and Boundary Detection methods used in [5]. Split and Merge segmentation handles the same concept as that of its name, the characters in the image are splitted into segments to represent them in a more understandable manner until there could be no more splitting done. Boundary Detection is a vehicle categorizer, which catergorizes the vehicles to hatchback, sedan, SUV or mini van. Using boundary detection it is easy to predict the location of the place in an image.

For other complexities that involve external features like light affecting the quality of the image, histogram equalization and contrast enhancement concepts were used. In [1], a proposed system which involves gradient analysis and grey level transformation was used.

IV. LITERATURE REVIEW

ALPR is the extraction of a vehicle's license plate information from a recorded footage or image which can be used for traffic surveillance, toll and parking payment. There were several hurdles overcoming which the ALPR became successful. The recognition system should overcome weather conditions, font and shape of the license plate as well as external accessories of the car [1]. To overcome these hurdles a verification of plates is needed. A license plate verification algorithm was then proposed which can give an outline of the characters in a license plate. This was done by connected component analysis CCA which uses the size and coordinates of the patches [2] and proposed four verification approaches to generalize the license plates. With the number of fast-moving vehicles passing through a highway on daily basis, it might be difficult to capture the images to recognize the license plates. So, it was necessary to recognize a pattern from a live stream video. To obtain this, two main components were introduced. Recognizer and Model Development where the given video is split into frames for recognition which are synthesized and subjected to training [3]. Overcoming these, the ALPR system was further proposed to be developed to recognize multi-national license plates based on a combination of PC and Digital Signal Processing [4]. Adding to the solutions proposed earlier for the complexities in achieving perfection in

ALPR, Split and Merge Segmentation and Boundary Detecction methods were proposed [5].

V. CONCLUSION

In this paper, we discussed about the working of ALPR systems, the complexities involved and actions to be performed to overcome those complexities. We also reviewed few publications in this area to learn about the ALPR systems in detail. Having known the working of ALPR, I intend to propose an idea of real-time tracking with ALPR. While the traditional uses of ALPR is to identify and vehicles why can it not be used to know a vehicle's location? We discussed that in ALPR systems, the license plate details and the location details can be stored in a database once the character recognition is done. This can be done in a sequential manner. For example, when cops are in look for a particular vehicle and if that vehicle is spotted in a particular junction or any location, the details can be updated to the database instantly and with that, the cops and infer close by routes that the driver might possibly choose. With this information, the cops can cover up the possible routes even before those are made by the driver. Once implemented, this idea would work as a weak GPS tracking device leaves its traces here and there. For a perfect functioning of this idea, the updates to the database should be made in such a way that the last seen location of the tracking vehicle keeps updating sequentially. Based on the factors like speed and direction the vehicle is heading, inferred from the image received, the cops can quickly plot the possible directions the vehicle might take on a graphical map to shut or narrow down the driving options.

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