



Automatic Number plate detection for law enforcement using optical recognition system

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Abstract

Automatic Number Plate Recognition (ANPR) is a specialized type of Optical Character Recognition System (OCR). It is a method of reading a vehicle's license plate using OCR to create vehicle registry or location data. ANPR is utilized by a variety of agencies around the world to enforce the law, including determining whether a vehicle is registered or not. Government entities, such as highway agencies, can categorize traffic movements for computerized toll collection. Images of the text from the license plate can be stored and processed using the ANPR system. Infrared cameras are often employed to take photographs in any lighting condition, whether it is day or night. To be more accurate ANPR technology should also consider plate variations from place to place.

Keywords: ANPR; OCR (Optical Character Recognition); AI; License Plate Detection (LPD); Social Security Administration (SSA); ASCII (American Standard Code for Information Interchange).

1. Introduction

Machine's replication of human functions such as reading number plates was just a dream. However, during the last few decades, machine reading has become a reality. In the field of pattern recognition and Artificial intelligence, OCR has been the most successful application. There are many existing systems for performing character recognition in a variety of applications such as the Automatic number plate recognition system. Although the machines will never be able to match human reading abilities. The basic difficulty of recognizing optical characters is addressed by OCR. Optical recognition (OR) is usually done after the writing or printing, whereas in online recognition computer recognizes the characters as they are drawn [1, 2]. The recognition of hand-written or printed characters is possible, but the quality of the input documents has a direct impact on performance. Since, its commercial debut in 1950 in Reader's Digest, OCR has made steady progress. After specially designed typefaces, such as OCR-A and Farrington 14B there came support for elite, pica typescripts, and then "Omni font" typeset text [3].

The acceptance rates of hand-printed digits and restricted alphanumeric fields have improved during the last decade. Many researchers now view cursive writing and fancy number plates as the next challenges to various OCR scripts. Characters classification is essential for testing improved algorithms in pattern recognition, but most of the trials are conducted on isolated characters, and the results are not always exact. Perhaps the decrease in cost is more noticea-

ble than the increase in scope and accuracy. Costly scanners and specific purpose optical hardware were required by early OCR systems for e.g.: - Optical Page Reader that was used to read typewriter reports at the SSA cost over three million dollars. The instant arrival of microprocessors for personal computers in 1980 resulted in a cost decrease nearing that of general-purpose computers [4]. Now small versions of OCR software are added to commercial desktop scanners having the same cost as a normal printer. Our aim is a discussion on working of Automatic number plate detection in detail with some examples of current ANPR, and OCR systems and to predict future scopes and improvements.

2. Related work

In today's development, the world is being tracked by the association of objects and people. In terms of technology, the transportation system also plays an important role. Automatic number plate identification is a well-known idea due to the rapid growth of cars, motorcycles, and other vehicles [8]. VNPR (Vehicle Number Plate Reader) is a graphic processing approach that employs OCR technology to recognize and identify fine vehicle points [3]. OCR is the process that converts handwritten and printed text into machine-encoded text, for example- ASCII. It is noted that reliance on execution depends upon the nature of printed or handwritten characters.

In [3] S. Bansal *et.al.*, described that OCR is the most common method for extracting text from photographs, reading car license plates, and matching with the document management system. The OCR method could be used to identify stolen automobiles or lessen crime on the roads/highways in the future by recognizing vehicles using its identification/verification method.

In [4] M. Onim *et.al.*, emphasized the LPD and CR (character recognition) of cars in Bangladesh. A graphical user interface (GUI) design is also offered to users to easily operate it. Firstly, the authors did the classification of the image to detect the presence of automobiles in video frames, followed by VLP detection using YOLOv4 and OCR using Tesseract. YOLOv4 and the tesseract OCR engine were used to detect VLP. Due to the varied orientations, motion blur, lighting conditions, and other characteristics of detected VLP, character identification from VLP were one of the most difficult tasks in this ALPR system.

In [7] O. Shobayo *et.al.* proposed a cost-effective VRPN system that detects moving objects using a clever IR sensor and captures the image with a camera also extracts the text from the image, and saves the text on a web page. The Raspberry Pi was chosen as the key component to perform the system's principal functions. For segmentation of characters and animation, OpenCV was combined with Python programming for character recognition and segmentation.

In [8] A. Tourani *et.al.* suggested a combined License Plate Detection (LPD) and Character Recognition (CR) system for Iranian automobile license plates with real-time performance and high accuracy. For this, the authors used two YOLO v.3 deep networks in sequential order and trained the system using realistic data collected in a variety of weather, noise, and illumination conditions.

In [9] P. Meghana *et.al.*, the authors explained various recognition approaches, their benefits, and limitations, and recommends the best user-friendly and efficient system that is unaffected by climatic circumstances. Factors such as speed, light, text size, and styles should have no effect on that system. In this paper, artificial neural networks (ANN) are used to identify the number plate of a car and the segmentation of the image.

In [16] M. T. Qadri & M. Asif discussed the automatic vehicle identification system based on the vehicle license plate. For recognizing the car from stored information, the system employs a variety of image processing techniques. This system is implemented in Matlab and its performance is evaluated using real-world photos.

3. Components of the ANPR System

There are several components in any typical ANPR system. The most basic setup is displayed in Figure 1. The first part of the process is the digitization of the Number plate using the optical camera. Symbols are then extracted through a segmentation process from regions that contain text [4]. These symbols are then pre-processed and disturbance is eliminated to help character isolation in upcoming steps. Then a description of the symbol classes is compared with the extracted features obtained through a previous learning phase. Finally, words and numbers from the license are reconstructed using context information.

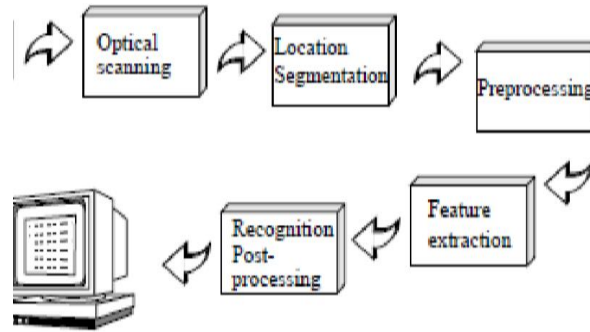


Figure 1: Modules of an OCR System

- **Optical scanning**

The image of the license plate is captured by the scanning process. Then the light is represented as different levels of grey by using an optical camera which is made of a sensor and transport mechanism. Number plates typically contain black ink print on white background, so it is a good practice to convert multicolored images to black and white images before performing OCR [5]. A process called thresholding is applied to save memory and calculation. The result of the recognition depends on the quality of the image. Thresholding is usually done on a scanner and blacks and white are determined by levels of threshold, so the Thresholding process is important [6]. A fixed threshold is sufficient for a high-quality image with good contrast but a lot of images that we use in practice have a large contrast range [13], [14].

- **Location and segmentation**

Characters and words are separated with the process of Segmentation. Words are usually divided to separate isolated characters in OCR/ANPR techniques [7]. These isolated characters are then identified individually. Segmentation is performed by separating all components that are isolated by white spaces [15]. This is an easy technique to implement, but there are some problems that happen if characters are touching or even if there are fragmentations in characters. Problems in segmentation are grouped as: -

- 1) Mistaking graphics and geometry for words and characters.
- 2) Distinguishing text from noise.
- 3) Taking words as graphics.

- **Pre-processing**

The scanning process results in an image containing some amount of disturbance. Smoothing is the process of thinning and filling. To eliminate breaks, gaps, and holes from characters filling process is used, while line thinning is used to reduce lines width [8]. The technique used for smoothing contains a moving window to traverse the image of a black and white character, applying some rules to the content inside the frame[17]. Normalization is then used to get the character of the same size. Then many different Variants to identify skew for returned pages are used[18], [19].

- **Feature-Extraction**

There are three main groups for extraction of features:

- Transformations, series expansions.
- Structural analysis.
- Distribution of points.

Images as cells are compared with the present templates with a command known as mat2cell [9]. Figure 2 is the extraction of character in form of a Matrix.

- **Correlation and Template matching techniques**

Here no feature is actually extracted therefore they are different from other processes. These techniques work such that the matrix that has an image of input character is matched directly with a prototype character set. Then the distance of the pattern prototype is calculated, and the best matching prototype class is the pattern [10]. Implementation of this system is basic so it is used in many ANPR Systems However the problem with this technique is that it does not have a way to handle rotated text[20-22].

Wrongly classified characters proportionate to all present characters. The system sometimes fails to detect Misclassified characters so for detection and correction of these errors manual inspection of processed text is needed sometimes. Recognition rates are usually in a trade-off condition this means that high rejection and lower recognition rates imply there might be a low error rate. When testing an OCR error rate is important while we consider the rejection rate less important. One example of this is Number plate reading. While reading a Number plate if a character gets rejected there will be re-scanning or manual entry may be done. But if a number plate is wrongly decoded incorrect information will be entered into the database. So, we conclude looking only at recognition rates of ANPR is not enough.

5. Experiment Design and Discussion

The result of the created ANPR framework is shown in this section. For this research infrared camera is used with MATLAB on a computer. Pictures of cars having distinctive lighting, and shades are taken (fig 3[a]) and supplied to the PC. Then pictures of number plates of cars are taken having 800 x 600 resolution as shown in (fig3 [b]). The number plate is extracted from the vehicle with help of yellow/white pursuit calculation (fig3 [b]). The remaining processes are focused on the extracted vehicle License plate as displayed in (fig3 [c]). After extraction License plate is worked upon in parallel. Multi-fold parallel organization is demonstrated with this. Then individual characters are worked upon by taking the help of the Segment division's strategies on the vehicle number plate (fig3 [d]). Results of division are demonstrated below. Finally, all alphanumeric characters are identified (fig3 2[e]).



Figure 3: (a) Images taken using the camera



Figure 3: (b) Vehicle number plate extraction



Figure 3: (c) Inverted binary image

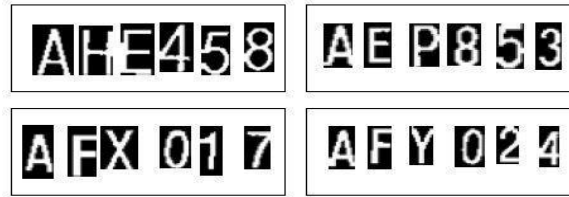


Figure 3: (d) Character segmentation using column segmentation

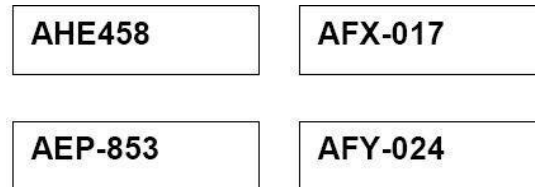


Figure 3: (e) character recognition using OCR

5. Conclusion and future scope

This paper concludes that the automatic number plate reader (ANPR) framework that uses vehicle number plates is rightly exhibited. The System compares the extracted data with a database. MATLAB is used for realizing the system and genuine pictures are used for testing. So, in conclusion, we demonstrate that the framework is capable of correctly identifying vehicle number plates in various lightning and clarity conditions.

The future scope of ANPR is that it will be essential for law enforcement and threat detection to police and defense forces. Also, if there is large-scale deployment and a database is maintained it can also be used by civilians to improve the overall security as they can easily detect number plates before using services. The system's effectiveness increases if a high-resolution camera is used so Government should take interest in developing this system as this system can save governments money if applied effectively in various areas.

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