License Plate Detection and Identification

Qatar University - College of Engineering - Department of Computer Science and Engineering

Marim Elhanafy
Computer Science and Engineering
Qatar University
Doha, Qatar
me1803468@qu.edu.qa

Hagar Elsayed
Computer Science and Engineering
Qatar University
Doha, Qatar
he1805123@qu.edu.qa

Asma Al-naimi
Computer Science and Engineering
Qatar University
Doha, Qatar
aa1608057@qu.edu.qa

***Abstract*—With the exponential increase in the number of vehicles over the past few decades, it has become increasingly challenging to monitor and manage traffic and enforce laws. License Plate Recognition (LPR) has emerged as a promising solution for automatic toll collection, traffic management, and law enforcement. Several techniques have been proposed for license plate detection, each with its advantages and disadvantages. The first step in LPR is to localize the license plate, which can be achieved using various methods. In this project, a histogram-based approach is used, which is simple and fast, and can be implemented using a dataset containing pictures of cars. The localization algorithm is implemented using MATLAB and verified for its functionality. The coordinates of the license plate location with the highest probability are then used for license plate recognition.**

***Index Terms*—Image, Segmentation, Feature, Extraction, Recognition, Edge Detection**

I. Introduction

Digital image processing involves the utilization of computer algorithms to carry out processing on digital images. It is used to enhance raw images acquired from cameras, sensors on satellites, space probes, aircraft, or everyday photographs for diverse applications. The typical steps in image processing encompass image scanning, storage, enhancement, and interpretation.

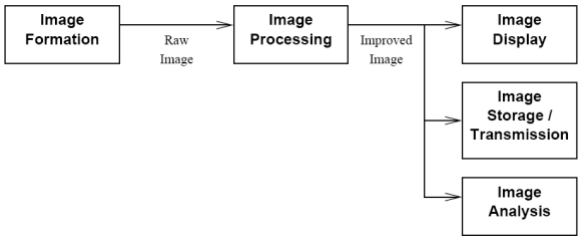

Fig. 1. Common steps in image processing.

Image processing play a vital role in identifying vehicles, as each country assigns a unique license number to them. These numbers are written on the license plates, distinguishing one vehicle from the other, which is especially useful when multiple vehicles of the same make and model are present. The use of an automated system for identifying the license plate of a vehicle and extracting the characters from the region containing the license plate can simplify this process. The license plate number can be used to retrieve additional information about the vehicle and its owner, which can then be utilized for further processing. The implementation of such a system can improve the efficiency of traffic management and law enforcement, as well as aid in toll collection. The common steps in license plate detection and identification are represented in Fig. 2.

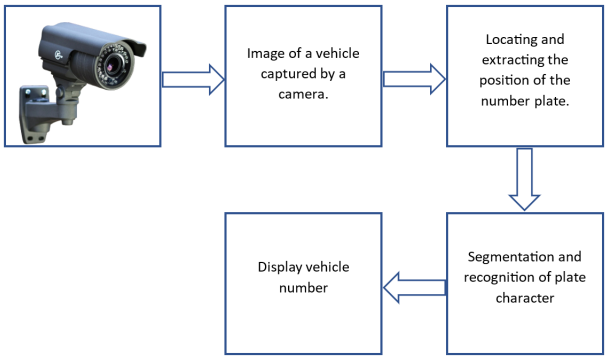

Fig. 2. Common steps in license plate detection and identification.

License Plate Recognition (LPR) involves the use of image processing techniques to detect and recognize license plates from images or videos. The first step in the LPR process is to localize the license plate in an image, which can be achieved using various methods. In this project, we aim to implement a histogram-based approach for license plate localization. This method is simple, fast, and can be applied using a dataset containing pictures of cars. The next step of the project involves license plate recognition using the coordinates of the detected license plate location. The project aims to contribute to the development of efficient and effective LPR systems that can improve traffic management and law enforcement.

II. Literature Review

The related work encompasses several approaches for automatic license plate recognition (ALPR) systems. One algorithm, as presented by [1], focuses on extracting number plates from vehicles under varying luminance conditions, enabling subsequent verification. Another method, as described by [2],

utilizes edge detection algorithms and morphological operations to extract numbers from input number plates for security purposes. Additionally, [3] proposes region-based algorithms for license plate extraction and character segmentation, combining adaptive iterative thresholding and template matching. Another approach, outlined in [4], involves morphological operations and Sobel edge detection to recognize numbers and characters, utilizing neural networks for segmentation using a bounding box approach. An integrated segmentation method, as discussed by [5], is presented for localizing license plates, with ALPR being a prominent research area. Lastly, [6] presents an efficient system design for vehicle identification that utilizes number plate extraction through a segmentation algorithm upon image capture at security checkpoints.

A. Challenges in Image Acquisition

Accurately extracting license plate regions from various scenes is crucial for achieving high system accuracy. However, this process faces several challenges, including poor image quality in different lighting conditions, image distortion from varying camera angles, diverse plate locations on different vehicle types, difficult-to-identify fonts, tilted plates, and interference from strong light beams. The image capturing process depends on factors like camera angle, dynamic range, lighting conditions, background complexity, and reflections. Hence, it is essential to develop a robust extraction process that can handle real-world scenarios effectively.

B. Techniques for License Plate Extraction

Several techniques are available for license plate extraction, including the Hough transform [7], edge extraction [8], histogram analysis [9], and morphological operators. Edge extraction utilizes gradient changes to detect image discontinuities quickly, but it may be sensitive to unwanted edges. The Hough transform is effective in identifying lines and shapes, particularly in images with large plate regions, but it requires significant memory and computational resources. Histogram analysis examines the distribution of pixel intensities, but its performance can be compromised by noise and tilted plates. Morphological operators aid in understanding image structure and object detection, although their slow operation limits their real-time applicability. These techniques offer different trade-offs in terms of simplicity, speed, noise tolerance, and suitability for real-world scenarios.

C. Character Recognition Methods

Character recognition is a critical component of the image analysis module, involving image processing algorithms to enhance the car image, detect plate positions, extract plate strings, and identify characters. Two primary methods for character recognition are commonly used. The neural network-based method [10] employs mathematical models inspired by connectionist approaches, such as Back Propagation and constraint-based decomposition (CBD), requiring training for improved accuracy. Alternatively, template matching [11] compares the character of interest against predefined templates with test points, selecting the template with the highest matched points as the recognized character. These methods offer distinct approaches to character recognition, each with its own considerations and potential applications.

III. Detailed System Design

A. Image Capture

The first step is to capture a picture with an electrical device such as a digital camera or webcam. The collected image is renamed in a stored manner before being transformed to grayscale using MATLAB.

B. Pre-processing (Image Enhancement)

After capturing the image, the next stage is to pre-process it. When acquired, a picture frequently contains other disruptions and noises that prevent optimal use. As a result, to acquire correct findings, the noises in the image must be removed in this stage.

- Gray Processing: This step focuses on converting the image into gray levels. It involves transforming color images into grayscale images. The corresponding gray values are calculated by evaluating each pixel's R, G, and B values, generating a grayscale image.
- Median Filtering: Median filtering is employed to eliminate noise from the image. Since gray levels alone cannot effectively remove noise, median filtering ensures a noise-free image.

C. Plate region extraction

The most critical step is to recover the number plate from the disrupted image. This extraction is performed by employing an image segmentation algorithm. Several picture segmentation methods are available in the literature, with image binarization being used in most of these approaches.

D. Character segmentation (Feature Extraction)

Using labeling components, the output of the extracted number plate is generated during this stage. Using a split function, each character is divided and split inside the number plate image. The length of the number plate is determined and compared to the database. The characters are categorized as alphanumeric (0-9 and A-Z), if the correlation values match. The values are then translated to strings and shown in an edit box. The characters are also saved in a text file within the code.

Fig. 3. Alphanumeric database.

E. Testing and Accuracy Evaluation

The implemented code was tested on multiple images, and the results were assessed for accuracy. Fig. 4 displayed the original license plate image with the detected car number, showcasing the successful detection and recognition of the license plate.

Fig. 4. License Plate Detection and Recognition Results.

To evaluate the efficiency of the algorithm, the elapsed time was measured using the tic-toc function. The execution time provides an indication of the algorithm's speed and efficiency in processing the images.

IV. Conclusion and Future Work

The human eye might find something easy, but it can be really hard for a computer. However, image processing is a powerful tool that allows us to do useful things, like what we did in this project.The algorithm implemented demonstrated accurate license plate detection and recognition, as depicted in the figure. The elapsed time measurement further confirms its efficiency in handling the image processing tasks.

Future work for this project includes exploring advanced image processing techniques and machine learning models. Additionally, there is a need to optimize the code for real-time implementation, enabling the system to operate in time-sensitive applications. Expanding the project to support multi-language license plate recognition and addressing challenging conditions such as low lighting or occlusions are important areas of focus.

V. A Brief Meta-Discussion of the Project

During the implementation of the project, we encountered both challenging and relatively straightforward aspects. One of the most difficult parts was the accurate extraction of the license plate region from various scenes. Overcoming these obstacles required extensive experimentation and fine-tuning of image processing algorithms. On the other hand, the implementation of the character recognition module was comparatively less difficult.

The project implementation differed from the proposal due to practical considerations and the iterative development process. Notably, we incorporated extra image enhancement techniques such as median filtering and adaptive histogram equalization. These enhancements notably improved the quality of input images and enhanced the accuracy of license plate detection.

VI. Author's Contributions

TABLE I
Task's Distribution

Task	Done By
High-Level View	All
Loading the image, converting it to grayscale, performing edge detection	Asma
Calculating horizontal histograms and calculating vertical histograms	Hagar
Determining possible locations for the license plate	Marim
Character Recognition	All
Presentation	All
Report	All

References

[1] M. Rathore and S. Kumari, "Tracking number plate from vehicle using Matlab", Int. Jrnl in Foundations of Computer Science and Technology (IJFCST), pp. 43-53, May 2014.

[2] V. L. Priya and K. Perumal, "Detecting the car number plate using segmentation", Int. Jrnl of Engineering and Computer Science, pp. 43-53, Oct. 2014.

[3] A. K. Parida, S. H. Mayuri,, P. Nayk and N. Bharti, "Recognition of vehicle number plate using MATLAB", Int. Rcrch Jrnl of Engineering and Technology (IRJET), pp. 846- 851, May 2016.

[4] B. Shanwar and N. Zakra, "Recognition of vehicle number plate using Matlab", Research Gate Publication, pp. 419 – 425, June 2016.

[5] T. Panchala, H. Patela and A. Panchal, "License plate detection using Harris Corner and character segmentation by integrated approach from an image", In Proc. 7th Int. Conference on Communication, Computing and Virtualization, pp. 419 – 425, Aug. 2016.

[6] S. Chauhan and V. Srivastava, "Matlab based vehicle number plate recognition", Int. Jrnl of Computational Intelligence Research, pp. 2283-2288, June 2017.

[7] E. Atkoci unas, R. Blake, A. Juozapavicius, M. Kazimianec, "Image Processing in Road Traffic Analysis", Nonlinear Analysis: Modelling and Control, 2005, Vol. 10, No. 4, 315–332 Faculty of Mathematics and Informatics, Vilnius University, Lithuania

[8] Ho C. H., Koay S. B., Lee M. H., M. Moghavvemi, M. R. Tamjis, "License Plate Recognition",Department of Electrical Engineering Engineering Faculty,University of Malaya

[9] Ondrej Martinsky,"Algorithmic And Mathematical Principles Of Automatic Plate Number Recognition" , Faculty of Information Technology,Department of Intelligent System, BRNO University of Technology

[10] Haris Al-Qodri Maarif, and Sar Sardy, "Plate Number Recognition by Using Artificial Neural Network " ,Department of Electrical Enginering, University of Al-Azhar Indonesia

[11] Muhammad Tahir Qadri, "Automatic Number Plate Recognition System For Vehicle Identification Using Optical Character Recognition", 2009 International Conference on Education Technology and Computer