Vehicle Number Plate Detection

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1. Background

In this world of new upcoming technologies which leads to our ease and comfortable life style, we also demand a comfortable traveling life, be it private or public vehicle. With rising traffic on roads and number of vehicles on roads, it is getting very difficult to manually handle laws, traffic rules and regulations for smooth traffic moment. Toll-booths are installed on freeways and parking complex, where the vehicle has to stop to pay the toll or parking charge fees. Also, Traffic maintenance systems are constructed on freeways to analyse for vehicles moving at speeds not allowed by law. All these operations have a scope of improve development.

In order to perform all these operations, the most important factor is a vehicle. We can find any particular vehicle using the vehicle number plate. This number differentiates one vehicle from other, which is effective especially when both are of the same type of make and model.

An automated license plate recognition system can be developed to find the license plates of a vehicle and recognize the characters on the same. These characters obtained from the license plate can further be utilized to fetch information about the vehicle and its registered owner for further investigation.

2. Your Understanding

License Plate Recognition Systems use the concept of optical character recognition to read the characters on a vehicle license plate. In other words, LPR takes the image of a vehicle as the input and outputs the characters written on its license plate.

In number plate detection system, image processing plays an important role. The typical number plate detection system consists of pre-processing stage which includes image conversion from RGB to Grayscale, apply edge detection, apply morphological operators on same image then extract plate region from image. After the number plate extraction, the last phase uses OCR (optical character recognition) to recognize the characters on the number plate. Every algorithm in this category always follows these basic steps, each algorithm has some pros and cons, because same algorithm cannot be useful for different environmental condition. The algorithm's efficiency totally depends upon the quality of input image which can be affected by resolution of camera, intensity of the image, illumination of image, shadow effect etc.

The data provided for this problem statement by TATA Consultancy Services is a JSON file which includes the coordinates of the presence of license plate in the image of the vehicle. So, the operations to be performed in the pre-processing phase will be reduced as the number plate can be directly extracted using those coordinates.

After the extraction of number plates, basic image processing is required to remove image noise which is followed by character segmentation for converting each character into an individual image. Once the characters are obtained, and optical character recognition model can be used to recognize the characters.

3. Scope

License Plate Recognition is one of the techniques used for vehicle identification purpose. The license plate recognition system developed in this project is trained and tested on the data of Indian vehicle number plates. So, this project is developed keeping in mind the format of Indian number plates.

This license plate recognition system directly works the number plates extracted from the vehicle images using the coordinates provided. Hence, image processing techniques for extracting number plates such as edge detection are not employed.

4. Out of Scope

The data provided for the developing the license plate recognition system is a JSON file which contains the links to images along with the coordinates of number plates of vehicles in the images and the class feature. The data provided contains Indian vehicles and their number plates. So, any vehicle belonging to a country other than India and which has different format than the Indian license plate will not successfully recognized.

5. Assumptions

General Assumptions that are considered to develop the license plate recognition system include:

1. Images are not of poor resolution because in cases when the license plate is too far away or a low-quality camera is used, it is difficult to identify individual characters.
2. Images do not contain poor lighting and low contrast due to overexposure, reflection or shadows.
3. License plates are not obscured by any object, generally by a tow bar or dirt.

Dependencies that are considered to develop the license plate recognition system include:

1. Python 3 and above version.
2. Pytessearct
3. OpenCV
4. Pillow

6. Solution Approach

The high-level solution approach of the project can be given as follows:

License Plate Recognition (LPR) sometimes called Automatic License Plate Recognition (ALPR) has 3 major stages.

1. **License Plate Detection:** This is the first and probably the most important stage of the system. It is at this stage that the position of the license plate is determined. The input at this stage is an image of the vehicle and the output is the license plate. This can be performed using the coordinates provided in the data.
2. **Character Segmentation:** In this stage the characters on the license plate are mapped out and segmented into individual images.
3. **Character Recognition:** This is the final stage which performs optical character recognition. The characters earlier segmented are identified in this stage. Using transfer learning, a pre-trained model by Google called the tesseract is used to perform character recognition.

The character segmentation stage uses the following techniques:

1. **Image Thresholding:** Image thresholding is a simple, yet effective, way of partitioning an image into a foreground and background. This image analysis technique is a type of image segmentation that isolates objects by converting grayscale images into binary images.

   In image thresholding, Simple Thresholding and Otsu's Binarization techniques are used.

   Simple Thresholding: If pixel value is greater than a threshold value, it is assigned one value (may be white), else it is assigned another value (may be black).

   Otsu's Binarization: In global thresholding, we use an arbitrary value for threshold value. So, the only way to know the selected value is good or not is by trial and error. Bimodal image is an image whose histogram has two peaks. For such images it automatically calculates a threshold value from image histogram for a bimodal image.

The character recognition stage uses Google's Tesseract for performing optical character recognition.

Tesseract is an OCR engine with support for Unicode and the ability to recognize more than 100 languages out of the box. It can be trained to recognize other languages. Tesseract is used for text detection on mobile devices, in video, and in Gmail image spam detection. Tesseract was developed as a proprietary software by Hewlett Packard Labs. In 2005, it was open sourced by HP in collaboration with the University of Nevada, Las Vegas. Since 2006 it has been actively developed by Google and many open source contributors. Tesseract acquired maturity with version 3.x when it started supporting many image formats and gradually added a large number of scripts (languages). Tesseract 3.x is based on traditional computer vision algorithms. In version 4, Tesseract has

implemented a Long Short-Term Memory (LSTM) based recognition engine. LSTM is a kind of Recurrent Neural Network (RNN).

7. Implementation Framework

The organization of the project implementation is as follows:

1. Data Collection and Data Visualization

   The data of Indian license plates is loaded and the corresponding license plates are extracted. The images in the data are graphically represented to understand the range of properties of images.

2. Labelling

   An algorithm must be shown which target answers or attributes to look for. Mapping these target attributes in a dataset is called labelling. Hence, the correct vehicle license numbers are mapped on to the data for verification.

3. Image pre-processing

   Pre-processing techniques like grayscale conversion are performed

4. Image Segmentation
5. Character Recognition
6. Model evaluation and testing

8. Solution Submission

The project GitHub link is as follows:
https://github.com/MonicaSai7/Vehicle-Number-Plate-Detection

9. Appendix

Bimodal image
Any image is a set of dots that are defined as **pixels**. Each of these pixels can be represented by a triplet of RGB values in the case of a colour image, and a single value if the image is in the gray scale. These values assume all values between 0 and 255. If you take all of the pixels of an image and count how many of these have value 0, how many 1, how many 2, and so on… up to 255, you get a **histogram**.

Otsu's Binarization

The bimodal image presents the histogram into two distinct distributions, almost separable between them. In fact, between the two mode there is a minimum point, where you might consider the possibility of separating the histogram into two parts. Well the Otsu's binarization helps you to automatically get that value.

Moreover, once this technique gained there will be no need to visualize and study the histogram in order to find the point, but everything will be done automatically.
This algorithm will allow you to quickly and automatically obtain the correct threshold value to choose between two histogram mode, so as to apply the thresholding in an optimal manner.

In OpenCV, the application of the Otsu's binarization is very simple. It will be sufficient to add as parameter within the cv2.threshold () function, called **cv2.THRESH_OTSU.**

Thresholding

One of the most used techniques for the analysis of the images is that of the **thresholding**, i.e. the application of a threshold along a particular scale of values, to filter in some way an image. One of these techniques is for example the one that converts any image in grayscale (or colour) in a totally black and white image. Often this is very useful for recognizing the regular shapes, contours within an image, or even to delimit and divide zones inside, to then be used in a different way in the subsequent processing.

So applied to a histogram, you will choose a value in which all the underlying values will be converted to 0 (white) and all those overlying to 255 (black), by converting an image to grayscale into black and white.

10. References

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