



Car Plate Number Detection System Using OpenCV

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ABSTRACT

Purpose – Most of the LPR systems are built using proprietary tools like Matlab. This paper presents an alternative method of implementing LPR systems using Free Software including Python and the Open Computer Vision Library. Design/method/approach – Basing on OpenCV and Python under Windows system, two methods of license plate detection are implemented, and the two algorithms are compared in detail from the aspects of license plate detection accuracy. These methods have high efficiency and good interactivity, which provide a reference for later license plate recognition. Findings – At present, the major means of transportation in Nigeria are vehicles, including cars, trucks, and buses, which are an indispensable part of daily life. To facilitate the management of vehicles, some related smart technologies have been developed, such as vehicle detection and tracking. Practical Implications – The work provide access to the content of the number plate for computer systems managing databases and process information using Open CV. This would reduce the number of stolen cars, managing parking toll, red-light violation enforcement and other security challenges. Originality/value – The originality of this is unique and contributes to several findings on car plate number detection system using open CV.

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INTRODUCTION

The scientific world is deploying research in intelligent transportation systems which have a significant impact on peoples' lives. License Plate Recognition (LPR) is a computer vision technology to extract the license number of vehicles from images. It is an embedded system which has numerous applications and challenges. Typical LPR systems are implemented using proprietary technologies and hence are costly. With the rise of free and open source technologies the computing world is lifted to new heights. People from different communities interact in a multi-cultural environment to develop solutions for mans never ending problems. One of the notable contributions of the open source community to the scientific world is Python. Intel's researches in Computer Vision bore the fruit called Open Computer Vision (OpenCV) library, which can support computer vision development.

Every country across the globe have their unique way of designing and allocating number plates to their country vehicles. This license number plate is then used by various

government offices for their respective regular administrative task like- traffic police tracking for people who are violating the traffic rules, to identify the theft cars, in toll collection and parking allocation management etc. In Nigeria all motorized vehicle is assigned unique numbers. These numbers are assigned to the vehicles by federal road safety commission (FRSC). In Nigeria, the license plates must be placed at the back of the vehicle. These plates in general are easily readable by human due to their high level of intelligence on the contrary; it becomes an extremely difficult task for the computers to do the same. Many attributes like illumination, blur, background color, foreground color etc. will pose a problem. Also, the License Plate Recognition (LPR) in Nigeria is difficult because the traffic rules are hardly obeyed and the number plate standards are not strictly practiced. Each one is adopting a different style leading to obtaining variation in parameters like, size of number plate and characters, location of number plate, type of font used, background (white background with black letters for non-commercial vehicles and white background

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with yellow letters for commercial vehicles), different unwanted pictures etc. which makes the task of number plate localization very difficult. Reviewing all the concerned Research Papers and Articles it can be thus concluded that Open CV gives the best result in vehicle plate detection consisting more function in computer vision than Matlab. For the recognition we have preferred tesseract OCR (Optical Character Recognitions) for better result. This work would be carried over for on car number plates. But this can be applied to any type of motor vehicle. Type of Vehicle (car, two-wheeler, commercial e.t.c.).

OpenCV

OpenCV (Open Source Computer Vision Library) is a library of programming functions mainly aimed at real-time computer vision (Pulli et al., 2012). Originally developed by Intel, it was later supported by Willow Garage then Itseez (which was later acquired by Intel (Intel acquire itseez)). The library is cross- platform and free for use under the open- source Apache 2 License. Starting with 2011, OpenCV features GPU acceleration for real-time operations (Cuda, 2020).

History

Officially launched in 1999 the OpenCV project was initially an Intel Research initiative to advance CPU-intensive applications, part of a series of projects including real-time ray tracing and 3D display walls (Kaehler and Bradski, 2016). The main contributors to the project included a number of optimization experts in Intel Russia, as well as Intel's Performance Library Team. In the early days of OpenCV, the goals of the project were described (Bradski, 2008) as:

1. Advance vision research by providing not only open but also optimized code for basic vision infrastructure. No more reinventing the wheel.
2. Disseminate vision knowledge by providing a common infrastructure that developers could build on, so that code would be more readily readable and transferable.
3. Advance vision-based commercial applications by making portable, performance- optimized code available for free- with a license that did not require code to be open or free itself.

The first alpha version of OpenCV was released to the public at the IEEE Conference on Computer Vision and Pattern Recognition in 2000, and five betas were released between 2001 and 2005. The first 1.0 version was released in 2006. A version 1.1 "pre-release" was released in October 2008.

The second major release of the OpenCV was in October 2009. OpenCV 2 includes major changes to the C++ interface, aiming at easier, more type-safe patterns, new functions, and better implementations for existing ones in terms of performance (especially on multi-core systems). Official releases now occur every six months (OpenCVchange logs, 2013) and development is now done by an independent Russian team supported by commercial corporations.

Programming language

OpenCV is written in C++ and its primary interface is in C++, but it still retains a less comprehensive though extensive older C interface. All of the new developments and algorithms appear in the C++ interface. There are bindings in Python, Java and MATLAB/OCTAVE. The API for these interfaces can be found in the online documentation (Kaehler and Bradski, 2016). Wrappers in several programming languages have been developed to encourage adoption by a wider audience. In version 3.4, JavaScript bindings for a selected subset of OpenCV functions was released as OpenCV.js, to be used for web platforms (Bradski, 2008).

Hardware acceleration

If the library finds Intel's Integrated Performance Primitives on the system, it will use these proprietary optimized routines to accelerate it.

OS support

OpenCV runs on the following desktop operating systems: Windows, Linux, macOS, FreeBSD, NetBSD, OpenBSD. OpenCV runs on the following mobile operating systems: Android, iOS, Maemo, (Maemo port) BlackBerry 10. (Blackberry 10) The user can get official releases from Source Forge or take the latest sources from GitHub (Github, 2020).

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WHY OPENCV??

Advantages of OpenCV over MATLAB

1. Speed: Matlab is built on Java, and Java is built upon C. So, when you run a Matlab program, your computer is busy trying to interpret all that Matlab code. Then it turns it into Java, and then finally executes the code. OpenCV, on the other hand, is basically a library of functions written in C/C++. You are closer to directly provide machine language code to the computer to get executed. So ultimately you get more image processing done for your computers processing cycles, and not more interpreting. As a result of this, programs written in OpenCV run much faster than similar programs written in Matlab. So, conclusion? OpenCV is damn fast when it comes to speed of execution. For example, we might write a small program to detect peoples' smiles in a sequence of video frames. In Matlab, we would typically get 3- 4 frames analyzed per second. In OpenCV, we would get at least 30 frames per second, resulting in real-time detection.
2. Resources needed: Due to the high-level nature of Matlab, it uses a lot of your systems resources. And I mean A LOT! Matlab code requires over a gig of RAM to run through video. In comparison, typical OpenCV programs only require ~70mb of RAM to run in real-time.
3. Cost: List price for the base (no toolboxes)
MATLAB (commercial, single user License) is around USD 2150. OpenCV (BSD license) is free! Now, how do you beat that?
4. Portability: MATLAB and OpenCV run equally well on Windows, Linux and MacOS. However, when it comes to OpenCV, any device that can run C, can, in all probability, run OpenCV.
5. Specific: OpenCV was made for image processing. Each function and data structure was designed with the Image Processing coder in mind. Matlab, on the other hand, is quite generic. You get almost anything in the world in the form of toolboxes. All the way from financial

toolboxes to highly specialized DNA toolboxes.

RELATED LITERATURE REVIEW

Developed algorithm which is applied on the car park systems to monitor and manage parking services. Algorithm is developed on the basis of morphological operations and used for number plate recognition (Chittode and Kate, 2012). Optical character is used for the recognition of characters in number plate. (Peng et al, 2003) presented an algorithm named "Document Image Recognition". DIR is most effective approach which is used to find most similar template for input image in a database. The algorithm is developed on the basis of global matching of CBP (Chunyu C et al, 2013) presented a technique for recognition of number plate from vehicle image. This technique is implemented using MATLAB and characters are recognized using edge detection segmentation and preprocessing of image (Lekhana and Srikantaswami, 2012) developed an efficient real time on-line Number plate recognition system NPR algorithm works in different steps firstly image acquisition, using fusion of spectral analysis characters are segmented and characters are recognized.

Proposed methodology which finds ROI using morphological processing and directional segmentation (Paunwala and Patnaik, 2014). The ROI is the area which includes the number plate from which alphanumeric characters are recognized. This method is tested on different databases which contain images. Developed an efficient approach works on opening and closing of morphological operations. Firstly, localization of plate in image has been done then skew correction is done for segmentation process of alphanumeric characters (Pandya and Singh 2011). Reorganization is done using the template matching (Pranathi and Kranti, 2011) presented a methodology for number plate extraction named "Feature based number plate localization". This methodology mainly deals on two methods edge detection and window filtering method. Both methods are used in this methodology and give efficient results.

Proposed a deep learning-based LPR system (Selmi, 2017). Although, the system performed

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well in both ideal and severe conditions, it only supported the recognition of numbers and English letters and did not involve the recognition of characters. Similarly, a robust system was created to recognize the LP with numbers and letters by using CNN, which was capable of working with various LP templates under different environmental variations (Masood 2017). In other work, an LPR system, including the recognition of numbers and Korean characters, was developed to recognize the images obtained from the vehicle black box. Experiments showed the overall accuracy is 89.79% by using a classifier called the k-nearest neighbor. The probable cause was that the data was so small that the classifier cannot acquire enough features (Kim et al., 2017). As for Chinese LP character recognition, a kind of feature extraction method called coarse-to-fine was applied to design the CNN architecture, and the experimental result proved the accuracy of the proposed method is 98.7% that was much better than the Back Propagation (BP) model and SVM classifier. Although Chinese characters are recognized in the experiment, Chinese characters only account for 13% of the training data that causes imbalanced data problems (Yao, et al). Besides, a framework was designed to detect the LPs from multiple directions, which can improve the performance of LPD when the obtained LP images are rotated (Xie et al., 2018). Nevertheless, the developed method was not an end-to-end model to simultaneously handle detection and recognition tasks. In another work, the problem of LPD and LPR was tackled well by using a unified model, while the processing speed needs to be further improved (Li et al., 2018).

MATERIALS AND METHODS

The following are the materials and the equipment that are used in the research

work.

Materials

The following materials are used in the research work;

1. Mathwork- Open CV
2. Mathwork- Simulink
3. Open CV- Open CV computer library vision.

Equipment

The following virtual equipment are used in the research work;

1. Oscilloscope
2. Generators etc.

Methods

The work consists of the following points:

Real time Input: The input can be an image or a video. Camera is used to take a real time image or video and goes through some image processing stages.

Pre-processing: This is an important step in analyzing an image. It includes grey scale conversion, noise reduction and binarization.

Segmentation: Character segmentation is carried on binary image. Horizontal scanning that makes use of a scanning line that finds the conditions satisfying the beginning and the end position of the characters.

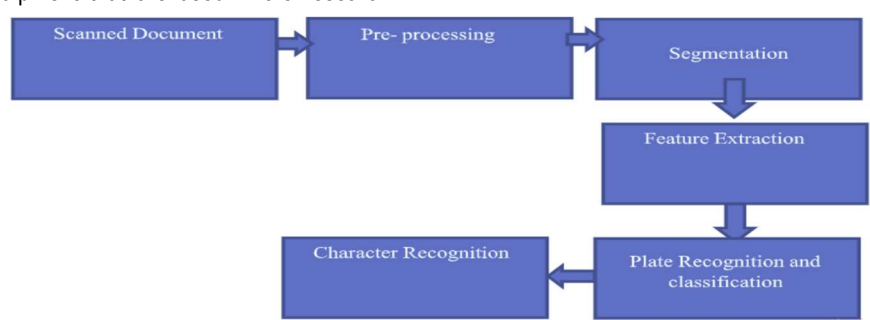
Extraction: Images are converted into grey images. Here the images level is extracted based on the parameters and the matrix values.

Plate Recognition and classification.

Recognized characters: Number plate is recognized.

Experimental Flow Diagram

Figure 1 below shows the step by step procedures that are used to carry out the research work.



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K-NN Algorithm Procedure

- 1: Begin
- 2: Input: Original Image
- 3: Output: Characters
- 4: Method: K-Nearest Neighbors
- 5: LP: License Plate
- 6: Convert RGB image to Grayscale
- 7: Filter Morphological Transformation
- 8: Transforms Grayscale image to binary image
- 9: Filter Gaussian for Blurs image
- 10: Finding all contours in image
- 11: Search & recognize all possible character in image
- 12: Crop part of image with highest candidate LP
- 13: Crop the LP from original image
- 14: Apply steps from 6 to 11 again on crop image
- 15: Print the characters in LP16: End

CONCLUSION

The message of this research is to show that free and open source technologies are matured enough for scientific computing domains. The system works satisfactorily for wide variations in illumination conditions and different types of number plates commonly found in Nigeria. It is definitely a better alternative to the existing proprietary systems, even though there are known restrictions.

Limitations and Future Studies

Currently, we have proposed the algorithms for our ALPR system. In future we would implement this system on Open CV library and would also do the performance check of the system designed. We would do the performance analysis in terms of number of plates successfully recognized. So far the algorithm looks good and suitable but if the OCR algorithm won't work then we will try to give some new algorithm or would do the comparative study of different OCR present in the market and would try to choose the best among them and implement the system.

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