



# SEGMENTATION AND RECOGNITION OF NIGERIAN LICENSE PLATE USING BOUNDING BOX AND TEMPLATE MATCHING

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## *Abstract*

**T**he Number Plate Recognition (NPR) is a system designed to help in recognition of the character written on the number plates of vehicles. Before the recognition, a number plate has to be segmented. Segmentation is a process of partitioning digital images into multiple segments. In this work thresholding of pixels values and Bounding Box were used for the segmentation. The recognition algorithm compares each individual character against the complete alphanumeric set using template matching. The matching process moves the template image to all possible positions in a larger source image and computes a numerical index that indicates how well the template matches the image in that position. Before the Segmentation and Recognition algorithm is applied, the License must be localized correctly using localization algorithm.

**Keywords:** Localized Plate (LP), Number Plate Recognition(NPR), Bounding box, Template Matching

## **Introduction**

Automatic license plate detection and recognition (ALPDR) is the key technology use in intelligent transportation system (ITS). The system applies image processing techniques to automatically detect the vehicles license plate region and recognized the characters printed on it. ALPDR finds applications in areas

such as; automatic electronic toll collection, road traffic monitoring, and parking lot, access control tracking of stolen vehicle and general gathering of traffic flow statistics among others. The success of ALPDR depends greatly on the simplicity of the license plate and absence of illumination variation. Nigerian license plate contains many inscriptions beside the license number; such as the image of the Nigerian map, State name, the inscription "Federal Government of Nigeria", Nigerian flag etc. To add to these complexities, the number plate comes in three different colors; red color for commercial vehicles, Blue for private and green for Government own vehicle. These variations make Nigerian plate complex compared to other countries number plate as shown in Figure 1.



Figure 1: Comparison of license plate complexity between Nigerian and other

ALPDR comprises of three crucial stages; the first detect and isolate the license plate from the given image, the second step deals with segmentation of alphanumeric numbers from the detected plate. While the third step complete the system by performing the recognition of the segmented characters. In the literature several algorithms are presented for number plate localization, segmentation and recognition using different methods such as; Global threshold using Otsu's method, Histogram of oriented gradient(HOG), Peak Detection Algorithm, horizontal and vertical segmentation, Template matching, [1 - 5]. In this work, we focus on license plate Segmentation and recognition using HOG.

#### Related work

The existing techniques and algorithms for segmenting characters have not been successfully applied in degraded images from the real world. In other words, they have not been able to simultaneously solve problems of fragmented, superimposed or filled characters with holes is still challenging. In [6] Number plate Recognition Using an Improved segmentation was introduced. Optical character Recognition (OCR) technique is used for character recognition. The OCR actually uses correlation method to match individual character and finally the number is identified and stored in string format in a variable. The drawback of this method is the computational difficulty in mapping a string to a text recognized character. However some factors were found which affect the effectiveness of template matching based on OCR technique i.e. font type, noise in image, tilting etc.

To surmount this problem, the authors in [8] used a novel method for character segmentation of vehicle license plates image regions. An algorithm for Noise removal was used on Document image affected by noise as the input to produce a Document image cleared from noise as the out-put. In [9] the author use connected component and bounding box method for Character segmentation. The number of connected components are labeled. After it we measured a set of properties for each labeled region. Bounded box is used to separate individual character from the license.

#### Vehicle Image Database

Since there is no existing Nigerian vehicle image database that can be used for the experiment, this research design and develop one called Bayero University Kano-Vehicle Image Database (BUK-VID). The database contains images of 50 different types of vehicles; which include trucks, buses and cars. The images were captured at the main gate of Bayero University Kano as they pass the gate. To add intensity variations in the database the recording were made in both day time and night across many days of December, 2015 to January 2016. To minimise image blur, the camera was mounted on a tripod.



Figure 2: Example images from BUK-VID

### Methodology

The proposed method composed of three main processes as illustrated in Figure 3.

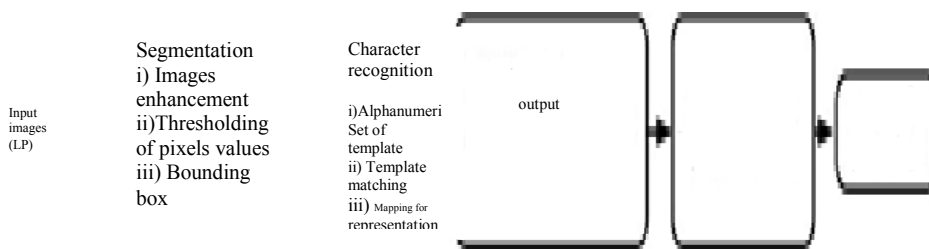


Figure 3: General frame work of the proposed method

### Input-image

The input images are localized plate number after detection has been successfully. Referto [7] for Nigerian license detected plate number.

### Plate Segmentation

Segmentation is one of the most important processes in the automatic number plate recognition, because all further steps rely on it. If the segmentation fails, a character can be improperly divided into two pieces, or two characters can be improperly merged together. In this work thresholding of pixels values and Bounding Box are used for the segmentation. The plate number image has a content of for ground and background. The for ground is set to have a pixels values less than 40 which were set to zero while the background has a pixels values greater than or equal to 40 which was set to 255.

The second phase of the segmentation is an enhancement of segments. The segment of a plate contains besides the character also undesirable elements such as dots, stretches and redundant space on the sides of character. There is a need to eliminate these elements and extract only the character. Figure 4 shows an example of a segmented plate.



(a) Before thresholding (b) After thresholding

Figure 4: Thresholding Plate number

### Bounding volume Hierarchies

A bounding volume hierarchy is a tree of bounding volume, such as spheres or boxes, whose collective leaf nodes spatially enclose all the model geometry, and in which each parent spatially enclose all the geometry covered by its descendent leaf nodes. Generally, each bounding volume in the hierarchy is made as small as possible in terms of volume, surface area, diameter, or other appropriate size measure while still covering its underlying geometry. In this work a rectangular bounding box was used to segment each character. Figure 5 and 6 shows the segmentation of plate Number.



Figure 5: Image enclose with rectangular bounding box



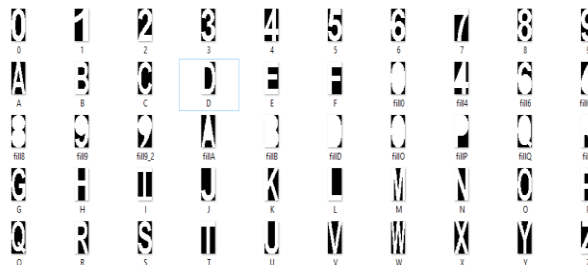
Figure 6: Segmentation of plate number

### Character recognition

The Nigerian Plate Recognition (NPR) is a system designed to help in recognition of characters written on a number plate of vehicles. It is employed for the purpose of conversion of text image into real character. In this stage, the algorithms compare each individual character against the complete set using template matching.

### Template

A template is a set of alphanumeric characters used for determining in NPR. Matching is done on a pixel by pixel basis. The template used is of size 24\* 42. The number figure is from 0-9 (10-figures) character and the alphabet A-Z (26-Characters). To increase the recognition accuracy additional figures and character were added to the alphanumeric basic set. This is necessary to account for seriously degraded plates in which a character such as A, P, 0, 9 changes to ~~AP09~~. So we added the basic character and figures and their fill version. Figure 7 shows individual text images used to create a template.



(a) Text images used to Create Template



Figure 7 (b) Template used for Template matching

### Template matching

The matching process moves the template image to all possible positions in a larger source image and computes a numerical index that indicates how well the template matches the image in that position.

Matching is done on a pixel by pixel basis. The similarity measure used to determine the numerical index is given in equation 1 below.

$$R = \frac{\sum_i \sum_j (A_{ij} - \bar{A})(B_{ij} - \bar{B})}{\sqrt{(\sum_i \sum_j (A_{ij} - \bar{A})^2)(\sum_i \sum_j (B_{ij} - \bar{B})^2)}} \quad (1)$$

Where A and B are images and  $\bar{A} = \text{mean}(A)$ , and  $\bar{B} = \text{mean}(B)$

### Results and Discussion

The experiments were performed on Intel (R) Pentium (R) CPU B960 @ 2.20 GHz, having installed memory of (RAM) 4.00GB. The new method was implemented in Matlab R2015a. 50 license plate images are used of which 15 were used to train the system while the remaining 35 images were used for testing. Experimental results show that the new algorithm has performed satisfactorily well with an average recognition accuracy of 91.42%. Figure 8 shows final recognition step of the algorithm with the plate number segmented correctly detected.



Figure 8: (a) Input image (b) Detected plate number (c) Segmented plate number (d) Recognized Character

### Conclusion

In this work, the applicability bounding box and Template matching on Nigeria license plate segmentation and recognition problem is presented. We were unable to find any exiting work that explained the details and images example on how a template is created to template matching. The research also presented a BUK-VID, a vehicle image database containing 50 vehicle images captured from complex scene and under non-uniform lighting condition. The results show that the new method has performed well even on complex license plate such as Nigerian. The average time of recognition on each image is 15.00 seconds, thus can be used in real time while recognition accuracy recorded was 91.42%.

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