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# Vehicle Number Plates Detection and Recognition using improved Algorithms: A Review with Tanzanian Case study

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**Abstract: — Invented in 1976, Number Plates Recognition (NPR) has since found wide commercial applications, making its research prospects challenging and scientifically interesting. A complete NPR system functions by *vz* steps, license plate; localization, sizing and orientation, normalization, character recognitions and geometric analysis. This paper is a review of NPR preliminary stages; it explains number plate localization, sizing and orientations as well as normalizations sections of the Number Plates Detection and Recognition-Tanzania Case study. MATLAB R2012b is employed in these processes. The input incorporated includes front and rear photographic images of vehicles, for proximity and simulation purposes the ample angle of image is 90 degree +-15. The captured image is converted to gray scale, binarized and edge detection algorithms are used to enhance edges. The output of this stage provides the input feature extraction, segmentation and recognitions.**

**Keywords: gray scale, thresholding, edge detection, algorithms, number plate, and extraction.**

## 1. Introduction

The vehicle number plate is a numeric or alphanumeric code that uniquely identifies the vehicle within the issuing country database. It is a metal or plastic plate attached at the front and /or rear of a motor vehicle. Being unique for every car, the number plate is an important resource for accessing particular data of the owner from the country information systems. In the United Republic of Tanzania we have varieties of number plate's registration standards as shown in fig1.0 below. This research is focused on designing algorithm(s) to serve the private and commercial feature to automate number plates that are used in Tanzania Mainland only. Furthermore the design criteria is limited to yellow and white commercial and private numbers, this automatically excludes vehicles with diplomatic ties in Tanzania i.e. green and blue.

The main goal of this research is to study, analyze and design an efficient and optimized algorithm(s) for detection and recognition of Tanzanian cars by their plate numbers. The algorithm(s) will provide accurate and timely alphanumeric recognition performance. The application of the algorithm(s) will facilitate automation capturing and recognition of vehicle plate number, additionally the license plate characters will be captured with information available in respective database, example Tanzania Revenue Authority database or parking lot database.

Tanzania population has double since 1988, with a current estimated population of 48 Million [1], the vehicles for personal/ public and business means of transportation has largely increased. The significance of this study lies in the ability to minimize human involvement meanwhile aiding laws enforcement agents,, road toll data collection processes and can set a ground for other automated systems such as automated gate controls for authorized/ non-authorized vehicle and record keeping for entry and exit time.


Figure 1.0 Tanzanian numbering system

Numerous image processing algorithms are available. These algorithms are customized to particular conditions, examples variations distributions of character spacing, plate color and ratios of dimension standards [2]. This has made it difficult to have same algorithm all over the world. Also, the available algorithms suffer from problems the robustness, stability, accuracy and convergence speed limitations. This research work to minimize these challenges, and in the process improve the accuracy and convergence speed of recognition rate. Inherently this will maximize the efficiency and performance of detection and recognition algorithms.

This paper is sectioned into (2) Literature Reviews, (3) an overview of proposed algorithms (4) Experiments and findings and, experimental and (5) Future works and Conclusions.

## 2. Literature reviews

A vehicle number plate detection and recognition (VNPDR) is an applied image processing algorithms to identify vehicles registration numbers automatically by reading their number plates [3] This technology is a relatively new in Tanzania, but has been used since the 1980s in Europe (especially United Kingdom) to prevent crimes from vehicle theft to terrorism [4, 5]The VNPDR has become most important because of its applications like speed control, road traffic, toll collections, security and entrance-admissions. Much research has been done in China, Europe, USA, India, Malaysia, in Middle East, Kenya [4-7]. VNPDR is a challenging research area its complexity increases due to lack of standardizations between the number plates of different countries. The variations occur in shape, size, color, texture or orientation of number place region of the image.

[3, 8, 9] In recent years, this technology of number plate recognition has increased popularity in security, traffic control and monitoring applications. Technically, the technology is sounding research topic because enormous discoveries of computers and sophisticated high resolution infrared cameras. This make easier for image processing techniques more applicable analyzing and extracting important features for plate numbers detection and recognitions [10, 11])

The License Plate Localization and Recognition for Tanzania Car Plate Numbers was proposed in [11], where Sobel operators were used for edge detection. The sobel command performs a two dimensional spatial gradient measurement on an image. Sobel edge detector uses a pair of 3x3 convolution masks. Normally Sobel operator is used to find the approximate absolute gradient magnitude at each point in an input image which is the gray scale image, [5, 12].
The Sobel filter for 3x3 matrix is given by

$$G_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \text{ And } G_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \quad \ldots\ldots\ldots (2)$$

And magnitude of the gradient is calculated as

$$|G| = \sqrt{G(x)^2 + G(y)^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Actually, the sobel masks is the oldest technology of image processing and does not provide good result for edge detection when considering in accuracy, stability, and robustness of the algorithms.

[13] proposed a morphological image processing method. This method deals with edge analysis for number plate detection. Despite the fact the algorithm gives convincing results, in a sense of providing strong edge information. The car images which contain dark characters on light background can be used as an indication to detect the number plate, but it doesn't perform well in complex scenes. Morphological method can make all the required areas visible, but their shape may not be correct. On the other hand, for wider interval of levels the shape of required areas is correct but on the binary image there exist some unnecessary and unwanted elements [5, 10]. In additional, the method involves complex arithmetic which makes the computation process slower.

Also, we have other logarithms using Artificial Neural Network and on multiple layer back propagation of neural networks, whereby Hough transforms was applied to find the boundary box of a number plate in spite of characters [3, 4, 6]. Despite the fact that, technique being very sensitive to deformation of boundaries of the image, it encounters some difficulties in extracting the plate regions when the boundary of the plate surface is not clear due to damage or dirt. It should be noted that dirt/dust/physical deformation of number plates is common in Tanzania due to underdeveloped infrastructure of roads. [14]. In this literature challenges rises between two critical factors required in recognition algorithms; these are; accuracy and time divergence for system performance. Therefore compromise is needed to solve this bottleneck above problems [15] whereby, two methods of single and multilayer back propagation neural network back propagation were used to tackle them.

Vehicle number plate detection and recognition algorithms work based on assumptions made. Ultimately developed algorithms have advantages and disadvantages, how to weigh advantages and disadvantages to get the level of accuracy and robustness required depend on assumptions. Due to the varying characteristics of the license plate among countries/regions further research is still needed in this area [16].

## 3. An overview of proposed algorithms

This section gives an overview of the techniques employed to design the algorithms of vehicle number plate detection and recognition. Image processing involves signal processing, processes in which an input image is subjected to standard and /or customized signal-processing techniques. In the context of this research, the front/rear images of a car are processed to improve the pictorial information for automatic recognition of number plate's details for human interpretation. Image processing involves pre-processing, basically this includes intensity normalization and low frequency background noise reduction figure 2 below shows the general overview of the adopted design processes.

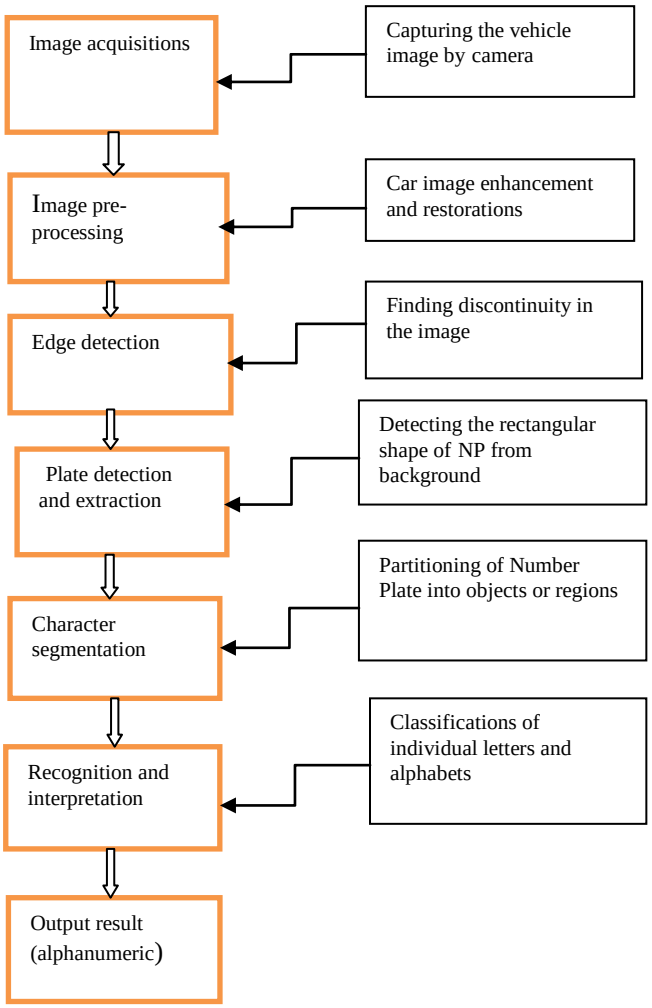



Figure 2. General overview of design process

### 3.1 Image acquisition

Image acquisition in a standardly developed NPR system is performed by high end IP cameras, placed at strategic positions to avoid obstacles meanwhile producing highly accurate images. Due to technological advancements image acquisition process can be achieved at low cost. In the presence of obstacles such as vegetation, or terrain conditions the image faces difficulties hence reducing the efficiency of the output in such conditions. Thermal Infra-Red camera can be used to produce effective images for successful output [6]

(i)Entrance gate

(ii)Car image

Figure 3. Image acquired from camera

### 3.2 Image Pre-processing

Image Pre-processing is the initial stage to image processing require for enhancement and restorations. The process involves processes which improve the image quality for computational by eliminating noises, highlighting edges of the captured image in real-time or stored in memory/hard disk). In the pre-processing, an image passes through the following procedure gray scaling, binary conversion and filtering [17, 18].

Image restoration deals with reversing the damage or deformed part or blur of image obtain from camera. Blurring is a result 'spill over' to neighboring pixel. De-blurring is an image restoration algorithm that recovers the origin sharpness of an image using mathematical model(s).

### 3.3 Image processing

[2, 9, 13, 19, 20] explain how edge detections, localization and extraction of number plate, character segmentation, recognition and interpretation are implemented. In this case processing includes the localization of the rectangular shape and size of the number plate from the images, separating the number plate from the background follow by splitting the number plate into several objects i.e. segmentation. Segmentation involves subdividing an image into constituent parts by finding lines, circles, or particular shapes of each character. Finally, is the recognition process used to classify and recognizes individual characters.

## 4. Experiments and findings

For the purpose of this research Matrix Laboratory (MATLAB) R2012b simulations is used for image analysis.

### 4.1Gray scaling process

Gray scale is often used in image processing and image analysis. Images acquired by camera always reflect the camera settings; among many include color and hue, essentially an image can be in its natural form or slightly altered, colored images are complex in space and time, it is therefore important to convert colored images to gray scale to reduce time and space complexity. The basic concept of gray conversion is to eliminate hue and saturation image while maintaining its luminance.

In this process, the threshold of an image with correct gray scale value is calculated for the purpose of separating the object of interest from background. Thresholding is important to provide sufficient contrast of an image such that, different level of intensity between foreground and background are taken into consideration. For computational purposes gray scale improves the quality of an image and later computational processes. Basically in a gray scale image the contrast frequency calculated for each position in the template creating a new image using the defined threshold value where by any color above threshold is set to white and below threshold is set to black. Gray scale images consist of different ranges of gray values; from 0 to 255. MATLAB rgb2gray function converts an RGB image to gray scale image.

(i)True color image (ii) Gray scale image

Figure 4. Gray scale conversion of car image

### 4.2 Binary conversion process

A binary image has only two values for each pixel, 0 and 1 corresponding to black and white. A gray scale image has eight bits of information per pixel, hence, 256 possible gray values. Binary conversion involves the process of converting a gray scale image to binary image. The output image replaces all pixels at the input image with luminance greater than 'level' with value 1(white) and other pixels with value 0 (black) as indicated in figure 5 bellows; level range (0,1). It can be assumed that the level value is 0.5 as midway between black and white for all class images. The level of optional threshold value of an image can be computed by function 'graythresh () in MATLAB.

Optional threshold level selection is necessary as the high limit tends to merge the label with the background (black), while a lower limit tend to bridge the digit with foreground the label white region. Binary conversion is important as it improves the quality and extracts information from an image. Binary images are less complex because of their reduced complexity.

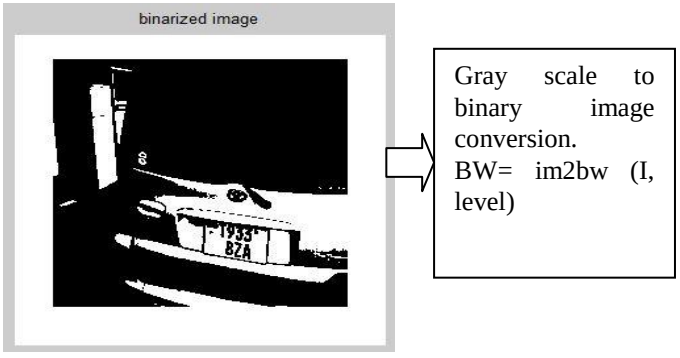
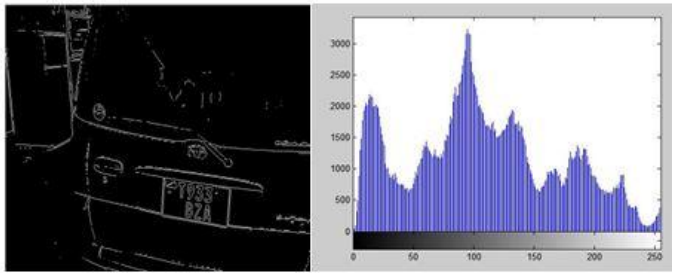



Figure 5. Binary image of a car

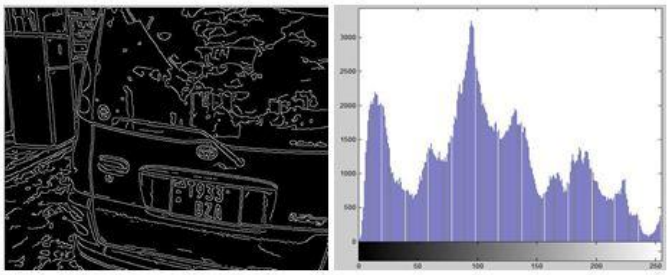
### 6.3 Edge detection

Edge detection is the process of localizing pixel intensities transitions or identification of sudden changes (discontinuities) in an object within the image. Edges are a significant local change of intensity in an image. Edges typically occur on boundary between two different regions in an image. To find edges, edge detection function is used. This function rapid change varies in images brightness and marks the edge.
Edge detection aims capturing important features, events and properties of an image. Edge return a binary image containing ones at edges and zeros elsewhere (see figure 6a and 6b below). Available edge detectors available are sobel, prewitts, Roberts, canny and artificial neural network as identified in literature. Canny is identified as powerful edge detector because it uses two thresholds detecting strong and weak edges (see figure 6b below



(i)Sobel edge detector (ii)Sobel histogram

Figure (a)



(i)Canny edge detector (ii)Canny histogram

Figure (b)

Figure 6. Edge detector

## 5. CONCLUSIONS AND FUTURE WORKS

### 5.1 Conclusion

Image processing are a robust involving diverse methodologies. However it should be noted that a complete NPR systems requires effective set of hardware and software components, most preferably efficient infra-red cameras and powerful computers to provide high quality images. For the purpose of this research work I have resolved to using; images taken by a 16 megapixel digital camera for demonstration purposes, this is due to high availability of digital cameras and research budget constraints. Canny edge detector as it is proven to have higher accuracy. The image acquisition adopted is not most efficient, but it will suffice the objective of this research work.

### 5.2 Future work

Having analyzed the pros and cons of various plate number extraction methodologies I have resolved to combine various features in ensuring that the extraction process captures the required information. Future work of this research includes plate number detection and extraction, character segmentation, character recognition and interpretation, the aim is to accomplish an efficient and optimum algorithm(s) for Recognition of Tanzanian Vehicle number plates.

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### References

[1] J. E. Kocher, "tanzania: population projections and primary education rural health and water supply goals," *development discussion paper*, 1976.

[2] S. Saha, s. Basu, m. Nasipuri, and d. K. Basu, "license plate localization from vehicle images: an edge based multi-stage approach," *international journal on recent trends in engineering (computer science)*, vol. 1, pp. 284-288, 2009.

[3] A. Akoum, b. Daya, and p. Chauvet, "two neural networks for license number plates recognition," *journal of theoretical & applied information technology*, vol. 12, 2010.

[4] M. M. A. Joarder, k. Mahmud, t. Ahmed, m. Kawser, and b. Ahamed, "bangla automatic number plate recognition system using artificial neural network."

[5] F. Martín and d. Borges, "automatic car plate recognition using a partial segmentation algorithm," in *iasted conference on signal processing, pattern recognition, and applications (sppra)*, 2003.

[6] N. K. Ibrahim, e. Kasmuri, n. A. Jalil, m. A. Norasikin, s. Salam, and m. R. M. Nawawi, "license plate recognition (lpr): a review with experiments for malaysia case study," *arxiv preprint arxiv:1401.5559*, 2014.

[7] S. Chugh and y. K. Jain, "character localization from natural images using nearest neighbours approach," *int'l journal of scientific&engineering research*, pp. 1-6, 2011.

[8] M. H. Dashtban and z. Dashtban, "a novel approach for vehicle license plate localization and recognition," *international journal of computer applications*, vol. 26, 2011.

[9] S. A. Daramola, e. Adetiba, a. Adoghe, j. Badejo, i. Samuel, and t. Fagorusi, "automaticvehicle identification system using license plate," *international journal of engineering science and technology*, vol. 3, pp. 1712-1719, 2011.

[10] S. G. Patel, "vehicle license plate recognition using morphology and neural network," *int. J. Cybernetics inform*, 2013.

[11] I. Bulugu, "algorithm for license plate localization and recognition for tanzania car plate numbers," *international journal*, 2013.

[12] P. Reshma, "noise removal and blob detection approach for number plate identification," *international journal of computer applications*, vol. 47, pp. 13-16, 2012.

[13] M. Iwanowski, "automatic car number plate detection using morphological image processing," *przeglad elektrotechniczny*, vol. 81, pp. 58-61, 2005.

[14] C.N.Anagnostopoulos, i. E. Anagnostopoulos, i. D. Psoroulas, v. Loumos, and e. Kayafas, "license plate recognition from still images and video sequences: a survey," *intelligent transportation systems, ieee transactions on*, vol. 9, pp. 377-391, 2008.

[15] S. Asthana, n. Sharma, and r. Singh, "vehicle number plate recognition using multiple layer back propagation neural networks," *international journal of computer technology and electronics engineering (ijctee)*, vol. 1, 2011.

[16] K. W. Maglad, "a vehicle license plate detection and recognition system," *journal of computer science*, vol. 8, p. 310, 2012.

[17] J. Olivares, j. M. Palomares, j. M. Soto, and j. C. Gámez, "license plate detection based on genetic neural networks, morphology, and active contours," in *trends in applied intelligent systems*, ed: springer, 2010, pp. 301-310.

[18] W. Weihua, "license plate recognition algorithm based on radial basis function neural networks," in *intelligent ubiquitous computing and education, 2009 international symposium on*, 2009, pp. 38-41.

[19] I. Bulugu and p. Zhijun, "an improved method for tanzania number plate location and segmentation based on mathematical morphology and regional features of an image," *international journal*, 2013.

[20] G. Guangying, b. Xinzong, and g. Jing, "study on automatic detection and recognition algorithms for vehicles and license plates using ls-svm," in *intelligent control and automation, 2008. Wcica 2008. 7th world congress on*, 2008, pp. 3760-3765.

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**Cosmo H. Munuo**, received PGD in Electronics and IT from University of Dar es Salaam (UDSM), Advanced Diploma in Electronics and Telecommunications from Dar es Salaam Institute of Technology (D.I.T) and Full Technician Certificate (F.T.C) in Electrical Engineering from Technical College Arusha. Presently, a Master degree student of Information and communication Science and Engineering specialized in Electronics and Telecommunications at Nelson Mandela Institution of Science and Technology (NM-AIST, Arusha), Tanzania. Currently is a Member of Engineer Registration Board of Tanzania. Sponsored and work at Tanzanian Government as Telecommunication Engineer. His research interest includes digital Image processing, wireless communication and electromagnetic interference and control.

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His area of interests includes evolutionary computation in Telecommunication networks; Antenna design and Triangular mesh modeling.

Projects

1. Electromagnetic optimizations in wireless networks
2. Direct Matrix Manipulation(DMM) methodologies as Speeding up catalyst
3. Cell planning and optimization for GSM networks
4. Designing of mesh wireless networks
5. Spread Spectrum system for measuring distance of moving plane from the radar
6. Planar Inverted F antenna (PIFA) design for GSM 900/1800
7. Emission of mobile phone radiation into operator's head
8. Propagation and Traffic analysis in GSM Networks.