Histogram Based Number Plate Recognition with Template Matching for Automatic Granting

LDSB Weerasinghe[1#], TGDS Tennegedara[1] and TMKK Jinasena[2]
[1]*Department of Computer Science, General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka*
[2]*Department of Computer Science, University of Sri Jayewardenepura, Nugegoda, Sri Lanka*
[#]*sidath.weerasinghe@gmail.com*

Abstract *— Automatic Vehicle number plate recognition (AVNR) is a very popular and highly demanding in transportation industry, law and enforcement such as automating fines for traffic rule violations, automating parking lots, entry and exit in highways, quickly identifying granted vehicles. Most of the AVNRs use image processing techniques such as image enhancement, restoration, segmentations, block-based character recognition, optical character recognition and template matching. This paper presents the design and implementation of such a system to General Sir John Kotelawala Defence University (KDU) to capture and recode vehicle logs. People face difficulties at the gate premises due to the existing manual system. To collect the data, qualitative research techniques such as interviews and observations were used. Once an image captured, median filters were used to remove noises. Sharpen filters used to detect edges. Camera calibration was used to correct the perspective view. Lines were detected using Hough transformation and, rectangles were identified. Histogram processing is used to identify the number plates. Template matching with different letters, numbers, and special character were used to recognize its content. Once a license plate is found, its figures are recognized, displayed on the user interface and checked in the database for grants. Moreover arrival or departure times are being recorded. MATLAB was used to develop the prototype together with MySQL. Two cameras with 720x480 resolution and an i5 laptop with 4GB RAM is used to test the system. Accuracy of the system was over 84%. Accuracy was differing under different muddy conditions. As a quantitative research technique data, such as light conditions, distance from vehicle to camera have collected and analysed. Findings show that some of the factors like non-uniform vehicle number plates, language specific characters such as "Sri" and dash, are challenging in AVNR. Post research questioners have proven that the system is very useful and time saving methods for KDU and also its reliability.*

Keywords *— Image Processing, Camera Calibration, Histogram*

I. INTRODUCTION

Today vehicle number plate recognition systems have become an important safeguard measure in video monitoring of community security. This applied science is utilized by various protection and traffic applications such as entry of highly restricted areas for security like Parliament house, Supreme Court, Military zones, or whatever other sensitive system. For Automated number plate recognition involves image processing, Image enhancement, segmentation, image calibrations and character recognition technologies to identify vehicles by automatically reading their number plates. However automatically recognizing characters in the number plate becomes difficult when no standard font style or size is used. Most image processing related researches and applications have faced such kind of poor performance due to the variety of plate formats, the non-uniform environment lighting conditions during image capturing, noisy patterns connecting characters and poor edge identification (Gilly & Raimond, 2013). This paper will discuss the implementation of automated number plate recognition system mainly based on histograms and template matching.

II. RELATED WORK

Though Vehicle License Plate Recognition is not a new problem to the image processing, still there are some challenges to defeat. For an example, situation where no standard number plate format and font is maintained, identification becomes difficult. Dipankar Bhattacharya and Anjan Bikash Maity (Bhattacharya & Maity, 2011) did a research about vehicle number plate identification using edge detection and template matching. Their system can't identify special characters; only English letter and numbers are identified. Parul Shah et. al did a research on algorithm for vehicle chassis number identification using optical character recognizing using neural network. This method gives a significantly 92% for the correct identification rate and low wrong identification rate. But that system cannot identify multiline number plates. M. I. Khalil (Shah, Karamchandani, Nadkar, Gulechha, Koli & Lad 2009)

developed a system to identify Arabic number plates using template matching. Another number plate recognition system based on template matching with individual character segmentation was developed by Serkan Ozbay, and Ergun Ercelebi (Ozbay & Ercelebi, 2007). Their system is not capable of identifying number plates with noises such as mud or dust. These system need clear view of number plate's images if there is 3D view in Processing image these system cannot identify characters correctly. In real word it is very difficult to give clear cut image to these systems.

III. PROBLEM DEFINITIONS

At present Kotelawala Defence University (KDU) is using a manual system to maintain vehicle details such as number, owner, owner's NIC and other details, and expire date of the gate pass. Apart from that a log book is maintained to keep track of their in and out times. When a vehicle arrives to the KDU, it has to wait several minutes at the gate premises till the military police person checks whether the vehicle has a gate pass or not. It has been noticed that sometimes these gate passes get misplaced. In such situations they would not allow to get in till they get proper permission. Usually it takes considerable time. On the other hand, though they have proper passes it takes time to validate it. Hence a long queue of vehicles can be seen at the gate premises during busy times such as morning, afternoon and in special functions. This traffic sometimes blocks near streets as well. In fact blocking gate premises and roads can be a serious security issue to a place like KDU.

IV.METHODOLOGY

Proposed model consists of noise removal, histogram processing, feature point detection, camera calibration, and dilation and erode, image segmentation, and template matching. Moreover system maintains a database of gate pass details and log details.

The system captures live video streams from two high quality cameras with 720x480 pixels (NTSC) resolution located at fixed places at both sides of the gate. Cameras can't place directly because they block the road. With the help of artificial lights, this camera can work even at night. Once the capture button pressed, the system automatically detects the number plate and checks its gate pass. Figure. 1 shows major steps of the system.

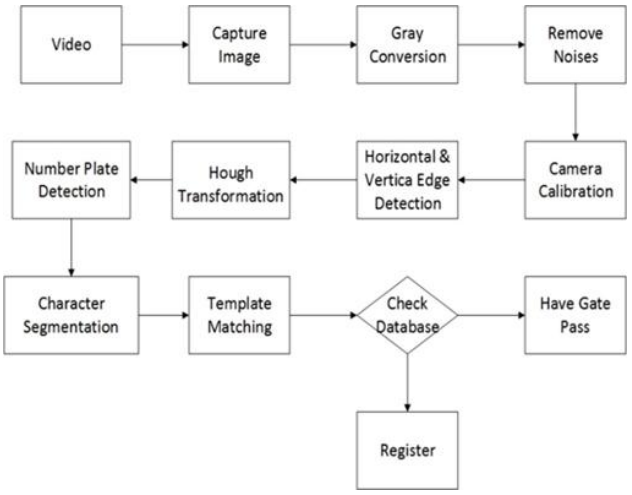


Figure 1. System Topology

A. Gray Conversion

After capturing an image, it converted to a grayscale image. It is also known as an intensifier, grayscale, or gray level image (Kumar & Verma, 2010). Usually a two dimensional array of class uint8 specifies intensity values of its pixels. These values can take any value between 0 (Fully black) and 255 (Fully white). For many image processing applications, colour information doesn't help to identify important details such as edges, segments, and other features.

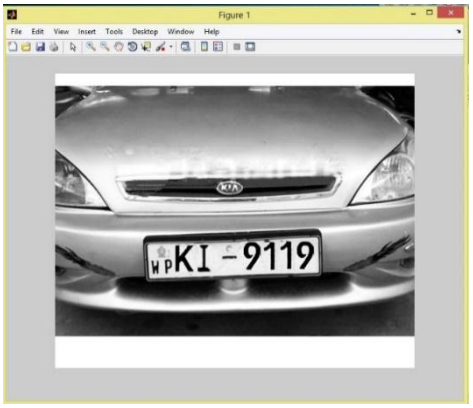


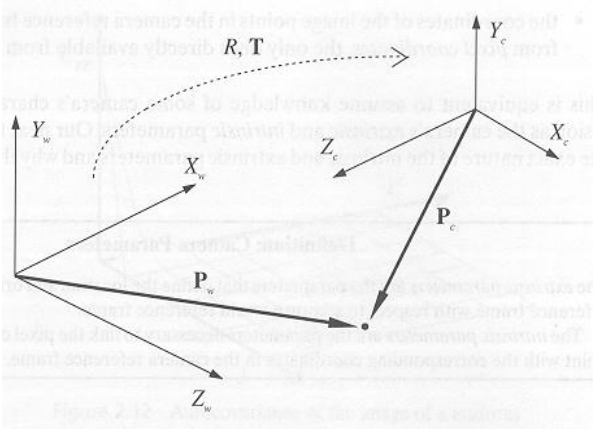
Figure 2. Rgb2gray

B. Remove Noises

Noise removal is another important task in image processing. Images are often degraded due to noises. Noise can occur during image capturing, transmission and etc., Noise removal makes a significant impact on the results of the image processing application (Mythili & Kavitha, 2003). Here, the median filter is used to remove salt-and-pepper noise from the images.

C. Camera Calibration

When a vehicle arrives to the gate premises, it may in a different position, and a different angle. Hence the side view of the camera creates a distorted view of the number plate. Therefore it makes difficult to perform template matching to identify its characters. Because in generally template matching can't be used to identify distorted or different size images.



Geometrical calibration technique is used to correct the perspective view thus the system can see the scene as a direct view. Another advantage of camera calibration is that it can identify the size of segmented character thus can be resized it to match with the template size. Check board pattern with known size is used to calibrate the camera. Since the size of square is a known value, it can be easily calculate the coefficients of the mapping equations. These equations are later used to map the pixels in the perspective view to a linear view. Once the camera is calibrated, it doesn't need to re-calibrate it till its position is changed (Jiang & Zhao, 2010).

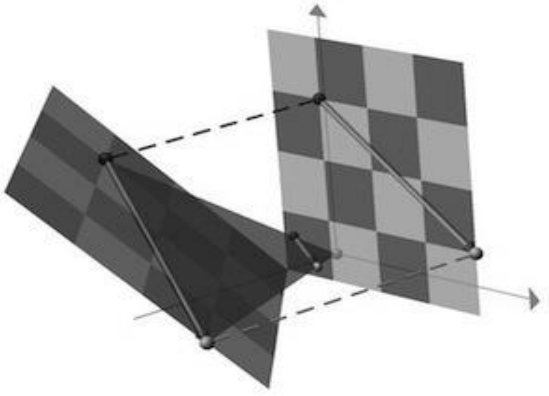


Figure 3. Perspective projection ("Concept Of Homogeneous

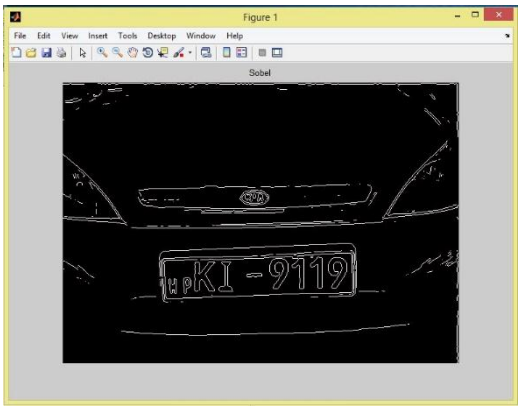


Figure 4. Apply Sobel High Pass Filter

D. Hough Transformation and First Order High Pass Filters

In this system Sobel high pass filter is used to detect both horizontal and vertical edges. Figure. 4 show that application of Sobel filter. After that; Hough Transform is used to identify straight lines in the image. Then all rectangles are identified using a heuristic method in order to locate the licence plate (Richard, Duda & Peter, 1972).

E. Capture Number Plate

Proposed system used horizontal and vertical edge processing. Each column and row of the image traversed by the algorithm, this is the difference in pixel value between calculated neighbouring pixels. If the difference in grey scale (0-255) value between the successive pixels exceeds a certain limit, which count up in the total of that particular column. Finally, all column totals are stored in a matrix. Figure. 6 shows the horizontal and Figure. 5 shows the vertical histograms. In horizontal edge processing, only the number of white pixels is counted. The number of white pixels per column, for a long time above a precomputed threshold is assumed that the given region horizontal position of the license plate indicates. In this case the system recognized many parts of the image. So the system gets vertical histogram to overcome that matter. Search for number of times a pixel of relative its neighbours in a row of high to low going or vice versa. So the algorithm can easily segment the number plate from the whole image. Then its characters are segmented into a block of size 38 x 20px.

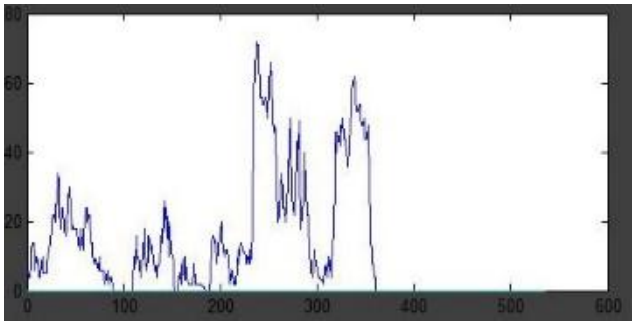


Figure 5. Vertical Histogram

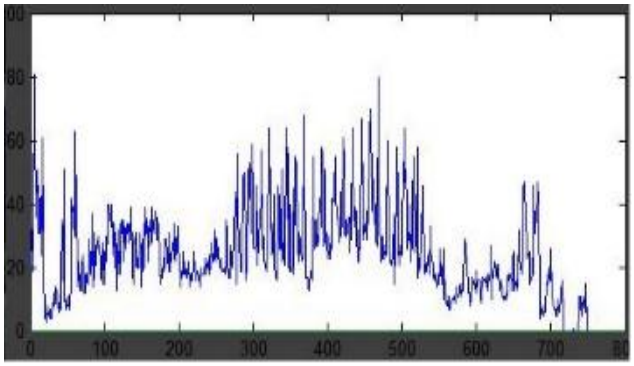


Figure 6. Horizontal Histogram

F. Characters & number recognition using template matching

Template matching is used to identify segmented characters, numbers and letters. There are 26 letters (A – Z), 10 numbers (0 – 9), dash, and Sri are stored in a database.

Figure 7. "Sri" Character Number plate

This image size 30 x 28 px is same as the segmented characters. In the template matching, the fundamental idea is to find whether the templates are correlated with the segmented characters or not. Matching is done pixel wise. The variables are the corresponding pixel values in two images, template and segmented image. The correlation value is between -1 and +1. Higher correlation value implies a strong relationship between the template and the segmented image.

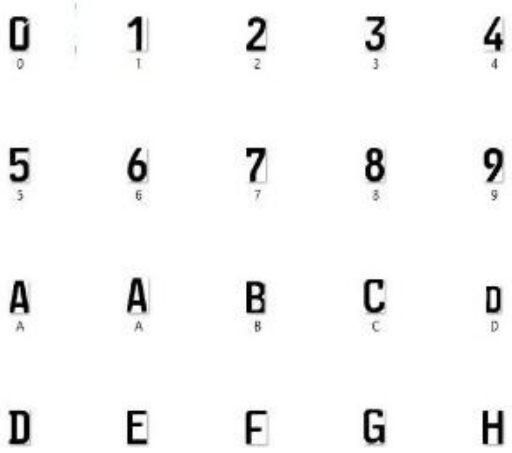


Figure 8. Templates

G. Database

This system maintains a MySQL database to maintain gate pass details. After recognizing the number plate, it checks against the records in the database. If it can find a matching record, the system shows it in the interface as "Granted"; otherwise shows "No gate pass". When there is no gate pass, the military police men can register that vehicle and can issue temporary gate pass to that person. The system required several information to register such as NIC number, Full name and etc. For the prototype, user friendly interface has developed using Matlab.

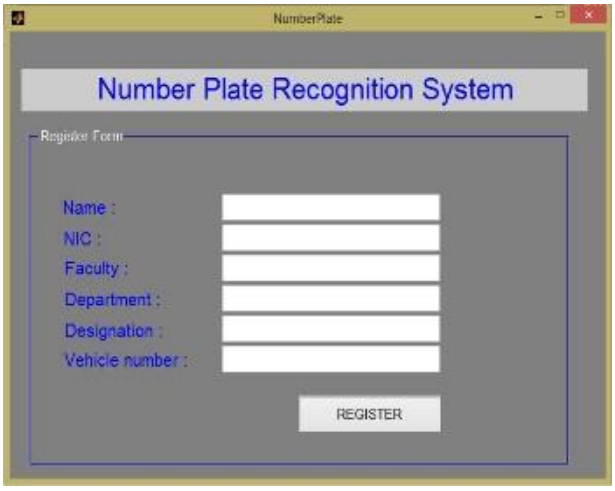


Figure 9. Registration Interface

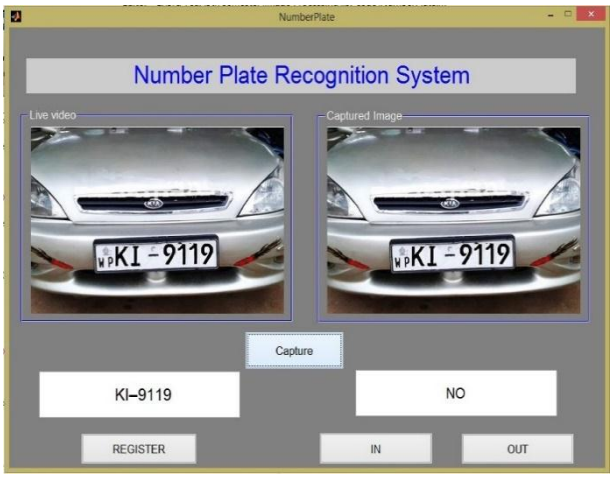


Figure 10. System Interface

V. RESULTS AND DISCUSSION

38 templates have used to identify the content of a licence plate. 48 vehicles were used to test the accuracy of the system. Vehicles were different in the size; number plates were in different conditions such as mud and dust. Out of 48 the system was able to recognize 41 number plates correctly. Even Special characters such as "Sri" and "-"have usefully identified. Also this system can identify multiline characters. But there are various types of "Sri" and "-"characters it is very difficult to identify these all types of characters. Figure. 11 show the various number plates use in Sri Lankan. The system has tested during different time of the day Such as morning, noon, evening and night in order to test its accuracy against the illumination. It has been noticed that the system is working with very high accuracy as 98% during the day time. But under bad light conditions, and bad weather conditions such as rainy, and misty, the accuracy was dropped significantly. Though the system was able to remove small mud and the dust, absence of the global illumination creates problems. The system has been tested in the university premises and users' feedback was positive and they agreed that the system is user friendly and efficient.

Figure 11. Various Number plates in Sri Lanka ("License Plates of Sri Lanka")

ACKNOWLEDGMENT

We would like to express our great thankfulness to authors for valuable and useful suggestions for image processing research work. We would also like to thank who makes online materials and also thank to math lab community for given valuable information to us. We would also like to thank who are helped to do this research and staff of the Faculty of Computing, for their valuable and precious time, which is generously and highly admired.

REFERENCES

Bhattacharya D, Maity A.B, (2011) A Study on Vehicle Number Plate Identification by Morphological Edge Detection and Template Matching, International Journal of Information and Education Technology, Vol. 1, No. 3.

Gilly D, Raimond K, (2013) License Plate Recognition- A Template Matching Method, International Journal of Engineering Research and Applications.

Jiang G, Zhao C, (2010) Camera Calibration Based on 2D-plane, Third International Symposium on Electronic Commerce and Security Workshops(ISECS '10), pp. 365-368.

Joshi P, The Concept Of Homogeneous Coordinates, Perpetual Enigma.

Kumar T, Verma K, (2010) A Theory Based on Conversion of RGB image to Gray image, International Journal of Computer Applications, Volume 7– No.2.

License Plates of Sri Lanka [WWW Document], URL http://www.worldlicenseplates.com/world/AS_SRIL.html (accessed 5.1.15).

Mythili C, Kavitha V, (2003) Efficient Technique for Color Image Noise Reduction, The research Bulletin of journal ACM, vol II.

Ozbay S, Ercelebi E, (2007) Automatic Vehicle Identification by Plate Recognition, International Journal

of Electrical, Computer, Electronics and Communication Engineering Vol:1, No:9.

Shah P, Karamchandani S, Nadkar T, Gulechha N, Koli K, Lad K, (2009) OCR-based Chassis-Number Recognition using Artificial Neural Networks, IEEE ICVES, pp. 31-34.

Richard O, Duda, Peter E, (1972) Use of the Hough Transformation to Detect Lines and Curves in Pictures, Communications of ACM.

BIOGRAPHY OF AUTHORS

Mr. LDSB Weerasinghe is an undergraduate of General Sir John Kotelawala Defence University – Ratmalana, Sri Lanka. He is following a Bachelor degree in Computer Science. He is now in his third year following the degree. He has learned and mastered in JAVA, C, Web Development, Databases and Computer Engineering. His research interests include Algorithms, Embedded Systems, Software Engineering, Image Processing and Artificial Intelligence.

.

Mr. TGDS Tennegedara is a student of Kotelawala Defence University – Rathmalana, Sri Lanka. He is following a Bachelor degree in Computer Science. He is now in his third year following the degree. He has learned and tried to master languages such as JAVA, Python, HTML. His research interests include implementation of programming and image processing.

Mr. TMKK Jinasena is currently working as a Lecturer (Probationary) at the Department of Computer Science of University of Sri Jayewardenepura. The author has obtained his BSc in Computer Science Special degree (USJP) with a First class honors, BIT(Colombo) degree with honors, and MSc in Computer Science degree(Colombo). He is currently reading for his PhD. His main research interests are Computer Security, Mobile Computing, Image Processing and Data mining. As a supervisor he supervises several undergraduate and post graduate researches covering many areas in the field of computer science.