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Research Article

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Performance Analysis of Vehicle Number Plate Recognition System Using Template Matching Techniques

Gajendra Sharma*

Department of Computer Science and Engineering, Kathmandu University Dhulikhel, Kavre, Nepal

Abstract

Vehicle number plate recognition (VNPR) system is a digital image processing techniques which is broadly used in vehicle transportation system to identify the vehicle by their number plate. Yet it's a very challenging problem, due to the diversity of plate formats, different scales, and non-uniform illumination conditions during image acquisition. This research mainly focuses on Nepali vehicle number plate recognition system in which the vehicle plate image is received by the digital cameras and the image was then processed to obtain the number plate information. A real image of a vehicle is captured and processed using various algorithms. Morphological operations, and edge detection, smoothing, filtering, techniques for plate localization and characters segmentation for segment character and these segmented character was cut in to block of 70×70 size and calculate the correlation with the template of database using the template matching algorithm normalized cross correlation and phase correlation and compare this result in term of accuracy. The system was tested by 90 patterns under several conditions. It includes experiment of number plate recognition using phase correlation and normalized cross correlation methods. From the study and analysis of test after applying on number of images of database, the normalized cross correlation method was found more accurate to recognize the number plate then phase correlation method and recognition accuracy of normalized cross correlation was 67.98% and phase correlation was 63.46%.

Keywords: Character segmentation; Template matching; Plate region extraction; Phase correlation; Normalized cross correlation

Introduction

Vehicle number plate recognition (VNPR) system is a digital image processing techniques which broadly used in vehicle transportation system to identify the vehicle. A number plate recognition system has broad implications, for e.g. traffic maintenances, tracing stolen cars, automatic electronic toll collection system and other applications [1]. Vehicle number plate recognition (VNPI) system is capable of identifying vehicles by extracting the number plate and reading the plate toidentity which unique identification code given to each vehicle, but the main aim is to control the traffic management system. Massive integration of information technologies into all aspects of modern life caused demand for processing vehicles as conceptual resources in information systems. Because a standalone information system without any data has no sense, there was also a need to transform information about vehicles between the reality and information systems. This can be achieved by a human agent, or by special intelligent equipment which is be able to recognize vehicles by their number plates in a real environment and reflect it into conceptual resources. Owing to this, various recognition techniques have been developed and number plate recognition systems are widely used in different traffic and security use, such as parking, border control and tracking of stolen cars [2]. In parking, number plates are used to calculate duration of the parking. When a vehicle enters an input gate, number plate is automatically recognized and stored in database. When a vehicle exits the parking area through an output gate, the number plate of the vehicle is recognized again and paired with the first-one stored in the database. The difference in time is used to evaluate the parking fee [3]. Automatic number plate recognition systems can be used in access control. For example, this technology is used in many companies to grant access only to vehicles of authorized personnel. In some countries, automatic number plate recognition systems installed on country borders automatically detect and monitor border crossings. Each vehicle can be registered in a central database and compared to a black list of stolen vehicles. In traffic control, vehicles can be directed to different lanes for a better congestion control in busy urban communications during the rush hours [3]. In case of Nepal according to motor vehicles and transport management act, 2049 public motor vehicle must be in white figures and letters on a black plate. Provided that, from now-onwards, the number plate of a tempo and micro-bus registered with the Baghmati zone and to be plied within and outside the ring road of the Kathmandu valley must be in black figures and letters on a white plate. Tourist motor vehicle must be in white figures and letters on a green plate. Private motor vehicle must be in white figures and letters on a red plate. Government motor vehicle must be in red figures and letters on a white plate. Motor vehicle of a body corporate or corporation must be in green figures and letters on a yellow plate. The schedule itself altered by the notice published in the Nepal gazette dated 20, September 1999. The proviso inserted by the notice published in the Nepal gazette dated 19 October 2000. Diplomatic motor vehicles should be in white plate and letters must be on a blue plate. As such the upper and lower half part of the number plate of motor vehicle carrying the top figures such as prime minister, chief justice, speaker of the house of representatives, chairperson of the national assembly or member of the council of ministers should be in white figures and letters must be on the blue background. The size of a number plate of different kinds of heavy or medium motor vehicle should be of size 14" × 8" that of a four-wheel motor vehicle out of light motor vehicles should be 12" × 7", that of a three-wheel tempo etc. should be 10" × 7" and two-wheel motor cycle, scooter etc. should be 8" × 5". The height and breadth of figures and letters in which the number plate of a heavy motor vehicle and of a medium motor vehicle is written must be three inch and ½ inch, that of a four-wheel and three-wheel tempo etc., out of the light motor vehicles, must be two-inch and ½ inch and that of a motor cycle, scooter etc., must be two-inch and

***Corresponding author:** Gajendra Sharma, Department of Computer Science and Engineering, Kathmandu University Dhulikhel, Kavre, Nepal, Tel: +97711-663734; E-mail: gajendra.sharma@ku.edu.np

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3/8 inch, respectively. The number plate of a motor vehicle must be written in figures and letters leaving ½ inch (1/4 inch in the case of the number plate of a motor cycle, scooter, etc.) on all the four sides of the number place. The distance between the figures and letters must be at least ¼ inch and that between the upper and lower lines must be at least ½ inch [2,3] . In transportation, vehicles play important role, day by day the human population is increased and use of vehicles is also increased due to increased human needs. As a result of it the control of vehicles is becoming a big complex problem. Automatic number plate recognition system is one of the methods used for the effective control of these vehicles that allow the extraction of number plate information without the needs of human. This automated system is an application of computer vision and image processing technology that allows one to extract number plate information from image or sequence of images. Automatic vehicles number plate recognition system is broadly used in vehicle transportation system to identify the vehicle [4]. Number plate recognition systems have wide range of application such as traffic maintenances, tracing stolen cars, automatic electronic toll collection system and many more. If a vehicle is stolen, it could be marked in the license plate recognition system as so. If at any point the stolen vehicle happens to pass a camera on the roadside that belongs to the license plate recognition system an alarm is set off to alert a guard. It controls the traffic flow management [5,6]. The main objectives of the thesis work are to recognize vehicle number plate by template matching technique using normalized cross correlations algorithm and phase correlation algorithm and to analyze the result of recognition of vehicle number plate by template matching techniques using normalized cross correlations algorithm and phase correlation algorithm.

Literature Review

Literature review section focus on the research previously done by several researchers. Number plate recognition is the hotspot area of research now days due to rapid development of transportation systems [6]. It is an image processing technology used to identify vehicles by only their license plates [4]. Number plate detection system investigates an input image to identify some local patches containing license plates. Since a plate is able to exist anywhere in an image with different sizes, it is not capable to check each pixel of the image. The advantage of this approach is success full recognition of a vehicle. Various research journals were consulted to find relevant information regarding based applications. Massoud, Sabee, Gergais, Bakhit, "Automated new license plate Recognition in Egypt", Alexandria Engineering Journal [1]. Shapiro, Gluhchev, Dimov, "Towards a Multinational Car License Plate Recognition System", Machine Vision and Applications [2]. Zheng, He, Wu, Hintz, "Character Recognition of Car Number Plates", International Conference on Computer Vision [3]. Kim, "Learning Based Approach for License Plate Recognition, Neural Networks for Signal Processing", IEEE Signal Processing Society Workshop [4]. Ozbay and Ergun Ercelebi, "Automatic Vehicle Identification by Plate Recognition", International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering [7]. Shapiro, Gluhchev, Dimov," Towards a Multinational Car License Plate Recognition System", Machine Vision and Applications [8]. In this research, performance analysis has to be done by using normalized cross correlation and phase correlation algorithm for vehicle number plate. The goal of the system is to recognize vehicle number plate by template matching technique using normalized cross correlations algorithm and phase correlation algorithm and to analyze the result of recognition of vehicle number plate by template matching techniques using normalized cross correlations algorithm and phase correlation algorithm. Vehicle number plate recognition algorithm consists of steps like as edge detection by using sobel edge detector, morphological operation like dilation and erosion. In dilation, every background pixel that is touching an object pixel is changed into an object pixel. Dilation makes the objects larger, and erosion is adversely of dilation [7]. Dilation as used in vertical and horizontal lines to detect the structure of rectangle. The filling holes algorithm used to fill the object that result from dilation process. Smoothing the filled image result from filling holes algorithm by eroding it using erosion operation with square structure element to specify the candidate plate regions. However, there may be more than one candidate region for plate location. Then apply opening filter to smooth the contour of a plate and eliminate false touching, thin ridges and branches. Then closing filter to smooth the contour of a plate and fill small gaps and holes inside image. Filtering the smoothing image by using 2-D median filter with mask 3 × 3 then followed by removing unwanted objects which its counts may not form a candidate region for the plate [8]. To obtain the plate region in this phase, the other regions must be eliminated [1]. Segmentation is one of the most important elements in automated analysis. At this step, the objects or other entities of interest are extracted from an image for recognition process. In the segmentation of plate characters, license plate is segmented into its constituent parts obtaining the characters individually [1]. Segmentation is performing by first labeling the connected component by 8 connected boundaries then calculates the maximum label and find the row and column having pixel value. Then find the starting position of each label store each pixel value of label in to target matrix then find the resulting image of each label. After segmentation steps, the characters and numbers were cut into blocks with fixed size 70×70. These blocks were matching with previous database blocks of characters. The normalized cross correlation and phase correlation method used in matching technique.

Related Theory

Gray scale conversion

The captured input image is Red Green Blue (RGB) format. The first step of preprocessing is to convert RGB image into grayscale. The basic purpose of applying color conversion is to reduce the number of colors. The R, G and B components are separated from 24-bit color value of each pixel (i, j) and 8-bit gray value is calculated [9]. Convert RGB image to Gray sale image by taking the weighted average of RGB value then,

$$\text{New grayscale image} = ((0.299 \times R) + (0.59 \times G) + (0.11 \times B))\ldots(1)$$

Sobel edge detector

The data amount in an image is able to preserve the structural properties for additional image processing. Edge detection facilitates to locate sharp discontinuities of an image. This is the most common approach for detecting meaningful discontinuities in intensity values. The edge is a boundary between two regions with relatively distinct gray level properties. In edge detection, many operators are defined such as sobel, log, canny, prewitt. The Canny operator was designed to be an optimal edge detector. It takes as input a gray scale image, and produces as output an image showing the positions of tracked intensity discontinuities [10,11].

Dilation

Dilation is one of the two basic operators in the area of mathematical morphology, the other being erosion. It is usually applied to binary images, but there are options that work on grayscale images. The basic effect of the operator on a binary image is to gradually enlarge the boundaries of regions of foreground pixels (i.e., white pixels, typically). Thus areas of foreground pixels grow in size while holes within those regions become smaller. The dilation operator takes two pieces of data as inputs. The first piece of the image is dilated. The second part is usually tiny which is set of coordinate points called a structuring element (also known as a kernel). It is this structuring element that determines the precise effect of the dilation on the input image [12]. Dilation of image f by structuring element s is given by f s the structuring element s is positioned with its origin at (x, y) and the new pixel value is determined using the rule:

$$g(x,y)=\begin{cases}1 & \text{if } s \text{ hits } f\\ 0 & \text{otherwise}\end{cases} \quad \ldots\ldots(2)$$

Erosion

Erosion is one of the two basic operators in the area of mathematical morphology, the other being dilation. It is basically applicable to binary images, but having versions that work on grayscale images. The basic effect of the operator on a binary image is to erode away the boundaries of regions of foreground pixels (i.e., white pixels, typically). Thus areas of foreground pixels shrink in size, and holes within those areas become larger. The erosion operator receives two pieces of data as inputs. The first piece is the image which is to be eroded. The second is a (usually small) set of coordinate points known as a structuring element (also known as a kernel). It is this structuring element that determines the precise effect of the erosion on the input image [13].

Holes filling

A hole may be defined as a background region surrounded by a connected border of fore ground pixels. Let A is the set whose elements are 8-connected boundaries, each boundary enclose background region (a hole). Given a point in each hole, the objective is to fill all the holes with ones (for binary images). We start from forming an array X_0 of zeros (first element of array), except at the locations in X_0 corresponding to the given point in each hole, which is set to one. Then, the following procedure fills all the holes with ones:

$$Xk = \left(X_{k-1} \oplus B\right) \cap \overline{A} \quad \ldots\ldots(3)$$

Where, B is the symmetric structuring element, k=1, 2, 3,……..

The algorithm terminates at the iteration step k , if $X_k = X_{k-1}$. The set X_k then contains all the filled holes; the union of X_k and A contains all the filled holes and their boundaries. The dilation would fill the entire area if left unchecked. However, the intersection at each step with the complement of a limits the result to inside the region of interest. This is an example of how a morphological process can be conditioned to meet a desired property [14].

Opening and closing

Opening and closing are two important operators from mathematical morphology. They are both derived from the fundamental operations of erosion and dilation. Like those operators they are usually applicable to binary images, although there are also gray level options. The basic effect of an opening is somewhat like erosion in that it tends to remove some of the foreground (bright) pixels from the edges of regions of foreground pixels. However it is less destructive than erosion in general. As with other morphological operators, the exact operation is determined by a structuring element. The effect of the operator is to preserve foreground regions that have a similar shape to this structuring element, or that can completely contain the structuring element, while eliminating all other regions of foreground pixels very simply, an opening is identified as erosion followed by a dilation using the identical structuring element for both operations. The opening operator therefore requires two inputs an image to be opened, and a structuring element. Gray level opening consists simply of gray level erosion followed by a gray level dilation. Opening is the dual of closing, i.e., opening the foreground pixels with a particular structuring element is equivalent to closing the background pixels with the same element. The opening of image A by Structuring element B is denoted by AoB and is defined as composition of erosion and dilation [15,16].

$$AoB = (A\ \theta\ B) \oplus B \quad \ldots\ldots(4)$$

First perform erosion and then dilation Then it smooth the contour of a plate and eliminate false touching, thin ridges and branches.

The closing of image A b y structuring element B is denoted by:

$$A \bullet B = (A \oplus B)\theta B \quad \ldots\ldots(5)$$

First perform dilation and then erosion then smooth the contour of a plat e and fill small gaps and holes inside image.

Normalized cross correlation

For image-processing applications in which the brightness of the image and template can vary due to lighting and exposure conditions, the images can be first normalized. This is typically done at every step by subtracting the mean and dividing by the standard deviation. Normalized correlation is a method employed for template matching, a procedure used for locating incidences of a pattern or object within an image. It is also the 2-dimensional version of Pearson product-moment correlation coefficient [1]. Where f (n1, n2) be the image to be match and g (n1, n2) be the database template and phase correlation can be calculated by taking the DFT of first and second image and multiply the DFT of first image by the complex conjugate of DFT of second image and result is divided by absolute vale then we get combine phase formula then taking IDFT peak value of phase correlation is found.

Methodology

The general NPR system block diagram

Input image: Input image is the first phase deals with acquiring an image. In the proposed system digital camera of 5 mega pixel camera is used. The input images are 1403 × 677 or 1932 × 2576 or 960 × 960 pixels.

Number plate extraction: The identification of objects within an image can be a very difficult task. In this stage, the capture image of the vehicle is converted to gray scale image. The aim of this stage is to find rectangles of plate vehicles. The edge detection was applied by using sobel edge detector. Morphological algorithm, dilation, and erosion, opening, closing, hole filling and filtering algorithm were used [1]. Every background pixel in dilation that is touching an object pixel is changed into an object pixel. Dilation makes the objects larger, and erosion is unfavorably of dilation. Dilation as used in vertical and horizontal lines to detect the structure of rectangle. The filling holes algorithm used to fill the hole inside the object that result from dilation process. Smoothing the filled image result from filling holes algorithm by eroding, it using erosion operation with square structure element to specify the candidate plate regions. However, there may be more than one candidate region for plate location. Then apply opening filter to smooth the contour of a plate and eliminate false touching, thin ridges and branches. Then closing filter to smooth the contour of a plate and fill small gaps and holes inside image. Filtering the smoothing image by using 2-D median filter with mask 3 × 3 then followed by removing unwanted objects which its counts may not form a candidate region for the plate. To obtain the plate region in this phase, the other regions must be eliminated [1].

Character segmentation: The next step after the detection of the number plate area is a segmentation of the plate. The 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 [11]. Segmentation is one of the most important elements in automated analysis. At this step, the objects or other entities of interest are extracted from an image for recognition process. In the segmentation of plate characters, license plate is segmented into its constituent parts obtaining the characters individually [1]. Segmentation is performing by first labeling the connected component by 8 connected boundary, then calculate the maximum label and find the row and column having pixel value. Then find the starting position of each label store each pixel value of label in to target matrix then find the resulting image of each label [17].

Character recognition and display the result: After segmentation steps, character recognition is very important stage in number plate recognition system to check for validation of character the characters and numbers were cut into blocks with fixed size 70 ×70. These blocks were matching with previous database blocks of characters. The normalized cross correlation and phase correlation method used in matching technique.

Algorithms

System algorithm:

Step1: Take the input image from camera.

Step2: Convert input image in to gray scale image.

Step3: Apply sobel edge detection methods.

Step4: Manage threshold until the correct edge is detected.

Step4: Apply dilation operation.

Step5: Fill hole inside image.

Step6: Perform erosion operation.

Step7: Apply filtering.

Step8: Segment individual character and number.

Step9: Calculate peak value of correlation matching with database template.

Case1: If peak value of correlation is greater than or equal to 0.5 then display recognized.

Case2: If peak value of correlation is smaller than 0.5 then display not recognized.

Sobel edge detector:

Step1: Consider an image A and horizontal and vertical mask G_x and G_y respectively.

Step2: Find X direction derivative. Subtract the first row from third row using them ask.

Step3: Find Y direction derivative. Subtract the first column from third column using the mask.

Step 4: Find the gradient by:

$$G = \sqrt{\left[\!\left[G_X^2 + G_Y^2 \right]\!\right]} \quad \ldots\ldots(6)$$

Dilation:

Step 1: Read image A and define structuring element B.

Step 2: Initialize a matrix D of size A with zeros.

Step 3: Pad the matrix A with zero on both sides.

Step 4: Place the structuring element B on matrix A and perform logical AND operation.

Step 5: If all the value is non-zero then update the matrix D with one.

Step 6: Repeated the process until the element in matrix A is visited.

Erosion:

Step1: Read an image A and define structuring element B.

Step 2: Initialize a matrix D of size A with zeros.

Step3: Pad the matrix A with one on both sides.

Step4: Place the structuring element B on A and check whether the one on structuring element overlap only the one in matrix A.

Step 5: If the condition is true, then update Matrix D with one.

Step 6: Repeat the procedure for the entire element in matrix A.

Median filter:

Step 1: Read image A.

Step 2: Initialize a matrix D of size A with zeros.

Step 3: Pad the matrix A with zero on both sides.

Step 4: Copy original image matrix A to the padded matrix M.

Step5: Define window as an array to store 3 × 3 neighbor value.

Step6: Sort and find the middle element.

Step7: Place the middle element on output matrix D.

Step8: Repeat the procedure for the entire element in matrix A.

Character segmentation:

Step 1: Read an image F after median filtering.

Step 2: Label the connected component of image F.

Step 3: Calculate the maximum label.

Step 4: Loop from 1 to maximum label.

Step5: Find the minimum and maximum column and row having pixel value of each label.

Step6: Calculate length and breadth using,

Len=max (row)-min (row) +2.

Breadth=max (col)-min (col) +2.

Step7: Define the target matrix of size equal to len and breadth.

Step8: Find the starting position of each label.

Step9: Store each pixel value of label in to target matrix and go to step 4.

Step10: Display target matrix.

Phase correlation:

Step 1: Read an image A and template B (Figures 1 and 2).

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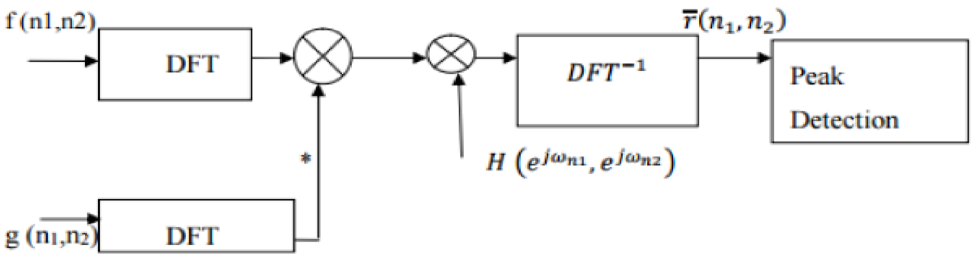

Figure 1: Block diagram of phase correlation.

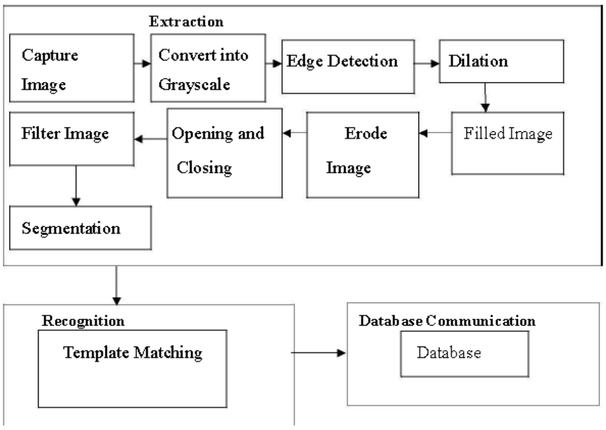

Figure 2: Block diagram of number plate recognition.

Step 2: Calculate 2D DFT of image A.

Step 3: Calculate 2D DFT of template B.

Step 4: Calculate complex conjugate of DFT of template B.

Step 5: Calculate the product of DFT of image A and complex conjugate of DFT of template B as numerator.

Step 6: Calculate the absolute value of product of DFT of image A and complex conjugate of DFT of template B as denominator.

Step7: Divide numerator by denominator and take inverse DFT of result.

Results and Analysis

Figure 3 shows the vehicle number plate capture by digital camera. Digital camera is used up to 5 mega pixels. The input images sizes were 1403 × 677 or 1932 × 2576 or 960 × 960 pixels.

Figure 4 shows the gray scale image of capture image. In this stage, the capture image of the vehicle converted to gray scale image, by taking the weighted average sum of RGB.

Figure 5 shows the edge detected image after applying sobel operator in horizontal and vertical direction.

Figure 6 shows the image after apply dilation operator. In dilation, every background pixel that is touching an object pixel is changed into an object pixel. Dilation makes the objects larger. Dilation was used in vertical and horizontal lines to detect the structure of rectangle.

Figure 7 shows the result after apply the filling hole algorithms.

Figure 3: Capture of original image.

Figure 4: Gray scale image.

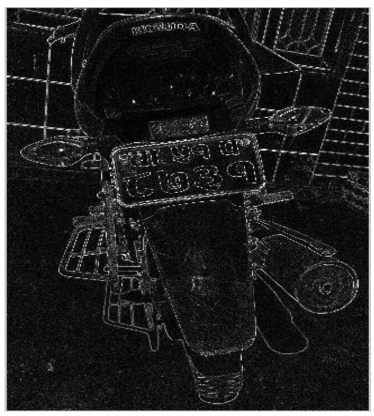

Figure 5: Sobel edge detector

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The filling holes algorithm used to fill the hole inside object that result from dilation process, so that it help to separate the part of object after segmentation.

Figure 8 shows the result after apply the erosion operator and smoothing the filled image result from filling holes algorithm by eroding it using erosion operation with square structure element to specify the candidate plate regions. However, there may be more than one candidate region for plate location.

Figure 9 shows the result after apply the opening operator first performing erosion and then dilation, then it smooth the contour of a plate and eliminate false touching, thin ridges and branches.

Figure 10 shows the result after apply the closing operator first performing dilation and then erosion. Then smooth the contour of a plate and fill small gaps and holes inside image.

Figure 11 shows the result after apply 2D median filter with mask 3 × 3 then it remove unwanted objects which its counts may not form a candidate region for the plate. It smooth and filter image. To obtain the plate region in this phase, the other regions must be eliminated.

Figure 12 shows the segmentation of individual character and number from vehicle number plate, where vehicle number plate is segmented into its constituent parts obtaining the character individually for further recognition process.

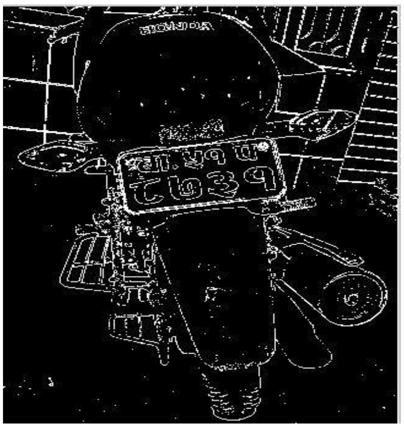

Figure 6: Dilation

Figure 7: Fill image.

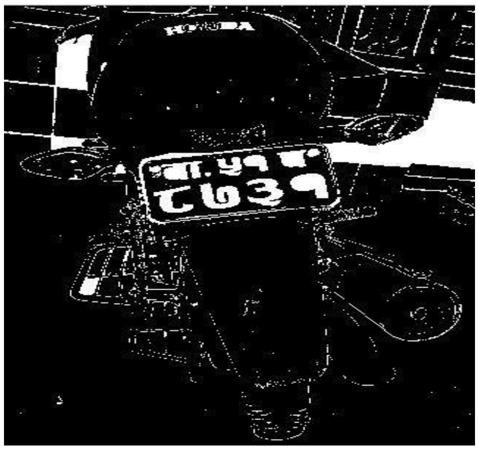

Figure 8: Erode image.

Figure 9: Opening.

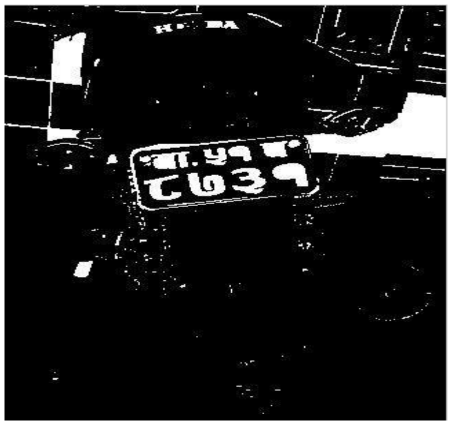

Figure 10: Closing.

Table 1 shows the result of segmentation of individual character and number from the vehicle number plate in different condition. Figures 1 and 3 was taken on lightening condition and there is no slant and dirty and plate, so the individual character and number were easily segmented and second figure in Table 1 shows the image taken in lightening condition but there is no space is maintained

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between individual character and number so these character were fail from segmentation and fourth image from Table 1 is taken from large distance so some character were fail to segment and fifth image is taken from far distance with certain angle and no character were segmented and last image was taken in dim condition only some character were segmented. Test was performing on 90 samples under the several conditions. The plate detection and segmentation was failed from slant and dirty in the plates and far distance between vehicle and camera and spacing not maintain between character and number. The presence of noise, blurring in the image uneven illumination, dim light and foggy condition make the task even more difficult to plate detection and segmentation. Detection of the VLP is also a problem due to distance between the camera and the vehicle. Sometime it also becomes difficult due to angular image. Table 2 shows the result of template matching using normalized cross correlation and phase correlation. From the 90 pattern of image total 15 sample of zeroes, 77 sample of ones, 22 sample of twos, 103 sample of threes, 58 sample of fours, 46 sample of fives, 12 sample of sixes, 92 sample of sevens, 70 sample of eights, 17 sample of nine, 70 sample of ba, 84 sample of pa, 15 sample of ve, 2 sample of ra, 4 sample of cha was taken. Among different sample of digit and character which are recognized by normalized cross correlation and phase correlation are as shown in Table 2 there were total 687 sample of digit and character among them 467 sample were recognized by normalized cross correlation and 436 sample were recognized by phase correlation most of the character were failed from plate detection and segmentation. If Character and numbers were clear and there is no slant and dirty in plate that were good for plate detection, segmentation after segmentation each segmented character were cut in to block of 70×70 pixel and match with the database template using normalized cross correlation and phase correlation.

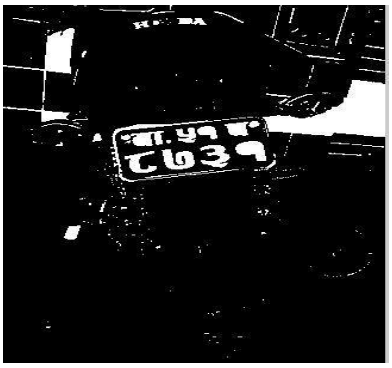


Figure 11: Filtering image.

Figure 12: Individual character and number.

SN	Image	Actual Number	Correct Segment	Remark
1		Ba51pa8731	Ba51pa8731	Correct

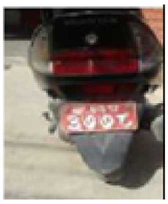
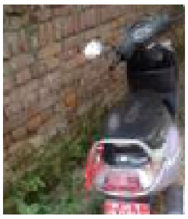
2		Ve5pa4229	ve5pa××××	Incorrect
3		Ba43pa3778	Ba43pa3778	Correct
4		Ba54pa1744	×××××××4	Incorrect
5		Ba34pa7457	××××××××	Incorrect
6		Ba49pa5424	Ba×××××××	Incorrect

Table 1: Segmentation result.

Letter	Test Sample	Normalized Cross Correlation	Phase Correlation
0	15	9	6
1	77	55	57
2	22	14	12
3	103	82	59
4	58	38	40
5	46	30	22
6	12	8	6
7	92	65	69
8	70	49	40
9	17	8	5
Ba	70	47	53
pa	84	51	55
Ve	15	8	9
Ra	2	1	1
cha	4	2	2

Table 2: Result of template matching.

Table 3 shows the result of performance analysis from the Table 2 accuracy was calculated by taking the sample recognized divided by total sample and multiply by hundred. The accuracy of phase correlation was 29% to 75.7% and accuracy of normalized correlation was 47% to 79.6%. Average accuracy was calculated from Table 3 and the success of recognition using normalized cross correlation was 67.98% and phase correlation was 63.46% in average. The plate detection and segmentation was failed from slant and dirty in the plates and far distance between vehicle and camera and spacing not maintain between character and number. The presence of noise, blurring in the image uneven illumination, dim light and foggy condition make the task even more difficult. Detection of the VLP is also a problem due to distance between the camera and the vehicle. Sometime it also becomes difficult due to angular image. Next problem in VLPR system is recognition of the character. In Devanagari script "7" is written in more than 3 styles. Similar is the case with "8"and "5". Lack of standardization in Devanagari script is the cause of this problem.

Letter	Test Sample	Accuracy (%) NCC	Accuracy (%) PC
0	15	60	40
1	77	71.429	74.026
2	22	63.636	54.546
3	103	79.612	57.282
4	58	65.517	68.965
5	46	65.217	47.826
6	12	66.667	50
7	92	70.652	75
8	70	70	57.143
9	17	47.059	29.412
Ba	70	67.143	75.714
Pa	84	60.715	65.477
Ve	15	53.333	60
Ra	2	50	50
cha	4	50	50

Table 3: Performance analysis result.

Conclusion and Recommendation

The proposed technique had been experimented to measure the performance of system by comparing the result of accuracy of the system using template matching algorithm normalized cross correlation and phase correlation algorithm. From the study and analysis of Table 3 after applying on number of images of database, came to conclusion that normalized cross Correlation method is more accurate to recognize the objects then Phase correlation method and recognition accuracy of normalized cross correlation was 67.98% and phase correlation was 63.46%. Work was performing on Nepali number plates obtained by taking image by using the digital camera up to 5 mega pixels and perform the various morphological operation like dilation, erosion, sobel edge detection, fill image, opening and closing for plate area localization and segment the image by using segmentation algorithm and the segmented image was cut in to the block of fixed size and calculate the correlation with data base template using template matching algorithm normalized cross correlation and phase correlation and work was done in mat lab in image processing and an average recognization accuracy of normalized cross correlation was 67.98% and phase correlation was 63.46%. Also, the work can be extended to improve the accuracy of phase correlation and normalized correlation by taking inputs from live video feed and selecting the best vehicle frame for classification of vehicle types and recognizing the number plates.

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