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Vehicle Number Plate Recognition and Parking System

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***Abstract* - This paper deals with the development of an application which recognize the Vehicle License Plate (VLP) and parking system that can be used for traffic system, parking area and the border crossing in Nepal. The paper combines the capabilities of hardware and software into one integrated automatic system. We used digital image processing software that locates the plate in a photo that was taken for the car at the entrance of the parking lot using a camera. The output of the image processing is the plate number, this number is used to decide whether the car to enter the parking lot or not. The system uses a number of sensors to send and receive signals for processing.**

Keywords: Image Processing, Optical Character Recognition.

I. INTRODUCTION

A parking lot (Australian and British English: car park), also known as a car lot, is a cleared area that is intended for parking vehicles. Usually, the term refers to a dedicated area that has been provided with a durable or semi-durable surface. In most countries where cars are the dominant mode of transportation, parking lots are a feature of every city and suburban area. Shopping malls, sports stadiums, mega churches and similar venues often feature parking lots of immense area. This system is developed based on digital images manipulation and can be easily applied to commercial purpose for the use of secure usage of parking houses and also to prevent car theft issues and many more.

An Automatic Number Plate Recognition (ANPR) is a technology that uses optical character recognition on images to read vehicle registration plates. It can use existing closed circuit television, road-rule enforcement cameras, or cameras specifically designed for the task. ANPR is used by police forces around the world for law enforcement purposes, including checking if a vehicle is registered or licensed. It is also used for electronic toll collection on pay-peruse roads and as a method of cataloguing the movements of traffic for example by highways agencies.

In the current era of information technology, the use of automatic system is becoming more and more widespread. Automatic number plate recognition can be used to store the images captured by the cameras as well as the text from the license plate, with some configurable to store a photograph of the driver. Systems commonly use infrared lighting to allow the camera to take the picture at any time of the day. ANPR technology must take into account plate variations from place to place. Fully automated systems are being adopted in industries across the world at a rapid rate. Control systems are replacing manual operators and fully automated machines are replacing human labor. Less personnel and smarter machines means less operating and labor costs while increasing the quality of the products or services offered. Though this limits the use of the parking lot, it increases the security of the lot which has been deemed as a reasonable trade-off.

II. RELATED WORK

In this section focus is on the related work that has been done previously by several researches. In literature we can find many methods for license plate detection and recognition system. The major drawback is that how long it will take to compute and recognize the license plates. This is critical and most needed when it is applied to real time applications. However, there is always a trade-off between computation time and performance rate. In order to achieve an accurate result and increase the performance of the system more computational time is required.

The problem of automatic VLP recognition has been studied since 1990s. The first approach was based on characteristics of boundary lines. The input image was first processed to enrich boundary lines information by some algorithms such as the gradient filter, and resulted in an edging image. This image was binarized and then processed by certain algorithms, such as Hough Transform, to detect lines.

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Eventually, couples of 2 parallel lines were considered as a plate-candidate.

Another approach was morphology-based .This approach focuses on some properties of plate images such as their brightness, symmetry, angles, etc. Due to these properties, this method can detect the similar properties in a certain image and locate the position of license plate regions. The third approach was texture- based. In this approach, a VLP was considered as an object with different textures and frames. The texture windows frames of different sizes were used to detect plate-candidates. Each candidate was passed to a classifier to confirm whether it is a plate or not. This approach was commonly used in finding text in images tasks. In addition, there have been a number of other methods relating to this problem focusing on detecting VLP in video data (objects appear in a chain of sequent images).

This fourth approach was based on statistical properties of text. In this approach, text regions were discovered using statistical properties of text like the variance of gray level, number of edges, edge densities in the region, etc. This approach was commonly used in finding text in images, and could well be used for discovering and designating candidate number plate areas as they include alphabet and numeral.

In addition, there have been a number of other methods relating to this problem focusing on detecting VLP using AI and genetic algorithm. These systems used edge detection and edge statistics and then artificial intelligence techniques to detect the location of the number plate-designate area. All of the systems discussed above have some kind of limitations for example they are plate size dependent, color dependent, work only in certain conditions or environment like indoor images etc.

III. NUMBER PLATE SYSTEM IN NEPAL

In our paper, we proposed machine learning based Nepali number plate recognition system, which is capable of automatically labeling a given number plate to its identity. Automatic number plate recognition is a widely researched problem from many decades and in many countries it is successfully applied to practical domain too. But for Nepali number plates, there are very few researches conducted so far. Most of them are based on simple distance measures for character matching. Plate localization and segmentation are again not researched much for handling all the situations. Nepali number plate character is selected from the pool of 29 characters (Fig. 1) in a specific order. Order defines various characteristic of the number plates (Fig. 2) such as vehicle type, vehicle load, etc. The number plates used in Nepal are usually of two formats, one containing all the characters in a single row and the other containing two rows of characters. Characters are selected from Devnagari script. Here, we propose a complete number plate recognition pipeline that automatically localizes, normalizes and segments number plates from vehicle images; segments characters from detected number plates and passes them to classification system for labeling. Localization of license plate refers to extracting the region in an image that contains the plate and some of the widely used techniques for localization include scale shape analysis, edge detection, mathematical morphology, connected component analysis, regional segmentation, and statistical classification. Different algorithms have claimed their accuracy for localization from 80% to 96%. The segmentation phase extracts the region of individual characters from the plate. Frequently used algorithms for segmentation include region merging and splitting, edge gradient analysis and region analysis. Coordinate of window enclosing each character is ascertained by segmentation. Template matching and statistical classification were widely used for number plate character recognition in the past. But with the advent of technology and machine learning algorithms, Artificial Neural Networks, Support Vector Machines, Hidden Markov Models are some of the widely used techniques in the current scenario. These algorithms claim to offer accuracy of up to 98% for tasks like character recognition even under different environmental variations.

Numbers	Zonal Representation	Vehicles' Category			
		Color (Foreground)	Heavy size	Middle size	Light size
०	१ Mechi	Private	ब	प	प
१	२ Koshi	Government	प	ब	ब
२	३ Sagarmatha	Public	ब	ब	ब
३	४ Janakpur	Diplomatic	बि डी	बि डी	बि डी
४	५ Narayani	Tourist	प	प	Not available
५	६ Bagmati	Public/National corporation	प	ब	Not available
६	७ Gandaki	Note: The box in the shaded region are the categories that are used in this research!!			
७	८ Lumbini				
८	९ Dhaulagiri				
९	१० Bheri				
	११ Rapti				
	१२ Karnali				
	१३ Seti				
	१४ Mahakali				

Figure 1: Nepali Number Plate Specification

Nepali vehicles have license numbers encoded in the both rear and front side with two different sized rectangular plates. The front sized plates are usually in 4:1 ratio and the back sized plates are in 4:3 ratio. For a profile test, we normally convert image regions into binary form and then calculate both row and column profiles. The row profile of the

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license plate rectangle will either have one or two peaks above the preset threshold corresponding to the 4:1 or 4:3 ratio plates respectively.

Similarly, in the column profile there will be minimum of four and maximum of eight peaks above threshold for the 4:1 ratio plate and for the 4:3ratio plate, which is previously detected from the row profile, we will first divide it into two halves and then the resulting column profile will have, for the upper part, minimum of three and maximum of four peaks and for the lower part the minimum one and maximum four peaks above threshold and all corresponding to the characters associated with the license plate. The rectangle with the best match is selected as the license plate for the segmentation process.

Currently, Nepal government has begun the process to distribute embossed number plates for vehicles on the basis of provincial structure against the current zonal format. Department of Transport Management (DoTM), The embossed number plate system was first envisioned in the government's three-year interim plan, 2007-10.DoTM is implementing the embossed system for government and diplomatic agencies-owned vehicles as a trial and plans to install this system for private vehicles thereafter.

Figure 2: New Vehicle Number Plate system

Nepal Government plans to implement the embossed number plate system for all vehicles in the country within the next five years. Embossed Number plate will keep a record of vehicles. Embossed plate come with radio frequency identification system (RFID), which reveals the model and the manufacturer's and the user's name and detail RFIDs also tracks the movement of vehicles.

IV. METHODOLOGY

The working of full NPR system can be divided in to two broad sections which are the hardware part and the software part. The working mechanism of all the parts is described in details below.

The first and the most important part in this process is the software model. The software model uses the image processing technology. The algorithm is divided into following parts: Capture image, Pre-processing, Plate region extraction, Segmentation of character in the extracted number plate, Character recognition, Comparison with database and Indicate result. The flow chart of license plate recognition system implementation in this work is shown in the following figure. There are various steps in this approach and these are implementation in Python Programming.

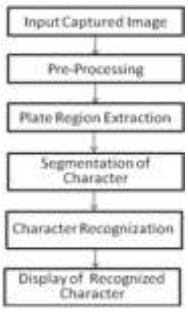

Figure 3: Recognition Process of Number Plate

Capture of Image: The first step is the capture of image. The image is captured by electronic device Pi Camera or Webcam. The image captured is stored in JPEG format. Later on it is converted in to gray scale image.

Pre-processing: The next step after capturing the image is the pre processing of the image. When the image is captured there is lot of disturbances and noises present in the image for which the image can't be used properly. So in this step the noises from the image are required to be cleared to obtain an accurate result.

a) Gray Processing: This step involves the conversion of image in to Gray levels. Color images are converted in to Gray image. According to the R, G, B value in the image, it calculates the value of gray value, and obtains the gray image at the same time.

b) Median Filtering: Median filtering is the step to remove the noises from the image. Gray level cannot remove the noises. So to make image free from noise media filtering.

Plate region extraction: The most important stage is the extraction of number plate from eroded image significantly. The extraction can be done by using image segmentation method. There are numerous image segmentation methods available in various literatures. In most of the methods image binarization is used.

Character segmentation: In this step get the o/p of extracted number plate using labeling components, and then separate each character and split the each and every character in the number plate image by using split and also find the length of the number plate, then find the correlation and database if both the value is same means it will generate the value 0-9 and A - Z, and finally convert the value to string and display it in edit

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box, and also store the character in some text file in this code. Following figure shows the segmented characters. The character recognition is now used to compare the each individual character with the character stored in the database. OCR uses the correlation method to match the characters. And if both the character matches then it displays the authorized otherwise it will display the unauthorized.

Figure 4: Sample Number Plate

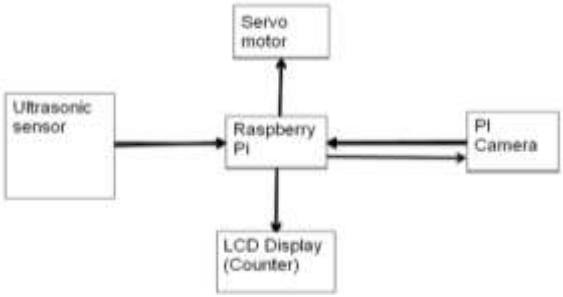
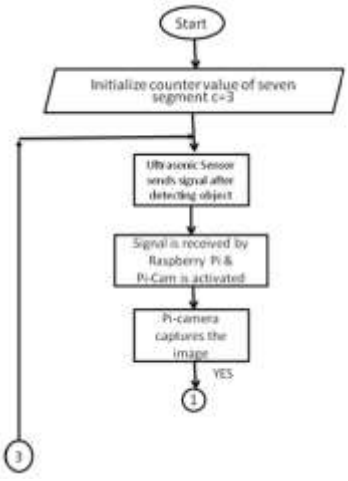
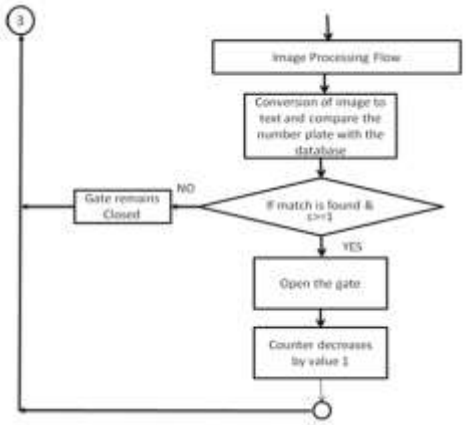


Figure 5: General Block Diagram of Proposed System

The main component of this system is Raspberry Pi for processing and controlling the whole system. Ultrasonic sensor is being used to detect any object availability at the parking door. Once any object is sensed by the sensor, it sends the signal to the Raspberry Pi which activates the Pi-camera to capture the image in order to detect the vehicle number plate. When the characters of the number plate is matched with the database and if the match is found, Raspberry Pi sends signal to the servo motor to open the door for 10 second and the counter is decreased by 1.

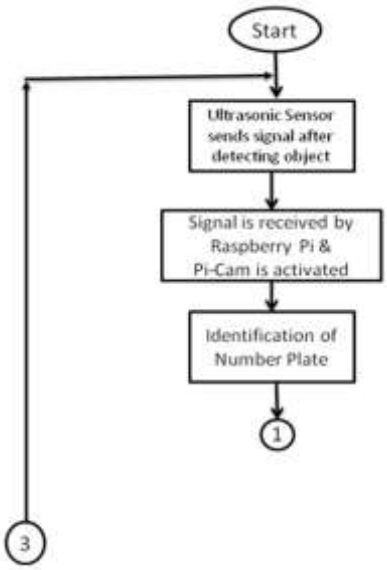
For Vehicle Entrance Process:





Similarly, while existing from the parking again the Ultrasonic sensor inside detects the object and door opens for 10 seconds and again closed. And hence the counter is increased by 1.

Vehicle Exit Process:



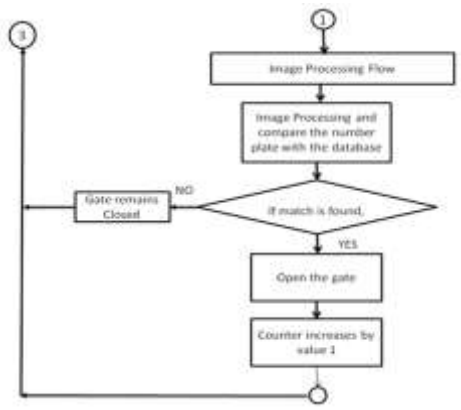


Figure 6: Flow Chart of Vehicle Entry and Exit Process

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V. DESIGN OF PARKING SYSTEM

Parking lot design in our project is shown in below figure from top view. There are two gates, one is IN and another is OUT gate. Also a counter display is placed in between gates. Since, there is several spot for car in the parking system.

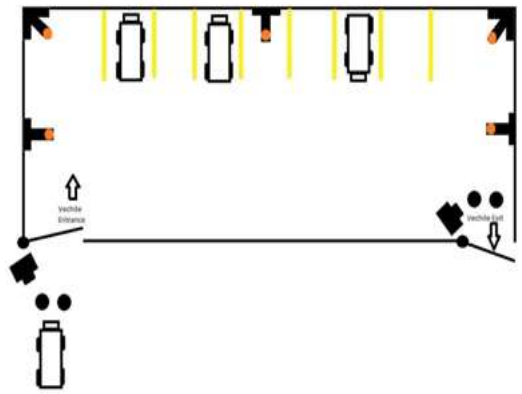

Figure 7: Parking Floor Plan

VI. RESULT ANALYSIS

After the completion of our project with proper conclusion and availability of the components, we are able to draw the following results as listed below:

- There are two ultrasonic sensors which are placed in from of the gate at entrance and exit point. The ultrasonic sensor which detects the Vehicle sends the signal to the raspberry Pi which activates the Pi camera.
- Once the camera is activated, it captures the image of the vehicle. The image of number plate is extracted and is checked through various image processing techniques with data-base weather if the vehicle is authorized or not.
- For the authorized vehicle the Raspberry Pi sends the signal to the servo motor which opens the gate for certain interval of time and closes the gate.
- There were several parking spaces and if the parking space is fully occupied then the gate would not be opened even for authorized vehicle.
- Data base successfully contained authorized vehicle along with their vehicle brand. It also contained the entry time and date of authorized vehicle. If a new vehicle had to be placed then one could easily entry his/her vehicle to the data-base.
- Use of dark activated LEDs so that the parking space was properly visible at night time and there was no loss of energy during day.

Since the project is license image dependent it takes image through Pi camera but there might be certain failure on extracting the image perfectly and sometimes the operation of the device during running can fail. These issues can be further resolved by using better resolution cameras by precise detection & extracting of the number plate and strong connection to avoid Hardware failure. And hence the project will run as per our expectation.

VII. CONCLUSION AND FUTURE WORK

Hence, after doing this project, we are able to implement our idea of recognizing authorized vehicle with the help of Raspberry Pi image processing techniques for various private parking, staff parking and VIP areas. We concluded that with this project one could create a organized parking only for authorized vehicle and collect the information on density of vehicle along with their timing details.

We also came with some idea for better improvement of this project in future such as:

1. Replacing Pi camera with higher resolution cameras.
2. Integration of Pi camera and LCD display.
3. Wireless communication or SMS system for adding up new vehicles to the database.

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