IoT Based Automatic Vehicle License Plate Recognition System

Prof.R.M.Sahu[1], Namrata B.Gaikwad[2], Chandrakant B.Sandage[3], Vikram S.Shinde[4]

[1] *Professor, Electronics Engineering, PDEACOEM, Maharashtra, India*
[2] *Student, Electronics Engineering, PDEACOEM, Maharashtra, India*
[3] *Student, Electronics Engineering, PDEACOEM, Maharashtra, India*
[4] *Student, Electronics Engineering, PDEACOEM, Maharashtra, India*

ABSTRACT

"IoT Based Vehicle license plate recognition System"has been intensively studied in many countries. Due to the different types of number plates being used, the requirements of an automatic license plate recognition system are different for each country. In this paper, a number plate localization and recognition system for Indian vehicles. This system is developed based on digital images and can be easily applied to car park systems for the use of documenting access of parking services, secure usage of parking houses and also to prevent car theft issues. Automatic license plate recognition system is to extract vehicle license plate from a digital image. The paper based on a combination of the IoT and Image Processing filling up the holes approach method with area criteria test for the number plate localization. Segmentation of the plate characters was achieved by horizontal and vertical scanning method. The character recognition was accomplished with the aid of optical characters by the process of Template matching. We mainly concrete on three steps: one is to locate the number plate, second is to segment all the number and to identify each number separately, third is recognize each character.

Keyword: - *Internet of Things, Raspberry pi-3.*

1. INTRODUCTION

Automatic license plate recognition system plays important role in real life applications such as automatic toll collections, traffic law enforcement, parking lot access control, and road traffic monitoring. VLPR system recognizes a vehicle's plate number from an image by digital camera. It is fulfilled by the combination of a lot of techniques such as image acquisition i.e. capturing the image of real image of plate localizing the license plate character segmentation i.e. locating and identify individual character on the plate, optical character recognition. The recognition problem is generally sub-divided into four parts are Image acquisition i.e. capturing the image of the license plate, Pre-processing the image i.e. localizing the license plate, Character segmentation i.e. locating and identifying the individual symbol image on the plate, Optical character recognition. A guiding parameter in this regard is country-specific traffic norms and structure. This helps to fine tune the system i.e. number of characters in the license plate, text luminance level (relative index i.e. dark text on light background or light text on dark background) etc.

For example, in India the norm is printing the license plate number in black colour on white background for private vehicles and on a yellow background for commercial vehicles. Number plate is a pattern with very high variations of contrast. If the number plates is very similar to the background it's difficult to identify the location, Brightness and contrast is changes to it. The morphological operation reused to extract the contrast Feature within in the plate. The work is divided into several parts:

1. Input image
2. -Input Gray scale/binirazation
3. Reduce the noise using median filtering Method
4. Plate localization
5. Character segmentation
6. Character recognition

1.1 Block Diagram and description:

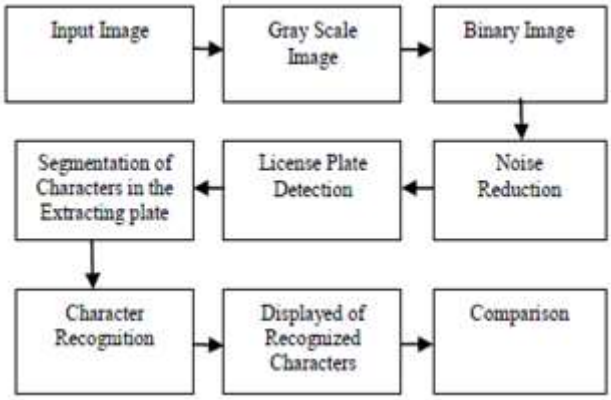

Fig-1. Block Diagram of IoT Based Automatic Vehicle License Plate Recognition System

- **Input image:**
  Input image is captured by digital camera.

- **Input Gray scale/ binirazation:**
  Input image has to be converted to 8-bit gray scale value is calculated. And after that Gray scale is converted into binary image by thresholding method.

- **Noise reduction:**
  We have used median filtering technique to reduce the noise. We have used 3 x 3 masks to get eight neighbors of a pixel and their corresponding gray value.

- **Plate Localization:**
  The basic step in recognition of vehicle number plate is to detect the plate size. In general number plates are rectangular in shape. Hence we have to detect the edges of the rectangular plate. Open CV toolbox function provides a function called region props. It measures a set of properties for each labeled region in the matrix. We used bounding box to measure the properties of the image region.

- **Character Segmentation:**
  We get individual character and number image by using, vertical and horizontal scanning method.

- **Character Recognition:**
  Template matching method is used for Character recognition and the resulting data is then used to compare with the records on a database, so as to come up with the specific information.

1.2 Internet of Things (IoT)

It is the future technology of connecting the entire world at one place. All the objects, things and sensors can be connected to share the data obtained in various locations and process/analyses that data for coordinating the applications like traffic signalling, mobile health monitoring in medical applications and industrial safety ensuring methods, etc. As per the estimation of technological experts, 50 billion objects will be connected in IoT by 2020. IoT offers a wide range of connectivity of devices with various protocols and various properties of applications for obtaining the complete machine to machine interaction.

The traditional technologies like home automation, wireless sensor networks and control systems will become more efficient and smarter due to involvement of IoT. IoT is having a wide range of application areas. Such as Medical applications for monitoring the health of a patient and sends the information wireless. The present developing Wearable instrumentation is also based on IoT. The example wearable instrumentation is Smart wrist bands, navigation pills, etc. All this methods require an internet interface to update the health info or

to control the device with a smart phone. The IoT also plays a vital role in media applications for advertising and exchanging the information worldwide. The manufacturing processes also require IoT for supply chain management, digital control systems for monitoring the manufacturing processes. The space requirements of IoT technology, the geographical specifications are always important in case of tracking applications. The geographical dimensions of objects is also important while obtaining the data from the objects. IoT in automobile applications and traffic maintenance became a most using area of automation. The automated devices in a vehicle should be connected to a cloud to update the car health within a period of time. By connecting the vehicles and traffic signalling systems to the internet, people can easily find the shortest path for their destination from the traffic monitoring systems and can navigate automatically by checking all other directions.

2. LICENSE PLATE DETECTION

The goal of this section is to elaborate on the methods of finding the vehicles plates location in captured images. Generally a monochrome camera with a synchronous IR projector and a color camera are employed in a multi-purpose industrial ANPR system. The monochrome camera with IR projector is responsible for plate detection during the night or other low illumination conditions. It is worthwhile to note that for the IR projector to be effective the vehicles plates should have been coated with IR reflective materials. The role of IR projectors is also important in detecting dirty plates even in daylight by taking care of the camera exposure time. IR projector power has a close relation with the camera exposure time and the exposure time plays an important role in the final clarity of the vehicles plates. Since vehicles move swiftly, high values of exposure time lead to blurred images while low exposure time values produce dark images. Therefore, it is important to tune the output power of IR projector with respect to the exposure time of the monochrome camera. It is also necessary to have an adaptive procedure to fine-tune the exposure time based on the lighting conditions. Modifying the exposure time is performed in an adaptive procedure that gets its feedback from the thickness of plate characters. Having thin characters is a sign of high ambient light. In this case, we must decrease the exposure time.

On the other hand, achieving thick characters shows that the environmental light is low and we must increase the exposure time. The modification steps are dependent on the setup and application and must be found experimentally. For example, at sunrise, sunlight reflects from vehicles that move from east to west. In such cases, exposure time should be lowered down to a value that eliminates the reflections. a comparison between fixed and variable exposure time algorithms is demonstrated. Color cameras are needed to provide visual evidences for the violation scenes in order to support the corresponding traffic tickets. As discussed in the introduction section, there are many algorithms to detect the exact location of plates in an image. We have tried most of the algorithms proposed so far. All of these algorithms fail on dirty plates and the plates with low contrast between plate characters and the background. Figs. 1 and 2 show the results of applying vertical Sobel edge operator and Hough transform on dirty and clean plates.

2.1 Finding License Plate Regions

The block diagram of our proposed ANPR system is shown in Fig. 4. This system has been tested extensively over one year of operation period in different streets and highways of Tehran, the capital city of Iran. Our efforts and eagerness to have the data sets of other researchers, mentioned in our tests and references, have been unsuccessful, as of now. Thus, to perform valid and fair comparisons, we have collected huge and highly inclusive data sets ourselves. As a matter of fact, we can claim that our test-bed (based on our data sets) is the most difficult and comprehensive one presented so far. In this paper, two different data sets are prepared and used for training, tests and evaluation purposes.

They are named “Crossroad Data set” and “Highway Data set.” The Crossroad Data set was collected from several crossroads to identify the vehicles that pass over the pedestrian line. It consists of more than 10 000 images captured by traffic cameras. For 8000 images of this data set, one to seven vehicles are present in each image. In 2000 images, no vehicle is present, that is, the scene shows an empty street. These 2000 images were used to measure the false alarm rate for the plate detection process.

The Highway Data set was collected from highways and streets for vehicle counting applications. Plate based car counting systems can capture valuable information about traffic congestions, type of vehicles in different lanes and so on. The Highway Data set consists of more than five million frames which include more than two hundred thousand different vehicles. The images of Highway Data set have been captured at different hours of the day and different days of the year, so that the changes in shadows, illuminations, reflections,and weather conditions affect the images considerably. It is worth mentioning that three different background colors exist in Iranian plates: red, yellow and white. The characters color, like those of many other countries, is either

black or white. In most industrial projects, due to the resolution of the traffic cameras, vehicles are not visible in regions where the vehicles distance to camera is substantial. Also, there are regions, such as pavement or sidewalk, where no vehicles exist. Therefore, an ROI (Region of Interest) is chosen to exclude the irrelevant regions. An ROI in our system can be a polygon, in its most general form. Polygon ROI selection is very useful for industrial ANPR systems since it helps to eliminate the regions where no plate exists and hence reduces the overall processing time. From now on, for evaluating the proposed algorithms, only the ROI is shown. Both Crossroad and Highway data sets are composed of clean, medium, and dirty plates. For quantitative evaluations and comparisons, we have come up with a clear definition of these plate conditions: In clean plates all the characters are legible, medium quality plates are those which include one or two illegible characters, and dirty plates are those with less than four legible characters.

The detection process is initiated by a gray scale image, as depicted . The main reason is that color cannot be used processing time, but also makes the algorithm more robust to color changes caused by different lighting condition throughout the day. Hence, Our detection algorithm is directly applicable to both color and monochrome cameras. In the next step, an algorithm to detect moving objects in two consecutive video frames is applied. There are a variety of methods to calculate the dynamic parts of images based on the comparison with previous video frames. Algorithms based on optical flow and background subtraction are just to name a few reported detection methods. Background subtraction methods need a background model to detect the foreground objects. These methods are computationally expensive and memory consuming for images of large sizes. Besides, they do not provide any sense about the speed of the moving objects and suffer from the noise components. On the other hand, optical flow based algorithms such as variational methods [44] are great for calculating speed vectors and removing the noise components. In this paper, the Lucas and Kanade method is utilized for extracting speed vectors:

First, key-points are extracted using Shi-Tomasi method and then these key-points are tracked in each frame to calculate the speed vectors. These vectors are connected to each other using simple morphological operations such as dilation and closing. This step helps to find the regions that contain the vehicles and reduces the total computational requirements.

2.2 License Plate Localization in Daytime

After extracting the regions that are most likely to include plates, as explained in previous section, a more accurate vehicles plates localization is performed based on the concept of Random Sampling Consensus (RANSAC). RANSAC is an iterative algorithm used to fit a robust mathematical model to a set of observed data . This method ignores the outliers and finds the best model to the rest of the given data. The main application of RANSAC in machine vision field is in stereo vision, and specifically in finding the Fundamental Matrix.

In this paper, a revised version of RANSAC algorithm is designed and exploited in license plate localization process. Our procedure to locate the plate candidates is performed in four steps.

Steps:

1. A sliding window is moved all over the binarized image. Fig. 6(e) is a sample input image to this step. The size of the sliding window in any region is chosen to be two times larger than the vehicle plate size in that region. We use (2) and (3) to calculate the window size at this step.
2. Connected Component Algorithm is applied to the window of step 1.
3. The components with heights and widths of a plate character are chosen and the rest of them are discarded.
4. RANSAC is utilized to determine the best line that represents the given data. This line should have two main properties: first, it should cross more than *k* character candidates with specific space between them, and next, it should have a reasonable slope. The limiting slope should be set based on the camera view. In this paper, the limiting numbers for crossing characters in Iranian plates and slope are found experimentally as 5 components and 20 degrees respectively.

License Plate Localization in Night time At night and other low light conditions, vehicles plates are not visible by traffic cameras. In countries like Iran where the vehicles plates are coated by infrared sensitive materials, IR projectors are utilized to make the plates visible without distracting the drivers. The plates, when exposed to IR rays, look shiny, clear and illuminated in images captured by monochrome IR cameras. Plate detection is generally much easier and faster using IR cameras. In an IR image, plates are the only high contrast regions compared to the rest of the image. In low light conditions, a large proportion of the image area is covered with low gray level regions. As such, the number of false positive errors in plate detection is reduced considerably. After detecting

Fig-2. Gray Scale Image

Fig-3. Binirized Image

Fig-4. Recognised Number

Fig-5. Final Recognised Number

the high contrast areas, the plate detection process is continued by the RANSAC algorithm. The remaining procedures are the same as the counterparts in the daytime version of the algorithm, which are explained in the previous subsection. To sum up, we can say that the main difference between night time and daytime algorithms is in the plate detection part. The next steps are completely the same.

3. DIAGRAM AND DESCRIPTION

3.1 Transmitter-

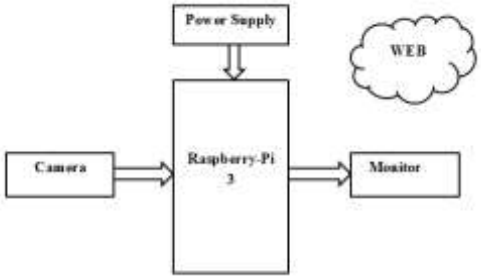

Fig-6. Transmitter

3.2 Receiver-

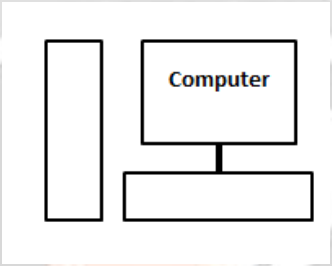

Fig-7. Receiver

3.3 Description and Working-

The onboard computer can efficiently communicate with the output and input modules which are being used. The Raspberry Pi is a credit card-sized single-board computer developed in the UK by the Raspberry Pi Foundation.

Recognizing vehicle number plates is a difficult but much needed system. This is very useful for automating toll booths, automated signal breakers identification and finding out traffic rule breakers. Here we propose a Raspberry Pi based vehicle number plate recognition system that automatically recognizes vehicle number plates using image processing. The system uses a camera along with LCD display circuit interfaced to a Raspberry pi. The system constantly processes incoming camera footage to detect any trace of number plates. On sensing a number plate in front of the camera, it processes the camera input, extracts the number plate part from the image. Processes the extracted image using OCR and extracts the number plate number from it. The system then displays the extracted number on an LCD display. Thus we put forward a fully functional vehicle number plate recognition system using Raspberry Pi.

- Raspberry Pi processor:

In the Proposed ALPR system we used the Raspberry Pi is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation. The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded to 512 MB.

- USB camera:

A webcam or USB camera is a video camera that feeds its image in real time to a computer or computer network. Unlike an IP camera which uses a direct connection using ethernet or Wi-Fi, a USB camera is generally connected by a USB cable, FireWire cable, or similar cable. The common use as a video camera for the World Wide Web gave the webcam its name. Other popular uses include security surveillance, computer vision, video broadcasting, and for recording social videos. Webcams are known for their low manufacturing cost and flexibility, making them the lowest cost form of video telephony. They have also become a source of security and privacy issues, as some built-in webcams can be remotely activated via spyware.

4. CONCLUSION

In this paper, an industrial, robust and reliable ANPR system for high speed applications is proposed. The main advantage of our system is its high detection and recognition accuracies on dirty plates. To achieve reliable evaluations, two new data sets were created and used in this paper: one for violation detection called "Crossroad Data set" and the other for vehicle counting in highways called "Highway Data set." The accuracies of our system on the Crossroad Data set are 98.7%, 99.2%, and 97.6% for plate detection, character segmentation, and plate recognition parts, respectively. In vehicle counting application, the detection rate and false alarm rate over the Highway data set are 99.1% and 0.5%, respectively. We have tested this system on a publicly available English plate data set as well and achieved an overall accuracy of 97%. The proposed system is compared to many reported ANPR systems from different point of views.

By considering the practical aspects, several copies of our ANPR system have been installed in different intersections and highways of Tehran, capital city of Iran. These systems have been tested day and night over a year and presented robust and reliable performances, in different weather conditions, such as rainy, snowy, and dusty. The character recognition part of our system has been tested separately over the data set and achieved 98.5% accuracy, with comparably low computational requirement. The presented techniques, algorithms and parameter setting procedures, along with our data sets and related evaluations, provide a complete set of solutions to issues and challenges involved in incorporating ANPR systems in various ITS applications.

5. REFERENCES

[1] C.-N. E. plate recognition from still images and video sequence a survey, IEEE trans. Intel. Transp. Syst. Vol. 9, no.3, pp.377-391,2008

[2] P.Anishiya, Prof S.M, Mary Joan, "Number Plate Recognition for Indian Cars Using Morphological Dilation and Erosion with the Aid of OCRs", IACSIT, Vol4, 2011, pp 115-119.

[3] Satadal saha, Subhadip Basu, Mita Nasipuri, Dipak Kumar Basu, "License Plate Localization from Vehicle Images: An Edge Based Multi-Stage Approach"", IJRTE, Vol 1, 2009

[4] Serkan Ozbay, Ergun Ercelebi, "Automatic Vehicle Identification by Plate Recognition" , Vol 9, 2005

[5] Phalgun Pandy and deep Singh, "Morphological based Approach to Recognition Number in India", IJSCE, Vol1, Issue 3,2011,pp107-112

[6] Tran Duc Duan, Tran Le Hong Du, Tran Vinh Phuoc, Nguyen Viet Hoan, "Building Automatic Vehicle License-Plate Recognition System" Int. Conf. in Compute. Sci. RIVF, pp. 59-63-,2005