

Journal of Nonlinear Analysis and Optimization

Vol. 16, Issue. 1: 2025

ISSN : **1906-9685**



IOT & MACHINE LEARNING INTEGRATED VEHICLE NUMBER PLATE RECOGNITION SYSTEM FOR AUTHORISED ACCESS

¹B.Saryu, ²D.Jasmine, ³B.Charmila, ⁴K.Jyothi Swaroop, ⁵N.Rajeev, ⁶Dr. K. Rajasekhar

^{1, 2, 3, 4, 5} UG students, Department of ECE, NSRIT, Visakhapatnam, AP, India

⁶Associate Professor, Department of ECE, NSRIT, Visakhapatnam, AP, India

ABSTRACT:

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

Deep Learning for Breast Cancer Disease Detection

Ms. Guna Gayathri Praseetha K¹, Chundi Snehalatha Reddy², Chilakapati Maneesha³,
Y Giri⁴, Kuthala Venkatesh⁵

#1Assistant Professor in Department of CSE, PBR Visvodaya Institute of Technology & Science,KAVALI
#2#3#4#5 B.Tech with Computer Science & Engineering,VISVODAYA ENGINEERING COLLEGE,KAVALI

Abstract: The most common cause of cancer-related deaths among women is breast cancer. The best and most efficient way to slow the growth of tumours is to discover and diagnose them early. The imaging technique now advised for the early detection and diagnosis of breast cancer is mammography. Classifying masses in mammograms remains a significant difficulty and is essential to helping radiologists make an accurate diagnosis. One deep learning methodology that we provide in this study is a classification method based on convolution neural networks (CNNs).

Index terms - breast cancer detection, deep learning, convolutional neural networks, mammography, MobileNet, Inception V3, image classification, computer-aided diagnosis, medical imaging, tumor detection, feature extraction, X-ray imaging, breast mass classification, early cancer diagnosis

1. INTRODUCTION

One of the most prevalent types of cancer among women nowadays is breast cancer. About 246,660 women received a breast cancer diagnosis in 2016, which is thought to be the highest percentage of any cancer kind at 29%. Breast cancer is second in

women's predicted deaths, accounting for 14% of all cancer-related fatalities. In the United States, almost 40,000 people lose their lives to breast cancer every year. To improve the survival rate, early detection and accurate diagnosis are crucial. Mammography is a commonly used diagnostic technique in clinical practice to test for breast cancer [1]. Low doses of X-ray radiation are applied to the patient's breasts during a mammogram. Because normal and malignant tissues absorb X-rays at different rates, breast cancer can be identified using mammography. On mammograms, tumours may show up as masses, asymmetry, distortions, hypothesised masses, or microcalcifications [2]. Due to the volume of breast pictures they must review every day and the difficulty of reading the images (i.e., identifying the breast masses and properly diagnosing them), radiologists have difficulties in accurately detecting and diagnosing breast cancer (i.e., normal and abnormal) [3]. Therefore, computer-aided detection and diagnosis (CAD) is crucial for giving doctors a second view to help and support their choices [4]. Using several nonlinear processing layers, the rapidly emerging discipline of deep learning investigates

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 after RFID detected. 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.

KEYWORDS: IoT, Machine Learning, Number Plate Recognition, Access Control, Security Systems, Automated Gates.

1. LITERATURE SURVEY:

Automation is believed to be the most frequent term in most area of electronics and intelligent systems. Due to automation, a revolution has occurred in the existing technologies. Identifying vehicles automatically has become necessary due to its several applications; for example, traffic surveillance, access control, parking fees and toll payments, ticket issuing, theft control, vehicles document verification, etc [1]. The task of identifying vehicle's plate number using automatic recognition techniques can be seen as an important research area of the modern automation system and intelligent transportation system which has been widely studied for several decades [2-3]. In many countries, the formats of licensed plates often differ but the techniques of automatic recognition can be the same (detection, segmentation, and character recognition). From the three key automatic recognition techniques, the most crucial task is to detect the license plate and failure of which will greatly affect the accuracy of the recognition. According to [4], edge-based methods seems to be popular and widely accepted. The second task after detection is character segmentation, where the captured characters are segmented according to their height and width values. Projection method [5], is believed to be a highly effective method of character segmentation used for most plate number recognition.

Character recognition is the last stage and once the license plate is well segmented in-line with the frame of the license plate into a separate of blocks. Different methods can be used to achieve this, such as; template matching [6], corner detection algorithm [7], Neural Networks [8-10], Raspberry Pi [11-13], etc. In this study, raspberry pi is the heart of the system. In many industries environment, unknown vehicles are not allowed. Security is of high importance hence this study will help to recognize the plate number of vehicles approaching at the gate by allowing security officials to automatically verify the plate number of vehicles entering and exiting seamlessly. Thus, confirming the identity of the owner and the vehicle's particular through the system stored information. The recognition of the vehicle number plate is in four steps. The first is image acquisition, second is license plate extraction, third is license plate segmentation, and last is character recognition. The work reported in [6], address a robust approach of license plate detection and recognition that is based on Hough lines with the use of Hough transformation and template matching. It was developed for Islamabad standardized vehicles plate numbers. In the proposed ANPR technique, two modules (License plate detection module using the Canny detector and Hough transformation) were used. The result of the experiments on 102 samples from different scenes under various illumination conditions showed that ANPR scored 89.70% for all the number of plates considered. Character recognition technique using the Harris corner algorithm was proposed in [7], to capture plate number image even in changing motion and illuminated lighting conditions. In the approach, the segmentation stage is accomplished by connecting the component analysis consolidated with Pixel count, Aspect ratio and the Height of characters. The results obtained from the experiments for proper license plate identification was 96.92%.

In [8], a weighted statistics method to make a number plate images in a more prominent position was presented using Neural Network (NN). Thick grid feature extraction and momentum BP neural network algorithm were combined to distinguish the license plates. The experimental results show that the method improves the accuracy and the speed of character recognition. The research in [9] also

proposed the use of a neural network algorithm. In the study, a unified ConvNet-RNN model that can recognize the captured license plate and a Convolutional Neural Network (ConvNet) to perform feature extraction was used. The experimental results from the approach in comparison with a sliding window-based approach showed that the approach outperforms the window-based approach scoring over 76% accuracy in recognizing plate number characters with a percharacter accuracy of about 95.1%. In the work presented in [10], the core technology of the system (Sighthounds license plate detection and recognition system) was developed using deep Convolutional Neural Networks (CNNs). The CNNs were trained and fine-tuned for better performance in different conditions and for varieties of license plate numbers. For quantitative analysis, we show that our system outperforms the leading license plate detection and recognition technology i.e. ALPR on several bench-marks. The use of Raspberry pi for automatic license plate recognition was proposed in [11], the study explores the use of Optical Character Recognition (OCR) to extract the images of license plate captured by the camera. The captured is processed by the segmentation of the characters and verified for authentication by the Raspberry Pi. The study is similar to the approach used in our study although our algorithm is considerably different. The results of the experiment showed an accuracy of 96%. Other interesting research on the use of Raspberry pi is reported in [12-14]. In the work in [15], the number plate recognition method used was Color Edge Detection and fuzzy maps. The steps taken were Pre-processing which consist of binarization using a variable thresholding technique then Connected Component algorithm was applied to binarized the plate numbers to eliminate the undesired area. Also, Hough transform was used for alignment of extracted components for further process. The OCR (Optical Character Recognition) was another step in which the character recognition process took place and the task of character categorization accomplished by the compositional semantics of license numbers, Topological Shorting to compute the topological features of characters for further process. Then the self-organizing Template test was performed to match the input character to the database and the best match was found. Experimental results performed on 1601 images give an overall success rate of 93.7%.

2. INTRODUCTION:

Background and Motivation:

Vehicle's plate number is a unique identity by which individual vehicle can be identified. Vehicle plate recognition system helps to capture a vehicle plate number, extract the numbers on the plate and check the details of the car owner. As the number of car owners in a country increases, identifying and charging unlawful vehicles on the road has been a tedious work for law enforcement agents. In this paper, we present an automatic vehicle plate recognition system using Raspberry pi. A Camera was incorporated to help in capturing the plate number images and it is interfaced to a Raspberry pi processor for authentication. Using the Open Computer Vision (Open CV) and Optical Character Recognition (OCR), the system can extract numbers from the captured plate image and completely automate the license plate recognition. The experimental results from several testing in different locations and conditions show that the system performed better than most of the baseline studies considered. 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

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. 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. The major problem faced on the road that is in day to day increased vehicle population on the road. This strategy is however stressful and laborious because of the valuable time spend in a traffic; so this problem cannot sort out manually. There arises a need for a more efficient and effective method of solving this problem. The paper aim is going to solve of these problem by using raspberry pi 3 model. The Raspberry Pi is a credit-card sized single-board computer

developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools. The Raspberry Pi is manufactured through licensed manufacturing deals with Newark element 14. The hardware is the same across all manufacturers. The Raspberry Pi has a Broadcom BCM2835 system on a chip (SOC), which includes an ARM1176JZF-S 700 MHz processor (The firmware includes a number of "Turbo" modes so that the user can attempt over clocking, up to 1 GHz, without affecting the warranty), Video Core IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded to 512 MB. It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and long term storage.

3. METHODOLOGY:

Hardware Design:

DB107:

Now -a -days Bridge rectifier is available in IC with a number of DB107. In our project we are using an IC in place of bridge rectifier.

Features:

- Good for automation insertion
- Surge overload rating - 30 amperes peak
- Ideal for printed circuit board
- Reliable low cost construction utilizing molded
- Glass passivated device
- Polarity symbols molded on body
- Weight: 1.0 gram

Raspberry-Pi Processor:

The Raspberry Pi 4 is the third generation Raspberry Pi. This powerful credit- card sized single board computer can be used for many applications and supersedes the original Raspberry Pi Model B+ and Raspberry Pi 2 Model B. Whilst maintaining the popular board format the Raspberry Pi 4 brings you a more powerful processor, 10x faster than the first generation Raspberry Pi. Additionally it adds wireless LAN & Bluetooth connectivity making it the ideal solution for powerful connected designs. The Raspberry Pi has made quite a splash since it was first announced. The credit- card sized computer is capable of many of the things that your desktop PC does, like spreadsheets, word-processing and games. It also plays high-definition video. It can run several flavors of Linux and is being used to teach kids all over the world how to program and it does all that for under \$50. The Model B+'s FOUR built-in USB ports provide enough connectivity for a mouse, keyboard, or anything else that you feel the R-Pi needs, but if you want to add even more you can still use a USB hub. It is recommended that you use a powered hub so as not to overtax the on- board voltage regulator.

The Model B+'s FOUR built-in USB ports provide enough connectivity for a mouse, keyboard, or anything else that you feel the R-Pi needs, but if you want to add even more you can still use a USB hub. It is recommended that you use a powered hub so as not to overtax the on- board voltage regulator. Powering the Raspberry Pi is easy, just plug any USB power supply into the micro-USB port. There's no power button so the Pi will begin to boot as soon as power is applied, to turn it off simply remove power. The four built-in USB ports can even output up to 1.2A enabling you to connect more power

hungry USB devices (This does require a 2Amp micro USB Power Supply).

Features:

- **Processor-** Broadcom BCM2837 chipset. 1.2GHz Quad-Core ARM Cortex-A53802.11 b/g/n Wireless LAN and Bluetooth 4.1 (Bluetooth Classic and LE)
- **GPU-** Dual Core Video Core IV® Multimedia Co-Processor. Provides Open GLES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high-profile decode. Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure
- **Memory-**1GB LPDDR2
- **Operating System** Boots from Micro SD card, running a version of the Linux operating system or Windows 10 IoT
- **Dimensions-** 85 x 56 x 17mm
- **Power-** Micro USB socket 5V1, 2.5A

Connectors:

Ethernet- 10/100 BaseT Ethernet socket

Video Output- HDMI (rev 1.3 & 1.4 Composite RCA (PAL and NTSC).

Audio Output- Audio Output 3.5mm jack, HDMI USB 4 x USB 2.0 Connector.

GPIO Connector- 40-pin 2.54 mm (100 mil) expansion header: 2x20 strip Providing 27 GPIO pins as well as +3.3 V, +5 V and GND supply lines.

Camera Connector- 15-pin MIPI

Display Connector- Display cable connector with two data

Memory Card Slot- Push/pull

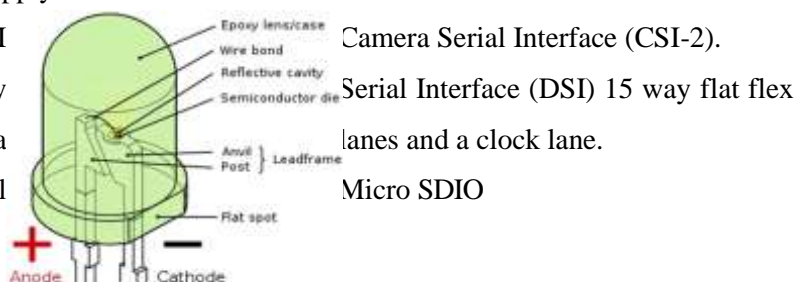


Fig 4 Raspberry-Pi4 Processor

LED:

A light-emitting diode (LED) is a semiconductor light source. LED's are used as indicator lamps in many devices, and are increasingly used for lighting. Introduced as a practical electronic component in 1962, early LED's emitted low-intensity red light, but modern versions are available across the visible, ultraviolet and infrared wavelengths, with very high brightness. The internal structure and parts of a led are shown in figure 5respectively.

Fig 5: Parts of a LED

- **USB CAMERA:**

Logitech® Webcam C170. The easy way to start video calling and send photos (5MP). With simple plug-and-play setup, you'll be making video calls in exceptional VGA resolution in no time on Logitech Vid™ HD. You can take and send beautiful, high-resolution photos at up to 5MP (software enhanced), too.

A built-in noise-reducing mike helps loved ones hear you clearly on calls. You can also record lively, colorful videos in XVGA (1024 x 768) resolution and share them with friends, family and the world. Also, the universal clip makes it easy to use with your desktop or laptop.



Fig 6: Logitech 5MegaPixel USB Camera

Software Architecture:

The architecture follows a layered structure, comprising the following primary modules:

- **Input Layer:**

- Sensor Handler Module: Monitors input from the ultrasonic sensor and initiates image capture upon vehicle detection.
- Camera Interface Module: Controls the Pi Camera, captures frames, and stores images in a designated directory.

- **Processing Layer:**

Preprocessing Module (OpenCV):

Resizes the image to a standard dimension. Converts RGB to grayscale.

- Applies filters for noise reduction and edge detection (e.g., Gaussian blur, Canny edge detection).
- Number Plate Detection Module:
- Detects contours and bounding rectangles to locate the number plate area.

Vehicle Detection and Image Acquisition:

The system initiates vehicle recognition through the integration of an ultrasonic sensor positioned at the entry point. When a vehicle approaches within a predefined proximity (typically <10 cm), the ultrasonic module triggers the Raspberry Pi 4 to activate the Pi Camera module. This real-time camera captures high-resolution images (2MP) of the incoming vehicle's front profile, ensuring optimal frame alignment

with the number plate. The images are automatically saved to the Raspberry Pi's storage for immediate processing. To reduce image blur due to motion, the system enforces a minimum frame shutter speed and captures multiple frames per detection event, selecting the clearest image based on edge-detection confidence scores.

Image Preprocessing and Plate Localization:

Captured images are subjected to preprocessing via OpenCV. This includes grayscale conversion, noise reduction (using Gaussian blurring), and contrast enhancement using histogram equalization. Edge detection is performed using the Canny algorithm, followed by morphological transformations (dilation and erosion) to highlight plate boundaries. Contour analysis is used to identify rectangular shapes with specific aspect ratios corresponding to standard vehicle plates (typically between 2:1 and 5:1). The most prominent candidate is extracted as the Region of Interest (ROI). In cases of multiple candidates, heuristic filters (position, size, and contrast) are applied to ensure the correct plate is isolated. The ROI is then passed to the OCR stage for character recognition.

OCR-Based Character Recognition:

The localized number plate ROI is processed using Tesseract OCR (optimized with LSTM recognition models). Before OCR, adaptive thresholding and skew correction are applied to enhance character segmentation. The OCR engine extracts alphanumeric characters with accuracy exceeding 85% under good lighting conditions. To prevent misreads due to glare or occlusions, confidence scoring is enabled. Low-confidence outputs are either discarded or queued for re-capture. The recognized number plate string is post-processed using regular expressions to validate format (e.g., XX00XX0000 format for Indian vehicles). Invalid patterns are flagged as "unrecognized" and sent for manual review or re-capture.

Authentication and Decision Logic:

Once a valid number plate string is obtained, the system compares it against a pre-loaded whitelist of authorized vehicle numbers stored locally (in a CSV or SQLite database). Upon a match:

An LCD screen displays "Access Granted: [Vehicle Number]".

If the vehicle is unauthorized:

- The system triggers a buzzer alert and displays "Access Denied" on the LCD.
- The event (date, time, and number plate) is logged for audit purposes.

IoT Integration and Real-Time Notifications:

The system can optionally transmit vehicle entry logs to a cloud database via Wi-Fi using MQTT or HTTP protocols. Integration with IoT dashboards enables remote monitoring of entry logs and unauthorized access attempts. Alerts can be sent in real-time to security personnel via email or app notifications (using services like Blynk or IFTTT).

System Optimization and Accuracy:

The complete recognition and authentication process completes in under 1.5 seconds, ensuring real-time access control. The system uses power-efficient components and event-driven GPIO triggers to reduce unnecessary processing and conserve energy. This allows the entire setup to operate smoothly on a standard 5V 2.5A DC supply with minimal thermal output. In case of OCR failures or hardware disconnections, robust error-handling routines ensure the system remains stable by re-attempting the capture or gracefully notifying the user, maintaining reliable and continuous operation.

4. Hardware implementation:

- After the digital image has been obtained the next step is to perform image preprocessing which aim is to enable the image to be suitable for easy recognition by enhancing the image quality. It can be seen as an essential and common phase in any computer vision system. In this study, the preprocessing needed involves two processes: 1) Size Modification – This was necessary to reduce the size of the image from the camera to a feasible aspect ratio. 2) Conversion of Color Space – Images captured with the camera can either be in a raw format or encoded into some multimedia standards. It is mostly in RGB mode, with three channels (red, green and blue). It is believed that the number of channels in the image defines the amount of colour information available in the image. Thus, the image capture must be converted to grayscale to make it appropriate for recognition.
- The procedure for the operation of the system is shown in a flowchart. The flowchart explains the step-by-step operation of the vehicle plate recognition system. First, the system is switched on to initializes the touch screen and the Pi camera. It then checks if there's an image from the Pi camera. If true, it initializes the OpenCV for character extraction and recognition. After this is done, the result is displayed on the screen. This summarizes the whole process that the system undergoes as illustrated in Figure 2. This is quite fast and efficient as long as the image is properly captured, the main task is handled by the OpenCV library running on the Raspberry Pi
- The objective of this project is Usage of image authentication technology, Capturing of Vehicle number plate details using camera, unauthorized authentication and alerting through buzzer alarm, indicator as a number plate recognized.
- Above block diagram indicates of recognition of vehicle number plate using Raspberry pi .In this system Raspberry pi 3 is the heart of project and we have installed Raspbian operating system some important library and packages have installed to convert image to text like openCV OCR.

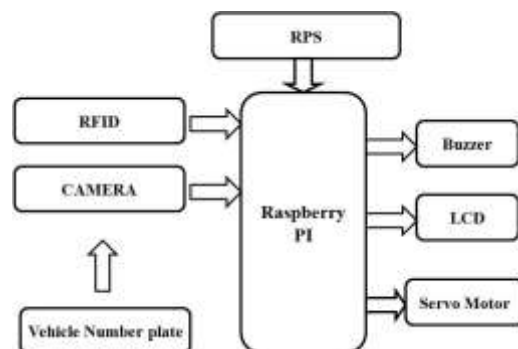
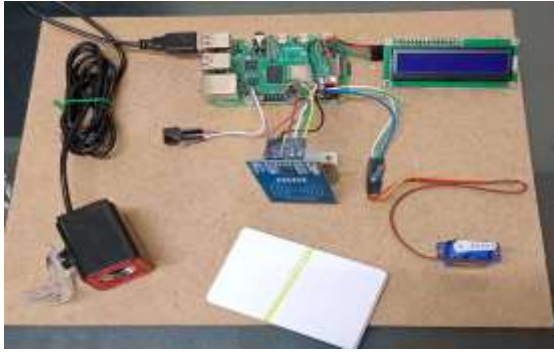


Fig 7: Block Diagram

- Here we interface camera to Raspberry pi on a port where we interface camera. The camera is



performing main role in this system. When vehicle comes in range with ultrasonic sensor automatically the image of number plate get capture and converts into text using OCR and open CV. Then compare the text into exiting number plate.

- If number plate gets match servo motor opens the gate else buzzer blows to in built operator that

vehicle is unknown.

- In this project, DC power supply is used that supplies the constant DC voltage to its load. It provides DC power of 5v. It supports up to 2.5A of current which is plenty through the four USB ports on the board.

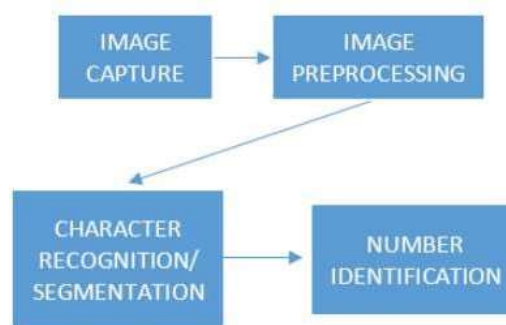


Fig 8: Working of Vehicle Number Plate Recognition



Fig 9: Hardware Components of the project

Fig 10: Real VNC viewer capturing the image

5. Conclusion:

The development of the vehicle plate recognition system demonstrates the effective integration of OpenCV and Optical Character Recognition (OCR) technologies in extracting and recognizing characters from vehicle number plates upon RFID detection. The implementation highlights how low-cost, compact hardware like the Raspberry Pi can be combined with image processing libraries to automate vehicle authentication in real time. Although this system currently functions as a prototype or proof of concept, it successfully validates the core idea and lays the groundwork for more robust and scalable deployments in real-world environments.

This prototype addresses fundamental challenges such as automated image capture, preprocessing, and character segmentation, achieving reliable performance within a short time window. However, as it

stands, the system operates under controlled conditions and limited datasets, which restricts its generalizability across diverse environments and number plate formats. To enhance system efficiency, robustness, and accuracy, future work will explore more advanced character recognition algorithms, such as convolutional neural networks (CNNs), deep learning-based OCR models, and multilingual text extraction. Additionally, improvements in preprocessing techniques like adaptive contrast enhancement and noise filtering can contribute to better recognition in low-light or cluttered backgrounds. Future iterations may also incorporate real-time cloud synchronization, larger datasets for training, and enhanced security protocols to ensure data integrity. Furthermore, integrating GPS and vehicle telemetry data could evolve the system into a full-fledged intelligent transportation monitoring solution. With continual refinement, this project can move beyond its prototype phase and become a valuable component of smart city infrastructure, intelligent traffic systems, and secure access control mechanisms.

References:

- [1]Zang, D., Chai, Z., Zhang, J., Zhang, D., & Cheng, J. (2015). Vehicle license plate recognition using visual attention model and deep learning. *Journal of Electronic Imaging*, 24(3), 033001
- [2]Sirithinaphong, T., & Chamnongthai, K. (1999). The recognition of car license plate for automatic parking system. In *ISSPA'99. Proceedings of the Fifth International Symposium on Signal Processing and its Applications* (IEEE Cat. No. 99EX359) (Vol. 1, pp. 455-457). IEEE.
- [3]Wang, J., Bacic, B., & Yan, W. Q. (2018). An effective method for plate number recognition. *Multimedia Tools and Applications*, 77(2), 1679-1692.
- [4]Al-Ghaili, A. M., Mashohor, S., Ramli, A. R., & Ismail, A. (2012). Vertical-edge- based car-license-plate detection method. *IEEE transactions on vehicular technology*, 62(1), 26-38.
- [5]Qin, Z., Shi, S., Xu, J., & Fu, H. (2006). Method of license plate location based on corner feature. In *2006 6th World Congress on Intelligent Control and Automation* (Vol. 2, pp. 8645-8649). IEEE.
- [6]Thangam, E. C., Mohan, M., Ganesh, J., & Sukesh, C. V. (2018). Internet of Things (IoT) based Smart Parking Reservation System using Raspberry-pi. *International Journal of Applied Engineering Research*, 13(8), 5759-5765.
- [7] Panchal, T., Patel, H., & Panchal, A. (2016). License plate detection using Harris corner and character segmentation by integrated approach from an image. *Procedia Computer Science*, 79, 419-425.
- [8] Zhang, Z., & Wang, C. (2012). The research of vehicle plate recognition technical based on BP neural network. *Aasri Procedia*, 1, 74-81.
- [9] Gao, P., Zeng, Z., & Sun, S. (2018). Segmentation-Free Vehicle License Plate Recognition Using CNN. In *International Conference On Signal and Information Processing, Networking And Computers* (pp. 50-57). Springer, Singapore.

- [10] Masood, S. Z., Shu, G., Dehghan, A., & Ortiz, E. G. (2017). License plate detection and recognition using deeply learned convolutional neural networks. arXiv preprint arXiv:1703.07330.
- [11] Sundararaman, V., Vijayalakshmi, T. G., Swathi, G. V., & Mohapatra, S. (2016). Automatic License Plate Recognition System Using Raspberry Pi. In Proceedings of the International Conference on Recent Cognizance in Wireless Communication & Image Processing (pp. 217-222). Springer, New Delhi.
- [12] Thangam, E. C., Mohan, M., Ganesh, J., & Suresh, C. V. (2018). Internet of Things (IoT) based Smart Parking Reservation System using Raspberry-pi. International Journal of Applied Engineering Research, 13(8), 5759-5765.
- [13] Kochlá, M., Hodo, M., echovi, L., Kapitulík, J., & Jureka, M. (2014, September). WSN for traffic monitoring using Raspberry Pi board. In 2014 Federated Conference on Computer Science and Information Systems (pp. 1023-1026). IEEE.
- [14] Iszaidy, I., Ngadiran, R., Ahmad, R. B., Jais, M. I., & Shuhaizar, D. (2016). Implementation of raspberry Pi for vehicle tracking and travel time information system: A survey. In 2016 International Conference on Robotics, Automation and Sciences (ICORAS) (pp. 1-4). IEEE.
- [15] Chang, S. L., Chen, L. S., Chung, Y. C., & Chen, S. W. (2004). Automatic license plate recognition. IEEE transactions on intelligent transportation systems, 5(1), 42-53.