

## Automatic License Number Plate Recognition Using Deep Learning and Open CV

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### ABSTRACT

#### Article Info

Volume 8, Issue 3

Page Number : 1012-1018

#### Publication Issue

May-June-2021

#### Article History

Accepted : 20 June 2021

Published : 30 June 2021

This paper illustrates a design and development of a new efficient Automatic number plate recognition system, using image processing and deep learning techniques. This system is implemented at residential parking entries. The number plate sensor will sense the presence of a vehicle and after that through camera it captures the frames of vehicles. This information is sent to Raspberry Pi to process the image. Using deep learning SSDMobile .Net model we detect the number plate of the vehicle. We create sequential convolutional neural network that is smart enough to recognize characters after training. The recognized plate number is matched with stored database and displays vehicle status on website. If the vehicle is an unauthenticate one, the gate remains shut and an email is sent to the parking management authority.

Keywords : Automatic Number Plate Recognition, Image Processing, Convolutional Neural Network, Authenticate, Unauthenticate

### I. INTRODUCTION

Security is a prime concern in every Apartment and residential complex which require regulated entry of vehicles. Automatic vehicle access to those residential complexes require a mechanism devoid of human intervention. Our system is designed to operate automatically on a 24/7 basis and check un-authenticate vehicles from accessing entry. The number plate of the vehicle is recognized and automatic access to the rightful member is granted. This system effectuates a competent and methodical paradigm of enhanced structure.

Detecting of number plates on moving vehicles utilizes many algorithms developed for this purpose. However a lacuna is discernible, and remains an evolving part year on year. Our Objective is to increase the safety of vehicles. This technology assists in a criminal investigation and prevents the proliferation of crime.

The craving for residential parking spaces supervised by an automated management system is an ever increasing need for city residents. The authorized vehicle is registered in the parking management system along with their owner information. The plate

number is used to automatically enter Authorized vehicle. This system allows residents of that residential complex easy and secure access to their respective parking slots.

## II. AUTOMATIC LICENSE NUMBER PLATE RECOGNITION SYSTEM IS IMPLEMENTED IN OUR PROJECT

The whole system is composed as follows:

### F2.1 Raspberry Pi

Raspberry pi is popularly used for real time video processing applications. It is at the heart of the whole system. With Raspberry Pi one has direct access to ports and GPIO pins to build the project. We are using Raspbian Buster operating system because it supports our new Raspberry Pi 4 model B.

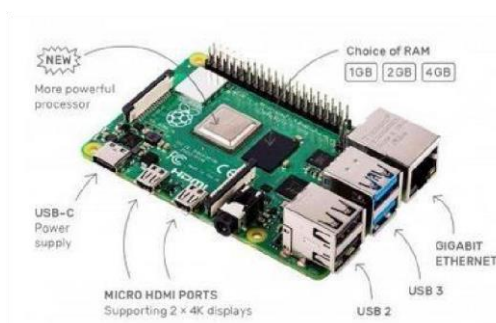


Fig - 1: Raspberry Pi 4 Model B

### 2.2 Camera

In this Project the usage of an image capturing digital camera is instrumental for extracting crystal clear images of vehicles.



Fig - 2: Logitech C170 USB Web Camera used in system

### 2.3 Ultrasonic Sensor

The module has transmitter and receiver and they are similar to two knobs. Ultrasonic pulse when emitted from the transmitter encounters the arrived vehicle and reverberates back to the receiver which displays the coming vehicle distance on the screen.

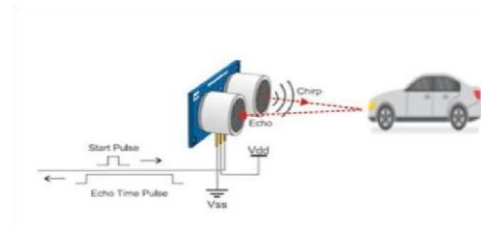


Fig-3: Working of Ultrasonic Sensor

### 2.4 Servo Motor

The SG90 Servo motor employed in our project is meant to rotate at the gate at some specific angles. Depending on the width of Pulses from the PWM signal, the angle of the Servo Motor's shaft will change.

### 2.5 Need of OpenCV

OpenCV stands for open source computer vision. This system teaches intelligence to machines and allows computer to see and process data just like humans. The computer vision transforms data extracted from a camera into a new paradigm. OpenCV is an image processing library to read, write and process images. OpenCV is written in C++ language and It has C, C++, Python and Matlab language interface.

### 2.6 Python

Python is an object-oriented, easy to learn and open source language. Popular for building websites and Framework Python

### 2.7 Django

Django is a high-level Python Web framework that assists in quick development of clean and user friendly designs. Django supports development of dynamic websites. Django framework is based on MVT architecture.

### 2.8 LAMP Server

'LAMP' being part of open source software's is usually assembled together thus, enabling the server to host dynamic websites. LAMP symbolizes the Linux

operating system conjoining with the Apache web server. Maria DB/MySQL is a database management system.

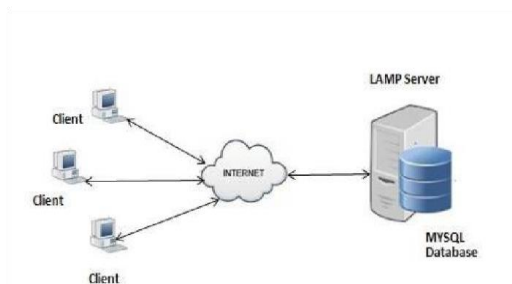


Fig - 4: Architecture of LAMP Server

### III. SYSTEM DESIGN AND IMPLEMENTATION

This system automatically recognizes an un-authenticate vehicle by using image processing and deep learning algorithms. Record of an authenticate vehicle along with owner information in residential areas is stored on the LAMP server. Whenever the vehicle arrives in the parking system, an ultrasonic sensor detects the distance and presence of the vehicle. By then camera will initialize and capture video frames. The taken image is sent to Raspberry Pi to process the data.

Initializing computer vision, the computer begins to read, write and display operations. Using SSD-MobileNet deep learning model vehicle number plate is detected. By applying image processing algorithms, each character is segmented in one single image and passed on to sequential neural network model. It is intelligent enough to recognize characters from the number plate.

The recognized number is matched with the record database. After that the vehicle status is displayed on the Website created using Django framework. If the number matches, then gate opens which is controlled through the Servo motor. If the number does not match, means the vehicle is un-authenticate and gate remains closed and entry is denied. An email to that effect is sent through SMTP to the parking management authority.

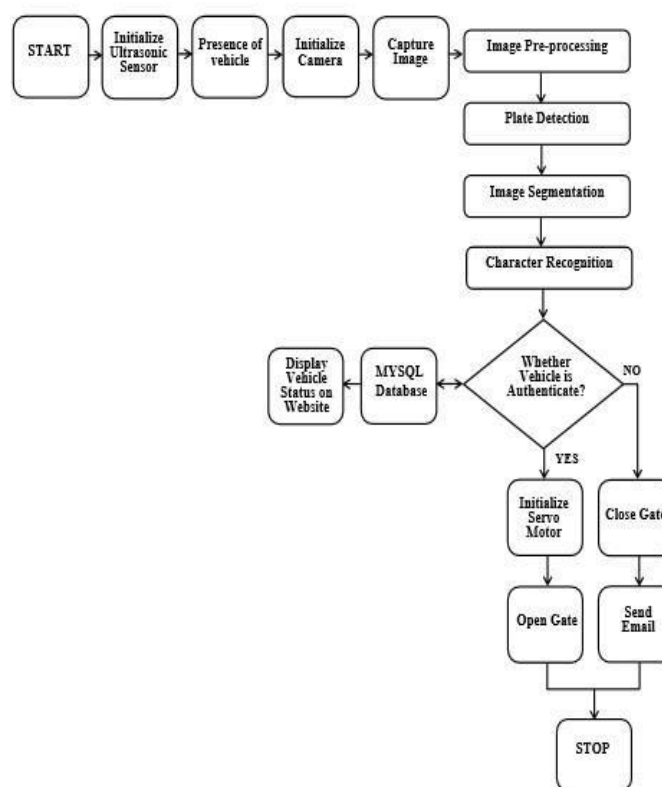


Fig 5: System Flowchart

### IV. SYSTEM ALGORITHM

#### 4.1 Image Acquisition

Capture input frames of moving vehicle through a videocamera.

#### 4.2 Plate Detection

SSD-MobileNet is a deep learning based object detection algorithm used to identify objects in image or video. An object detection model is trained on lots of number plates to detect the location of the number plate. When we subsequently provide an image to the model, it detects output as number plate, the location of a bounding box that contains number plate and a score indicates the confidence that detection was correct.

#### 4.3 Convert RGB to Gray Scale Image

Processing of RGB image is complex and time consuming, hence we convert color image to gray scale image. This image has only a single 8-bit channel ranging from 0 (black) to 255

#### 4.4 Binarization

In binarization, gray image is converted into an image having pure black & pure white pixel values.

#### 4.5 Segmentation

Segmentation is a very important step going into the analysis of processed image data. An efficient segmentation algorithm subsumes the Accuracy of character recognition. The aim is to compartmentalize an image and which is strongly in consonance with objects or areas contained in the captured image.

### V. CLASSIFICATION AND RECOGNITION

#### Basics of Convolutional Neural Network

CNN is a type of feed-forward artificial neural network. In Convolutional Neural Network, the neuron in a layer will only be connected to a small region of the layer before it.

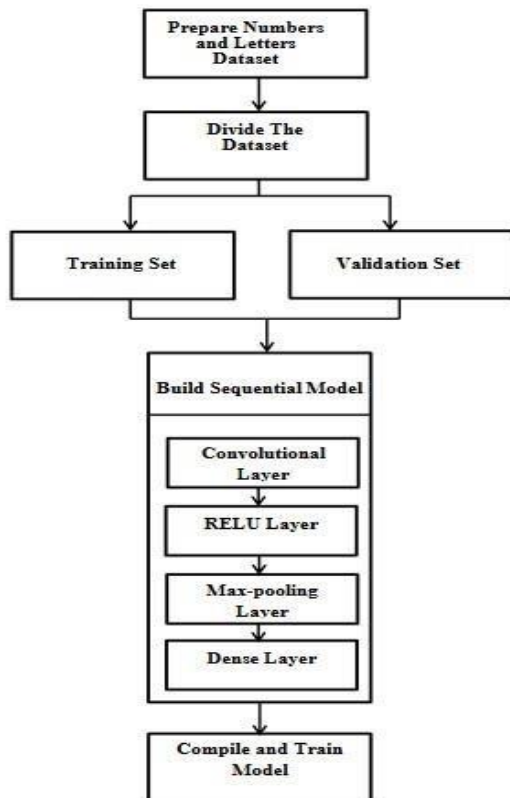


Fig – 6 : Flowchart of Training CNN model on Dataset

#### Step 1-Prepare Dataset

For our project a prepared dataset of numbers and letters to recognize characters on vehicle number plate, which in spite of any environmental conditions and at any capturing angle is stored.

Two folders are created, A. training and B. validation folder.

A.Training Folder- In training set, total 36 classes and each class contains 800 images for training. Training folder data is on which the neural network works.

B.Validation Folder- Similarly, In validation set total 36 classes and each class containing 200 images for validation. The neural network while learning through the training set also checks the loss from the validation set.

#### Step 2- Build Sequential Model

Build the model using deep neural network library called Keras and using Tensorflow as backend. We are using sequential object to model our neural network.

Basically a convolutional neural network has following layers:

Convolutional layer-The first layer is a convolutional layer extracting features from images with a convolution window size and it keeps iterating over the pixels of input image. Add all the pixels and divide them by the total number of pixels and it results in an output for each feature to be forwarded to the next layer.

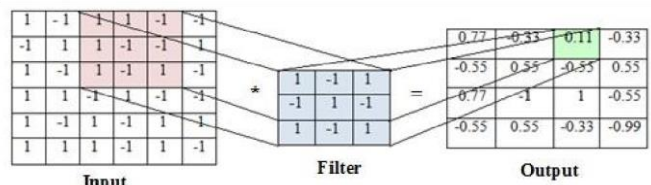


Fig - 7: Graphical Representation of Convolutional Layer

ReLU Layer- Rectified linear unit is an activation function used only to activate the node if input is above certain quantity.

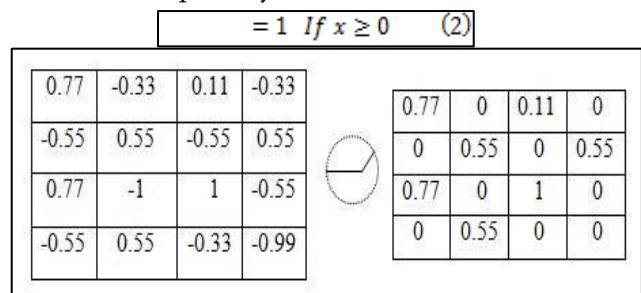


Fig - 8: Graphical Representation of ReLU Layer

Max-Pooling –In Max-pooling move your window across the filtered image. Take maximum image value and reduce the dimensionality of input which comes from a previous layer.

Results of CNN Model- Validation loss has direct relation with accuracy, which in turn means lower validation loss results in higher accuracy. In a result, when validation loss reduces to 0.0335 accuracy rises to 0.98. By using trained model we test input data and it predicts correct output.

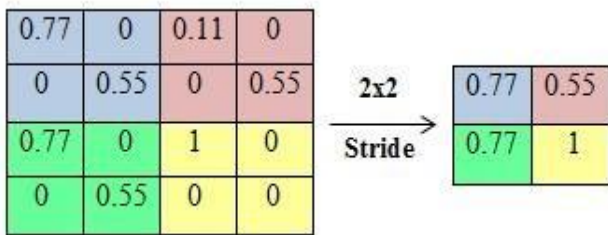


Fig - 9: Graphical Representation of Max-pooling Layer

Dropout –Dropout is used to prevent Neural Networks from Overfitting. Dropout is a technique where randomly selected neurons are “dropped-out” randomly during training. Layer Flatten –The flatten layer takes data from the previous layer and represents it in a single dimension.

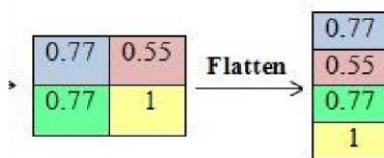


Fig - 10: Graphical Representation of Flatten Layer

Dense Layer – It connects multiple layers into a single array of neurons where the value of each neuron votes toward probability, detailing the accuracy of the image and it helps to create an output layer.

A. Step 3-Compile and train the model

We use categorical cross entropy as loss function, because we utilize multi-classification in our project. Adam optimizer is used to reduce the loss function.

After training for 10 epochs, our model achieved an accuracy of 98.57 %

Save and load the model -After training, we save all the weights of the neural network. Add requisite weights (.h5 file) on the hardware and load it when required.

Character recognition- After segmentation of the number plate, the segmented numbers sent for character recognition and by loading saved neural network weights we recognize the characters on the number plate correctly.

VI. EXPERIMENTAL RESULTS

We tested this system on a Raspberry Pi 4 Model B with 2 GB RAM. Equipped with Logitech C170 USB Web Camera. We tested the system on Frame sequence of Vehicle images at Residential Parking Areas. The system is able to detect and recognize most of the vehicles number plate successfully.

Convolutional Neural Network is a very powerful algorithm which is outstandingly efficient, so that it can be

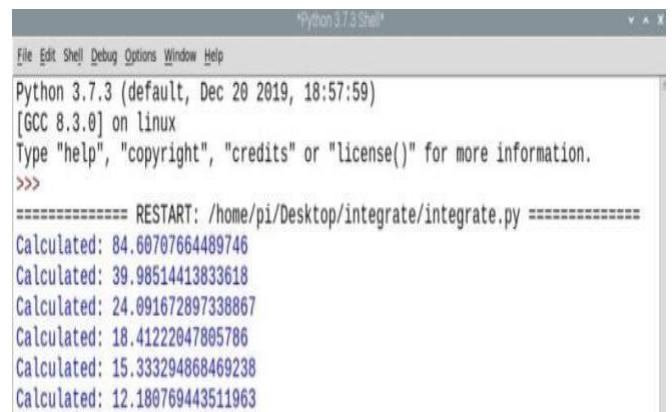


Fig - 11 : Screen shot of vehicle distance detected by ultrasonic Sensor





Fig - 12: Screenshot of Detected Vehicle Number Plate



Fig - 13: Screenshot of Plate Detection



Fig - 14: Screenshot of Binary Plate Image

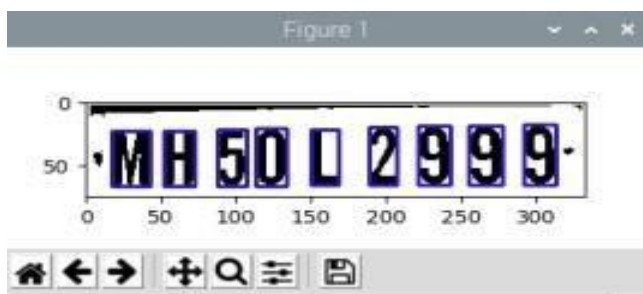


Fig - 15: Screenshot of contour applied on Plate Image

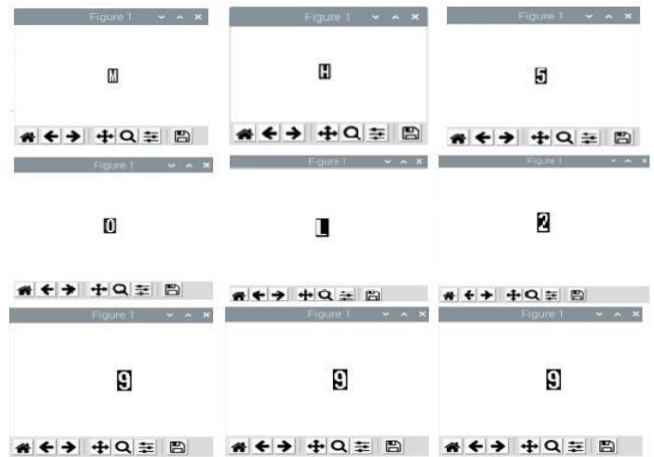


Fig - 16: Screenshot of Segmented Number Plate

### VII. CONCLUSION

Implemented on embedded platform. Efficacy of algorithm can be certified from the afore denoted tests. Results of all these tests are satisfactorily similar. Tests on algorithm suggest that the training of letters and numbers dataset captured from different angles is an important parameter to look out for. This smart system for vehicle monitoring and inherent security will help vehicle owner to use their vehicles with maximum security and efficiency.

### VIII. ACKNOWLEDGEMENT

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without the mention of people who made it possible, whose consistent guidance and encouragement crowned our effort with success. We consider it is our privilege and duty to express our gratitude and respect to all those who guide us in the completion of this project report.

First and foremost, it's our immense pleasure to thank our beloved guide SWATHI S, Asst. Professor, Department of Computer Science and Engineering, Nagarjuna College of Engineering and Technology, for helping, guiding and strengthening us to complete this project work.

We would like to thank our project coordinator Srikanth M S, Asst. Professor, Department of Information Science and Engineering, Nagarjuna College of Engineering and Technology, Bengaluru for her constant support and assistance at every stage. We would like to express our sincere thanks to Dr. Anil Kannur, HOD, Department of Information Science and Engineering, Nagarjuna College of Engineering and Technology for his valuable suggestions and guidance throughout the period of this project work.

We take this privilege to express our deep gratitude to Dr. Jitendranath Mungara , Principal, Nagarjuna College of Engineering and Technology for his constant support and encouragement in preparation of this report and for providing library and laboratory facilities needed to prepare this project report.

Last but not least, we would like to thank our parents, friends, teaching and non-teaching staff of NCET.

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#### Cite this article as :

Swathi S, Harshitha D, Kavya NR, Mounika B , " Automatic License Number Plate Recognition Using Deep Learning And Open CV ", International Journal of Scientific Research in Science and Technology(IJSRST), Print ISSN : 2395-6011, Online ISSN : 2395-602X, Volume 8, Issue 3, pp. 1012-1018, May-June-2021.  
Journal URL : <https://ijsrst.com/IJSRST2183211>