Design of a Plate Number Recognition System for Vehicles

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ABSTRACT

Vehicle Plate Number Recognition system is an automated mass surveillance method that uses several Digital Image Processing (DIP) technique and Optical Character Recognition (OCR) on images to read and identify vehicle registration plates. It has yielded multiple positive results in practical applications such as: access control, traffic law enforcement, inventory and property management, security systems surveillance, parking space allocation, and road traffic surveillance. The vehicle plate number recognition system designed focused mainly on number plate localization and licence plate extraction from an image for possible application in different areas. It achieves this by using several OpenCV digital image processing (DIP) technique developed with python to bring about image segmentation from which some image segments were tested for characters, so that the length of character found on each segment with similar properties becomes the key towards localizing and cropping off the region with the actual vehicle licence plate. Some properties of characters that was used to isolate the possible licence plate are the fact that characters of the licence plate have corresponding image height, width, aspect ratio etc. using these pixel properties it was possible to filter off unwanted contour lines/curves that stands out as noise while localizing the actual region of the image having the plate number. Once the region was obtained OCR was used via a trained template for several character styles to obtain the text format of the licence plate. The design had a plate localization accuracy of 100% and 90% read accuracy.

Keywords: Design, Vehicle Plate Number, Recognition System, Monitoring, Digital Image Processing

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1. BACKGROUND OF THE DESIGN

Vehicle Plate Number Recognition is a part of automation application in the area of digital image processing, which is used to categorize vehicle. This can be used in various applications such as, traffic violation control, tracing of stolen vehicles, restricted areas, parking lots, tollbooth etc.Vehicle Plate Number Recognition are utilized as distinguishing proof of vehicles everywhere throughout the countries.

However, this number plate recognition system uses a picture handling technique for perceiving automobiles by their number plates. These systems are utilized with the point of viable movement control and security applications like access control to limited regions and pursue wanted vehicles etc. This system uses image processing technique for identification of the vehicle's number plate. Although noise on the number plate can sometimes cause error and low accuracy.

There are some limitations that lead to failure in most practical applications due to the diversity of the number plate characteristics and the intricacy of the natural environment like rain, snow etc. we anticipated a method mainly based on embedded devices such as Raspberry pi, Raspberry Camera and Using the Open Computer Vision (Open CV) and Optical Character Recognition (OCR) to extract the numbers on the plate and record the plate number with respect to date and time on a database. This system includes a camera, a computer, and custom designed software for image processing, analysis and recognition.

1.1 Scope of the Design

The scope to design a system to keep track of vehicles identities through their plate number and link such to their respective owners for tracking and record keeping. This was achieved using embedded device. It also has the capacity to generate the records for other use, either by the security guards or other authorities in charged. The result generated can be exported into a Portable Document Format (PDF). This project can only capture and record a plate number of the entire vehicle that only passes through the entry gate.

2. REVIEW OF RELATED WORKS

Nikolas & Anagnostopoulos, (2018) in their paper, mainly aimed to present the various existing techniques, categorize and assess them. According to the paper, the number plate recognition consisted of three main steps. Extraction of the region of interest which consisted of edge statistics, morphology and connected component analysis (CCA). Segmentation of the plate characters was another approach using Histogram Processing, Mathematical Morphology, Local/Adaptive thresholding and Transformations. Character recognition which used Statistical/Hybrid Classifiers and Pattern/template Matching. Better Results have been achieved by using the concept of neural networks and statistical classifier approach but a large amount of learning training sample is needed for the better work.

Ezhilarasi, et al , (2019) have used Matlab toolbox function that delivers a function called region props. It measures a set of properties for each labeled region in the label matrix. They have used bounding box to measure the properties of the image region. After labeling the connecting components, the region was removed from the input image. This is used for segmentation of characters In the work of Nelson, Kumar & Siva, (2010) the algorithm for number plate recognition composed of the following steps. Pre-processing and Plate Recognition which helps to improve the image quality by converting color image to gray level image using Standard NTSC model then median filtering was applied for noise reduction. Feature-based number plate localization method was implemented for further process.

Character Segmentation was also used in which Otsu method was used as threshold for the plate values. Character Recognition in this, Statistical feature extraction had been implemented for the character recognition process. Performance analyzed for different part of proposed method was 85% for number plate localization, for character segmentation 95% and for character recognition it's was 82%.

Sharmila& Uma, (2016) used the adaptive threshold to highlight the characters and suppress the background. In order to remove unwanted image spaces, a component algorithm is first applied to the converted binary image from the original panel. However, a special algorithm called Image Scissoring was used to divide the Optical Character Recognition engine called tesseract, which returns ASCII to the license number. The entire system has been implemented using open CV. In the work of Chang, Chen, et al (2013), the number plate recognition method used was Color Edge Detection and fuzzy maps. The steps taken were Pre-processing which consisted of binarization using variable thresholding technique then Connected Component algorithm was applied to binarized plate to eliminate undesired area. Also, Huge transformed 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 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 self-organizing Template test was performed to match the input character to the database and best match was found. Experiment was performed on 1601 images and the success rate achieved approximate 95.6% and overall success rate take place up to 93.7%. In the work of Cevikb & Kocera, (2011), the approach was mainly based on Artificial Neural network while the steps proposed were Plate Localization which used Canny Edge Detector for the image localization. Character segmentation used Histogram approach for Contrast extension and median filtering for noise reduction. Feature Extraction was also used in which Artificial Neural Network (ANN) was proposed in the process.

Two separate ANN used one for Character and other for character extraction because confusion was high when combined approach was applied to both character and numbers so to increase the success rate separate ANN was implemented. Character Recognition was done by Multi layered perceptron (MLP) model of ANN which was used for the character recognition. Test was taken on 259 vehicle images and out of which 247 was recognized and overall accuracy was achieved near about 95.36%

3. METHODOLOGY

This design used an onboard computer commonly termed as Raspberry Pi2 processor as the heart of the project. The on-board computer can efficiently and effectively communicate with the output and input modules which are being used. The Raspberry pi is a credit-card sized single board computer which was firstly developed in UK by the Raspberry pi foundation. Basically, the operating system for the detection of vehicle number plate using Raspberry pi is the Raspbian JC. For the recognition purpose, Raspberry pi model3 was used. Raspberry pi is a SOC (system on chip) device with inbuilt 1.2 GHz BCM 2837 Arm Cortex processor.

The arm cortex processor is 64 bits. Raspberry pi has 1GB Ram. The overall average power is ranging from 1.5 to 6.7 watt. Raspberry pi has 40 digital input output pins in which 27 pins are GPIO (General Purpose Input Output). It has operating system which is installed in external SD card for booting and long term storage. This desig made use of an on board computer, commonly termed as Raspberry Pi processor. The whole process in this design was divided into nine (9) phases: Setting up the raspberry Pi, Interfacing the Raspberry Pi camera, Installing the Camera Module, Installation of OpenCV, Download Models for Recognition, Apache Installation, PHP config., Local Database Configuration and Packaging.

3.1 Setting Up the Raspberry Pi

The Raspberry Pi is not generally supplied with an operating system. ISO DISK image was downloaded from raspberry site then zip file folder was extracted. Fedora ARM Installer was used to run the installer using an SD card.

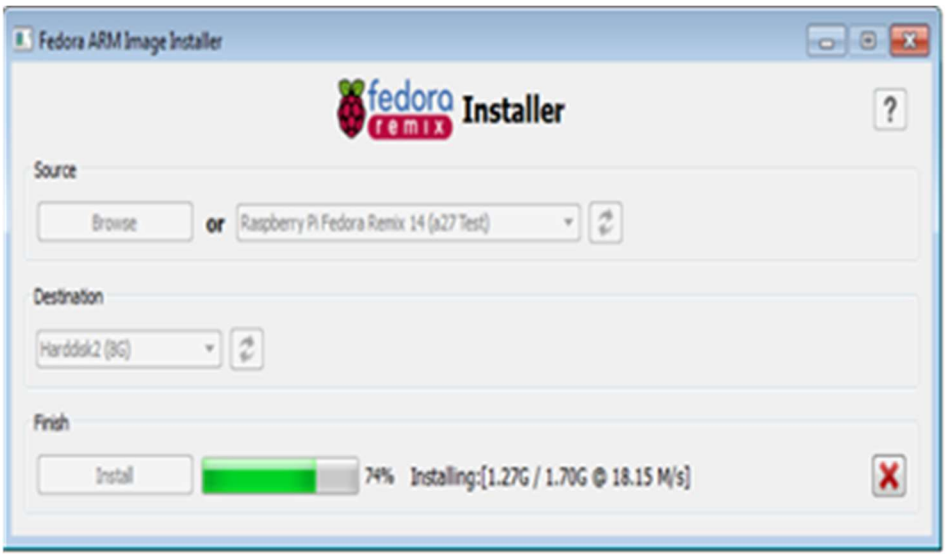


Fig. 3.1a

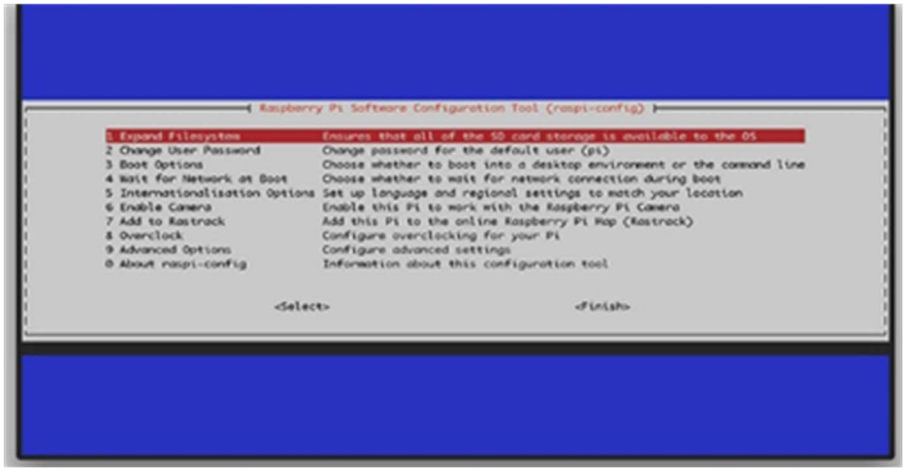


Fig. 3.1b

Fig. 3.1(a and b); Preparing the SD card for Operating System Installation

3.2 Description of Component and Applications used

3.2.1 Open CV

Open CV is an open source library which is very useful for computer vision applications such as video analysis, CCTV footage analysis and image analysis. Open CV is written by C++ and has more than 2,500 optimized algorithms. When we create applications for computer vision that we don't want to build from scratch we can use this library to start focusing on real world problems. There are many companies using this library today such as Google, Amazon, Microsoft and Toyota. Many researchers and developers contribute to it.

3.2.2 Car Plate

A vehicle registration plate is a metal or plastic plate attached to a motor vehicle for official identification purposes. The registration identifier is a numeric or alphanumeric code that uniquely identifies the vehicle within the issuing region's database.

3.2.3 Raspberry Pi Camera and Board

Pi Camera module is a camera which can be used to take pictures and high definition video.Raspberry Pi Board has CSI (Camera Serial Interface) interface to which we can attach PiCamera module directly.This Pi Camera module can attach to the Raspberry Pi's CSI port using 15-pin ribbon cable.

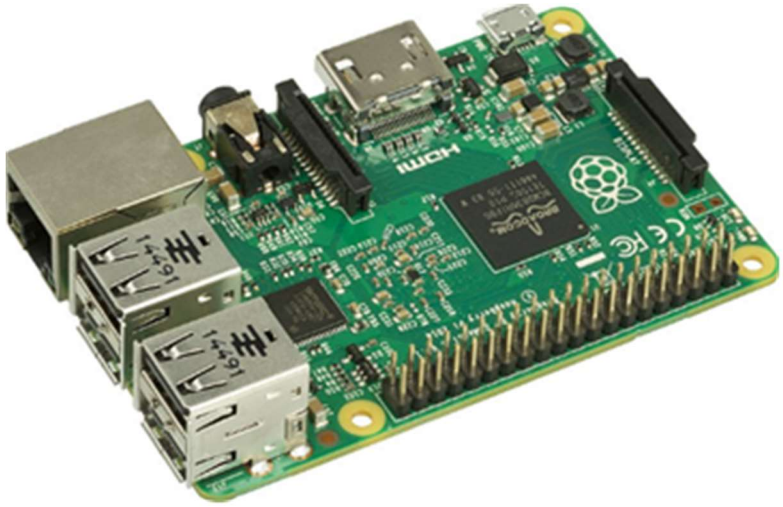


Fig 1.1: Raspberry Pi 3 board
Source:(www.electronicwings.com, 2020)

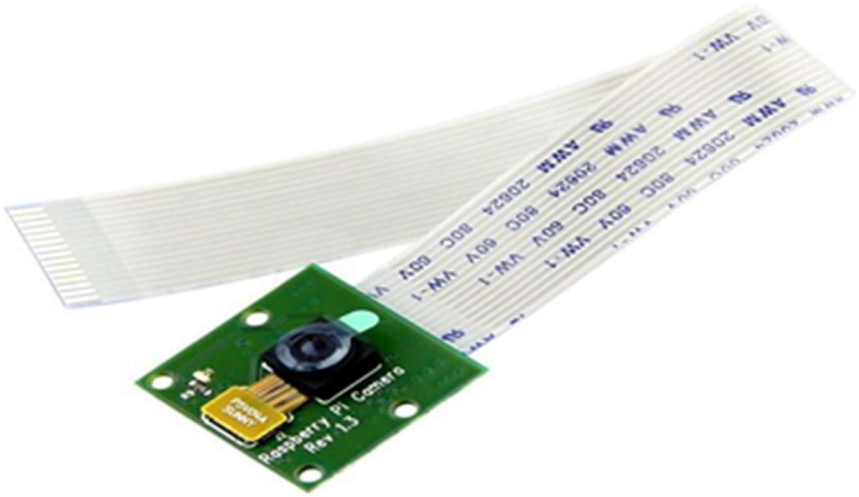


Fig 1.2: Raspberry Pi 3 camera
Source:(components101.com, 2017)

3.3 Features of Pi Camera

Here, we have used Pi camera v1.3. Its features are listed below,

- Resolution – 5 MP
- HD Video recording – 1080p @30fps, 720p @60fps, 960p @45fps and so on.
- It Can capture wide, still (motionless) images of resolution 2592x1944 pixels
- CSI Interface enabled.

3.4 Interfacing Pi Camera with the Board

The common Raspberry Pi distributions come with the IDLE Python development tool. In both the Python and Python 3 versions. Python programming was used to transfer captured images of vehicle which has crossed speed limits.

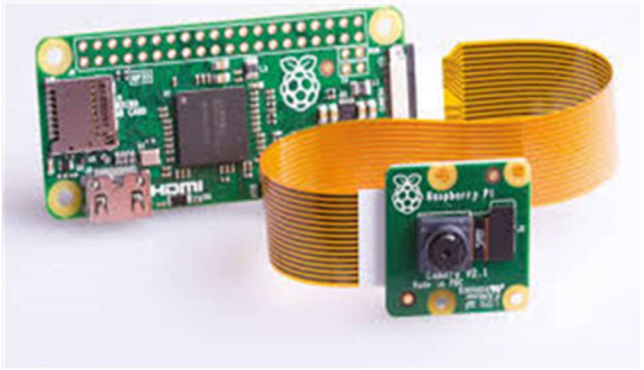


Fig. 3.2: Raspberry pi zero interfaced with pi camera

3.5 The Process Flowchart diagram

The process flowchart diagram of the design showed the instruction flow as presented below.

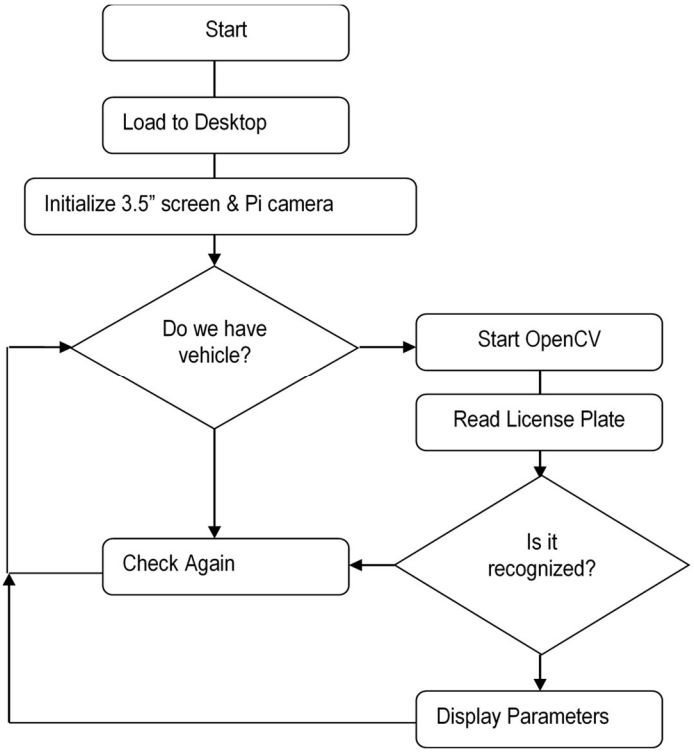


Fig 3.5: Process of Downloading Models for Recognition

4. SYSTEM IMPLEMENTATION & RESULTS

This chapter demonstrated practically the Vehicle Plate Number Recognition System operation and applications.

4.1 System Implementation

The design was implemented using the Raspberry Pi, Raspberry Pi Camera, and Monitor for display etc. The entire system is powered and dependent on Raspberry Pi Zero. The following demonstration shows the functionality of the system.

Fig. 4.1a

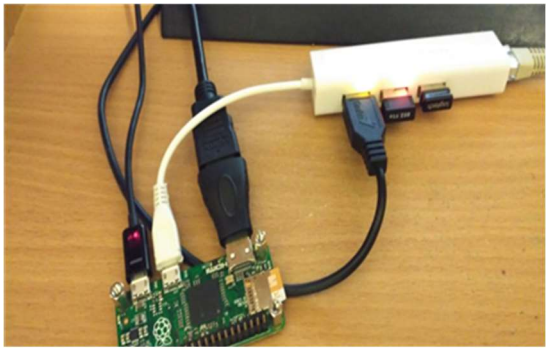


Fig. 4.1b

Fig 4.1(a and b): Project Setup for testing with Raspberry Pi Zero (unpacked).

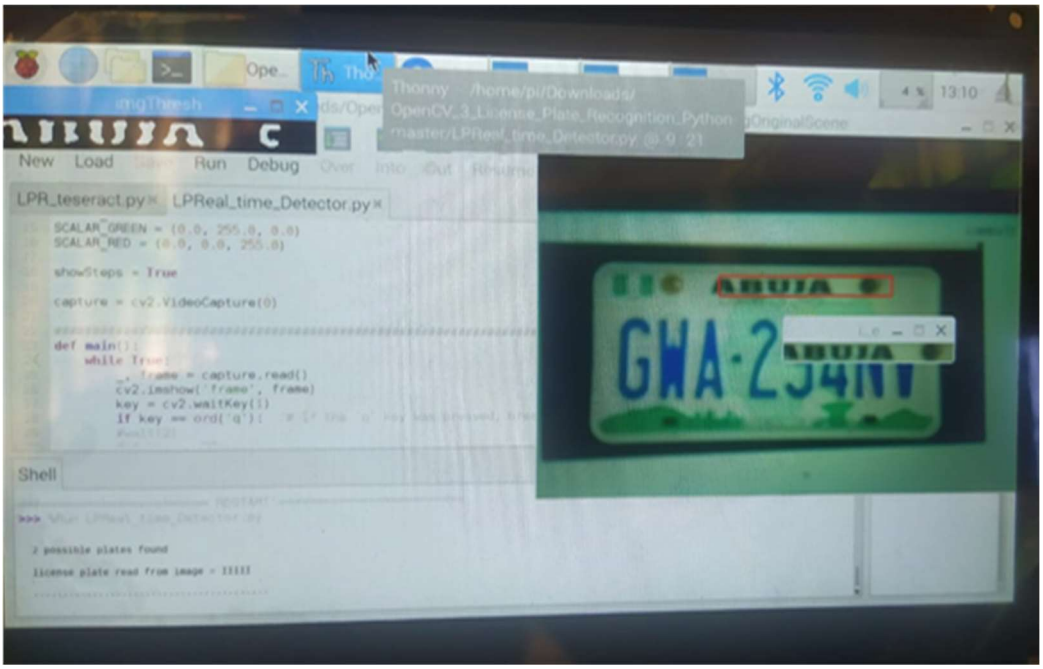


Fig 4.2: Plate Number Capturing And Processing 1

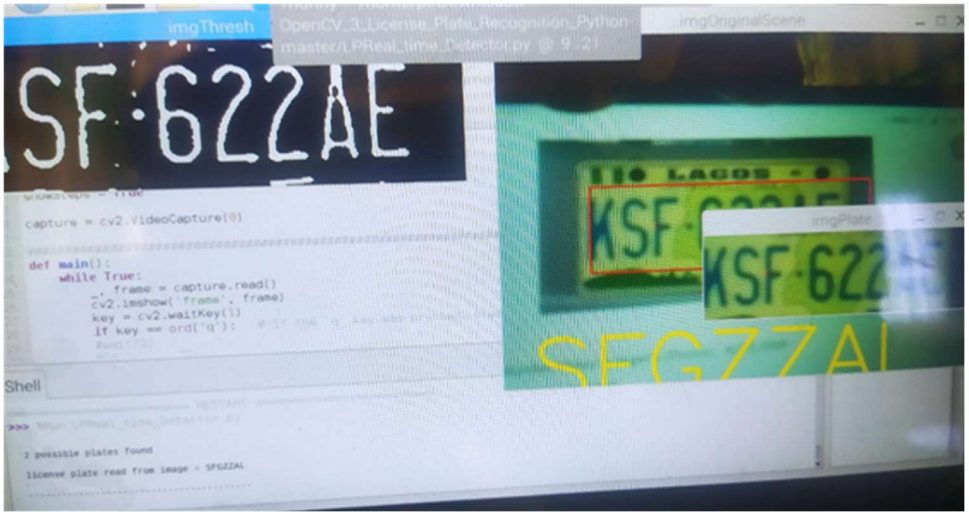
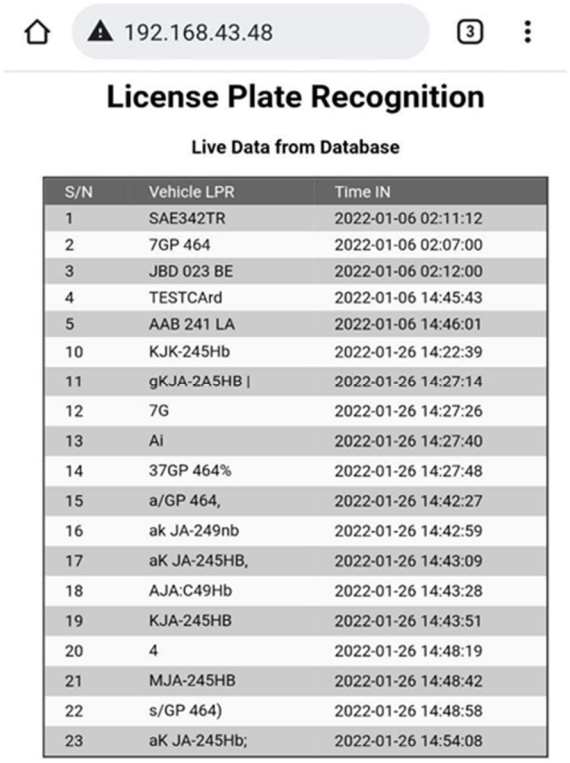


Fig 4.3: Plate Number Capturing and Processing 2



S/N	Vehicle LPR	Time IN
1	SAE342TR	2022-01-06 02:11:12
2	7GP 464	2022-01-06 02:07:00
3	JBD 023 BE	2022-01-06 02:12:00
4	TESTCArd	2022-01-06 14:45:43
5	AAB 241 LA	2022-01-06 14:46:01
10	KJK-245Hb	2022-01-26 14:22:39
11	gKJA-2A5HB |	2022-01-26 14:27:14
12	7G	2022-01-26 14:27:26
13	Ai	2022-01-26 14:27:40
14	37GP 464%	2022-01-26 14:27:48
15	a/GP 464,	2022-01-26 14:42:27
16	ak JA-249nb	2022-01-26 14:42:59
17	aK JA-245HB,	2022-01-26 14:43:09
18	AJA:C49Hb	2022-01-26 14:43:28
19	KJA-245HB	2022-01-26 14:43:51
20	4	2022-01-26 14:48:19
21	MJA-245HB	2022-01-26 14:48:42
22	s/GP 464)	2022-01-26 14:48:58
23	aK JA-245Hb;	2022-01-26 14:54:08

Fig 4.4: List of License Plate Registered in the Database

5. CONCLUSION

License Plate number recognition was implemented and deployed. The design captured plate numbers using optical character recognition (OCR) based on trained dataset from registered plate number. License plates were cropped correctly after discovery and processed. There are several applications of this design ranging from vehicle tracking, speed control, parking control, remote vehicles user's identification, remote detection of expired vehicle papers etc.

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