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Automatic Number Plate Recognition and Parking Management

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***Abstract*- ANPR (Automatic number plate recognition) is a widely used technique globally. It is a real time recognition system for vehicle identification. Parking of vehicles plays an important role especially in country like India. Due to increase in number of vehicles, we need a vehicle identification system, as most of the car parks and educational institutions the procedure for continued vehicle registration for entry and parking for site employees, workforce/college student getting inside requires the security people to verify the info of the car via examining of the identification document of the driver. This procedure of manual work is monotonous and time ingesting and is susceptible to incorrect information noted down by the security guard, also the sharing and backup of this automobile data is hard since the information is difficult to reproduce. The proposed system will be having Automatic number plate detection capabilities which will help in detection and storing of vehicle license plate and then allotting it a free parking lot through our parking management system. This simple and not complex system has the ability to significantly reduce the time taken in registration and also create a hassle-free experience in parking. The ANPR system developed, applies OCR which uses the raspberry pi camera to detect and identify the license plate. Yolo image detection algorithm is used for fastest possible recognition. The performance comparison of Tesseract and CNN depicts the usage scenarios. A combination of Yolov4 and Contour detection also forms one of the main basis of this research.**

Keywords— ANPR, Character recognition, OCR, convolutional neural network, YOLO (you only look once), Tesseract, LPR (license plate recognition).

I. INTRODUCTION

This project of an automated parking lot is an absolute use of technology advancements in today's world. as you see in most of the metropolitan cities, parking seems to be an extreme hassle. This project comes up with an innovative technology that solve the urban need by saving time and search for parking makes easier.

The system that is intended, makes use of electronic devices and other programmable devices and solve the problem. In areas like tollbooth, parking lots. The first use case of ANPR system dates back to 1976 in United Kingdom. It was used for controlling crime by the police.

Fig 1. Project overview

This system basically retrieves the vehicles license plate number from the digitized images by implementing image processing or character recognition techniques. [3] For controlling crime, the ANPR system compares the license plate number recognized, by the database of license number maintained by the government. If any similarity is found, then the police is alerted. This license plate recognition system will basically consist of a photographic camera, a microprocessor, and a program which performs optical character recognition and retrieves the license number from the number plate.[4] Let us assume that 2 cars are entering a parking lot with decently filled spots inside. Firstly, the camera at the entrance scans the number plate and sends the data to our server and saved there for security purposes. There is a screen on the right side because INDIA Is a right-handed driving country so that makes sense. The screen displays the parking availability, and a spot is allotted by the programmable device without any human intervention.[5]If the driver spots his car in the allotted position, then the parking lot is saved as full in our server, if the driver failed to do, then allotted lot will be booked for 10 minutes and later on if driver failed then the lot is again shown

available at the entrance of the parking lot[10]. When a car is exiting the lot, the ultrasonic sensor cluster in the lot detects any empty slot then the spot is again shown in the entrance. The screen at the entrance shows the nearest lot available at the time. The project uses raspberry pi as our programmable device and interfacing of cameras, ultrasonic sensor, and display is done. The Project also focusses on low cost and high efficiency.[5]

II. Literature Review

The ANPR system is a procedure in which recognition of vehicles is done through the recognition of number plate text. It uses image processing methods which extracts the vehicles number plate from its digitized images, tesseract ocr is used for character recognition. The number plate detection systems consist of 2 components: There is a camera which helps in capturing images of the license plate and also program which obtains the license plate character from the detected photo obtained by an optical text detection method which changes pixel to characters which are readable [1,2].

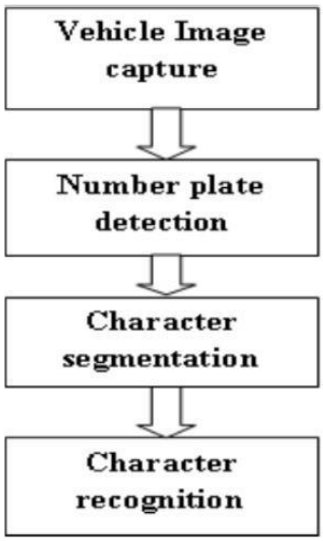

Fig 2. Flow chart of Execution of code [1]

So the, recognition system normally proceeds in 4 major (methodologies which are acquisition of image, number plate detection, text segmentation, text detection. [1]

A. Acquisation of Image

In this stage, camera detects vehicle. Here the vehicle image is detected in a method by selecting the input image, number plate of the vehicle should be clearly visible [1].

RGB (Red, Green, Blue) color model image is captured. There are many factors that affect Captured images, they are: noise, distortions which results in a degraded image of the vehicle which affects the image processing outcome.[5] Pre-processing of image is brought forward to see of any problems which must have come out during the acquisition of image. Through filtering of image, pre-processing is done. Pre-processing of image includes changing the RGB images into gray scale, removal of noise, enhancement of border which enhances brightness of the image [2].

B. Detection of Vehicle license plate

In the next stage which is license plate of the vehicle recognition phase which performs various methods like change the size of image into proper dimension and changes coloured image into grey colour image [4]. It checks the input image to find certain parameters which can include the number plate. The number plate is to be found inside the image, not senseful to go through each and every pixel of image to find license plate. Hence, considering only the pixels which have license plate [3].

C. Text Segmentation

A process in which partitioning of words from images into single characters. It decomposes the array of characters of image into various images with different set of values [4]. It is a method in which from the background the characters part of image is segregated [4]. For a proper recognition of text, the characters are segmented and then in the line which is segmented, segmentation of words takes place after which, the segmentation of all characters takes place [2].

D. Text Recognition

It is the study of capturing all characters from input images then converting them to text which is known in ASCII, else a different but compatible machine type code [1]. According to the predefined character class it classifies the input character. The most used segregation method is matching of template, similar to matching a matrix. So, the matching of template is done by taking a single image pixel as features. Hence, it is the comparison of templates sets from every character class with a character image which is the input [3].

E. Process of ANPR

1. It The picture has been taken from the camera of the car with license plate which is acquisition of Image stage.
2. In the second stage, camera identifies the license plate and then the brightness is adjusted after that the contrast and then we get the character after segmentation which is license plate detection and then the segmentation stages.
3. Then in the third stage every single character pattern has been inspected, which changes the given image into characters. This stage can be understood as text recognition stage. [1,2]

F. YOLOv4:

It can capture various objects with the help of Convolutional Neural Network (CNN). The Neural Networks used with this algorithm use certain techniques which are trained with the help of users using boxes which are bounded. It captures the images as an input and put it through a Neural schema which gives outputs of the images in the form of bounding boxes.[5] Then this input image gets divided in the form of S*S grid, where each cell in a grid contributes to detection for the object.[6] The cell in the grid estimates the Bounded Boxes and probabilities of classes. Prediction happens of five parameters. Those five parameters are w, x, h , y confidence Where y and x is the bounding box center and w and h represents the box height and width. We have used this algorithm because it is the fastest and can give good real time detection results [7,8,9]. The Fig 3. shows the block diagram of yolov4 model

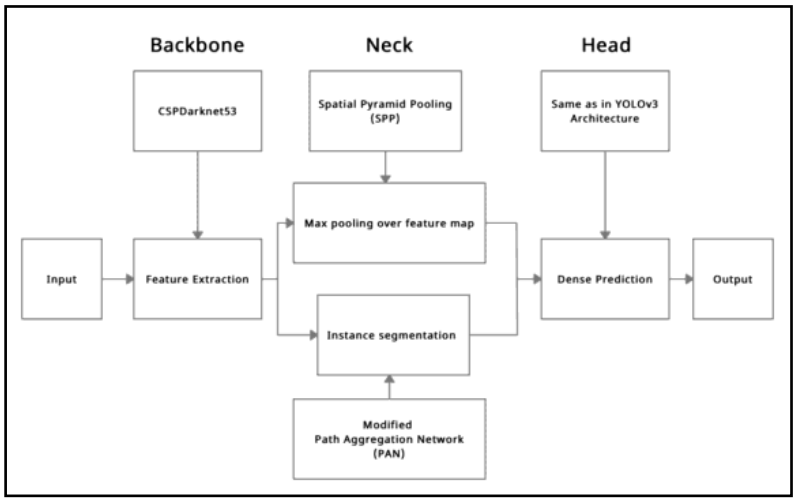

Fig 3. Block Diagram of Yolov4 model

III. Methodology

The steps needed for the detection of the number plate involves,

1. Using Object detection techniques like YOLO (you only look once), Contour detection the number plate is detected. Once the License plate is detected by the camera the entry/exit gate is opened. Using Hybrid approach the detection system performs faster.
2. The Parking management System comes into effect after detection. As it Displays to the driver empty parking spots.
3. Using the character segmentation methods (like identifying contours which are rectangular) on the retrieved license plate, all the number plate characters are separated.
4. The last stage involves the character recognition stage, using deep learning the segregated characters from the number plate are identified.

In the detection stage we came to an important conclusion that, on creating a hybrid approach i.e., by combining both the techniques (YOLO, Contour detection) we can significantly improve the accuracy of the model.

We have tried our hands on both, CNN as well as Tesseract due to which we got to know some important performance comparisons which we will be discussing shortly.

IV. Performance Comparison

This part would be describing OCR techniques CNN and Tesseract.

A. Convolutional neural network

Due to the rapid development of high-quality digital image processing with massive data sets, deep learning has become an important field in the areas of artificial intelligence, machine learning and computer vision.[12] The purpose of the deep learning method is to find a better solution and set the correct output array. Examples include handwriting recognition, image classification, and object recognition tasks. The methods focus more on convolutional neural networks [13]. For number identification a new method was proposed that comprises of LeNet-5 which uses seven layers of convolutional neural network.

A huge data set is perfectly supported/validated in CNN. They showed a strong correction in the classification of images.[14] However, it takes a long time to train in the CPU process. Today, GPUs have overcome this problem with faster parallel processing. Pannus introduced the CNN approach in the field of OCR [16]. The LeNet5 5 design approach used by *LeCun* is what we are using in CNN. The input image has 256 x 256 pixels and is a grayscale image, contains seven layers, 36 labels with "0" to "9" and "A" to "Z".[12]

B. Tesseract

It is an OCR engine which is open source and was created between 1984 and 1994 by HP. The OCR engine was submitted to UNLV for annual OCR accuracy testing in 1995.Tesseract was launched in 2005 by HP as open source. Tesseract had developed an analysis of page layout technology. Due to which, it understands that the input images are a binary image which can use both negative text in which black text is on a white text and positive text in which white text is on a black text. In Fig. 4, the structure of Tesseract is described[12]

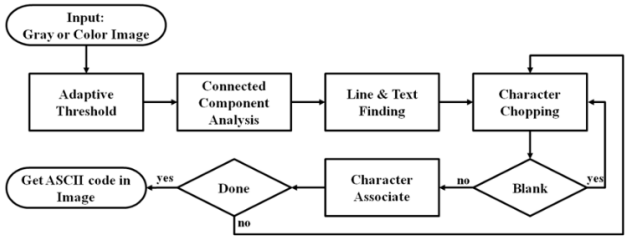

Fig 4. Structure of Tesseract [12]

C. Performance Comparison

For training CNN, we need an optimized data set, due to which we have used Caffe ocr dataset for training. Caffe is considered one of the best frameworks for Deep learning. This Data set supports various types of fonts (example Courier new, Times new Roman arial and more). This section of the Paper will show the performance, accuracy of recognition characters in Tesseract and CNN.

Caffe dataset is being used for optical character recognition training.[12]

TABLE I.

Datasets	**Image components**	**Number of characters**
Caffe OCR	Natural number 0 ~ 9, Upper case alphabet A ~ Z	6,400 characters for training 2,700 characters for test
VCOCR	Same as Caffe OCR	Same as Caffe OCR's test sets

We are using Caffe Data set for optical character recognition training (Table I).

Table II. Recognition Result Of Ncocr(Noisy Caffe)

	Pass	Fail
The number of characters	2607	92
Probability	96.62%	3.28%

TABLE II describes the result of the NCOCR character sets recognition accuracy experiment which is Success: 96.62%, fail: 3.28%.

TABLE III. VCOCR RESULT

	Pass	Fail
The number of characters	2607	92
Probability	96.62%	3.28%

TABLE III explains the result of the VCOCR character sets recognition accuracy experiment which is Success: 98.77%, fail: 1.13%.

Tesseract

TABLE IV describes the result of the VCOCR character sets recognition accuracy experiment which is Success: 85.23%, fail: 14.98%.

TABLE IV. VCOCR RESULT

	Pass	Fail
The number of characters	2398	412
Probability	85.23%	14.98%

TABLE V explains the result of the NCOCR character sets recognition accuracy experiment which is Success: 54.66%, fail: 45.54%. You will be a seeing a notable difference when the results are compared to CNN[12,15].

TABLE V. NCOCR RESULT

	Pass	Fail
The number of characters	1475	1228
Probability	54.66%	45.54%

D. Final results

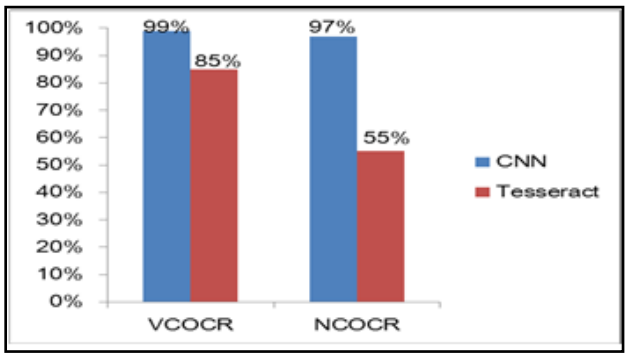

Fig 5. Final result

TABLE VI. PROCESSING TIME

	Processing Time
CNN	4200 sec
Tesseract	600 sec

From TABLE VI and Fig 5. we can conclude that the CNN has a far superior accuracy than Tesseract. But the processing time of Tesseract is far superior to CNN. So, depending on the demands of the system weather it requires higher accuracy (CNN should be used) or if it requires less processing time/ time complexity (tesseract should be used). We can select from the 2 optical character recognition techniques.[16]

V. Parking Management System

The parking management simulation has been done in *proteus*. The System includes a step-by-step process.

1) Let us assume a vehicle entering a parking lot in which our parking management system is installed, Then the camera installed at the entrance detects the number plate of the vehicle, and then the recognized number is saved on to our database with the time logs. The Fig 6. Shows the simulation of parking management with the proteus software , the fig shows the startup log.

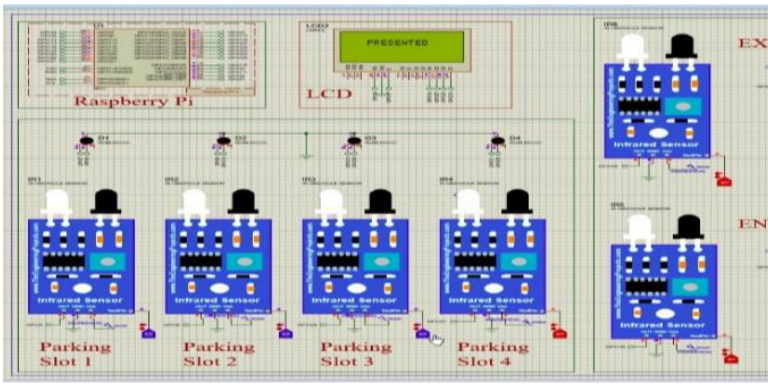

Fig 6. Startup log

2) Fig 7. Depicts the working of the parking management when the car has occupied the parking area.

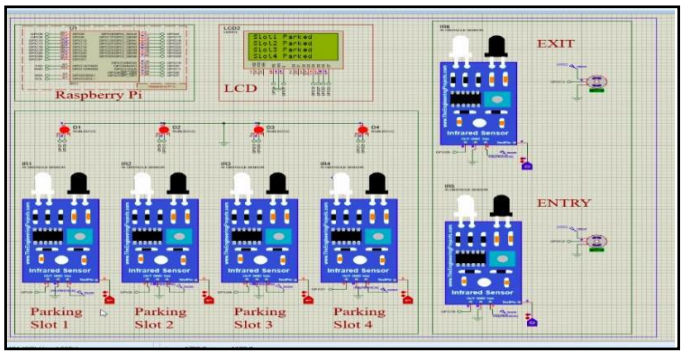

Fig 7. This is the Indication of lots

3) If the vehicle detected at the entrance is registered, then the barricades open and the vehicle is allowed inside. If the vehicle is not a registered user, then a code pops up and asks the user to register the vehicle.

4) Parking live status is shown on a display that is fixed at the entrance, by having a look at the entrance, the person can allotment of the nearest parking space and be directed to go there. This step helps users to save fuel and time.

5) When the vehicle reaches the assigned space, its sensors detect the car and mark the parking space occupied and make it unavailable to the others until the vehicle is present[11] depicted in Fig 8.

6) When the vehicle is leaving the lot, the log is again calculated at the exit and according to the time of using the parking space, a bill is generated at the exit point. We use image recognition techniques to

detect the object and make a log with it.

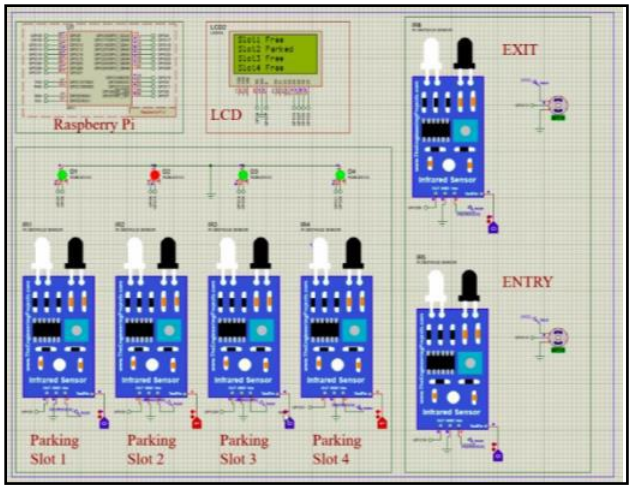

Fig 8. This is the changed log when a vehicle enters

VI. Hardware And Software Used

A. Power Supply

Every electronic and electrical device we are using in our life requires a certain power supply. Generally, we are using 230v and 50hz. But in microcontroller requires a 5v dc supply so we need to convert these ac power supply to dc power supply, so for this process, we are using a transformer, bridge rectifier, and regulator.

To convert 12 v AC to 5 v dc we are going to use a rectifier. there are different rectifier types like Half-wave, full wave, and bridge rectifier. we recommend using the bridge rectifier over full and half-wave rectifier. The Bridge rectifier has 4 diodes they will only conduct in forward bias but not in reversed bias. If the cathode voltage of the diode is < than anode voltage, then the it is said to be in forward bias.

B. Ultrasonic sensor

It is a sensor that can calculate the distance of a particular target with ultrasonic sound waves and then wait for the wave to reflect. Calculating distance baked on time taken to bounce back and reflect to the initiator. There are many ultrasonic sensors that are available, we will be using hscr-04 the range is half a meter and that is most appropriate for a car parking system that is automated. Ultrasonic sensor uses ultrasonic wave spectrum to analyze the distance. This sensor uses sonar to calculate the distance of the target, also has a great range detection with great precision and approximately stable readings. The sensor can range from (2 to 500 cm).

C. Pi camera

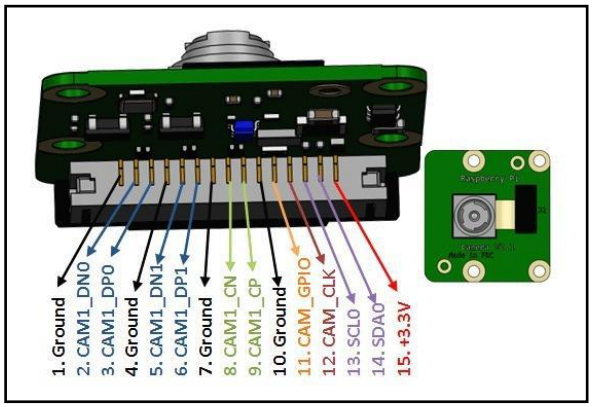

Fig 9.

Pi camera is a specific camera type that is used to interface with raspberry pi models. It is more compatible and easier to use with pi model controllers. Pi camera is a light weighted model with good image quality. It communicates with pi models using mipi camera serial interfacing protocol that is specific for pi models. Various configurations are available for this camera type. There are varied options of clarity and resolution. This camera in our automated system is used for image processing and to store the number of car and machine learning for our model. This camera detects the number plate of the car and saves It to our server/ data base. The image is converted, and image processing is done, and the text characters of the number are detected and saved. Fig 9. Shows the pin diagram of pi camera.

D. Lcd Display

Lcd display is available in various configurations, we are thinking of using 16*2 lcd display. It is the best display to show small texts and content. This is interface with raspberry pi model. The Fig 10. shows the pin diagram of Lcd Display

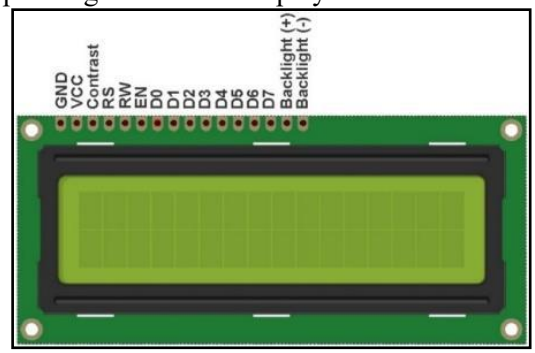

Fig 10. LCD display

E. Raspberry pi

It is a cheap and small size portable computer that can be used with a monitor, keyboard and a mouse. It's a device were everyone can start learning any of the programming languages from scratch. So, basically it can do everything what a full size computer can do like browsing internet, playing a video, games, word, all the text editing work. It's a great device for building projects. kids can use it to understand the working of a computer and learn how to program. Fig 11 shows the pin diagram.

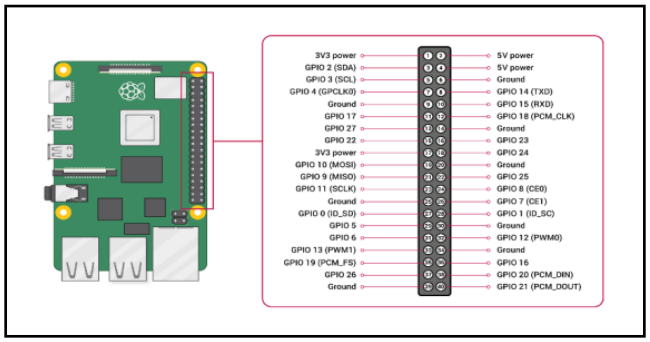

Fig 11. Pin diagram of Raspberry Pi

VII. Results

Fig 12 shows the simulation result obtained from automatic number plate recognition system which has been done using Yolov4 for plate detection and Tesseract/CNN for optical character recognition.

Fig 12. Simulation results

VIII. Conclusion

The challenges and the problems associated with the OCR accuracy and the fastest possible detection time of license plate formed the main interests in this research. The main motive for this research is to develop an automatic number plate recognition system with optical character recognition to minimize the manual and time consuming registration process done by the guards. The parking management forms the module two of this system, it aims for a smooth parking experience.

The research benefitted the project in OCR accuracy as it is significantly improved by using CNN instead of tesseract (but requires a very good configuration system so as to reduce processing time) also for fastest possible image Detection we used the combination of yolo and contour detection techniques. The simple and not complex parking management system simplifies the whole parking process.

Refrences

[1] Mutua Simon mandi, Bernard Shibwabo and Km.Raphael,"Automatic number plate recognition system" International journal of computer applications, Volume 175 7,October 2017.

[2] Lotufo, R., Morgan, D. & Johnson, S. 2013. "Automatic license plate recognition (ALPR) a state-of-the-art review". Journal of IEEE transaction on circuits and system for video technology, Vol. 23,no,2013,pp.311-325 DOI:1109/TCSVT.2012.2203741

[3] Reshma, P. 2012. "Noise Removal and Blob Identification Approach for Number Plate Recognition". International Journal of Computer Applications (0975 – 888) Volume 47– No.8, June 2012

[4] Friedrich, M., Jehlicka, P. & Schlaich, J. 2008. "Automatic number plate recognition for the observance of travel behavior". 8th International Conference on Survey Methods in Transport, 2008

[5] Joseph Redmon , Santosh Divvala , Ross Girshick , Ali Farhadi "YOLO: Unified Real-Time Object Detection." Publisher: IEEE Year: 2016 ,Conference Location: Las Vegas, NV, USA .

[6] Chengji Liu , Yufan Tao , Jiawei Liang , KaiLi , Yihang Chen. "A Object Detection Based on YOLO Network." Publisher: IEEE Year: 2018 , ConferenceLocation : Chongqing, China,China ,

[7] Ji-Hun Won , Dong-Hyun Lee , Kyung-Min Lee , Chi-Ho Lin. "YOLOv3 based Neural Network for De-identification Technology". Publisher:IEEE Year:2019 , Conference Location : JeJu, Korea (South), Korea (South) .

[8] Paulius Tumas , Artūras Serackis."Automated Image Annotation based on YOLOv3". Publisher: IEEE Year: 2018 , Conference Location: Vilnius, Lithuania .

[9] Hua Gong , Hui Li , Ke Xu , Yong Zhang "Object Detection based on Improved YOLOv3". Publisher: IEEE Year: 2019, Conference Location: Hangzhou, China.

[10] T.Subramani."A Parking Study on Main Corridors in Major Urban Centre." International Journal of Modern Engineering Research (IJMER) ISSN: 2249-6645 Vol.2, Issue.3, May-June 2012 pp-742-748

[11] Litman, T. 2013. "Parking Management Strategies, Evaluation and Planning". Taken from http://www.vtpi.org/park_man.pdf.

[12] D. G. Ko, S. H. Song, K. M. Kang, S. W. Han and J. H. Yi. "Optical Character Recognition performance comparison of Convolution Neural Network and Tesseract" The 31st International Technical Conference on Circuits/Systems, Computers and Communications (ITC-CSCC 2016).

[13] R. Mither, S. Indalkar and N. Divekar, "Optical Character Recognition", International Journal of Recent Technology & Engineering, IJRTE, 2013.

[14] M. Dillgenti, P. Frasconi and M. Gori, "Hidden Tree Markov Models for Document Image Classification", IEEE Transactions

on Pattern Analysis and Machine Intelligence, IEEE, 2003.
[15] Y. Cao, S. Wang and H. Li, “Skew detection and correction in document images based on straight-line fitting”, Pattern Recognition Letters, ELSEVIER, 2003.
[16] A. Kain and M. W. Macon, “Spectral voice conversion for text-to-speech synthesis”, Proceedings of the 1998 IEEE International Conference on, IEEE, 1998.