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Cloud-Based smart parking system with ALPR algorithm and APP integration

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Abstract - *This paper is to describe a model for Smart parking system that is hassle free, human labor free and meets the requirements of modern-day customer. We propose a system based on machine-learning and image processing technology integrated with cloud data storage and Android app and payment system functionality for smart parking. A number of attempts have been proposed in recent years, but lack important components like automatic payment system, security mechanisms etc. We present a cost efficient and easily implementable fully automatic system consisting of booking-identification-pay per use model of smart parking. Customer books a slot for the vehicle beforehand through android app. Dynamic display of available slots. The vehicle when arrives at the parking lot is identified. Customer is charged as per the parking time through the app when the vehicle leaves the building.*

Key Words: Machine learning, image processing, smart parking, pay-per-use payment, customer-friendly system

1.INTRODUCTION

A lot of research has been done in the areas of recognition using machine learning and deep learning. Smart parking System uses the advantages of these technologies to overcome the problems of traditional parking system. Typical traditional parking system involves a third-party owner of the parking area managing the parking space and responsible for the payment.

There are various problems associated with the existing parking system. The customer does not know whether the parking space is empty or not until he reaches the parking lot. The people managing the parking lots sometimes give a hard time to customers by overcharging them. Physical record has to be maintained on who has parked the vehicle. There is no way to check whether the vehicle is legitimate or not. There is high chance of vehicles getting stolen, damaged due to more than capacity parking. The hiring of human labor to maintain the parking lot is costly. If the management staff is unavailable at some point in time, the parking lot is rendered useless. The payment and parking process is time consuming as everything needs to be handled physically with the involvement of customer and management staff. At some places pay per use model isn't implemented rendering the vehicle insecure if not taken back by the customer in time.

To tackle these problems, we propose a smart system which makes use of Android App to book the slot for parking from anyplace. When the registered vehicle arrives at the parking slot it is identified using deep learning technology. Camera sensor and ALPR (automatic license plate recognition) algorithm consisting of models SSD mobile net version 1 for number plate detection and CNN character-digit classifier for vehicle number recognition are used which is then compared with the cloud database and vehicle is identified. Instructions on the app are displayed to guide the user to the parking slot. The user can pay for the parking time through our app interface. The exit gate again makes the use of ALPR which detects whether or not the user has made the payment.

Thus, this system is capable of implementing a fully automatic car parking. It is customer friendly and implements pay per use model. Security measures are taken into consideration using cameras and secure payment Gateway. Since machine learning tools are used for vehicle identification, there is low chance of impersonators entering the slots in any unethical manner.

2. RELATED WORK

In the model proposed by Juhi Seth [1], their system was built on Arduino UNO along with the IR sensors. They have used RFID for verifying the entry of the user. Cloud based services are used for checking the accessibility of the parking areas. The user is updated about the parking details through SMS. A GSM module is used for providing this service. The proposed system involves lot of hardware equipment's which can be easily cut down. The proposed system does not talk about the payment process and also about the time for which the vehicle would be parked.

In the model proposed by J. Cynthia [2] they have used google maps for location of parking slots, IOT and cloud for the storage and the execution of the project. RFID tags are used for the validation and payment procedure. The data is stored in MYSQL format. The main issue in this project was the security. RFID cards are vulnerable and can be stolen or

hacked. The entry needs to be verified and thus requires man power. This model lacks flexibility
for the parking time as it has to be entered during the registration process.

3. PROPOSED MODEL

Following is the proposed model that comprises of three main components:

1) Booking system through Android App
2) Identification using ALPR
3) Payment System

3.1 BOOKING SYSTEM THROUGH ANDROID APP

Booking of the parking slots are done with the android application. As the android application is first to be installed by the user on their devices. Then to book the parking first the user needs to register and then login to the system with their credentials which are being authenticated. All this information is stored on the Firebase which is the cloud storage for any time accessibility from anywhere. Below image shows that the user has logged-in to application

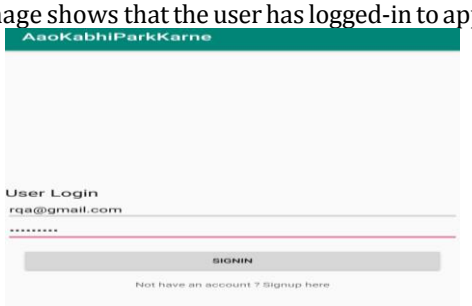


Fig-1: Login activity

After logging into the system, the user has to enter the car number and choose the slot of the parking as the customer desires. All this are being updated once the parking is booked through the android application.

Fig-2: Booking activity

Here some of the slots are not shown as these slots are being booked by the other users. The updating of the slots booked or not booked are being dynamically updated through the database. After the selection of the slot by the customer the customer books the slot and while booking the slot, he is being authenticated with the UserID and all this slot is being booked and updated into the database. After the slots are being booked the application navigates you to the parking when the customer reaches the parking lot. Below image shows the instructions to the parking slot.

Fig-3: Navigation activity

Once the user has booked the slot the user goes to the parking slot and park his car. After the booking the customer has to make the online payment through Gpay or UPI.

3.2. IDENTIFICATION USING ALPR

Once the customer goes to the parking lot after the booking, the number car plate is being authenticated and s-canned using the camera through ALPR algorithm.
ALPR algorithm has four basic steps:

- Capturing image
- Obtaining license plate from image
- Character Segmentation
- Identifying the characters

We have created our algorithm on similar guidelines and divided into two phases – Obtaining the number plate and Character Identification from the number plate obtained [3]

3.2.1 OBTAINING THE NUMBER PLATE FROM IMAGE

The captured image is converted to NumPy array and then using a trained model the possible number plates are marked with boxes around them. We have used the Single Shot Detector Model with mobile net version 1 feature for faster results [4]. The high-level Meta architecture can is displayed in Fig1. Fig2 displays the Depth wise Separable convolutions with point wise layers [5]

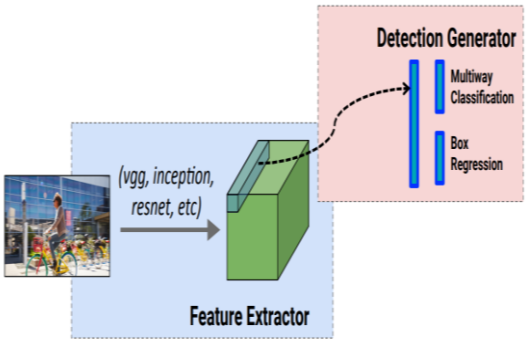


Fig-4

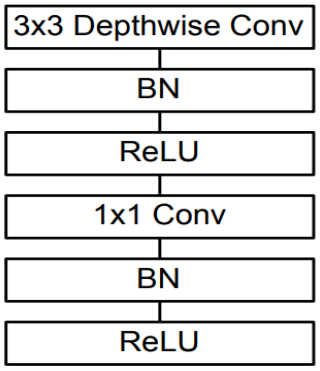


Fig-5

SSD uses a single feed-forward convolution network to predict classes. It does not require a second stage classification operation [6]. Mobile net uses conv 11 and conv 13, and 4 more convolution layers with decaying resolution and depth of 512, 256, 256, 128. ReLU6 is the nonlinear activation function and both batch norm parameters β and γ are trained. During training, the base learning rate was set to 0.004, followed by learning rate decay of 0.95. The model is trained on COCO dataset [7] [8] This particular model was used to make the learning and implementation faster in comparison to other models. The difference can be clearly seen in the graph fig (7) Thus mobile net takes the least CPU time as seen in the dark red circle. Based on the scores the possible number plates are collected and sent for character detection.

3.2.2 OBTAINING THE CHARACTER FROM NUMBER PLATE

Each possible number plate are preprocessed (grayscale and threshold). Its size is increased and again threshold value is applied to remove any gray areas and noise from the image. Then this processed image is used to detect the characters. Contours of image are identified and then compared with preset constant variables to identify the number of possible characters in the image. if we have two chars overlapping or too close to each other to possibly be separate chars, remove the inner (smaller) char, this is to prevent including the same character twice i.e. if two contours are found for the same character, for example for the letter 'O' both the inner ring and the outer ring may be found as contours, but we should only include the char once. The length of the possible characters is compared whether they are enough or not to qualify for being a number plate. All the remaining plates are thus eligible for recognizing the characters. These characters are then recognized using a CNN classifier Model built using Keras [9]. The overall architecture of the output can be seen in Fig. (6)

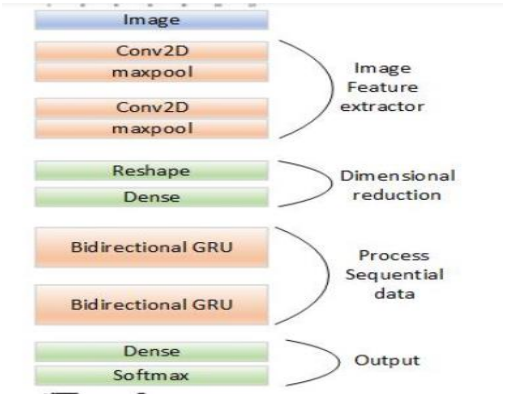


Fig-6

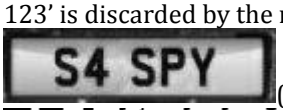
The network is trained with 5 epochs and 47605 steps per epoch. The accuracy of the model with different epochs can be seen below in fig (8) [10].

The character-digit sequence identified is thus displayed in the terminal and sent to the database for comparison. If the sequence matches with any of the user that has registered and booked a slot. The gate opens and the vehicle can be parked at the spot booked on the app.

Visual representation of the working of ALPR:

(original Image)

(Possible number plate (the 'rroh 123' is discarded by the model)



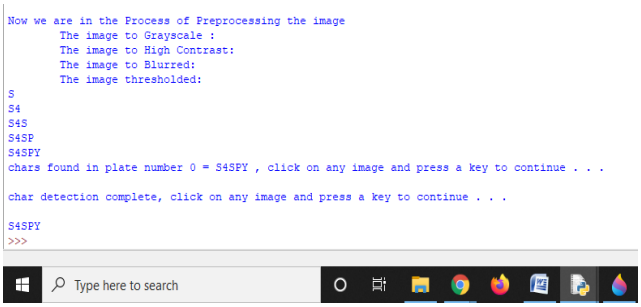
(preprocessing)

(preprocessing)

(possible characters)

(list of possible characters)

(identified characters)



(terminal: the characters identified by the system)

3.3 Payment System:

When the vehicle arrives on the booked slot, the infrared sensors placed in those slots will detect it. As soon as the vehicle is detected, the timer for the particular slot starts which is triggered by the sensor. When the vehicle leaves, the sensor detects it and triggers the timer to stop. The total time calculated is updated in the database, which also is used to calculate the fare for parking. This fare is sent to the user's app. The user is supposed to pay the required amount using various payment options available in the app. As soon as the payment is done by the user, the payment flag is updated in database. When the vehicle arrives to exit, the ALPR detects the plate number to verify if the payment is done.

4. RESULT AND ANALYSIS

The android app sends the credentials for verification and other data such as vehicle no. and booked slot is updated in the database. The identification model gave us an 87.32% accuracy at 5 epochs and 47605 steps. The character recognition model gave us an accuracy of 93% at same configuration with batch size 32. The mobile net version gave us a upper hand to increase the speed of model by compromising a little on accuracy. The algorithm eliminates the noise and identifies the number plate and sends it for recognition.

This is important as any other graphiti or written matter on the vehicle may give unsatisfactory results. The IR sensor triggers the timer on and off by which the payment can be calculated and paid by the user using App interface. The payment gateway is secure. Thus, the resultant system effectively manages the automation process.

The accuracy of the model with different epochs can be seen below in fig (7)[8].

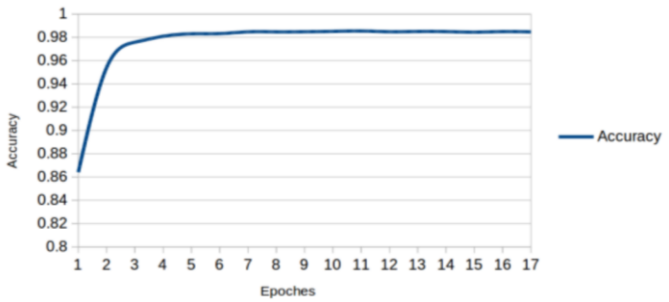


Fig-7

Mobile net takes the least CPU time as seen in the dark red circle in fig (8)

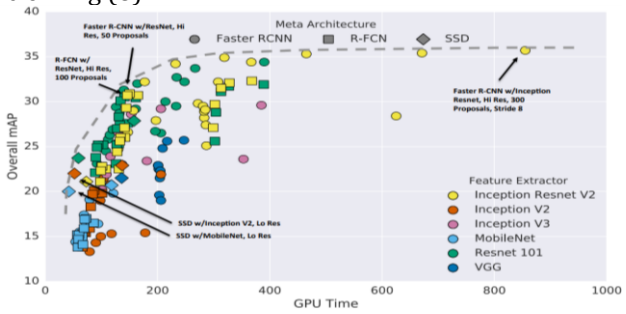


Fig-8

5. CONCLUSION

Thus, the proposed model introduces a character recognition system that can identify the different alphabets and numbers which helps in the automation of the whole parking system. ALPR plays the important role in authenticating the legitimate vehicle. The android application makes easy for the customers to book the parking easily and hassle free. Due to the android app the customer can know that which slots are empty and which are not. Here the payment system is implemented which uses pay per use model which helps user to makes payments for the parking without waiting in long queues.

6. FUTURE WORK

With the automation process ready. We do look into exciting percepts of partnership with cities, malls and private owners of all the parking spaces in the area and it can be displayed in a color scheme depending on the availability of slots in a map using the GPS i.e. real time location. The app can also have a parking meter, where the user can be aware of real time parking charges and take the decision appropriately. Integration of NLP and voice-controlled parking space finder can be integrated that does the booking part automatically at just one voice command of user. Physical parking lots can also be combined with vehicle cleaning services. Since the data is easily collected regular customers can be given credit points. Multiple vehicular parking option can prove very effective for customers.

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