Automated Car Parking System Using Optical Character Recognition

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Abstract— In today's world, the number of vehicles on the road is surging each and every day at a very high rate. The limited number of parking spaces compared to the rising number of vehicles, makes finding a suitable parking space a tedious as well a time consuming process, thereby leading to traffic congestion. Studies in this field has shown that cars spend an average of 15 minutes in search of a parking space, driving at an average of 10 mph and covering just half a mile in the meantime. By successfully implementing smart parking systems, these issues can be significantly reduced. Conventional methods involve the use of various sensors installed at each parking lot that makes it highly expensive as well complicated to install.

The proposed system is used to develop an efficient car parking system using image processing methods as a replacement of sensor-based technology. Automated car parking system allows users to pre-book the available parking slots at the convenience of their homes. The system consists of two major sections: parking slot detection and user notification. A user can book the slots through an android mobile application. The parking area consist of slots which are uniquely numbered. A camera installed at the location captures the real time images of the parking area. Optical Character Recognition (OCR) technique is used to detect the available slots in the parking area. These vacant slots are then allocated to the users based on priority basis via Short Message Service (SMS) with the help of a Global System for Mobile communication (GSM) module. Finally, the authentication of valid user is ensured by means of Radio Frequency Identification (RFID) technology.

Index Terms— GSM module, Image processing, Mobile application, Optical Character Recognition, Parking slot detection, RFID technology, SMS.

1 INTRODUCTION

In order to improve the operational efficiency for the public, Smart City uses information, connectivity and technology to help accelerate towards improving the quality of life for people. Internet of Things (IoT), Automation, and Machine Learning are the new technologies driving the implementation of smart cities. Any city can be considered a smart city initiative by introducing a system such as smart parking using a mobile app to help drivers locate parking slots, smart traffic management track and analyse traffic flows, sharing information electronically, monitoring changes to the environment enabled sanitation, etc.

The advancement of technology has led to a lot of changes in the world. But these changes haven't affected the parking system which is still the same and time consuming. It takes a lot of effort and time to find a vacant parking slot. It is known that the there is a huge problem of traffic especially in countries where population is high. If population is high, more people are there to park in a limited number of parking slots.

This phenomenon is referred to as "multiple-car-chasing-single-space" which may cause severe congestion. Therefore, people who end up last to the parking area unable to find a suitable slot to park their vehicle.

This proposal aims to implement a reservation based automated car parking system to address the rising problems faced due to traffic congestion. The identification of vacant spots is implemented based on image processing techniques thereby overcoming the disadvantages of conventional sensor-based methods. The reservation of slots through mobile application can help drivers locate parking slots with minimum effort and in less time. The user authentication is ensured by proper verification of details implemented by means of Radio Frequency Identification process.

2 RELATED WORK

Intelligent parking schemes have been significantly improved in urban environments and the associated technologies. Some types of car parking system are also required wherever traffic is relevant. Rapid population growth in the urban areas and increased traffic congestion have increased smart parking demand.

S.Sunmathi [1] uses Infrared sensors to locate a car in parking spaces. The red LED colour glows when the slots are filled by a car. When there is no car filling the slots, a green LED light shine. The information of parking space is posted automatically on a website with the aid of the Arduino and Wi-Fi module. When the user reaches the target at the car door the image is captured by the camera and the license plate number is taken with the help of the image processing and checked in a database with the recorded number plate. After testing, the parking space will be reserved, and the vehicle identifier will be displayed in the LCD and details will be posted on a website. When the vehicle leaves the parking fee for the gate is calculated by in-time and out-time calculations and the sum automatically charges from the account. It ensures that, before accessing the car parking system, the parking vacancies are identified on the Website that is accessible through the smartphone, tablet and laptop. A green LED for simple user identification indicates the empty slot and at the time of the departure, the user 's money is deducted automatically by measuring the time and length of the vehicle.

Zakria Qadir [2] uses Zig Bee technology which is much more efficient than Bluetooth and Wi-Fi. There are two main components of the wireless smart parking model; the first one is Arduino, whereas the second is a digital module. Kit interfaces Arduino to perform any task like other microsystems with multiple electrical components. It's relatively much simpler to program an Arduino board than the previous microcontroller because it receives and sends digitally data. It binds ZigBee, servo motor, IR sensors, LEDs and LCDs. GSM is incorporated into GPRS module because it can use high data rates of 172 Kbps and GSM is voice-centric so low data. GSM is also incorporated in GPRS mode.

Sanam Kazi [3] uses a Smart Parking App where user should install the mobile app on their mobile devices first. Constant Internet connection is necessary to access this system. When the application has been enabled, the user must open the smart parking app and will enter basic information, such as username, email address , mobile number, payment methods and vehicle details such as 2 wheelers and 4 Wheeler and Vehicle number plate data, when the user first visits the application. Such information will then be passed to the server by device, which will store and validate user data. Using GPS technology to map user position. The nearest parking areas are displayed to the user based on the user 's location. The parking area is selected, and the system displays the parking slots available and reserved, using a white and grey paint. To book this slot the user must click on the correct parking spot. The time during which the vehicle is parked is demanded by the user; the amount is paid according to the specified date. The intelligent parking system to minimize congestion of traffic is focused on the allocation of resources and the reservation of parking spaces for a fixed period. Upon successful completion of the booking timer, it is checked if the user exceeds the predefined time. If timer is longer than the predefined time, the user and the manager assigned for that area will be informed and charged the user for the exceeded time. If the user removes the slot before deadline the user is reimbursed for the remainder of the time. This enables the parking system to book the parking

Nazia Bibi [4] uses image processing where videos from 10 feet heighted camera were obtained from the top view of the car park. The system video data has been captured under various conditions and temporal shifts to increase the recognition capacity. Video is separated into frames. Then a key frame is extracted from each segment and further processing is applied to this key frame, in order to reduce computer complexity. When you enter the parking lot or exit the parking area with a radio operated toy car, motion of the vehicle is determined by the main frame subtraction. At first there were no parking lines in the parking arena. The parking area and vehicles intended for parking are entered manually by the driver. The device creates virtual parking lines automatically that take into account the vehicle size. In this training model, the maximum parking space capacity is 14. Each parking lot is issued with a specific numerical mark. The device will test the presence of the car in any block after the parking arena is divided into virtual blocks. On the image is applied a binary filter and a ROI region is used to remove car. Calculates the interest in ROI of the connected area and sets the threshold as reserved parking space to more than eighty. The number of blocks free of charge is shown in green for the divers and the blocks reserved in red.

Md Omar Hasan [5] uses ultrasonic sensors. When the parking space is empty, ultrasonic sensors change its value. Raspberry Pi 3 is linked to the sensors to get the data from a microcontroller computer. To collect data from the Raspberry Pi 3 using the CoAP protocol, Google Cloud IoT Core has been set up. Google Cloud stores and manages the value of empty

parking spaces. You will see empty Cloud spaces by the user of a smartphone application. The user can book this place through the user interface. The Cloud parking space will be allocated to the user if the user books and the free parking space status will be changed. The smartphone application keeps the data on each user's license plate information. Deep learning framework for Google, TensorFlow is used for user authentication. The picture of the car license plate is captured in a real time scenario prior to entering the parking area by the Raspberry Pi 3 camera. The numbers of the license plate are then detected using the Convolutional Neural Networks (CNN). The user verification is validated and can reach the parking area if the data matches the custom dataset.

3 METHODOLOGY

Automated car parking system enables drivers to pre book a parking slot in a parking area with the help of a mobile application. Identification of the available parking lot is done using Optical Character Recognition (OCR) based on image processing. Once the available parking slots in a parking area are acquired, the parking slot will be allotted to the requested driver through Short Message Service (SMS). For verification purpose, we use Radio Frequency Identification (RFID) tag to know that the parking slot has been occupied by the same driver who has booked that specific parking slot. Fig 1. shows the schematic diagram of the proposed model.

3.1 System Design

The camera will capture the image of the parking slots in the parking area. It will capture each and every slot clearly so that it can be passed on for further processing. From the camera the image will be passed on to Raspberry Pi, where all the further processes take place. This includes converting the image from RGB to greyscale. This is done because differentiating such images requires less information that is needed to be provided for each pixel. It also reduces the complexity of the image. Another process that is taking place is the removal of noise from the image. Image noise is an undesirable by-product of image capture that influences or obscures the desired information of the image. Removal of such noise from the image improves the quality of image, which will be helpful in further processing. Raspberry Pi also handles the process of extracting the information of empty parking slots from the processed image of the parking area. This data will be stored in the memory. The information is then passed onto GSM(Global System for Mobile communication), which is used to provide a communication with the user. GSM acts as an interface between Raspberry Pi and the user. Derived information from the Raspberry Pi will be passed onto the user through GSM. The requested user will be informed about his/her allotted parking slot number in the parking area through SMS (Short Message Service), with the help of GSM.

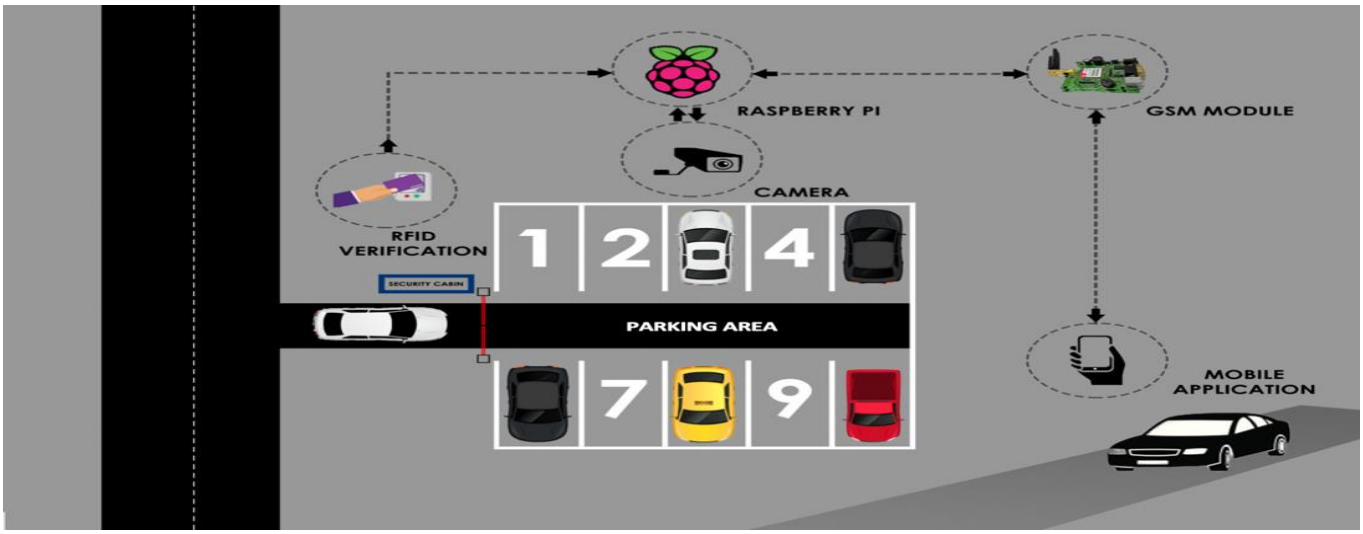

Figure 1: Schematic diagram of the model

3.2 System Initialisation

Each parking slot will be allotted a unique number, which is drawn manually one time, in the parking area. This is done to identify or find the location of each parking slot in every parking area. The image of the parking area will be retrieved, using a camera

which will be placed to capture the entire parking slot numbers. The only thing to be made sure is that the placed camera captures the slot numbers in the parking area accurately and clearly.

The slot numbers in the image will be hidden if a car is parked in that parking slot. Therefore, meaning that the specific parking slot is not available. So, the only thing that is needed to be done is to extract the slot numbers of the parking area which are visible in the image, which will be assigned as the available parking slots. This whole process is done using Optical Character Recognition (OCR) techniques in image processing [6]. A typical optical character recognition process is shown in Fig 2.

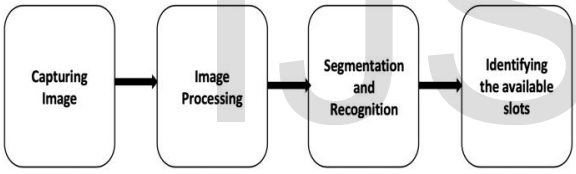

Figure 2: Optical Character Recognition Process

a. *Capturing Image*: Cameras are placed to capture the image of the parking area. The placement of the camera should be in such a way that it should capture each and every parking slot in the area with clarity so that the slot numbers are clearly visible in the image. After the capturing of image, the image will be stored so that it can be used for processing.

b. *Image Processing*: The image that has been captured will be processed, so that its quality can be increased. This involves the conversion of the image to greyscale from RGB. It also involves improving the contrast of the image. Processing of the image also involves removal of unwanted noises, that might be there in the image. After the processing, we will get a more enhanced and clearer image which can be used for further processing.

c. *Segmentation and Recognition*: This is one of the main techniques which is used for optical character recognition system in image processing. Here, it basically involves the process of identifying the available slots in the parking area. In the form of vector, the available slot numbers are stored.

d. *Identifying the available slots*: The slot number won't be visible if a car is parked in that particular slot. So, in the output vector, this specific slot will not be present, and it will be assigned as an occupied slot. The remaining will be considered as the empty or available slot, whose slot numbers are visible and are extracted from the captured image. The output vector comprises of the available parking slots.

3.3 Verification

Radio Frequency Identification (RFID) is used to verify whether the parking slot has been occupied by the same person who has booked that specific slot. Usually, there are systems which require the driver to wait in the queue to get a token, the token is used to know how much time the driver has parked his car in the parking area, so on return of the token, a bill will be generated which calculates the total amount of money to be paid.

RFID transfers data between a tagged object and a reader through RF waves. Here, the identification of objects is done through tags. There will be a unique tag id for each tag. These tag ids can be provided either by system programmer or by the manufacturers. Usually, these tags are of 2 types, active tags and passive tags. Even though passive tags are cheaper than active tags, but tags that are used widely are active tags. Passive tags are powered or charged through antenna, as they don't have batteries inside them. On the other hand, active tags are more expensive than passive tags because they have battery inside them. Also, passive tags have less memory space compared to active tags.[7]

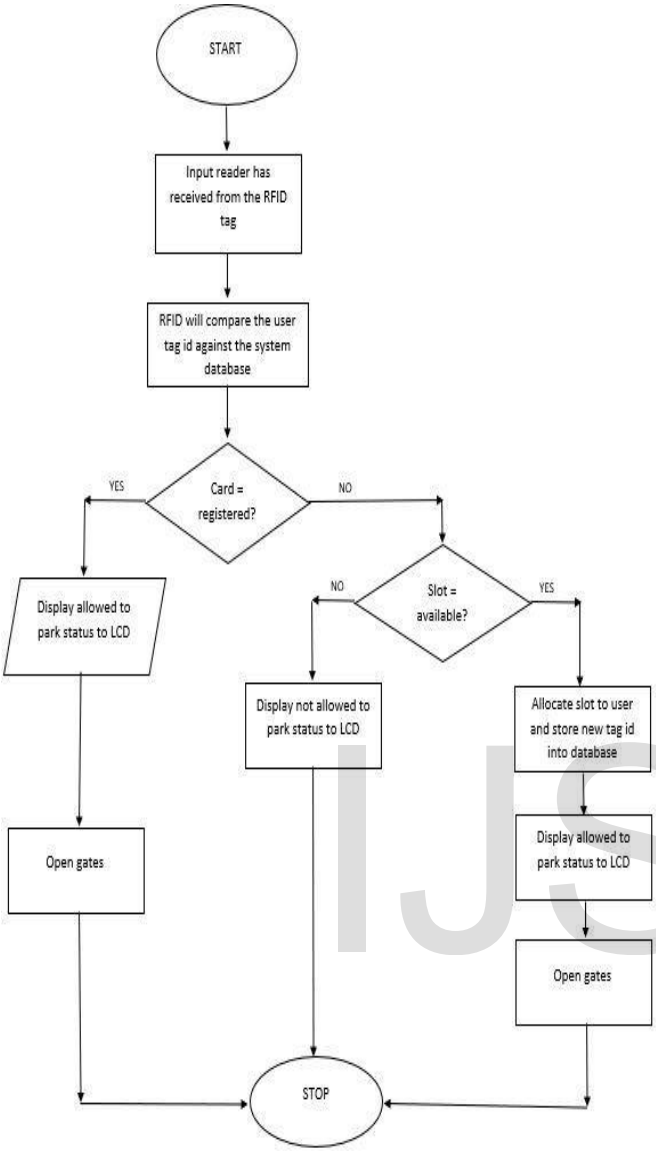

Figure 3: RFID Verification Process

All the information about the vehicle will be stored in the database if the vehicle has gone through one-time registration process and the vehicle will be allotted with respective tags. Initially, the RFID reader will read the vehicle tag when the vehicle checks in. Here, there will be a comparison between information of that particular tag in the database and information present in the RDIF tag. If the tag number of the user is already registered, the RFID reader will read all the information available for that specific tag, followed by transferring all information to the system. Hence, the user is allowed to park in the respective slot allocated to him. In case of an unregistered tag number, the model checks for any available slots in the parking area. If a slot is available, the user is allotted the respective slot followed by storing the users' RFID tag number in the database. If no slots are available, the system displays not allowed to park as output. Fig 3. depicts the detailed flowchart of the RFID verification process.

4 EXPERIMENTAL RESULTS

The Raspberry Pi 3 module is powered up using a microUSB power connector. The Raspberry Pi 3 module operates at 5 volts.

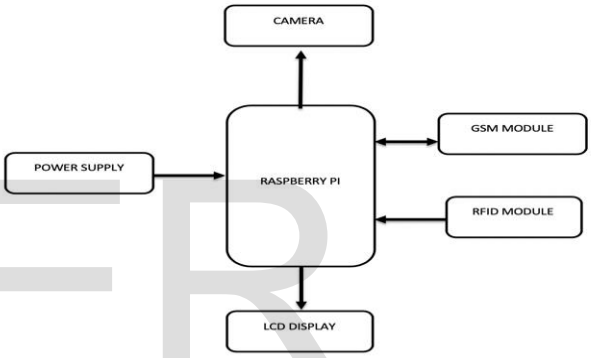

Figure 4: Raspberry Pi Connections

4.1 Data Acquisition

A camera placed at the parking lot captures the images of the parking area on receiving a booking request. The camera is placed at such an angle that all the numbers in the parking slots are clearly visible. The captured images are then stored for preprocessing.

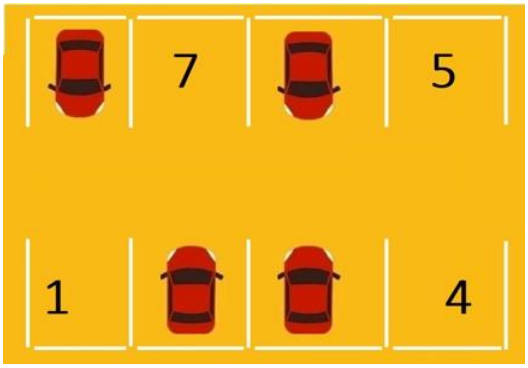

Figure 5: Parking lot image captured by camera

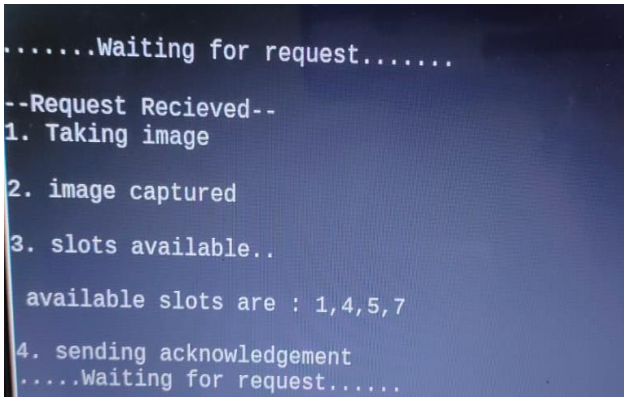

Figure 6: Raspberry Pi generated output

4.2 Pre-processing

Transformations that the data undergo or are applied to before it is given to the algorithm is referred to as pre-processing. Data pre-processing takes raw data as input and outputs a clean data set. Different types of pre-processing have been applied to the input images captured by the camera. The raw image is first processed to get a grey scale image. This image is then threshold in order to classify each pixel according to a given threshold value. For automatically deriving the threshold value, Otsu's Binarization have been applied. Other preprocessing techniques like smoothening, morphological transformation and canny edge detection have also been defined, which can be used to further improve the accuracy of prediction.

4.3 Segmentation and Recognition

OCR function is used to process the image, which as a result gives the characters present in the image. Python-tesseract is an optical character recognition tool for python. This function takes the threshold image and the configuration file for recognizing digits, as arguments thereby returning a string of characters in the image. These characters will be then converted into integer numbers. The extracted slots are then assigned to the user on priority basis (i.e. ascending order of numbers) which is passed on to the mobile application. Fig 6. shows the extracted available slots from the parking lot using OCR technique.

4.4 Training and Verification

The backend is an OpenCV Python code (Python 3.7) run on Raspberry Pi 3. The data used are custom designed parking slot images. The model has been trained with different images containing empty and occupied parking slots. The empty slots are then assigned to the user through an android app application.

The front-end application is deployed as an android application developed using MIT App Inventor software. The application accepts the unique RFID tag number of the user and provides a booking option for the user, which when clicked is used to send a booking request SMS to the GSM module. The application waits for the booking SMS confirmation and retrieves the allocated slot.

Global System for Mobile Communication (GSM) modem is used to connect the mobile application with the Raspberry Pi. A valid SIM card provided by a wireless carrier is inserted into the GSM modem and is connected to the Raspberry Pi using USB cable. AT (ATtention) commands are used to send booking SMS messages.

The verification is done using a Radio Frequency Identification (RFID) module. Once the user books a particular parking slot, the user will receive an SMS containing the allocated parking slot. When the user arrives the parking area, the RFID tag number will be checked against a database containing the allocated tag numbers. If a match is found, then the user is allowed to park in the allocated parking slot.

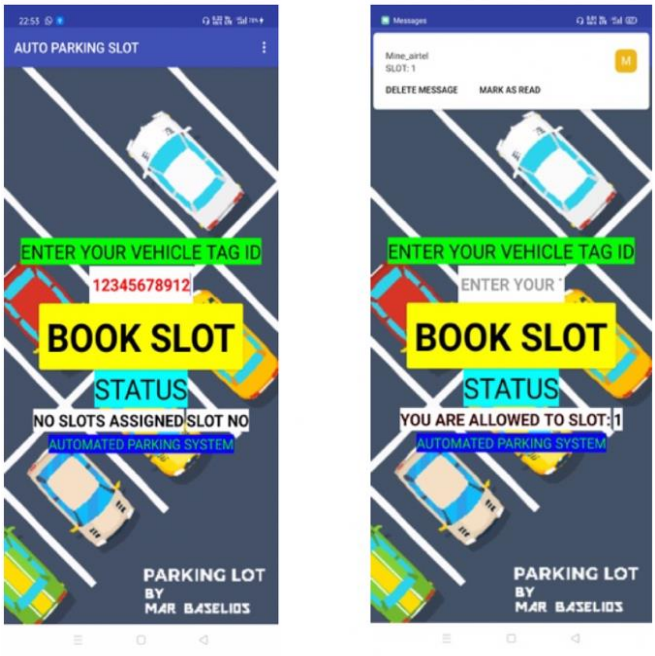

Figure 7: Booking request and user notification

5 CONCLUSION

This study would primarily help to refine the detection of the parking spaces available, so that congestion in the parking sector can be minimized. The proposed model achieved this goal with high accuracy and in minimum time. The image processing technique which focused on the identification of the empty parking slots, made the device both easy and less expensive. In future, the model can be further improved by providing a payment gateway by calculating the entry and exit time of each vehicle using the RFID verification data. This approach will become an important part of the future intelligent parking system.

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