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Smart Parking System usingIOT and Deep Learning

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Abstract: In this fast-growing economy, the number of vehicle users increases exponentially demanding more parking space. Pervasive presence of smart phone encourages users to prefer mobile application-basedsolutions. To overcome this problem, we introduce the concept of the Internet of Things (IOT) and Deep Learning. Deep learning is a subset of machine learning in Artificial Intelligence (AI) that has networks capable of learning unsupervised from data that is unstructured or unlabeled. Also known as Deep Neural Learning or Deep Neural Network. In recent time, we concentrate on Deep Learning to overcome parking related problems. It is a smart car parking system that will assist users to solve the issue of finding a parking space and to minimize the time spent during a search in a year around 17-18 hour is waste. The owner of the parking space can get the analytics of the number of free and available slots for a given period, the occupancy rate on week days and weekend and the amount collected for a given period and can use it for fixing variable parking fees. The mobile application is designed to provide rich customer experience.
Keywords: Arduino, Deep Learning Algorithm, Edge devices, IOT, Mobile Android Application, SmartParking, Sensors.

I. INTRODUCTION

The rapid industrial growth in the world is reflected in an increased number of cars on the roads globally. It is expected that the number of cars in the world will increase significantly from 841 million cars in 2008 to over 1.6 billion cars in 2035. Nowadays, the shortage of available car spaces is evident in many public places such as stadiums, market areas, hospitals, shopping malls and airports are looking to improve their existing transportation systems and infrastructures.

Especially for some large and old parking structures. Another major problem is the limited sensor data, e.g., empty or not, without rich information like license plate number, vehicle or motorcycle identification. To get rich information, some solutions are deploying camera as the sensor in every parking spot. To enable smart services like finding the vehicle location via the License plate number for continuous vehicle tracking and feature extraction via the camera network. Specifically, some of the cameras with zoom-lens and motorized head can capture license plate numbers by tracking the vehicles when they enter or leave the parking lot.

1. Our proposed solution using a network of cameras

The block diagram for the proposed system using camera networks is given below. The entire system consists of:

(i) A network of ground cameras which are placed close enough to the ground to capture license plate numbers of vehicles.

(ii) A network of top-view cameras whose view when combined will cover the entire area of the parking lot.

(iii) Edge devices i.e. Raspberry Pi or Arduino. Both the ground cameras and top-view cameras are interfaced to an RPI.The RPI interfaced with the ground camera runs OpenALPR to perform license plate number recognition. The RPI also extracts features of vehicles that enter the parking lot using OpenCV and time-stamps their entry and exit times.

(iv) A cloud server and database which will be used to hold information such as the occupancy status of all the slots, license plate numbers of vehicles that are parked in the lot along with entry and exit time-stamps for each vehicle.

(v) A web application which provides us necessary information about parking.

2. Our proposed solution using a network of LIDAR sensor

A traditional sensor-based parking solution will require a sensor to be deployed under each parking slot. But our proposed LIDAR based solution will be able to cover7-8parking slots with only one LIDAR. The LIDAR is interfaced to a Raspberry Pi and a slot is classified as either occupied or empty based on the distance

readings from the LIDAR. The LIDAR system will be combined with OpenALPR and a Raspberry Pi camera for detecting the license plate number of vehicles.

3. Model Design for Parking Lot Occupancy Detection

Many existing vision-based vehicle and parking spot detection services use modern machine learning techniques, such as deep learning. The leading deep learning frameworks (e.g., TensorFlow) are expected to run on top of high-end servers in data centres.

4. License plate number recognition and vehicle tracking

OpenALPR is used for Optical Character Recognition. It uses the Tesseract OCR library. For the application at hand, OpenALPR bindings have been used along with python to recognize the characters in an image. The vehicles have to be tracked until they reach and settle in a spot in order to identify the slot number each vehicle has occupied.

Smart Parking's Automatic Number Plate Recognition (ANPR) parking system is a reliable, accurate and cost-effective off-street car park management solution, already proven to serve a wide range of industry groups including supermarkets, retail parks, hotels, hospitals, and leisure centres.

Currently managing more than 1200 car parks throughout the UK, our technology solutions such as ANPR linked to Pay & Display, ensure greater compliance and increased parking revenue.

Principal Features:

- CCTV style cameras are placed at the entrance and exit to a car park.
- Timed photographs are taken of the vehicle itself entering and leaving the car park, and also close-ups of the vehicle's number plate.
- The duration of the stay of the vehicle is calculated from the times registered on the two sets of photographs and communicates this to Smart Rep.
- Pay & Display machines accept payment and acknowledge the time of purchase and therefore the sufficient paid for the time allowed and communicate this to Smart Parking's parking management tool "SmartRep".
- If a vehicle has exceeded the duration of the paid time allowed plus an agreed 'Grace Period', then the driver of the vehicle will be required to pay an excess parking charge

II. LITERATURE SURVEY

In this section, we will look at several similar systems that are been researched and implemented by other researchers. For further understanding on their methods and techniques, refer to the reference page at the end of the report to search for text and even websites published.

1. Smart Parking Applications Using RFID Technology.

There has been a considerable amount of reduction in transaction costs and decrease in stock shortage with the use of Radio Frequency Identification (RFID) technology in automation. Most of the RFID networks include a wide range of automation technologies. These technologies are RFID readers, RFID writers, RFID barcode scanners, RFID smart sensors and RFID controllers. The software has been handled for the management, controlling, transaction reporting and operation tasks for parking lots located on various parts of the city. Check-ins and check-outs of the parking-lots will be under control with RFID readers, labels and barriers. Personnel costs will be reduced considerably using this technology. Vehicles are identified and parking-lot fees are collected automatically via this system. RFID system enables vehicles to check-in and check-out under fast, secure and convenient conditions. Most of the gate controlling systems includes barriers. The timing of the gates and additional sensors enables a one by one parking-lot circulation thus preventing multi check-ins or check-outs at a time.

2. RFID Based Smart Car Parking System Using IoT.

As the use of number of motor vehicles in transport systems went up, the issue regarding parking is one of the major concerns in terms of space occupation. In United States rising traffic issue is an irresistible one, so that they have planned to reduce traffic to automate parking system bydelivering prior information to the user using a web page [2]. With RFID vehicle tracking system there is high identification accuracy, parking areas or gated communities can manage their vehicles efficiently without human intervention as well as easy in-and-out access for drivers and with low deployment and operation cost. In this we design a Smart Parking System (SPS) which enables the user to find the nearest parking area and gives availability of parking slots in that respective parking area. Thus, it reduces the fuel consumption which in turn reduces carbon footprints in an atmosphere.

3. Smart Car Parking System Solution for the Internet of Things in Smart Cities.

The rapid industrial growth in the world is reflected in increased number of cars on the roads globally. It is expected that the number of cars in the world will increase significantly from 841 million cars in 2008 to over 1.6 billion cars in 2035 [3]. Nowadays, the shortage of available car spaces is evident in many public places such as stadiums, market areas, hospitals, shopping malls and airports, hence, governments are looking to improve their existing transportation systems and infrastructures. First, the data is collected from different distributed sensors in indoor parking's and on-street parking. Second, the collected data from the sensors will be analysed and processed locally with the help of IoT devices. It is proposed that a real time processing for the smart parking data is extracted from the sensors. The data will be evaluated by using machine learning algorithms, which in turn processes according to predefined conditions.

4. Wireless based Smart Parking System using Zigbee.

This system uses a Bluetooth communication technique which is used for verifying the driver's identity and also to book a slot by identifying the vacant spaces. Zigbee sensors are used to detect the vehicle. As most people migrate from small town to big town, from village to the cities, most people want to increase their quality of life by getting more wealth and health at the same time. However, one of the important aspects that always haunted people to visit shopping complex during peak hour is to find out an empty parking space. While some shopping complexes implementing counting number LED board at the entrance of the parking lot, it does not do much help as the visitors still cannot find out where the location of empty parking space and end up searching for their own. Sometimes, the technology to install counting number LED board is too costly while they need to install and maintain wired connection of each parking sensors at the ceiling of parking lot [4].

5. Smart Parking Service based on Wireless Sensor Networks.

This system experienced the use of video cameras where they are deployed in the parking slots and are able to capture the license plate of the car and also monitor the parking spaces. We have designed and implemented a prototype system of smart parking services that allows vehicle drivers to effectively find the vacant parking spaces, both in outdoors and indoors environments [5]. The proposed smart parking system consists of wireless sensor networks, embedded web-server, central web-server and mobile phone application as Android and iPhone. In this system, low-cost wireless sensors network modules are deployed into each parking slot equipped with one sensor node. The state of the parking slot is detected by sensor node and is reported periodically to the embedded web-server via the deployed wireless sensor network. And this information is sent to central web-server using Wi-Fi networks in real-time, and the vehicle driver can also find vacant parking lots using a mobile phone or a tablet.

6. Android Based Smart Car Parking System

During peak hours most of the reserved parking area gets full and ultimately the user has to search for his/her parking among other parking area creating more traffic and leaves them with no indication on the availability of parking space [6]. To overcome this problem there is a need of a designed parking in commercial environment. The aim of this paper is to propose a design of a smart car parking system commanded by an android application that reserves the parking slot in the parking area and displays the availability of parking slot in the parking area on the LCD display.

III. DEEP LEARNING

Deep learning is a collection of algorithms used in machine learning, used to model high-level abstractions in data through the use of model architectures, which are composed of multiple nonlinear transformations. It is part of a broad family of methods used for machine learning that is based on learning representations of data.

Deep learning is a specific approach used for building and training neural networks, which are considered highly promising decision-making nodes. An algorithm is considered to be deep if the input data is passed through a series of nonlinearities or nonlinear transformations before it becomes output. In contrast, most modern machine learning algorithms are considered "shallow" because the input can only go only a few levels of subroutine calls.

Deep learning removes the manual identification of features in data and, instead, relies on whatever training process it has in order to discover the useful patterns in the input examples. This makes training the neural network easier and faster, and it can yield a better result that advances the field of artificial intelligence.

When Smart parking applied to IOT environments, Deep Learning can improve parking occupancy predictions thus contributing to more efficient parking guidance, proper parking space utilization, and better traffic management.

IV. PROPOSED SYSTEM

In our proposed solution we have performed object detection as well as to object classification and hence two different types of datasets are required. They are discussed in the section below.

PHASE 1 – Dataset used for object classification:

An open source dataset is available for parking lots and it is given inandcalled PKLot consisting of 12,417 images of parking lots and 695,899 images of parking spaces segmented and perspective transformed. consists of a dataset which is an extension to and it is called CNRPark. CNRPark adds about 12,000 images to the PKLot which were taken in different weather conditions, which have not been perspective transformed and some are occluded. Out of the created dataset, 75% of images were used for training the network model whereas 25% of the images were used for validation.

PHASE 2- Dataset to detecting the object and tracking

It consisted of raw images, without any annotations. So, the first step is to label the objects in the images and prepare the dataset.We utilize the annotation tool developed by Nvidia.the labels were converted into formats compatible with the models that have been selected. The YOLO model requires the images to be in Darknet format. Finally, after converting the images into Darknet format, 59,482 training images and 19,272 validation images of size 1920 x 1080 pixels.

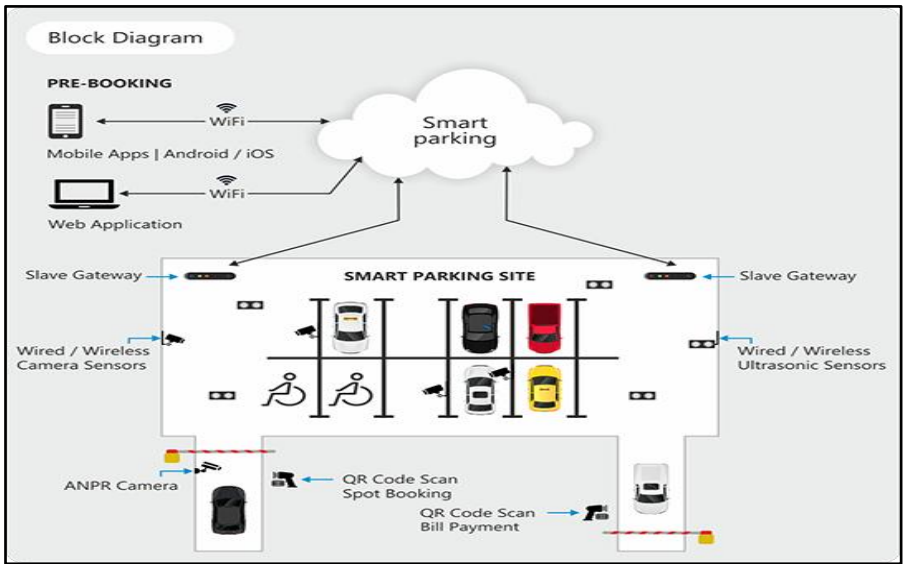

Fig 1. Block Diagram for Smart Parking

PHASE 3- Efficient Neural Network Model Design for Parking Lot Occupancy Detection

Many existing vision-based vehicle and parking spot detection services use modern machine learning techniques, such as deep learning. Alexie has 5 convolution layers, 7 ReLu layers, 3 max-pooling layers, 3 fully connected layers and though it is very accurate, it is slow for real-time computation. Alexie was originally created for the ImageNet dataset which consisted of 22,000 categories. The network model created for this application hasa 1inputlayer,1convolutionlayer,1ReLu,1maxpooling, and 3 fully connected layers. It can be calculated using the equation:

$Wout(i)=1+((Win(i)-R +2P) / S$

Where,

R - Receptive field or Kernel, P - Padding, S - Stride.

The convolutional layer is followed by the ReLu layer with sigmoid activation function:

$F'(x)= d /dx \ln (1 + ex) = 1 /1+ex$

The reduction of size leads to loss of information. Our designed model has been trained using a custom dataset as well as the carpark and PKLot datasets in DIGITS

PHASE 4- YOLO model based on darknet framework

Every input image to the model is split into grids and each cell in a grid predicts some bounding boxes and gives a confidence value which indicates how sure the model is that the box contains an object. For knowing the class, each cell predicts a class probability using the pre-trained weights.

The complete process of booking a parking slot and after entering in parking area is explained with the help of the following flow chart.

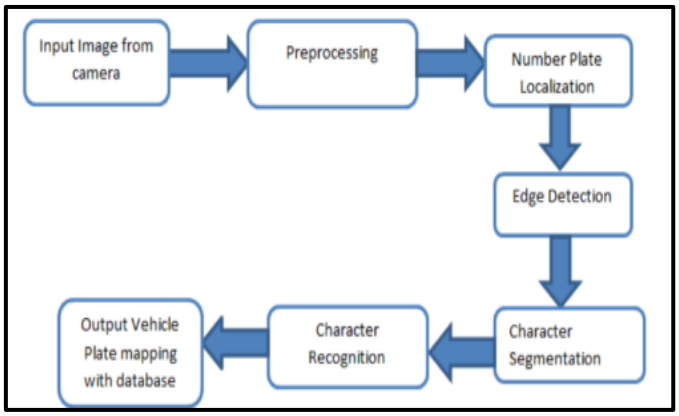

Fig 2. Steps involved in Parking Area

Below are the steps that a driver needs to follow in order to park its car using our parking system.

- Step 1: Install the smart parking application on your mobile device.
- Step 2: With the help of the mobile app search for a parking area on and around your destination.
- Step 3: Select a particular parking area.
- Step 4: Browse through the various parking slots available in that parking area.
- Step 5: Select a particular parking slot.
- Step 6: Select the amount of time (in hours) for which you would like to park your car.
- Step 7: Pay the parking charges either with your wallet or your credit card.
- Step 8: Once you have successfully parked your car in the selected parking slot, confirm your occupancy using the mobile application.

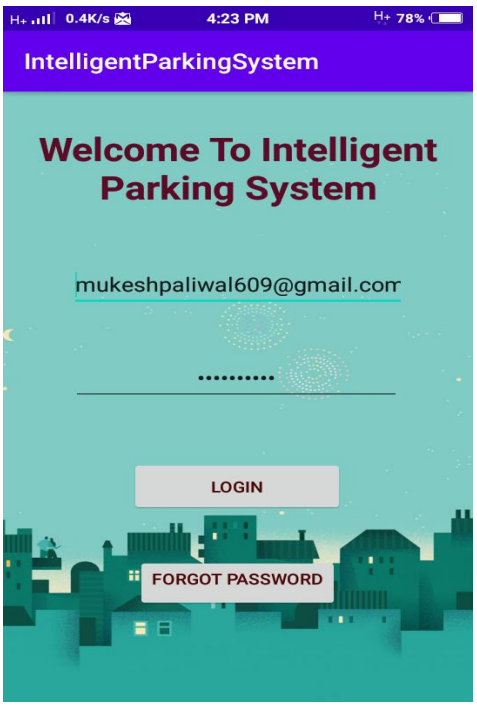

Fig 3. Sign in Page

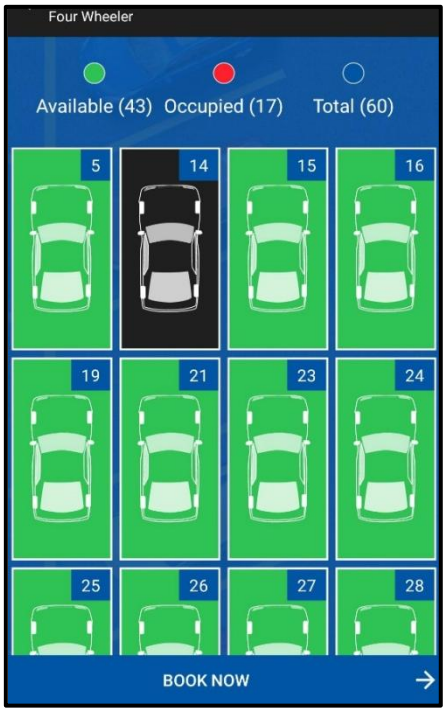

Fig 4. Slot Booking Area

In the admin website he can create many users as he wants based on the user's permission. The permission is setup on the group section. The super admin can create the group with limited functionality. In this application, there are alot of dependencies that you will have to understand. For instance, to create the parking information, you will need to have the parking category, rates, and slot information on the system.

Requirements

- PHP Version +7.0.0
- Web Server (Recommended: Apache with PHP and MySQL)

Features

- Manage User
- Manage Category
- Manage Rates
- Manage Slot
- Manage Parking
- Reports
- Manage Company information
- View Profile information
- Manage Setting

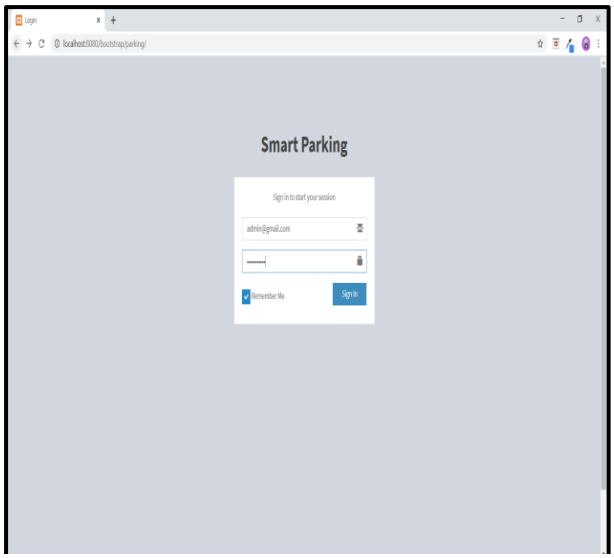

Fig 5. Login Page of Website

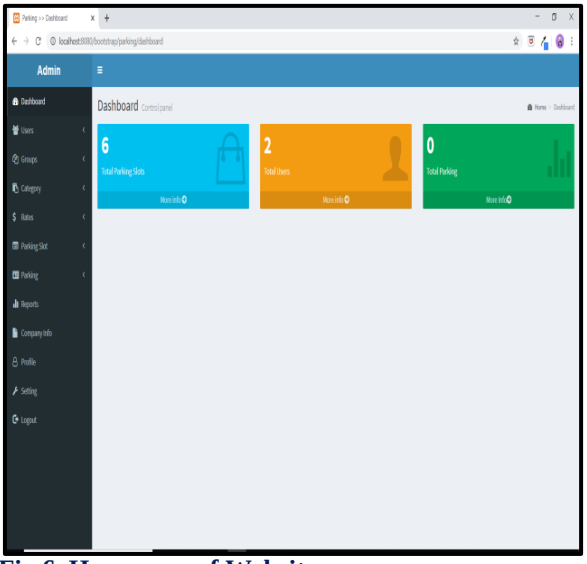

Fig 6. Homepage of Website

V. CONCLUSION

The conclusion is that the system is proposed for detection of parking spaces using image processing and deep learning methods. Smart parking system is an answer to the current traffic congestion to reduce drivers disturbance and saving fuel costs by giving data about the vacancy status of the parking places. It can also provide sustainable parking management in an eco-friendly manner. It provides security to the parking. We proposed a well-rounded solution for solving parking problems. Our solution overcomes the disadvantages of the existing parking system.

VI. FUTURE SCOPE

Our future work includes increasing the speed and accuracy of the object detection model. The future scope to adopt this automatic Smart Parking System (SPS) so that availability of spaces could be displayed on a smartphone Application and system could also be connected to GPS systems to allow clients to search for empty in different parking areas remotely while driving thus saving them time. The model can be expanded and used in the real time systems where the users can have the "Smart Parking" in their handheld devices.

VII. ACKNOWLEDGMENT

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