A Synopsis on

IOT and ML based Cross Platform Application for Designing Smart Parking

Submitted in partial fulfillment of the requirements
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in

Information Technology

by

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CERTIFICATE

This is to certify that the project Synopsis entitled ***"IoT and ML based Cross Platform Application for Designing Smart Parking "*** Submitted by ***"Snehal Shanbhag, Akansha Rawat, Pranjali Shimpi"*** for the partial fulfillment of the requirement for award of a degree ***Bachelor of Engineering*** in ***Information Technology*** to the University of Mumbai,is a bonafide work carried out during academic year 2022-2023

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Abstract

The term parking management system usually refers to the custom built hardware intensive systems installed in buildings and malls. We intend to build a cross platform smart parking system which aims to mitigate the parking problems by reducing time for drivers to look for vacancy positions in car parking lots and providing efficient parking space utilization. Several reports have shown that the smart parking system not only alleviates traffic problems but also drives business growth and economic development within that neighborhood. However, there are many places where such expensive solutions cannot be installed due to various reasons, like cost and setup requirements. This project focuses on developing a parking management system based on image processing to detect vacant parking slots in our college premises where automated systems are not installed. Camera images of the parking area are subjected to an image processing algorithm which marks virtual slots in the area and extracts occupancy information to guide the incoming drivers about availability and position of vacant spaces. A smart parking system which consists of a camera connected to a mobile application using cloud computing utilizes a reduced complexity Machine Learning model to detect vacancy positions. We train and cross-validate our model using the Open-source Google dataset and YOLO v5 algorithm. IoT will be used to display reserved spaces, the data fetched from the dashboard. Project will be deployed using Cloud Computing.

Introduction

With the continuous development of economy, personal vehicles have become an important part of our daily lives. The commodity provides comfortable way of life ans has become affordable to most working class which had led to exponential increase in number of vehicles in past few years causing multiple problems. The organizations such as schools, Universities and MNCs witness heavy inflow and outflow of vehicles throughout the day. Vehicles' drivers find it difficult to get real time information about an available parking slot and managing the parking of the vehicle as size of parking slot is getting reduced and vehicle size is increasing (Community Data. Gov.in, 2019).

The smart parking occupancy detection system is a technology which aims to mitigate the traffic congestion problems by reducing time for drivers to look for vacancy positions in car parking lots and providing efficient parking space utilization[1]. A number of smart parking solutions employ multiple low-cost cameras to detect vacant parking spots in the area. To detect available parking spots from visual information captured by cameras, several papers proposed using machine learning techniques such as support vector machine (SVM), Bayesian and convolutional neural network (CNN) but so far few have presented acceptable prediction accuracy over a range of visual information[1].

There are various techniques for object detection, they can be split up into two categories, first is the algorithms based on Classifications. CNN and RNN come under this category. In this, we have to select the interested regions from the image and have to classify them using the Convolutional Neural Network. This method is very slow because we have to run a prediction for every selected region. The second category is the algorithms based on Regressions. The YOLO method comes under this category. In this, we won't select the interested regions from the image. Instead, we predict the classes and bounding boxes of the whole image at a single run of the algorithm and detect multiple objects using a single neural network. The YOLO basically divides an image into a grid system and every grid detects objects within that particular grid. Thus, they are used for real time real world object detection based on the data provided[2]. The YOLO algorithm is fast as compared to other classification algorithms. In real time our algorithm processes 45 frames per second. YOLO algorithm makes localization errors but predicts less false positives in the background.

These algorithms are not tested with degraded images, i.e. they are trained with academic data sets, including ImageNet, COCO and VOC, etc. but they are not well tested with randomly captured data sets. The main issues of images captured in the real scene are :

- Due to the instability of the camera, the captured images may be blurred.
- The images can also not be clear enough because the object can be obstructed.
- The images may have poor quality as a result of bad weather, overexposure or low resolution.

Objectives

We intend to achieve following Objectives during project implementaion:

- To identify and locate one or more vacant parking slots for vehicles detected through camera after entering a certain parameter using geolocation through google map Api.
- To have a maximum number of vehicles which can be parked in an organized manner into the temporary parking lot.
- To enable drivers to locate any available parking spots and reserve a particular spot through the App GUI.
- To train and test data using Yolov5 algorithm for maintaining high accuracy.
- To display the count of vacant and reserved parking on App dashboard as well as LCD dashboard using MQTT protocol.
- To monitor parking availability based on high precision and detection of parking space using machine learning and image processing.

Literature Review

This section aims to understand IoT and ML cross-platform application for designing Smart Parking. The following papers helped us in deciding the algorithms and flow of our project.

1. A Multi-storey Garage Smart Parking System based on Image Processing

In this paper[1], the authors Chyn Ira C. Crisostomo, Royce Val C. Malalis, Romel S. Saysay, and Renann G. Baldovino state that Car drivers and motorcycle riders spend a large amount of time finding an available parking space where slots are spread throughout multiple storeys which causes traffic congestion and long queues. The proposed system design described in the paper uses Python IDLE and the OpenCV library. OpenCV makes use of the combined edge detection and coordinates bound pixel sections in determining whether a parking space in the acquired footage is occupied or not. For the testing, of the accuracy and reliability of the parking space identification system, sample videos of actual indoor parking garages were used. With this study, real-time image processing and updating of the parking slot availability offers an increased efficiency to the parking system and lower cost than installing individual car sensors in each parking space.

2. An Elaborative Study of Smart Parking Systems

In this paper[2], the authors Adesh Pawar, Ajay Pawar, Ashish Pawar, Ganesh Pawar, and Prof. Anagha Chaudhari state that People nowadays face the issue of finding empty or vacant slots for vehicle parking. For this, they spend nearly 6-8 minutes. The authors think that this is the reason which causes the major traffic in the big cities. For that, there are many facilities and techniques available in the market to reduce the tension of finding a vacant parking lot. Deep learning is one concept of data or image-processing that helps in this area. In Deep Learning various algorithms are used such as CNN, RCNN, MASKRCNN, YOLO, etc. The paper gives an elaborative comparison of available research on smart parking systems and talks about various algorithms with their results, pros, and cons. In this paper, they have deployed two algorithms on two datasets and measured their performance in terms of Precision score, Recall score, and F1 score. The authors concluded the paper by stating, the use of IoT with deep learning algorithms and giving a touch of wireless networking to the core system i.e. object detection and image processing will be more efficient in terms of result but somewhat not in terms of its overall cost. But using IoT, sensor selection will be a major task if one wants to build the system with a low budget. still, problems like deem light, occlusion, and bad climate need to be addressed.

3. A Camera-based Smart Parking System Employing Low-complexity Deep Learning for Outdoor Environments

In this paper[3], the authors Chantri Polprasert, Chaiyaboon Sruayiam, Prathan Pisawongprakan, and Sirapob Teravetchakarn state that the smart parking occupancy detection system is a technology that aims to mitigate traffic congestion problems by reducing time for drivers

to look for vacancy positions in car parking lots and providing efficient parking space utilization. Several reports show that the smart parking system not only alleviates traffic problems but also drives business growth and economic development within that neighborhood. In this paper, they have proposed a computer vision-based smart parking lot occupancy detection system employing low-complexity deep neural network architecture. A smart camera system that consists of a Raspberry Pi 3 attached to a camera utilizes a reduced-complexity deep neural network model to detect vacancy positions. They have trained and cross-validated their model using PKLot- Val dataset and tested the performance of their model using PKLot- Test and SWUpark datasets. SWUpark dataset has been created in the context of this research, accumulating visual information of parking lots at Srinakharinwirot University across several weather conditions. Through exhaustive hyperparameter tuning and stochastic gradient descent optimization, their model has achieved 88 percent accuracy, almost 15 percent higher than those obtained from the state-of-the-art approach.

4. Automatic Parking System Based on Improved Neural Network Algorithm and Intelligent Image Analysis

In this paper[4], the authors, Yucheng Guo and Hongtao Shi state that Parking management services need to achieve a variety of functions, such as parking information query, map route navigation, display, and guidance of spare parking spaces, intelligent payment, and car locating system, involving multidisciplinary technology, including edge computing, image processing technology, smartphone application development technology, and deep learning algorithm. While discussing algorithms they came to know that CNN's model can accurately identify parking spaces, but the real-time performance is poor. Hence their paper "Automatic Parking System Based on Improved Neural Network Algorithm and Intelligent Image Analysis" improves the convolutional neural network recognition model and establishes a one-time deep learning framework integrating the YOLO algorithm to improve the real-time performance of CNN model. In order to verify the superiority of the designed CNNs system, the simulation experiment is designed. The experimental comparison between CNNs and ZigBee and artificial parking was carried out.

5. Smart Vehicle Parking Management System using Image Processing

In this paper[5], the authors, Maria Waqas, Umar Iftikhar, Muhammad Safwan, Zain Ul Abidin, and Ahmed Saud state that sophisticated systems detect the exact location of the empty spaces and guide the incoming drivers accordingly. Some advanced vehicles have their own parking systems installed but still hard for the system itself to confirm whether a vacant parking area truly exists or not. Despite all these systems, there are still places where parking facilities need to be set up on temporary or urgent bases; their application provides a cost-effective, image proceeding-based solution for such scenarios. It just needs to install cameras on the location to take images at regular intervals. Images are then processed to mark virtual parking slots of appropriate sizes, which are then used to keep track of the vacant spaces and can guide the incoming drivers accordingly through a mobile app. The Final Version of their Project is a mobile Application that aims to address the parking difficulty issues at some

mega-events where vehicles have to be parked in temporary parking areas. The vision-based parking management system features to have maximum parking within the Region of Interest and facilitates the user with the best. The user has a real-time parking lot update in order to see if there are any vacant spaces available to park the car or not. Since most people are in a hurry and park the car in the wrong way. In order to track it out, they have designed an admin application as well, where the admin can check into the system for any wrong parking, the total number of vacant spaces, the number of correctly parked cars, and other details.

6. Image Processing Based Intelligent Parking System

In this paper[6], the authors Kaarthik.K, Sridevi.A, and Vivek.C state that Abstract— India is one of the Countries with High dense population. Due to this high population Transportation and Parking of Vehicles is the major issue faced by the people. This Paper aims to provide an Intelligent Parking System through Image Processing. The Image Processing Technique is used to identify the free empty Parking area to park the vehicles. In the proposed process the parking area can be marked with a certain specific number and a sensor and with the help of this sensor the empty space can be identified to park the vehicle. The Image processing Display consists of the seven segments of display in real-time. In addition to the display, they have implemented an Audio system in order to provide Oral information about the parking system. The seven-segment display can be used to identify the empty parking area with specific numbers. The specific numbers can be displayed in order to park the vehicle in a vacant position without any struggle. The proposed process is implemented in a software platform with the help of an Image processing technique and Hardware implementation can be done by interfacing with the Arduino Uno.

Problem Definition

There are many challenges present in today's transportation structures and drivers on a daily basis regarding special parking structures for which intelligent town engineers and architects need to be prepared. Numerous recent studies have caused the belief that new clever parking structures are wished in nearly every metropolitan city within the global specially with-inside the subsequent ten years to relieve many problems, which includes petrol consumption and pollutants emission, and to enhance time-saving and decrease frustration whilst seeking out a parking space. Therefore, for any proposed machine to be taken into consideration with regards to the parking process, it should have as a minimum, the subsequent elements, and specifications.

- Be capable of displaying the automobile occupancy in actual-time.
- Provide guidance for users about available parking.
- Enable intelligent decisions to be made using data, including real–time status applications, and historical analytic reports.
- Be capable of offering the person with all of the essential facts approximately the fame of any adjustments with-inside the parking area that could take place in actual time.

These challenges must be addressed from the very beginning to ensure that the system will work efficiently. Many studies related to traditional smart parking systems in the last decade have indicated that they satisfy neither the driver's requirements nor the parking facility's budget. In order to reduce hustle at peak time i.e. time-saving, reduce frustrations, enable accurately sensing vehicle occupancy in real-time, simplify the parking experience, and add value for parking stakeholders.

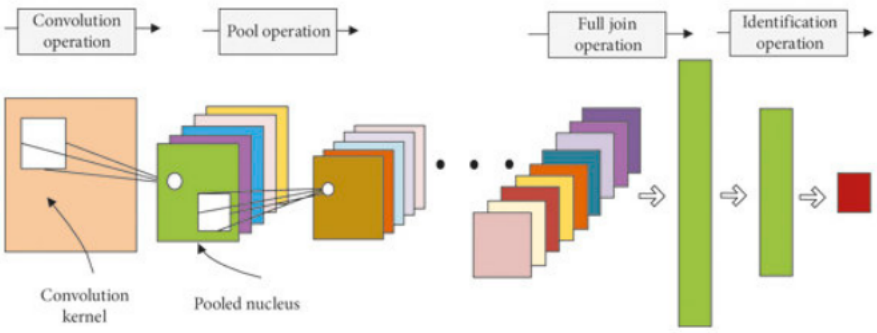

Figure 1: Feature extraction and recognition of convolution neural network.

Proposed System Architecture

This project, a parking management system using machine learning to create a better environment for a vision based vacancy parking place detection; offers a modern and revolutionary answer for transient parking places. For example, dirt ground, and cemented floors where no precise parking structures are used. The main objective is to have the maximum number of vehicles that may be parked in an organized manner in the vacant lot.

This system intends to locate and apprehend the real-time vacant parking area. The system contains a digital camera installed on the rooftop of our college basement or a few assisting poles at a positive angle where it covers most places of the vehicle parking zone which is being used for taking the input. The images received from the camera are then fed to the processing module, which detects the area of interest which includes the place to be included for parking areas. A vehicle detection Module is used to locate the vehicles inside the basement using YoloV5. This module tracks and detects the parking area in an image. The parking area detection module generates the bounding boxes for parking so one can be seen by a person on a vehicle parking app.

Two interfaces will be developed, the user interface and the admin interface. Whenever the user opens the app, he will see the virtual representation of the parking lot and the number of vacant areas in the vehicle parking zone and reserve a parking spot when the driver is in a particular radius from the college area. To offer ease to the person; an assist display screen will be provided which will inform the person how to check the status of the parking lot.

The Admin interface will have extensive data where the admin can see and update the total number of parking slots, the total number of vehicles, vacant area, and occupied area.Furthermore, the users who do not use our application and directly enter the college basement looking for a vacant spot to park their vehicle will have a LCD dashboard displayed at the entrance stating the number of vacant spots available. If no vacant spots are available then the dashboard will display zero or full parking as no spots are available.

Python Programming language version 3.9.13 is used to train the models and do the processing. Android Studio is used to expand the mobile programs for users and admin. Cloud will be used for deploying our system and Message Queuing Telemetry Transport connection protocol will be used for creating the connection between IoT devices and the dashboard.

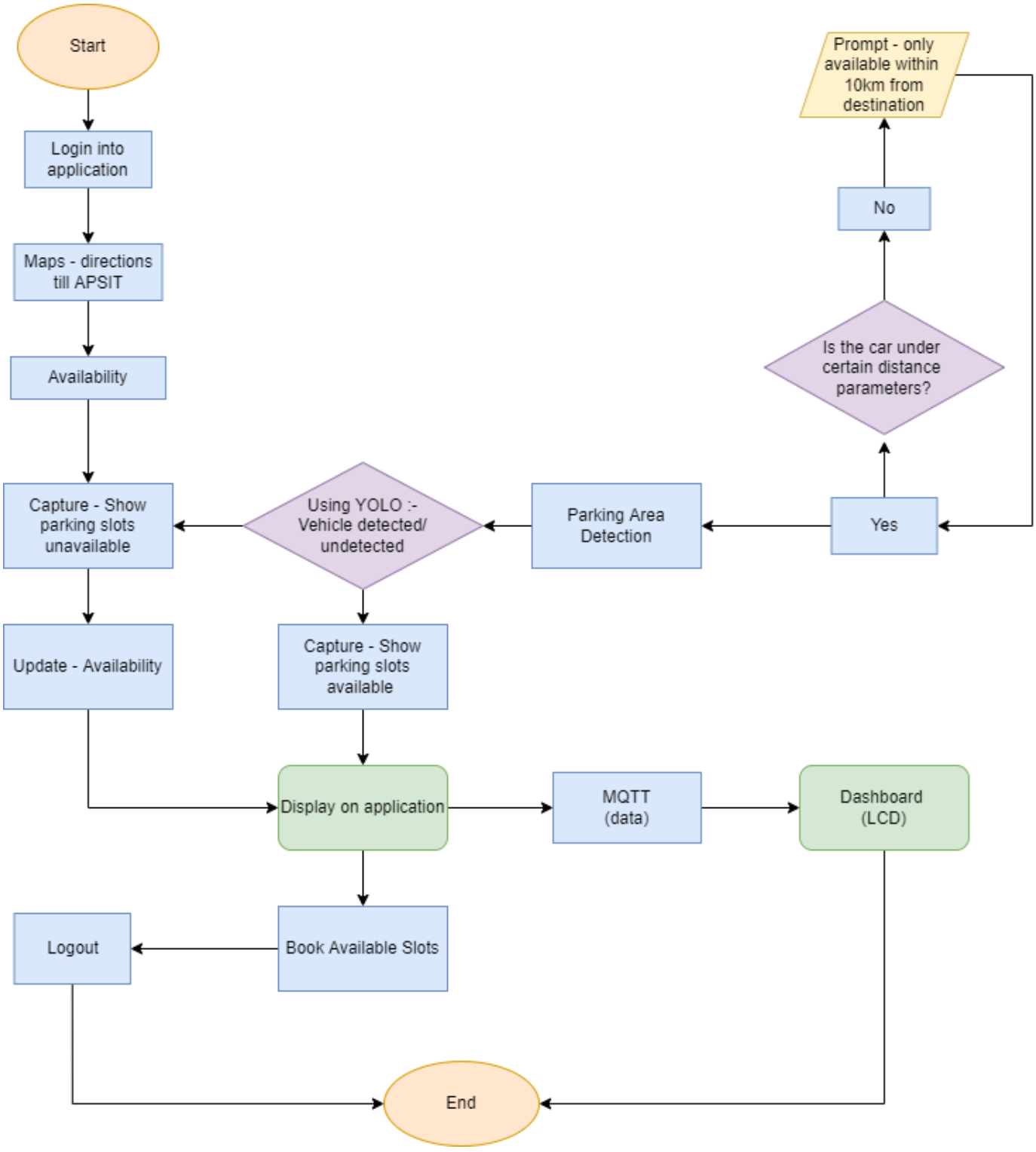

Figure 2: Work flow of Smart Parking Application Design.

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