

Smart Parking: an Application of Internet of Things

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ABSTRACT: Locating a parking space in central city areas, especially during the peak hours, is cumbersome for drivers. The issue arises from not having the knowledge of where the available spaces may be at the time, even if known, many vehicles may seek very limited parking spaces to cause severe traffic congestion. In this project the design and implementation with a prototype of Smart Parking System that permits drivers to effectively locate and withhold the vacant parking spaces in mentioned. This system use cluster based algorithm which helps in periodically learning the parking status from the sensor networks deployed in parking spaces, the reservation service is influenced by the change of parking status. The drivers are allowed to access this said cyber-physical system with their personal communication devices. The system implemented is cost efficient smart parking system for multi-level parking facility using Wireless Sensor Network (Infrared Sensor) and develop an android/iOS based application, by cluster based allocation method. The system monitors the availability of idle parking slots and guides the vehicle to the nearest free slot. Cost is minimized by keeping the number of sensors low without sacrificing the reliability. Energy consumption of each mote is kept in check by allowing the systems to sleep periodically and by reducing their communication range. This system's reservation-based parking policy has the potential to smoothen the operations of parking systems, as well as mitigate traffic congestion caused by searching for parking.

I. INTRODUCTION

In today parking lots there are no standard system to check for parking spaces. The system heavily relies on human interaction with the physical space and entity. This leads to wastage of human manpower and also parking spaces at times. These parking lots are dependent on Human-to-Human Interaction (HHI) which is not efficient. Previously, various techniques have been proposed to overcome such problems like Short Messaging Services, Zigbee, RFID, etc.

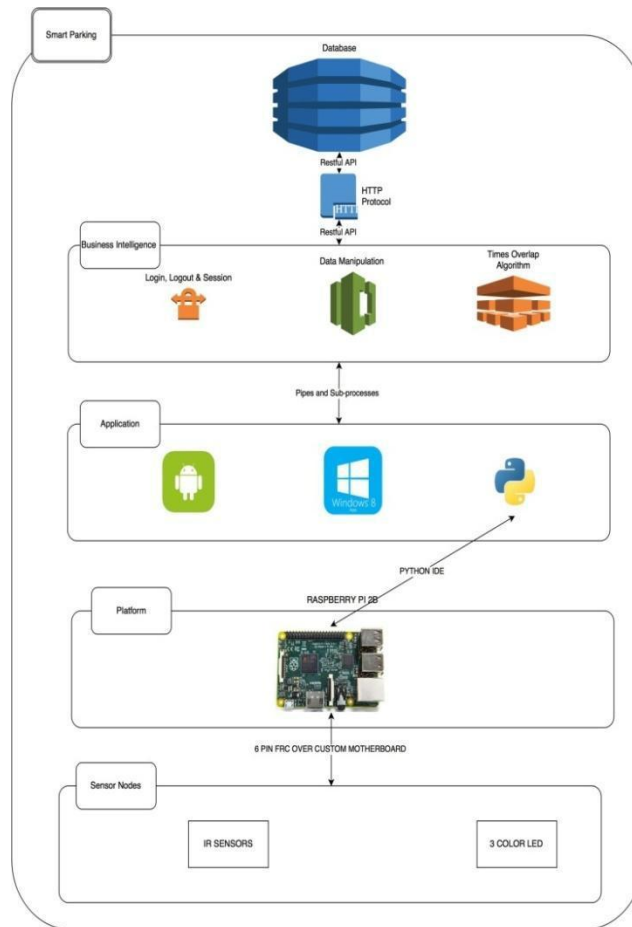
Most of the time when users go to malls and commercial complex, they experience that there is a limited space for parking spots especially on prime hours. Hence, there is a desperate need of a robust parking system that will enable us to reserve the parking spots. For that it is necessary to build a centralized system to gather all the information on parking spots of malls, commercial complexes, and multilevel car parking systems. According to the International Organization of Motor Vehicle Manufacturers (OICA), the number of cars produced in 2014 alone stands at 60 million. With the explosive growth in automobiles, on-street parking will soon disappear, given the constraints on road space. Hence there is a desperate need of multilevel car parking and which should be smart also.

In urban areas, one-third of cars which have reached their destination and are circling around looking for a parking space thus leading to problems like pollution and traffic congestion. In a recent survey, researchers have found that in one year, car cruising for parking created the equivalent of 38 times trips around the world, burning 1.7 lakh litre of fuel and producing 730 tons of CO₂. So, it is essential to control the air pollution using a robust parking system that will be used for the reservation of parking spot as well as parking spot allocation in on spot resource allocation scenario. Reservation can be made using multiplatform tools such as Android application, iOS application, Windows applications or even Web Portal allowing user to have a hassle free parking experience. Recommender system will help user find the right parking lot closest to his location.

With the help of recommender system predictability of nearest available slot becomes easier. User location data is accessed in the mobile platform to suggest best location for parking. The Google Map API uses user's geo-location and location of parking spot to determine the above.

Paper is organized as follows. Section II describes automatic text detection using morphological operations, connected component analysis and set of selection or rejection criteria. The flow diagram represents the step of the algorithm. After detection of text, how text region is filled using an Inpainting technique that is given in Section III. Section IV presents experimental results showing results of images tested. Finally, Section V presents conclusion.

II. SYSTEM ARCHITECTURE



2.1 Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

2.2 IR Sensors

An infrared sensor is an electronic device which is used to sense light wavelength of its surroundings by either emitting or detecting infrared spectrum. It is also capable of measuring the heat being emitted by an object and detecting motion. LED will glow with respect to the IR sensor detection. Every IR sensor has a transmitter and a receiver. For every transmitter and receiver, there are total two registers and one more register is present to maintain voltage of LED that will show the status of parking slot to customers. When the IR does not detect any object in front of it, it returns the value TRUE, meaning HIGH volt output from the sensor and FALSE for when a object is detected meaning LOW volt output.

2.3 LED

A tricolor LED has a cut section at either of its sides. These LED have 4 pins. The longest one is common cathode and the rest are represented as RGB.

2.4 Parse

Parse is an open source web server framework that allows the implementation of the back end server. It is suitable for implementation of a prototype for various projects. Parse works as a mediator between the Raspberry Pi and other Platform applications. Parse handles the NoSQL database behind the system. It also facilitates the use of push notifications through its services.



2.5 Admin Dashboard

Admin gets different kinds of data from various sources in JSON formats on its dashboard. Admin dashboard shows the activity logs, reserved parking slots, free parking spaces. It is also responsible for the parking spot allocation to different users. Algorithm will allocate the nearest free parking space to various customers who don't reserve their parking spaces.

III. METHODOLOGY

3.1 Parking Space Detection:

The system works on real time parking information based on which it makes reservation and on spot resource allocation of parking spaces for drivers. Several sensing technologies available to monitor real time parking status like ambient light sensor, Ultra sonic sound, etc. System works on IR led Sensors providing Energy efficiency with less power consumption.

IR led keeps transmitting infrared rays up to some range when some object is detected in the infrared range the IR waves hit the object and come back at some angle the photo diode next to IR led detects that infrared rays reflected from the object.

Thus the object or the car standing in front of the IR sensors gets detected, providing us the status or availability of a particular parking space.

3.2 V2I and I2V Communication

For the need of utilization of resources a reliable and effective two way communication is essential between the vehicle and the allocation center (infrastructure).

In this system V2I communication involves drivers sending their parking request providing driver information, status confirming reservation and utilization of resources to the system. In I2V communication the system reserves the space for user and the application shows the driving directions to the reserved parking space with the help of a directed map, the map contains the images of the path allocated to the driver by the system.

Both I2V and V2I communication are implemented through an Android application & other Windows or Web application.

3.3 Reservation Guarantee

In case of an efficient parking system the resources allocated to a particular user must not be designated to any other user. To successfully imply this idea, QR Code Generation technology is applied.

The system does QR code verification at the entrance of the parking lot with the help of a web camera which is placed on the system. User with its application reserves a parking space, QR code gets generated on the reservation which provides unique "object id" for every user on every transaction. This generated QR code should be presented in front of the camera. The System scans and detects the unique object ID and then verifies the ID from the database.

3.4 Optimal Allocation

The most powerful feature of the system is that it determines the nearest or closest parking space for the user with the help of globally optimized list.

The Admin dashboard fires the query on the database through the application in such a way that it returns only the unreserved resources which are globally optimized. On the acquired list linear search is performed and it gives the closest parking slot from the list which also the first element of the optimized list[O(1)]. This helps in optimal allocation of the resources through the system.

3.5 Backend

For the efficient working and communication of the server, application and database backend devices use server side languages to build an application and data storage tools to find change or save data and serve it back to the user.

The system uses NoSQL database management system which contains unstructured data. NoSQL also provides storing of images and videos. It also is scalable, instead of using tables NoSQL stores data in the form of objects and key/value pairs tuples.

JSON (Java Script Object Notation) it is a light weight format used for data interchanging. It is used as a web service response. Instead of using XML as a primary data format for the transfer of data JSON is more preferred format due to its light weight property.

RESTful API (Representational State Transfer Application Programming Interface) is used to ease development and simplify client adoption it does not follow a prescribed standard except for HTTP. System uses four important methods viz POST, GET, PUT, DELETE.

- POST: POST is utilized to “create” new resources especially used to create subordinate resources means POST to the parent. On creation, return HTTP status 201.
- GET: GET method is used to “read” or “retrieve” resource. It returns representation in JSON and HTTP response code 200 and in case of error it returns 404.
- PUT: PUT is utilized for “update” the resources it can also be used to create resource when the resource id is chosen by client instead of server.
- DELETE: It is used for “deleting” the resource. On deletion it returns HTTP status 200 with response body. It can also return HTTP status 204 with no response body.

3.6 Sensors

Sensors are the devices which sense from the physical world and stimuli on the environment. The system uses IR sensors to detect the vehicle above it.

Sensors respond to system to the availability of the vehicle above the IR sensors. If the vehicle is present above the IR sensor, it will return value FALSE and the voltage goes LOW, If the vehicle is not present above the IR sensor, it will return value TRUE and the voltage remains HIGH.

The parking space is reserved but the vehicle is yet to arrive, the LED glows RED. In another case vehicle is at the entrance of parking lot then LED glows BLUE, to notify the driver the parking slot allocated to him. When a vehicle has already occupied a parking slot the led will glow GREEN. The GREEN LED is used as a positive indicator to showcase proper functioning of IR Sensors.

3.7 Data Analysis

- Nearest resource allocation:**

Admin fires the query to get the globally optimized list. The list contains only the unreserved free parking spaces available in the parking lot. The list is natively optimized so, the first element in the list is the nearest of all.

- QR scanner:**

Every time when user reserves a parking slot for him, a QR code is generated along with the payment receipt with the help of unique object id. While entering in the parking lot, user first has to scan his unique QR code. For that user has to place his QR code i.e. smart phone in front of the webcam. The webcam will scan the QR code and object id along with the name of reserved parking slot will get displayed. Admin dashboard updates the logs and the event gets generated by glowing the LED light BLUE. User already has a directed map showing the exact location of parking space. Only after a successful authentication via QR code, user is allowed to enter into the parking area.

- System Logs:**

System log is produced on the admin dashboard showing all the activities which are done in the past. It includes username, vehicle number, object id for every transaction, slot number allocated to user, time of arrival and departure, date of reservation etc.

3.8 Platform

An Android application is created using Android studio. The android applications are developed using the JAVA code. Using the JAVA compiler the source files are converted to JAVA class files. The .dex file and the resources of an android application are packed into an .apk (Android Package) file. The resulting .apk file contains all data to run the Android application and can be deployed to an Android device using adb tool.

The Windows Application is made using Visual Studio 2012. Visual Studio allows us to create windows forms and windows runnable applications. This application has its minimum requirements according to the safety standards of .Net Framework. This platform generates a setup file for the “Smart Parking” and allows us to run the .exe for creation of account to reserving parking.

Using the slot allocation method these application are developed for the “Smart parking”. Slot reservation can be done using the slot allocation method. The request is updated in the server and forwards it to parking area. Platform allows



user to enter arrival and departure time of the parking. Both platform application ensures that reservation of parking spaces is allowed maximum two days before the actual reservation date. The reserved spot will be available again only after three hours of departure time of previous reserved vehicle, maintaining a buffer for consecutive reservation of same parking spot.

IV. PROTOTYPE IMPLEMENTATION

The proposed system has been partially implemented and tested in lab prototype. Client devices have been connected via TCP/IP protocol to a parking database. The latter is updated in real-time with the status of parking lots. Two kinds of client applications have been considered for parking lots monitoring: mobile device application, for phones and tablets, and desktop application for laptops and desktop computers.

4.1 Hardware Prototype

Hardware prototype contains 5 IR sensors as of now that will represent the 5 parking spaces. These IR sensors are connected through wires to Arduino Nano which will also act as a server. Internet is provided to Arduino Nano via W-LAN connection to send the real time data to admin dashboard.

4.2 Android Application Prototype

Android application contains only one parking area. That parking area contains only 4 parking slots viz. S1, S2, S3, and S4 which are present on the hardware. 3 leds to depict whether the particular slot is “Available”, “Unavailable/Reserved”, “User selected”.

V. CONCLUSION

Smart parking is fully automated parking management system which uses a website, servo motor, ATMEGA 2560 Reed sensor, USB cable for transferring the data from PC to ATMEGA 2560. The main objective of the project to remove the existing parking system.

Smart parking helps in booking the parking slot in advance i.e. before 10 to 15 days with the help of calendar provided in the website. As the smart parking is fully automated system (Opening and closing of the barrier without any manpower) so it reduces the manpower. Existing system do not have the two-step verification but with the help of two step verification the authorized people (i.e. who have booked the Parking space) can only enter the parking hence increases the security.

If the parking space is free but the user has not booked the parking place then by simply entering the 10-digit mobile no the user can enter the parking space hence this led to efficient utilization of the resources' i.e. of parking space.

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