

A SURVEY ON SMART CITY APPLICATION: AN IOT BASED CAR PARKING SYSTEM

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Abstract: The paper proposes a survey conducted on the various Methodologies used for implementing a smart car parking system. Facilitating mobility which is sustainable is one of the most important goals of the smart city aspect where the development of a parking system which is intelligent represents a key aspect. Parking space monitoring and allocation is the solution to the parking problem faced in cities. Through this survey we have analyzed few fine features and scant flaws in the existing systems. These failing factors affecting the overall performance of the system can be overcome by further research and development.

IndexTerms - Survey, Smart Car Parking, Monitoring of Parking, Smart City.

I.INTRODUCTION

More than half of the world population lives in the urban areas so the cities have reached its full occupancy. As a result number of vehicles in the cities has also increased. In a recent survey conducted there has been an increase of 7.64% of usage of cars per year. Hence, continuous problem of traffic congestion exists. It is found that 22% of traffic is due to cars. This increase in the usage of cars has resulted in a serious parking problem. A survey of drivers found that 81% say, it often takes them 20 minutes or more to find a parking slot, with 45% describing parking as their biggest monitoring headache. A lot of time is wasted in searching for parking slot and while searching, unintentionally it effects environment by the emission of harmful and dreadful gases. Hence, monitoring of parking is an important solution.

A major factor through which the solution for this problem can be achieved is by implementing a system which can obtain information regarding the available parking space in a particular geographic area and process the data in real time to facilitate easy vehicle parking at available positions.

Section II discusses the various technologies, advantages and disadvantages of the existing parking systems. Section III gives an overview of the author's proposed model. Section IV concludes over-all survey conducted.

II.RELATED WORKS

A. CLOUD-BASED INTELLIGENT CAR PARKING SERVICE FOR SMART CITIES

Zhanlin Ji .et.al, [1] proposes a generalized concept for car parking in smart cities using cloud-based platform. It mainly focuses on the key purpose to search, allocate, withhold, and provide the best parking space for cars. The system is based on an automatic threshold algorithm to detect the free car parking slot. This system has presentation tier, a web tier and a persistence tier that follows the top-down approach. The paper explains the implementation and the design of a smart parking system for cars within a university campus. The car parking is constructed with three layers: application, communication, and sensor layer. Here each car parking lot is provided with a sensor, which senses the presence of the car. The information about the presence of the car is collected in close proximity by a parking meter by a set of sensors. When a user is nearing to the university campus, an automatic requisition through the user's smartphone is sent to OSGI car parking web server requesting for a vacant slot for the car parking. The server locates the best place for the car to be parked and will also guide the user to the place through maps. This system is best suited for a large university campus and also, it helps the user to efficiently find the parking lot within the campus. But, the service cannot be provided if there is no smartphone and the system cannot be implemented for parking cars on roads in the city

B. SMART PARKING: PARKING OCCUPANCY MONITORING AND VISUALIZATION SYSTEM FOR SMART CITIES

Robin Grodi .et.al, [4] presents a smart parking system using WSN (Wireless Sensor Network). It provides an optimal solution to reduce searching time and economical cost associated with, time searching for empty parking space, traffic jams and cost associated with wastage of fuel. In this paper, it divides the whole parking system into two fundamental parts: detection of empty parking space and notification to the user. The paper discusses a variety of sensors that can be used to detect the empty

parking space like the Induction Proximity Sensor, Active Ultrasonic Sensor, RFID Sensor, LIDAR Sensor, and Camera Detection. The sensors used need to be connected to the notification system of the user which can be done in multiple ways. The user can get the notification by directly wiring the sensor to the notification system or by connecting all the sensors to a central coordinator, this central coordinator is capable of displaying the information or by allowing the central coordinator to place the information on the web. The system makes use of an Arduino Uno that controls the ultrasonic sensor, MySQL database, XBee devices, and Node.js Webserver. The proposed model is economical and it efficiently monitors the available slots and still is able to give real-time information about parking spot to commuters. This system can also provide service even without the use of mobile application. The disadvantage of the system is that it cannot be implemented for streets parking and is confined only to large university campuses.

C. AUTOMATIC PARKING SPACE DETECTION SYSTEM

Nazia Bibi et.al, [12] presents a system that will detect the total number of parking spaces available and passes the information to the drivers enabling easy parking for cars. The system makes use of a web camera to get the images of the parking area and image processing techniques are made use of to check the presence or absence of a car. Status of the parking lot is updated whenever a car enters or leaves the space.

The framework involves videos which are acquired from the top view of parking lot. This video is segmented into frames from which a key frame is selected from each segment. The motion of the car either entering or leaving the parking arena is estimated by this keyframe subtraction. These captured RGB images are converted to grayscale and then calibrated giving separate coordinates for both parking area and cars. The parking lot is divided into equal-sized blocks based on these coordinates. Each grayscale block is converted to binary and then inverse binary to get the car in white color and parking area in black color. The threshold value is calculated in each block to detect whether that particular block has a car or not. If the value is less than the threshold the block is free and if greater the block is occupied. This system is more efficient when compared to ROI detection technique and edge based detection technique. But, the accuracy of captured images vary due to weather conditions.

D. IOT BASED SMART PARKING SYSTEM

One important issue that relates to the smart city is parking facilities and traffic management. Abhirup Khanna et.al, [3] demonstrate an IoT based cloud integrated smart parking system. Monitoring of parking space, signaling the availability of parking lot and booking accordingly is achieved using an on-site deployment of an IoT module.

The system makes use of a mobile application that is connected to the cloud which acts as an intermediary between things and applications to hide the difficulties necessary for smooth running of an application. Mobile application connected with cloud helps the user to know the vacancy of lots on real-time basis. Storage capacity, computation power, communication resources, scalability, interoperability, and availability are the factors that led to the combination of cloud and IoT.

Three types of sensors like infrared, passive infrared and ultrasonic sensors are used in this parking system. It helps in determining the slot is vacant or not. The system made use of raspberry pi processor unit which acts as an intermediate between cloud and sensors. Wifi module acts an intermediary in sending the data to the controller collected from various sensors. The controller uses a protocol over a single channel to transmit the data to the server. The mobile application developed in ApacheCordova (runs in both Android and IOS) and angular js framework helps in providing the information and allows the end user to book a slot. Data transfer between the server and mobile application is performed using JSON format. The server, hosted on the cloud serves as a database to save all the documents associated to the parking area and end users that have approach to the system. In case of any failure in the system, Continuous backup of data is made in the cloud for easy and quick recovery. But, the non-availability of on spot registration if the user doesn't have mobile application is a disadvantage.

E. AN APPROACH TO IOT BASED CAR PARKING AND RESERVATION SYSTEM ON CLOUD

Vibhav Hans .et.al, [2] emphasize on the idea of using IOT and technology based on cloud for car parking services in the city. Data storage in cloud foundry is one of the main ideas the paper discusses. It also talks about applying the Hadoop framework in analysis of Big Data. The system implements objectives such as allocating the nearest parking slot at the entry point, payment through a payment wallet which skips waiting period in queues and locating vehicle through mobile app.

The vehicle entry is detected using a Passive Infrared sensor. With the aid of Digital Image Processing, the camera captures an image of the car's number plate and identifies the user id of the person who owns the car. A Parking ticket with the details of the pre-reserved slot will be displayed on the owner's mobile application. An LED is allotted on each slot which turns red indicating, the slot has been booked. Once, the vehicle is parked inside the slot the proximity sensor is triggered. As a result of this, the timer for calculating the bill amount ticks off. As the vehicle leaves the parking slot, timer for calculating the parking period will stop. The total bill amount is subtracted from the linked payment wallet. The PIR sensor captures the image of the number plate as the vehicle approaches the barricade and verifies whether the payment has been processed or not. Upon verification the barricade gates open and user can drive away. An additional express entry and exit for important users and a special reservation system for physically handicapped visitors and senior citizens is unique to this system. No provision for on-spot registration is provided and the payment can be made only through payment wallet

F. IOT BASED SENSOR ENABLED SMART CAR PARKING FOR ADVANCED DRIVER ASSISTANCE SYSTEM

Mahendra B M .et.al, [11] presents one of the applications of combination of IOT and cloud computing technology. The objective of this work is to design analyze and implement “IOT based sensor enabled car parking system. “ which allows user to pre reserve parking slot from remote place with the help of mobile application. The system is implemented using low-cost IR sensors, Raspberry-Pi model 3b for real time data collection where the E-parking mobile application is developed using android studio having baseband version of android 4.3.

User authentication an important aspect in the system is accomplished using unique ID which in this case is the Adhaar Card number. Ultrasonic sensors are used for detecting the availability of parking slot where each sensor is attached with a Wi-Fi chip. The waiting time is predicted based on the variable parameters such as time, day, weather, temperature etc. Algorithm used for prediction is Regression tree, Support vector regression and neural network. Four parking states are defined, they are, reserved parking space, load-unload parking space, in-use parking space and available parking space. Amazon web server is used to host PHP files in order to maintain database. A dc gear motor is used for opening and closing of parking area main gate. By accessing the mobile application the user can book his parking slot by entering user ID, Slot number along with date and time, then this information is updated to cloud. When the driver reaches the parking area, the driver and the vehicle are authenticated by using unique booking ID, generated at the time of booking. During checkout temporary charge is displayed in his application, though actual parking charge is calculated by taking input from sensor. Once the car vacates parking slot the user will be charged for the calculated amount of time and status of slot is updated as free in server database. The information regarding status of parking slot is achieved through IR sensors which can work in critical conditions such as dirt and dust. When the driver selects checkout button, a temporary charge is displayed in his application to give an idea to the user as to what the cost might be, though actual parking charge is calculated by taking input from sensor which proves to be advantageous. Geomagnetic sensors are used for detecting the presence of car which is a disadvantage as they are prone to magnetic interference. The mobile application used is user friendly.

G. ADVANCED CAR PARKING SYSTEM USING ARDUINO

Hemant Chaudhary et.al, [10] explain the architecture and design of Arduino based car parking system. The implementation of the proposed is in areas which are specifically meant for parking. This system will provide the automatic management of parking lots with ease. Also, its implementation will ensure security of the vehicle, reduces corruption due to reduced man power and makes the whole parking system automated, which will be error free along with reduced time consumption for the parking process. The working model of this system comprises of an RF Reader, RFID Tags to be issued to authorize the users, Relay Board which acts as gate and a motor to open and close the gate, LCD Display and IR Sensors to sense the presence of vehicles in a particular slot. This system helps reduce congestion on road, time of users, human power and pollution and also provides security for vehicles. The drawback of this system is the use of IR Sensors which is of low cost. This gets the sensor heated and it may not work properly. The integration of all the available parking areas in a particular region and its unification using a mobile application can be implemented to make the working simpler.

H. A SMART PARKING SYSTEM TO MINIMIZE SEARCHING TIME, FUEL CONSUMPTION AND CO₂ EMISSION

Mujeeb ur Rehman et.al, [9] presents a type of Smart Parking System (SPS) which is based on Global Positioning System (GPS) placed in a car. The main objective endorsed by them is to reduce the searching time, fuel consumption and CO₂ emission by the vehicle during parking in big cities, organizations and congested areas. This system is not based on sensors which means that the proposed system has low maintenance cost. The system is easy to use because there are two types of using this system. One is manually and the other is automatic. The working model will consists of three main parts i.e. server side, client side and parking location. Usage of no sensors facilitates low cost of maintenance. There is no need for the user to use additional components to make use of this system. This system does not provide proper security to vehicles. The implementation of this model for the real world in large scale is not possible.

I. SMART PARKING WITH RESERVATION IN CLOUD BASED ENVIRONMENT

Karthi M et.al, [8] introduced a cloud-based SPRS (smart parking reservation system) employing internet of things (IoT). The proposed system inquires the vacancy of the parking slot using the ultrasonic sensor in order to determine the existence of a vehicle. Arduino Uno board receives the information collected from the sensor. The Ethernet card associated with the Arduino Uno board forward the data to the Amazon Web Service (AWS) - Relational Database Service (RDS). The information regarding the vacancy of the free slot in that particular parking lot is issued to the driver when the request is made through a mobile app and the same is indicated using LED lights. These lights assist the other users in finding the availability of lots. Buzzer starts alarming if in case an unreserved user parked in the reserved parking slot. The alarm can be switched off only by the reserved user i.e, by using the password code which is generated during the reservation of the slot. Amazon RDS collects the code entered on the keypad and checks with the correct code and provides the notification to Arduino Uno which will make the buzzer unalarmed and modifies the lights for the parking status. Cancellation of slots & parking map is made available in mobile application, which is an advantage. The user can only monitor the status of the parking lots but cannot proceed for reservation until he creates account in the mobile application.

J. IOT SMART PARKING SYSTEM FOR REDUCING GREEN HOUSE GAS EMISSION

Prabhuramaswamy et.al, [7] provides solutions in smart parking system to override parking hazards and describes how it benefits in minimizing the emission of greenhouse gases using the Internet of Things (IoT). Raspberry Pi, Distance Sensor, Pi Camera are the interconnected devices to enable smart parking system using Iot. Restful web services which can be consumed by the mobile applications send the real-time data to the cloud using the internet that is interconnected to these pi devices. Ultrasonic distance sensors & raspberry pi camera connected through raspberry pi devices controls every lot in the parking system. Information regarding the presence of a vehicle in each lot of parking area is sent to the central parking system along with the number plate details using internet-enabled pi devices. Rasterizing incoming image feed to find the number plate details of the car is achieved using wiring Pi APIs installed in Raspberry Pi. The distance between the car and the parking curb can be calculated using the time difference between sending and receiving time of sounds at some particular frequency and is achieved using ultrasonic sensors. Online payment is not made available in this system.

K. SMART URBAN PARKING DETECTION SYSTEM

Nastaran Reza .et.al, [5] the authors makes use of raspberry-pi and ultra-sonic sensors at the entrance and exit gates of parking zones to detect cars and calculate number of parking slots available. The system also includes a mobile application in order to help the users to detect the available parking area. The mobile application is developed with Android Studio. From the mobile application the user can view the empty slots in real time on a map through graphical user interface. A web server has been designed for parking managers who wish to monitor and edit their parking zone data. The user gets the navigation to nearest available parking spot through the mobile application. The parking system is designed for different types of parking zone such as: open space car parking and multilevel car parking. The users without mobile application will not get the service and the ultra-sonic sensors are very sensitive to variation in the temperature.

L. A SMART PARKING SYSTEM BASED ON NB-IOT AND THIRD-PARTY PAYMENT PLATFORM

Jiong Shi .et.al, [13], suggest that the data of the sensor node is transmitted by NB-IoT module; it is a newly introduced cellular technology for low-power wide-area (LPWA) application. It uses geomagnetic vehicle detector, BC95-B5 NB-IoT module, STM32F103 MCU at the parking lot to detect the number of cars that occupy the available slot. The system has integrated third-party payment platform and parking guide services. A mobile application has also been developed for driver convince. This system has been developed in two cities to improve the utilization of existing parking facilities effectively. The use of Narrowband Internet of Things addresses requirements such as long battery lifetime, low device complexity and development flexibility. Also, the drivers who do not have the knowledge of using a smart phone and idea about third-party payment will find it difficult to use the service.

M. SMART PARKING SYSTEM WITH PRE AND POST RESERVATION, BILLING AND TRAFFIC APP

Smart parking system provides reservation of parking slot in advance, which helps in reducing the time wasted for searching the parking slot and also in reduction of traffic congestion, pollution, frustration of drivers etc. In this paper a smart parking system based on internet of things is discussed which not only allows the drivers to book a particular parking slot but also helps in automatic cashless billing, hacking intimation and post trip booking is proposed. Gaytri N Hainalkar et.al, [14] have proposed that regular updates of each parking areas to traffic police helps to easily manage the urban traffic problems. The proposed system also provides all the essential features for upgrading the quality of life of an individual in regards to smart city. The user has to login into the system and select particular area of interest when he wants to find a parking slot. The information about the locations of the area of interest is provided by the system. After this the user reserves a parking slot whose status is updated as pending for some time. If a vehicle arrives within time the status of that slot is updated as unavailable otherwise if no vehicle arrives the status is updated as available. The vehicles are permitted to enter and exit a particular parking location only after authentication through RFID card. The system helps in reducing the number of peoples who fail to park successfully, thus reducing the urban traffic congestion, pollution etc. No availability of on spot registration if the user doesn't have mobile application.

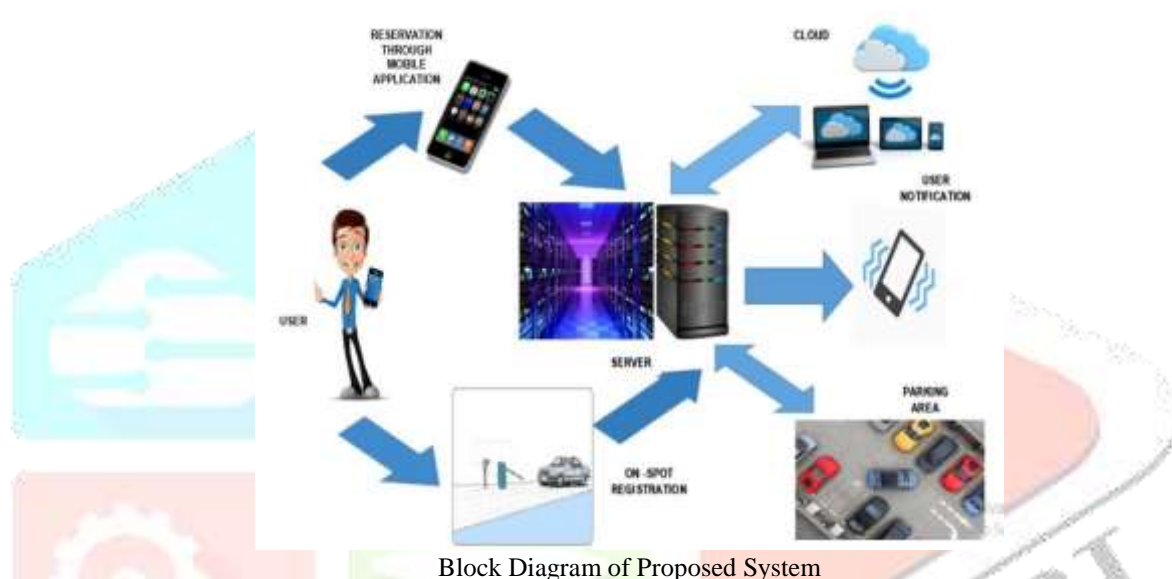
N. A SMART PARKING SYSTEM USING WI-FI AND WIRELESS SENSOR NETWORK

Cheng Yuan .et.al, [6] have put forth a model that constitutes of a model for parking space detection. It includes a module for vehicle positioning and a server for background processing for detection of navigation and parking space. The system consists of a network of wireless sensors and Wi-Fi. The detection of the parking space availability is carried out with the help of geomagnetic sensors whereas for navigation, Wi-Fi is used. A 3-axis magnetometer sensor is used to detect the parking space. The magnetic field near the parking area is monitored by the magnetometer which also analyses the parking occupation state through an algorithm. This detection algorithm estimates how the car is being parked. In this system, various co-ordinates are utilized in order to understand the basic parked position of the car. With continuous changes in the parked positions of the car, the three-axis data of magnetic sensor also changes correspondingly. The real-time monitoring of the 3-axis magnetometer helps in accurately recording the changes of parking space occupation. The fingerprinting technology with smart phones is used to collect signal strength. This algorithm involves two stages, the online positioning and off-line collecting. It provides

high accuracy and low cost. As the system is divided into different modules, it provides good portability. The Wi-Fi readings may vary due to changing weather conditions and the working of the magnetometer is a complicated procedure.

III. PROPOSED FRAMEWORK

Through the survey few gaps have been observed. The authors have come up with few solutions to overcome these gaps which are discussed further in this section. One of the drawbacks of these proposed systems involves the absence of an on-spot registration facility which has been added to our project. A well designed and powerful security system is added which lacks in other proposed systems. In addition to the above features that have been included, the system also involves a mobile application through which pre-booking of parking slots within a radius of 2km can be made which is absent in other systems. Most of the systems that have been implemented are in reserved areas such as malls, university campuses, hospitals and offices and does not provide provision for Safe Street parking facilities. Proposed model overcomes these problems. It is ideal for smart cities.



Block Diagram of Proposed System

IV. CONCLUSION

This paper includes a survey on various techniques used for smart parking system. The main contribution of the study is to analyze the pros and cons involved in each technique and to propose a better solution which has been explained in section III. The proposed model is well suited for implementation in smart cities is an effective solution for illegal parking.

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