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An Intelligent Parking System based on Cloud using IoT Technologies

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Abstract: Internet of things (IoT) is a interconnected network of things/devices which are embedded with sensors, software, network connectivity and necessary electronics that enables them to collect and exchange data making them responsive. Basically it should have smart sensors to collaborate directly without human involvement to deliver a new class of applications. This paper has the application of (IoT) in which the efficiency of the current cloud-based smart-parking system increases. It helps the user to find the space for parking the vehicle at the least cost which is based on performance which calculates the user parking cost depending upon the distance and total number of free places for each car. This cost will offer a solution of finding an available parking space upon request. It will also suggest a new car park if current parking is full. This helps to improve the probability of successful parking and it will also minimize the user waiting time.

Keywords: IoT, Smart Parking System, RFID.

I. INTRODUCTION

There is increase in population along with the density of vehicles all over the world. Hence it becomes difficult for drivers to find parking slot and to park their vehicles. The drivers waste their time and park their vehicle on the street itself they find any space. Especially during festive seasons people fail to find any parking space.[1] This is not the solution as sometimes the car parking could be far away from your destination.

However, in current parking system a better but not an optimal solution is being provided. It does not provide economic benefit, vehicle refusal services and there is no resource reservation mechanism leading to queuing system which is again time consuming. Sometimes it does not provide large parking area. There are android applications available where the cost is calculated from the time the parking slot has been booked which is not economically beneficial for the users. Parking Guidance and Information (PGI) systems for better parking management is also available. PGI systems will provide the drivers the required information on parking within the controlled areas and lead them to free parking slots [2] [3]. And parking management system is also available which is using ZigBee technology [4].

We can resolve the above problems proposing a cloud based smart parking system which uses Internet of Things (IoT) [1] [5]. In this system, all the physical objects like Smartphone, GPS location, and cloud based servers and all car parks are connected to form network architecture and it is an automatic system where we use a Radio Frequency Identification (RFID) technology. We use RFID reader which is a sensor that reads the RFID tag and authenticates the user information. All the car parks in the intended area are connected to form a parking network. Here, each car parked in the parking network is an IoT network which is connected to its neighboring car parks through Wi-Fi [6]. First, the parking manager have to register his car park in the portal (cloud server), if he wants to provide the service in smart parking system and then login to the portal. The user has to register first to get the service from the smart parking system which returns him the RFID tag which contains a unique number. After the registration is done, the user has to download the android application for booking a parking slot.

II. LITERATURE REVIEW

In some studies [1]–[3], the authors proposed a algorithm for treatment planning in real-time parking. They used an algorithm to schedule the online problem of a parking system into an offline problem. Then they set up a mathematical model describing the offline problem as a linear problem. After that they made a design of algorithm to solve the linear problem. Eventually the evaluation of the proposed algorithm is done by using experimental simulations of the system. The experimental results indicated well timed and efficient performance. However, these papers does not mention the resource reservation mechanism, the mechanism to assess the resource system, the mechanism to guide vehicles to the parking space, the mechanism for handling situations when the request for service is denied and does not calculate the average waiting time and average total time that each vehicle spends on the system. Bonde et al. [24] aimed to automate the car and the car parking. The paper discusses a project which presents a small model of an automated car parking system which can regulate and manage the number of cars

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that can be parked in a given area at any given time based on the availability of parking spaces. The automated parking method allows the parking and exiting of cars using sensing devices. Entry or exit from the car park is commanded by an Android based application. The difference between the Bonde system and the other existing systems is that the authors were aiming to make the system as little human dependent as possible by automating the cars as well as the entire car park; on the other hand, most existing systems require human intervention to park the car. Lambrinos and Dosis [19] described a new SPS architecture based on the Internet of Things technology. The architecture of this system consists of a Zigbee Wireless Sensor Network (WSN), an IoT middleware layer and a front-end layer as the final user interface that provides data reporting to the user. However, there are disadvantage as it does not use a suitable application protocol for the transfer of data from the WSN to the server, such as the constrained application protocol (CoAP), there is no mathematical model for the system operations, and there is no system performance evaluation. Other researchers have proposed intelligent parking assistant (IPA) architecture aimed at overcoming current public parking management solutions.

III. PROPOSED ARCHITECTURE

A. System Overview

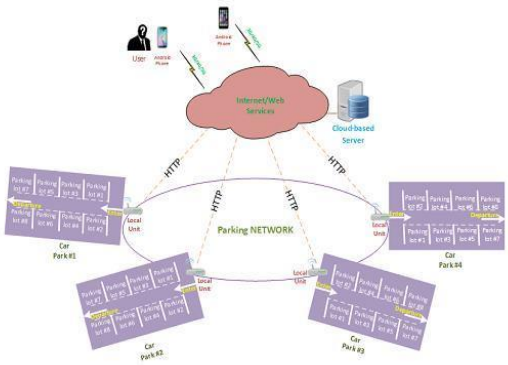

Fig 1. Architecture of Proposed System

The system is derived from the IoT [13], [14]. The system uses the Wireless Sensor Network (WSN)[15] which consists of RFID technology to determine car parks. An RFID reader counts the percentage of vacant parking space in each car park. The use of RFID facilitates implementation of a large-scale system at low cost. The system provides a mechanism to prevent disputes in the car park and helps to minimize the waste of time in looking for a parking space. After logging into the system, the user can choose a suitable parking space. Information on the selected parking location will be confirmed to the user via notification. The system will update the status of the parking space to ‘‘pending’’ during which time the system will not allow other users to reserve it. The system determines that no car is parked in that space after a certain period of pending time, then it changes the status to ‘‘available’’. The system will update the status from the WSN node (the status of car park spaces) when a new car joins in the system. Therefore, the status of the overall parking system is always updated in real time. The system helps to plot the parking time for each parking space in real time and it supports the business with hourly parking charges.

B System Architecture**:**
The elements in the system are:

• Cloud-Based Server: This is a Web entity that stores the resource information provided by local units located at each car park. The system allows a driver to search and find information on parking spaces from each car park without the need to directly access the local server node by directly accessing the cloud-based server.

• Local Unit: This unit is located in each car park and stores the information of each parking space. The local unit includes the following:

◦ Control Unit: This is an Arduino module, which is connected using an RFID reader. The card reader authenticates the user information and then displays this information on the screen. If the information of the RFID tag or card is correct, then the Arduino module will control the opening of the door for the vehicle to enter. The Arduino module connects with the cloud server through an Internet connection to transfer data from the local car park to the cloud server database.
◦ Screen: This displays information on the capacity of the local car park, the total percentage of free spaces, the status of the RFID tag check, the user card while entering, and a mini map of the local car park.
◦ RFID Tag or ID Card: This is used to check and authenticate user information and calculate the percentage of total free spaces in each car park.

• Software Client: This is an application software system. Running on Android operating system, the users will install it on their smart phones and use it to reserve parking spaces. The users access the system via 3G/4G mobile connections.

C. Implementation
The parking system is designed in such a way that it is applicable for covered parks, open parks and street side parking[10]. The centralized server which manages to store entire smart parking systems information such as number of slots, availability of vehicles etc. And this information will be accessed through some secured gateways through network.

The smart parking system consist of different components and their functions are:
• Centralized server: maintains databases which contain information about parking spaces present in the city.

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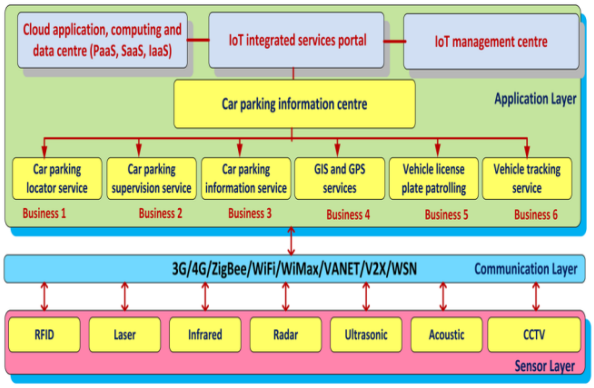
• Navigation system: shows the availability of parking slots to the users and navigates to the exact location of nearest parking area from current location.
• Display device: a monitor or tab is used to display admin side interface and it modifies the parking lots by observing the device.
• User device: user can connect with the smart parking system with their smart phones or with some browsers.

D. Architectural Diagram:



IV. PATH FINDING FOR SMART PARKING

Smart parking system guides the drivers to find available parking spaces to avoid increasing parking issue. In many metropolitan cities have initiated parking guidance and information (PGI) systems [2], provides with up-to-date information on the available parking spaces and direct the drivers accordingly. The information is provided to the driver by using internet. The systems provide the location of the available car park spaces based on the driver's current location in intended area or his final destination. Global Positioning system (GPS) is used to trace the driver's route to the parking destination, after the parking space is reserved [3]. This results in traffic congestion as multiple users are being directed toward the same parking area at the same time. In this paper, a standard A-star path-finding algorithm is been implemented to trace multiple users concurrently, while taking into account one another's nearest distance to the parking area in their respective routes. In this the user avoids over occupying the same parking space by taking different decision on the respective shortest route. A selection technique is used to identify and provide the most efficient solution for all users at any particular time. A Smart routing scheme which will use a PGI system is beneficial which provides less congestion and journey times for users are also reduced [2]. This approach is also economically beneficial and efficient.

V. SAMPLE CAR PARKING FOR UNIVERSITY SPACE

Every big university has a number of different car parking areas for visitors, students, staff members, etc. University car parking belongs to the category of a residential/community car parking.

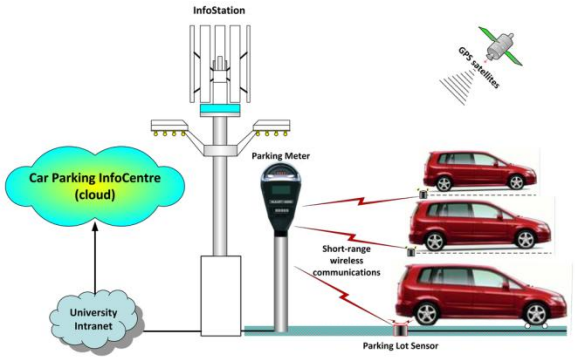


Fig 2. Info station based university car parking system

Every working day, students and staff members find it difficult to find available car parking slot. This is not only a time-consuming process but it may also cause car traffic jams. With the cloud-based car parking service, an efficient utilization of available car parking facilities could be achieved within a 'smart university' environment. One way to achieve this is to have each car parking lot equipped with a sensor which is able to sense the presence of a car. An information station (Info Station), which operates in the car parking area, periodically collects and aggregates the car presence information from all sensors moving in the area, e.g., by means of Wi-Fi, ZigBee, or other short-range wireless technology. In case of paid car parks, optional parking meters could operate between the Info Station and the sensors. When the occupation status of a car parking lot is changed, information about this is pushed by the Info Station to the car parking Information Centre (Info Centre) in the cloud via the university Intranet.

VI. CONCLUSION

This automatic smart parking system includes RFID which provides user to control system and vehicle which is very simple and cost effective. It easily provides the space for parking vehicles. It eliminates the unnecessary travelling to find the space for parking vehicle. The average waiting time for users to park their vehicle is also reduced.

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BIOGRAPHIES

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