Smart Parking System Using IOT and Cloud Computing

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ABSTRACT

This paper introduces a novel algorithm that increases the efficiency of the current cloud-based smart-parking system and develops a network architecture based on the Internet-of-Things technology. This paper proposed a system that helps users automatically find a free parking space at the least cost based on new performance metrics to calculate the user parking cost by considering the distance and the total number of free places in each car park. This cost will be used to offer a solution of finding an available parking space upon a request by the user and a solution of suggesting a new car park if the current car park is full. The
simulation results show that the algorithm helps improve the probability of successful parking and minimizes the user waiting time. We also successfully implemented the proposed system in the real world.In this paper, we describe the formatting.

General Terms

Smart-parking system, performance metrics.

Keywords

Internet of Things, Cloud Computing

1. INTRODUCTION

In the development of traffic management systems, an intelligent parking system was created to reduce the cost of hiring people and for optimal use of resources for car-park owners. Currently, the common method of finding a parking space is manual where the driver usually finds a space in the street through luck and experience. This process takes time and effort and may lead to the worst case of failing to find any parking space if the driver is driving in a city with high vehicle density. The alternative is to find a predefined car park with high capacity. However, this is not an optimal solution because the car park could usually be far away from the user destination. In recent years, research has used vehicle-to-vehicle and vehicle-to infrastructure interaction with the support of various wireless network technologies such as radio frequency identification (RFID), Zigbee, wireless mess network , and the Internet. This study aimed to provide information about nearby parking spaces for the driver and to make a reservation minutes earlier using supported devices such as smart phones or tablet PCs.

Furthermore, the services use the ID of each vehicle in booking a parking space. However, the current intelligent parking system does not provide an overall optimal solution in finding an available parking space, does not solve the problem of load balancing, does not provide economic benefit, and does not plan for vehicle-refusal service.

To resolve the aforementioned problems and take advantage of the significant development in technology, the Internet-of-Things technology (IoT) has created a revolution in many fields in life as well as in smart-parking system (SPS) technology . The present study proposes and develops an effective cloud-based SPS solution based on the Internet of Things.

Our system constructs each car park as an IoT network, and the data that include the vehicle GPS location, distance between car parking areas and number of free slots in car park areas will be transferred to the data centre. The data centre serves as a cloud server to calculate the costs of a parking request, and these costs are frequently updated and are accessible any time by the vehicles in the network.

The SPS is based on several innovative technologies and can automatically monitor and manage car parks. Furthermore, in the proposed system, each car park can function independently as a traditional car park. This research also implements a system prototype with wireless access in an open-source physical computing platform based on Arduino with RFID technology using a smart phone that provides the communication and user interface for both the control system and the vehicles to verify the feasibility of the proposed system.

2. LITERATURE SURVEY

In some studies [1]_[3], the authors proposed a new algorithm for treatment planning in real-time parking. First, they used an algorithm to schedule the online problem of a parking system into an offline problem. Second, they set up a mathematical model describing the offline problem as a linear problem. Third, they designed an algorithm to solve this linear problem. Finally, they evaluated the proposed algorithm using experimental simulations of the system. The experimental results indicated timely and efficient performance. However, these papers do not mention the resource reservation mechanism (all parking requirements are derived immediately and are placed in the queue), the mechanism for assessing the resources system, the mechanism to guide vehicles to the parking space, the mechanism for handling situations when the request for service is denied and do not calculate the average waiting time and average total time that each vehicle spends on the system.

In another study [4], the authors propose an SPS based on the integration of UHF frequency, RFID and IEEE 802.15.4 Wireless Sensor Network technologies. This system can collect information about the state of occupancy of the car parks, and can direct drivers to the nearest vacant parking spot by using a software application. However, in this work, the authors have no mathematical equations for the system architecture and do not create a large-scale parking system. The results of this paper only implement the proposed architecture; they do not mention the performance of the parking system.

Hsu *et al.* [5] proposed an innovative system including the parking guidance service. A parking space can be reserved by a smart phone via Internet access. Upon entering the car park, the reserved parking space will be displayed on a small map using wireless transmission for vehicles under the dedicated short-range communication protocol DSRC.

An inertial navigation system (INS) is implemented to guide the vehicle to the reserved space. The system will periodically update the status of the parking space in real time to help ensure system accuracy. System performance is measured through the accuracy of the inertial navigation systems run in an indoor environment, and the system implementation is evaluated by considering the accuracy of the GPS. In this paper, the authors have not evaluated the performance of the parking services, they do not provide any mathematical model of the system, and do not consider the waiting time of each vehicle for service.

Other researchers have designed architecture for parking management in smart cities [6]. They proposed intelligent parking assistant (IPA) architecture aimed at overcoming current public parking management solutions. This architecture provides drivers with information about on-street parking stall availability and allow drivers to reserve the most convenient parking stall at their destination before their departure. They use RFID technology in this system. When a car parks or leaves the IPA parking spot, the RFID reader and the magnetic loop detect the action and send this information to the unit controller to update the information on the car park status. This study uses only some simple mathematical equations for the system architecture and does not create a large scale parking system.

In other works, authors have designed and implemented an SPS [7] to solve the parking problem. A part of this system is implemented in the Zigbee network which sends urgent information to a PC through a coordinator and then updates the database. The application layer can quickly pass the parking information over the Internet, and use the advantages of a web service to gather all the scattered parking information for the convenience of those who want to find a parking space. This paper simply reports the design and implementation of an SPS and does not evaluate the system performance.

3. SYSTEM ARCHITECTURE

3.1 System Overview

The system is derived from the idea of IoT [13], [14]. The system uses the WSN [15] consisting of RFID technology to monitor car parks. An RFID reader counts the percentage of free parking spaces 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 minimize wasted 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 con_rmed to the user via notification.

Then, the system updates the status of the parking space to ``pending" during which time the system will not allow other users to reserve it. If after a certain period of pending time the system determines that no car is parked in that space, 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 will help plot the parking time for each parking space in real time and can support the business with hourly parking charges.

3.2 System Architecture

Elements in the system:

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, as shown in Fig.2. 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, 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 current percentage of free spaces, the status of the RFID tag check, the user card when 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 smartphones and use it to reserve parking spaces. The users access the system via 3G/4G mobile connections.

Fig1. System Architecture

3.3 Network Architecture

In general, we will use the term ``user" when referring to the driver or vehicle and the term ``resources" when referring to the parking spaces.

1) PARKING NETWORK:

We use the car park network (CPN) architecture infrastructure backbone. The architecture is shown in Fig. 3 where the dashed lines indicate wireless link and the solid lines indicates wired link. This type of parking network includes routers that form as the infrastructure for connected clients.

The CPN infrastructure/backbone can be built to allow sensor networks to connect using wireless radio technologies. The routers form a self-configuring and self-healing link network. We have assumed that each car park is a node in a CPN. Each Parking is labelled as P1,P2,P3,……..Pn having capacity N1,N2,N3,…Nn. Hence the total capacity of system is N=N1+N2+N3+…….+Nn.

2) CONSTRUCTING THE NEIGHBOR TABLE OF NODES

We use a function named F(a, b) to calculate the cost between the nodes in the network. F(a, b) is a function that depends on the distance between two nodes and the number of free parking spaces in the destination node. F(a, b) is considered to be a weighted link between two nodes in the parking network. If two nodes are not directly linked, then F(a, b) = ∞.

If the vehicle comes into a node and that node is full, the vehicle will be forwarded to the next node, which is a neighbour of

this node with the smallest value of F(a, b) in the neighbour table. We calculate the cost function F(a, b) from node Pi to node Pj, i.e.,

$$F_{ij} = F(a,b) = a \times \frac{d_{ij}}{D_{up}} + b \times \frac{t_j}{T_{up}}$$

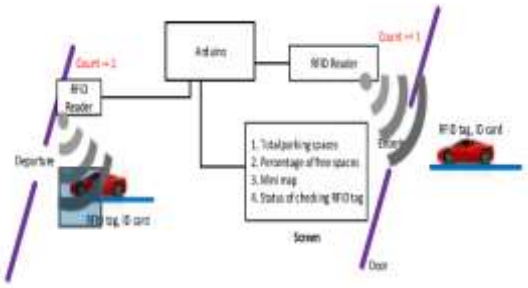

Fig2. Local Unit

4. ALGORITHM

We propose an algorithm to describe the operation of the system.

- SYSTEM OPERATIONS
  Following is the algorithm for system operation.
- When a user wants to find a parking slot, he must login to our system. After successful login, a request message is sent to search for a free parking slot.
- Then, the system will send back a response message containing the information, including the car park address and the directions to reach it. The choice of the car park is based on the function F(a,b), which is calculated based on the current location of the vehicle and the location of the car park.
- The system will forward the vehicle to a car park with a minimum F(a,b)value if the current car park is full. When the user arrives at the car park, he must be authorized to enter.
- This authorization is achieved via the RFID technology or by scanning the user card. This mechanism is simple but economical.
- If the information is correct, the user is allowed to park. If the current car park is full, the system will send a suggestion message that includes information on a new car park, including the address and new directions, with a minimum cost.
- The new car park will be selected based on the neighbour table of the current car park.

2. UPDATING STATUS OF CAR PARK

- Step 1: First iinitialize the process.
- Step 2: If vehicle is detected entering car park then count = +1.
- If vehicle is detected leaving a car park then count = -1
- Update the neighbouring table.

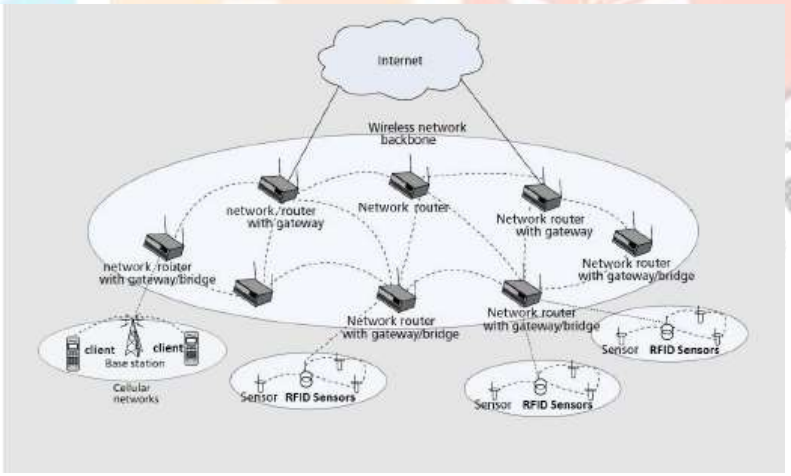

Fig 3: Car Parking Network

5. ADVANTAGES/DISADVANTAGES

Following are the advantages of using IOT and Cloud together:-

- Storage capacity
- Computational Power
- Communication Resources
- Scalability
- Availability
- Interoperability

Following are the disadvantages current system:-

- Arduino is a microcontroller which conducts single process for a long time
- It can be easily replaced by Raspberry Pi if we wish t increase the functionality
- Typical LDR sensors are used in this system which can be replaced by more efficient ultra sound sensors
- Also the security at socket layer for the protection of data and authentication of user is low .

6. CONCLUSION

This study has proposed a parking system that improves performance by reducing the number of users that fail to find a parking space and minimizes the costs of moving to the parking space. Our proposed architecture and system has been successfully simulated and implemented in a real situation.

The results show that our algorithm significantly reduces the average waiting time of users for parking. Our results closely agree with those of our proposed mathematical models. The simulation of our system achieved the optimal solution when most of the vehicles successfully found a free parking space. The average waiting time of each car park for service becomes minimal, and the total time of each vehicle in
each car park is reduced. In our future study, we will consider the security aspects of our system as well as implement our proposed system in large scales in the real world

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