

Survey Paper on Smart Parking for Smart City

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Abstract: Parking space is becoming a serious problem due to the day-by-day increase in number of vehicles on the road. To deal with such problems parking planning should be done. We are implementing an algorithm which will solve this issue. The algorithm will guide drivers to find and direct them to their respective parking space at the entry level. For this, we used sensors which are deployed at parking lots to check the availability of the respective parking space. Using wireless sensor network (WSN) parking lot is detected. Also data is transmitted to the database along with necessary details about vehicle. This system provide user with near instantaneous update of available parking spot. Therefore, time needed to search parking space that are caused by inefficient parking system will be significantly reduced. We hereby present the study of issues related to the different structures used and algorithms for smart parking system. With the successful implementation of smart parking, the economy and time costs related with traffic jams, cost of wasted gas fuel, and time wasted looking for an empty parking space that are caused by inefficient parking will reduce significantly.

Keywords: Wireless Sensor Network, Smart Parking, Connected Vehicles, Intelligent Parking System.

I. INTRODUCTION

It is something we are all familiar with: you pop into town with the car to do a little shopping or meet some friends. But such short trips can turn into a nerve-wracking ordeal when you have to keep circling around time searching for a parking space every time. That costs time, gas and nerves. Parking management system can improve usage of provided parking spaces such that it will help to reduce traffic in towns and cities caused by drivers searching for parking space. Smart Parking systems first obtain information about available parking spaces in a specific geographic area and process is real-time to place vehicles at available positions. Low-cost sensors, real-time data collection are used in this system.

Parking guidance system first obtains information about available parking spaces, and then processes the gathered information and then present it to drivers. To provide information according driver's need such as parking position and number of the parking lots that are actually available within given parking structure can be provided. This system helps to reduces wastage of time as well as fuel while searching for empty parking lots. It also helps the car park process to operate efficiently.

Another factor to consider is the wired infrastructure needed for most vehicle detecting sensors. Since installation of traditional systems require that wired infrastructure be installed, some systems have suggested using a Wireless Sensor Network (WSN) through the use of Zigbee networks. Zigbee networks are able to wirelessly communicate with a central coordinator that has information about all nodes. This allows for sensors to be moved or repositioned easily without the need for costly removal or installation

II. RELATED WORK

Several smart parking ideas have been proposed in the last decade, including completely manual system semi-automatic the system can be a wired network or a wireless system.

A. Domain

The overall idea of smart parking system include Wireless Sensor Network data analysis. The idea of smart parking comes under smart cities since the system is automatic

B. Related Study

Robin Grodi, Danda B. Rawat, Fernando Rios-Gutierrez [1]

In this paper, a prototype of smart parking system is developed using wireless sensor technology and networks is presented. Using a Wireless Sensor Network (WSN), statuses (occupied or idle) for given parking spots are detected and transmitted to a database. This information then is accessed by users through website or mobile app (application) to receive real-time updates. This system should provide users with near instantaneous updates of available parking spots while the WSN allows for flexibility of sensor placement. With the successful implementation of smart parking, the money spent and time costs related with traffic jams, cost related with wasted gas fuel, and time looking for a parking space caused due to inefficient parking will be reduced significantly.

This paper has two sections: Section I describes the different ways to detect a vehicle in a parking spot (specifically the types of sensors) and how to notify users of a vacant spot Parking detection requires some sort of sensor that can check the occupancy status of a parking



spot. Many different types of sensors can be used for this objective; each sensor will have advantages and disadvantages depending on the location sensors need to be connected to a user notification system either wire the sensor directly to a notification system or have all of the sensors connected to a central coordinator that is able to then display this information. One step further would be to have this central coordinator put this information on the web allowing anyone with a Internet connected device to view the information. The implementation of system is shown in Section II, which is broken down into both hardware and software specifics. Description and pictures of the working prototype are shown in Section II. A gateway device is used to communicate with the XBee modules and provide internet access. This gateway device must have a communication path to all XBee devices in the network (either through single or multi hop communication). Since XBee is capable of mesh network configuration, any XBee device is considered as both a router and client device. In order to organize and store the data from the sensors effectively, use of a MySQL database is employed. Each XBee device is assigned a unique identifier when installed in network and uses this identifier as the row it will use in the database. Each row has information about the status of the parking spot, the last read time and the identifier used to store the information. A 'true' value stored in the status column means that the parking spot is occupied while a 'false' value means the parking spot is available

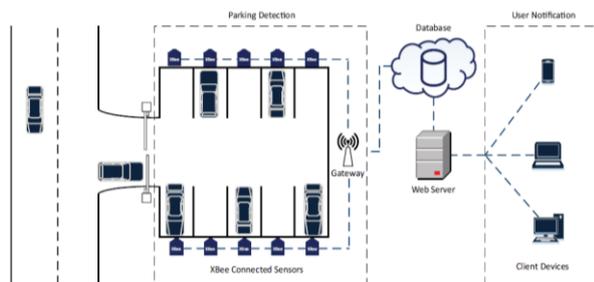


Fig. 1 Typical system model for smart parking system

Xuejian Zhao, Kui Zhao, Feng Hai [2]

In this paper, a feasible method to do parking planning is presented. They used linear assignment problem to explain the parking planning problem. Consider vehicles as jobs and parking spaces as agents. Distances between vehicles and parking spaces are considered as costs for agents doing jobs. Then an algorithm is designed according to particular assignment problem and solve the parking planning problem. This method can give efficient guide information to vehicles without wasting time for a real time smart parking system. It shows the effectiveness of the method as it is experimented over specific amount of data, which helps to simulate the situation of doing parking planning in the real world. In order to make parking planning strategy be efficient in most situations, instead of processing it immediately parking queries are held in a queue for a while and the count of queries held is

a controllable parameter. To get more information the on-line problem is transformed into an off-line problem and then we can get efficient solution in most situations

In Algorithm 1, DNN is the square matrix for the graph of the give area and we save the solution in XNN. The space complexity of Algorithm 1 is $O(N^2)$.

In Algorithm 2, P represents the set of vehicles that have query in the queue and DMN is the original distance matrix. We save the subset in S' picked from S, denoting the set of all available parking spaces which is the output from algorithm 2. For each vehicle in P, we save the top nearest M available parking spaces in S Set temporarily. To the best of our knowledge, we can get the top M nearest available parking spaces by using Heap, which is a common and useful

data structure. The time complexity of it is $O(MN + M \log 2N)$. We check whether s_j has been in S' or not by using Hash method. The time consumed by that is constant, thus it can be omitted. So the the total time cost by Algorithm 2 is $O(MN + M^2 \log 2N)$. The space complexity is $O(N + M^2)$.

In Algorithm 3, S' is the subset picked from the set of all available parking spaces by algorithm 2, DMN is the original distance matrix. We save the new distance square matrix in $D' N' N'$. We use MAPP to map the row index in $D' N' N'$ to the vehicle in P'. We use MAPP to map the column index in $D' N' N'$ to the parking space in S' . They help us to construct the new distance square matrix $D N' N'$. The time complexity of

Algorithm 3 is $O(MN')$ and the space complexity is $O(N^2)$. If we notice $O(N') = O(M^2)$ and substitute it into $O(MN')$ and $O(N^2)$, the time and space complexity are $O(M^3)$ and $O(M^4)$, respectively.

In Algorithm 4, M is the number of vehicles in set P, MAPP and MAPS are used to map the index in $D' N' N'$, $XN' N'$ is the temporary solution from Algorithm 1. We save the final solution in X'. The time complexity of Algorithm 4 is $O(MN')$ and the space complexity is $O(M)$. If we notice $O(N') = O(M^2)$ and substitute it into $O(MN')$, the time complexity is $O(M^3)$. a novel method of parking planning for smart parking system. parking planning is transformed into a kind of linear assignment problem by holding parking queries in a queue for a while. by developing a new approximation algorithm to solve this particular linear assignment problem. The experimental results on simulation clearly show our method is a feasible method which can give timely and efficient solutions for a real time smart parking system

Pablo Sauras-Perez, Andrea Gil, Joachim Taiber [3]

This paper presents the conceptual model of a smart parking application that helps drivers to look for and reserve parking spots based on their current needs, using their car HMI system or their smart-phone. In addition, the application allows the driver to extend the parking time if needed. By integrating other value-added services like digital coupons of some merchants can be used to compensate overall cost related to the adoption of these



technologies in parking system, since the cost of deploying smart parking technologies is not negligible. A smart parking ecosystem will be created after integrating such services in the application. It will be also beneficial to parties not related to parking system such as the aforementioned merchants. The use of this system can help to reduce the environmental burden caused by drivers cruising for parking. At the same time, it provides to its users a convenient way of securing a parking space, by means of its reservation before the start of the trip.

Thus, Parking Gain reduces the uncertainty and potential stress derived from searching for 2 parking in a congested city. side effect mentions are the user the possibility to access to offers simply by using the application, it increases the customer base of the merchants and it helps to subsidize the costs related to the installation of the technologies needed to develop smart parking services.

G. Yan, W. Yang, D. B. Rawat, and S. Olariu[4]

A smart parking system is suggested, By using the secured wireless network and sensor communication, Smart-Parking is a intelligent parking service application as well as a novel security/privacy aware infrastructure. First, vehicles on the road can view and reserve a parking spot. The parking process can be an efficient and non-stop service as well as parking service is an intelligent service. New vacant parking spot and advertisement of discount of parking fees can be distributed to the cars passing by also the parking process has been created as a stochastic process. Not only maintenance work can be scheduled but also the revenue of the parking site can be predict. New business promotions can be broadcasted to all vehicles passing by the parking site through wireless networks. Finally, privacy of the drivers and security of the information are protected by using the sensor infrastructure and encryption/decryption approach.

Simulation results prove the proposed system results in high parking space utilization and fast parking spot finding time. The future work includes more extensive simulations on the proposal. The analysis of efficiency needs to be studied as well.

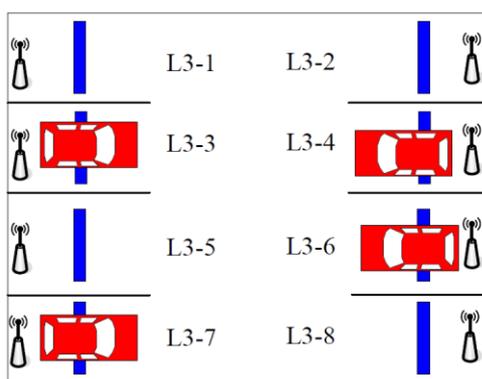


Fig. 2 parking spot detail map

Zhanlin Ji, Ivan Ganchev, M'airt'in O'Droma and Xueji Zhang [5]

A cloud-based intelligent car parking system is described in this paper. It is considered as an important component of an Intelligent Transport System (ITS) for smart cities, there are three layers in the car parking system: sensor-, communication-, and application layer. In the implementation part, a sample car parking service for a university campus were proposed as shown in architecture. The related IoT sub-system includes following layers sensor layer, communication layer, and application layer. Using cloud-based intelligent parking system car parking services with proposed platform can be implemented. It can be used on any private parking space. As result the system development follows the personal software process (PSP) methodology. Methods used for the PSP are either test-driven or feature driven. When a user/car enters the University campus through one of its gates, the car parking mobile app, installed on the user mobile phone, will send an automatic HTTP request through the gate's access point toward a web server, and a JSON response will be returned, containing information about the 'best' available car parking lot. For a GPS-enabled mobile phone, a Route Utils generates the steps that must be followed by the driver, and displays them on the Google Map

C. Overview

A sensor which will detect presence of a car at the entrance using a RFID sensor. System will check for nearest available parking space available and allot it to that vehicle. After parking of the vehicle, parking space will be marked as allotted and the new entry will be added to database. At exit bill will be generated for the vehicle as per the given rates and the respected parking spot will be marked as free

III. CONCLUSION

This paper demonstrates a survey on different algorithms and methods that were proposed by researchers earlier for better development in the field smart city. The multiple algorithms discussed above will be of great use for developing a new improved technique for a smart parking system which is efficient and effective. In future we will be developing an algorithm and method to create a smart parking system using wireless network sensor to have real time updates on the parking spot occupancy status.

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REFERENCES

- [1] Robin Grodi, Danda B. Rawat, Fernando Rios- Gutierrez” Smart Parking: Parking Occupancy Monitoring and Visualization System for Smart Cities.”, IEEE ,2016.
- [2] Xuejian Zhao, Kui Zhao, Feng Hai “An Algorithm of Parking Planning for Smart Parking System”., IEEE , 2015.
- [3] Pablo Sauras-Perez, Andrea Gil, Joachim Taiber “Parking Gain: Toward a Smart Parking Application with Value-Added Services Integration.” International Conference on Connected Vehicles and Expo, 2014.
- [4] G. Yan, W. Yang, D. B. Rawat, and S. Olariu, “Smart Parking: A secure and intelligent parking system.”, Intelligent Transportation Systems Magazine, IEEE, vol. 3, no. 1, pp. 18–30, 2011.
- [5] Zhanlin Ji, Ivan Ganchev, M’airt’in O’Droma and Xueji Zhang,” A Cloud-Based Intelligent Car Parking Services for Smart Cities”, IEEE , 2014.