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The navigation at parking stations and parking spaces

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ABSTRACT

This contribution is a discussion concerning parking space navigation. It is based on existing technologies for orientation determination and telecommunications. The design depends on the classification of the parking stations or areas. In this paper, the parking station classification distinguishes between centralised parking lots and dispersed parking lots. Based on their similarities and differences, the navigation for centralised parking stations will be relative to the model's generation and sensors, while the navigation for dispersed parking lots is based on calculations using parking meter information. In addition, the requirements, process and components of design are also discussed.

KEYWORDS: parking space, navigation, GIS, classification, model.

1. INTRODUCTION

During the parking process, the most important factor is convenience, which includes seeking an empty space, the method of payment and overtime disposal. Firstly, people must find the address or location of parking lots. Then they need to make sure there is an empty space and to find it. Nowadays, people can check the address of parking stations, and even the status of parking spaces, on some websites, such as parkingatmyhouse.com or findacarpark.com, which are based on map searching APIs and real-time monitoring. However, these websites mostly only provide details of private parking stations, and some general information of public parking lots, such as the number of parking spaces and time of access. People cannot be certain if it still is an empty parking space when they reach it, unless they can check the status of the parking space in question at any time. [1][2]

There are two methods that can be used. The first way requires people to have mobile internet access so that they can check the website - collecting general parking lot information or a special website of the parking station/area itself (if it exists) which provides the status of the parking space. Another way is to require a special server to send parking space status to a customer's mobile device. However, there is not a large difference between these two methods, because both of them require the collection of parking spaces' status. The advantage of the second method is that it may include the functionality of navigation inside or outside of the parking station building.

2. BACKGROUND

There are two main types of parking services: (1) centralised parking lot/station and, (2) dispersed parking lot/station. Centralised parking stations have an entrance and exit. Some centralised parking stations have their own online booking system which allows people to reserve their parking space before driving there. A significant advantage of centralised parking is ease of management. Compared to dispersed parking lots, the design of the payment system and the vehicle detection system in centralised parking stations is more effective. For instance, the toll collection system, such as E-ZPass Plus and Auto Toll, only needs to be set up at the entrance and exit, and the sensor used for detecting vehicles can cover many more parking spaces than in the case of a dispersed parking lot. [3][4]

The main problem of centralised parking stations is the design of navigation. Generally, people can know that if there are some empty spaces in the centralised parking station building. But it is difficult to let them know the accurate position of those empty spaces. Although there are many symbols of indicating direction, drivers have to seek those empty spaces by themselves, and they often forget their own position in that building. Sometimes the parking station owner has to employ people to direct drivers to an empty space. However, there are many researches for indoor navigation, e.g. orientation by Wi-Fi, which will give a great improvement on this part.

Most dispersed parking lots are roadside parking spaces. Roadside parking lots can be considered as being built up by aggregating many single parking spaces with or without separating line, typically along both sides of a street. Many roadside parking spaces are free, but increasingly many of them require a parking payment, especially in the CBD and many inner cit suburbs. In general, people do not know beforehand if there is an empty roadside parking space at their destination. Although a parking space may change its status between

empty and full at any moment, it would be attractive if a driver can know that there is a street near his/her destination that has many more empty parking spaces, and some of those parking spaces may have a higher probability of being empty.

3. METHODOLOGY

The main contribution of this paper is parking space "pre-navigation", which does not aim to let people know their position, but designed to let people search parking lots, including centralised parking stations and roadside parking spaces nearby to a specified area, and obtain the position and the status of the parking spaces at any time.

There are three main components: client, server and data provider. Client is the drivers who can get and provide their own position using any available positioning technology. Server has the responsibility of responding to the request of the driver and storing the data of parking lots, while data provider is the parking station owner, who can provide the information concerning the status parking spaces. [5]

Figure 1 shows the communications links between client, server and property/station owner or operator.

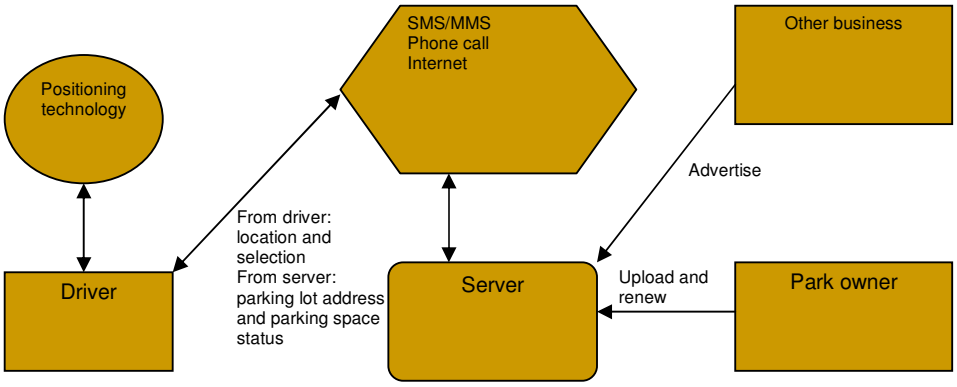

Figure No 1. Flow chart of communication

From property owner or parking station operator to server, the data transferred would be different between centralised parking lots and dispersed parking lots:

- For centralised parking stations:
  a. Address of building.
  b. Map or model of parking stations structure.
  c. Real-time (refreshed) information allowing people to check each parking space's status: creation, initialization and update. This information is provided by sensors.
- For roadside parking stations:
  a. Name of street around the journey destination.
  b. Number of empty parking spaces in a fixed or defined area.

Between customer and server, the data transferred could be:

- Data provided by the customer:
    a. Customer's position and destination (for navigation).
    b. Selection of centralised parking stations or street of roadside parking.
- Data transferred to customer from sever:
    a. Address of parking lots for navigation
    b. The map or model of centralised parking station, or the percentage of empty roadside parking spaces
    c. Refreshed information concerning parking space status

The most important step is collection of information on parking spaces' status.

4. DATA COLLECTION

4.1 Centralised parking

For centralised parking station, it will show the status of each parking space to the customer. There is a precondition that a model of the parking station building should be available. The model can be generated by GIS for a 3D visualization.

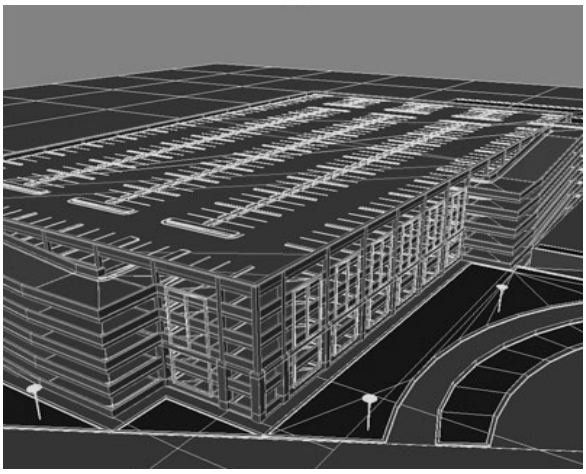

Figure No 2. An example of a 3D model of a parking station [6]

The model should be very simple to limit its size, and the key information is the position of all parking spaces.

The position of an individual parking space can be described with "inside" coordinates, relative to the whole building, or can be recorded with some form of serial number. Then this coordinate or serial number information will be stored in a central server to build a map for drivers:

- Use sensors to monitor each parking space's status:
    a. Infrared sensor installed on each of parking space can sense the car, which can aid the navigator and manage vehicles in centralised parking stations. Each sensor has a corresponding number or a coordinate associated with it, e.g. the ID of the sensor could be the same as its parking space.
- The information concerning the parking spaces' status for the client:

a. The map or model of the centralised parking stations should be transferred to the customer and stored on customer's mobile device.
b. The server should send refreshed information on the parking space to the customer's device perhaps with some fixed frequency. In fact, only the information on changes to a parking space's status should be sent.

- Show parking space status on client's map or model
  a. The model format should be converted to xml and be input by a map API or a 3D model API in Java such as M3D or JPCT. [7][8]

Each parking space shown on a map or model on a customer's device has its own ID, which will be compared to the refreshed information received from the server. Then it can show which parking space's status has changed.

On the other hand, the data's transfer would be a problem, which relates to the DSP and telecommunications. Once above steps have been done, it would give a capability to let people find the parking stations according to their address or location, and also let people check the position of empty parking spaces in that building through 3D visualization.[9]

This design is an improved search service, which attract people to the building of parking station with many empty spaces, and give them the position of an empty parking space. The limitation is that it does not give the driver's position in the building. So it is important to combine this design with the indoor positioning system in the future.

4.2 Dispersed parking

As mentioned above, the situation for roadside parking is different to that of a centralised parking station. Most roadside parking spaces are not fixed, which means there is no fixed separation, and accurate coordinate for each parking space. That is why the installation of a sensor in each parking space is not practical. On the other hand, people do not need to know the accurate position of roadside parking space, because the structure of roadside parking lot is much simpler than in the case of centralised parking stations. They only need to know if there is an empty space on the street of their destination. A set of camera may give some information on roadside parking, but it has the same disadvantage as sensors.

One of methods is to count the quantity of parking vehicles. It could be done by parking meters. If the parking meter can store the amount of tickets generated in a fixed duration, it would calculate a percentage of capability of roadside parking in that street, and send this information to a central server. Once people get this roadside parking percentage of streets near their destination from central server by internet or SMS/MMS, they can choose the lowest one to seek an empty parking space easier than other streets. But of course, this percentage does not include the illegal parking that someone did not pay anything on parking meter.

Another method is to monitor each vehicle by satellite and local network. It will be a kind of application of GNSS in the future and some corporation such as Skymetre have already started developing such systems. [10]

5. CONCLUSIONS

The design of parking space's pre-navigation incorporates four main technologies: orientation, surveying, telecommunication and programming. In this situation, the orientation is not the key point at the beginning stage. The model or map of the parking station building and street can be generated through GIS or mapping technology. After that, the important thing is the arrangement of sensors and the synchronization of their status on the generated map. It relates to the data processing and transfer of data between data provider, server and customer. It is necessary to reduce the size of data, the amount of packets sent and the time of transfer, because the ability of mobile client is limited, although it may not be such an issue between server and data provider.

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