Eurasia Journal of Mathematics, Science & Technology Education, 2016, **12**(5), 1231-1242
doi: 10.12973/eurasia.2016.1509a

A City Parking Integration System Combined with Cloud Computing Technologies and Smart Mobile Devices

Her-Tyan Yeh, Bing-Chang Chen & Bo-Xun Wang
Southern Taiwan University of Science and Technology, TAIWAN R.O.C.

•*Received 26 June 2015*•*Revised 9 August 2015* •*Accepted 25 August 2015*

The current study applied cloud computing technology and smart mobile devices combined with a streaming server for parking lots to plan a city parking integration system. It is also equipped with a parking search system, parking navigation system, parking reservation service, and car retrieval service. With this system, users can quickly find parking lots near their destination, using various parking servers and the system center to connect to and integrate the cloud server. The computing power of the cloud servers transmits five of the closest parking lots with available parking spaces to a user's smart mobile device so the user can choose the most suitable parking lot. After users arrive at the parking lot, they can scan the information in the parking lot using an RFID indoor positioning system and the users' current location, so that the location of vacant parking spaces in the parking lot and moving vehicles will be displayed on their smart mobile device. In addition, the stored traffic flow record can provide local governments with statistics for building parking lots in the city in the future.

Keywords: cloud computing, smart mobile device, global positioning, RFID

INTRODUCTION

Due to the rapid development of the economy, a large number of job opportunities have attracted many people from rural areas with a surplus of labor to urban areas. This has resulted in the rapid growth of urban populations and an increase in car ownership, making it more and more difficult to find parking spaces in cities. Moreover, parking problems in the city are rising, causing headaches for local governments. Therefore, local governments have started to build large three-dimensional parking lots in downtown areas and in areas where stores are most concentrated and large numbers of people shop. In comparison to general parking lots, these large three-dimensional parking lots can accommodate more cars.

Correspondence: Her-Tyan Yeh,
Department of Information and Communication, Southern Taiwan University of Science and Technology, Tainan City 710, Taiwan R.O.C.
E-mail: htyeh@stust.edu.tw

In urban areas where buildings stand tall and cars fill the streets, finding a parking space near the destination takes a lot of time and drivers cannot be sure whether the parking lots they find have any parking spaces left. After spending a long time finding a parking lot, drivers have to spend even more time finding the most suitable parking space in the given parking lot.

Radio frequency identification (RFID) has gradually become widely applied in many areas (Sarangan, 2008, Juan, 2011, Dakkak, 2012, Pingley, 2012, Jürgen, 2008, Jaselskis, 2003, Su, 2008, Tsai, 2012). All users have to do is use a reader to carry out non-contact scanning on RFID tags to quickly obtain the current location and related information of the tag. South African RFID provider Trolley Scan designed the RFID-Rader to detect the location of the target object or destination in space and provide information such as distance, angle, and tag ID.

The increasing growth of cloud computing technology has led to its increasing adoption by industries and gradually greater use in daily lives (Andrea, 2012, Donato, 2012, Luis, 2012, Moussa, 2012). Cloud computing technology obtains information at low costs via convenient ways, causing it to become the focus of the technology industry today. Nevertheless, the impact, influence, and integration of the different platforms that cloud computing technology brings have provided the direction for the current study. The issue of how to integrate services from different platforms has proven to be a great challenge.

State of the literature

- Infrared Detection system：Infrared sensors are placed above parking spaces to scan and see if there are any obstacles in the parking space.
- Image Detection System：All the cars in the parking lot should be compared and analyzed, which requires complex calculations and takes up a lot of time.
- Smart Parking Card system：Load-cell sensors are installed to each parking space in the parking lot to detect if the parking space is available and send the information to the parking card system.

Contribution of this paper to the literature

- Allow users to quickly search and make parking reservations for nearby parking lots with vacant parking spaces available before arriving at the destination.
- Allow users to use smart mobile devices to immediately obtain information on the parking lot and find the most suitable parking space when driving into 3D parking lots with many floor levels.
- Users can also use smart mobile devices to indicate the location at which their cars are parked so that they can quickly find them.

Due to the rapid development of modern technology, traditional telephones and mobile phones have gradually been replaced by smart mobile devices. The rise of smart mobile devices has brought many benefits to our daily lives. The diversified applications of such devices provide us with various and more convenient ways of living (Muhammad, 2010, David, 2012, Zhengwei, 2011, Papapetrou, 2012). This study planned a system of city parking integration through the use of smart mobile devices, cloud computing technologies, and the global positioning system (GPS) combined with parking navigation services and parking reservation services to improve on the lack of parking navigation systems and the resulting inconvenience. The system was set up to achieve the following:

1. Allow users to quickly search for nearby parking lots with vacant parking spaces available before arriving at the destination.
2. Allow users to use smart mobile devices to make parking reservations so as to avoid users arriving at the parking lot to find that it is full.
3. Allow users to use smart mobile devices to immediately obtain information on the parking lot and find the most suitable parking space when driving into 3D parking lots with many floor levels.
4. Users can also use smart mobile devices to indicate the location at which their cars are parked so that they can quickly find them.

LITERATURE REVIEW

In the past, parking lots only provided the number of vacant parking spaces at the entrance, leaving drivers to spend a lot of time searching for parking spaces in the parking lot. More recently various navigation systems have been developed to guide drivers to vacant parking spaces. Parking navigation systems currently available in the market can be categorized as follows: (1) infrared detection systems; (2) image detection systems; and (3) smart parking card systems.

Infrared detection systems

In these systems, infrared sensors are placed above parking spaces to scan and see if there are any obstacles in the parking space. When there are vacant spaces available, the green signal next to the infrared sensor will shine; when spaces are occupied, the red light will shine. That way, users can identify and head towards the locations of vacant parking spaces by observing the red and green signals.

However, users can only obtain information on vacant spaces within visual range, so infrared detection systems are unable to assist drivers in finding their cars.

Image detection systems

Image detection systems are installed at the entrance and on parking spaces. The ones installed at the entrance are mainly used to record the images of license plate numbers of cars entering the parking lot, which are then saved in their parking cards equipped with RFID tag and sent to the vehicle retrieval searching system so that when drivers are searching for their cars they can touch their parking cards to the vehicle retrieval searching system installed on each floor, and the screen will read the license plate number image in the parking card. Then, the system will compare and analyze all the license plate numbers and display the results on the screen, and provide the best route to retrieve cars.

By using this method to retrieve cars, all the cars in the parking lot should be compared and analyzed, which requires complex calculations and takes up a lot of time. Moreover, there is only a certain amount of vehicle retrieval system function that is available on each floor, so during peak hours, when too many people are waiting to retrieve their cars, it will result in long queues and waiting time.

Smart parking card system

Load-cell sensors are installed to each parking space in the parking lot to detect if the parking space is available and send the information to the parking card system. Then, the parking card system will print the information on the parking card and the card will print out the map of the floor, mark the location of the parking space, and provide the best route. After all the information has been sent, users can quickly find a parking space on their parking card and retrieve their cars when leaving.

Although the Smart Parking Card System provides users with a convenient way to find parking spaces and retrieve cars, the parking spaces are provided by the parking system center according to information on vacant spaces, so users are unable to choose themselves, and the information may vary depending on the time it takes users to park their cars. Therefore, the parking card cannot be reused.

System design

The city parking integration system planned by the current study mainly uses a parking guidance system and parking navigation system as the basis to achieve a convenient, interactive, and real-time integrated service.

City parking integration system

The city parking integration system combines parking guidance system and parking navigation system to connect and integrate various parking servers and system center with cloud server. After calculating users' location after storage, the computing power of cloud servers calculates five parking lots with available parking spaces closest to the user and sends this information to users' smart mobile devices

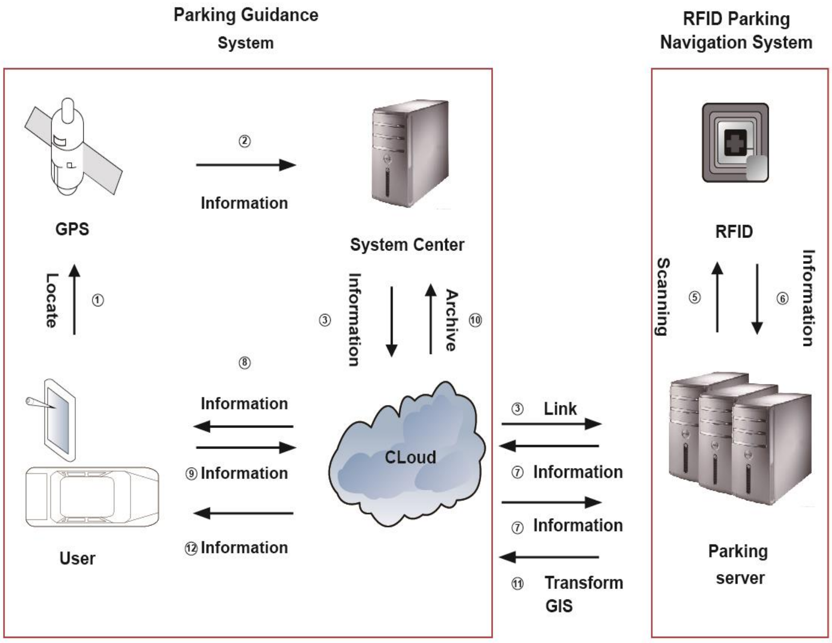

Figure 1. Diagram of the establishment of the city parking integration system

so that users can get hold of nearby parking lots and available parking spaces via smart mobile devices.

The structure of the system is shown in Figure 1. Users can turn on the applications of smart mobile devices and use global positioning system to send location information to the cloud computing system. Then, each parking server will send the parking information scanned by the RFID system in the parking lot to the cloud computing system, which, after comparative analysis, send the five closest parking lots with available parking spaces to users' smart mobile devices, allowing them to choose the most suitable parking space. Users can reserve parking spaces after choosing, and the cloud computing system will then send the reservation information to the parking service to complete the reservation process. This information will also be filed and saved in the system center. Users can obtain information of the parking lot via GIS and smart mobile devices so as to find the best parking space in the shortest amount of time.

The detailed procedures are as follows:

1. Users install the application on their smart mobile devices and turn on the application before finding a parking lot. The application will then begin to detect the location of users via GPS.
2. After GPS detects the location of users, it will send related information to the mobile device and location information to the system center for storage before sending it to the cloud server.
3. When the cloud server receives users' information and location, it will begin to search for five parking lots nearby and connect to the parking server to

make sure that the parking lot has vacant parking spaces.

4. The parking server will receive request from the cloud server for vacant parking spaces, and send the information scanned by the RFID so that the cloud server can send the information back to users.
5. After turning on the RFID system in the parking lot, a reader installed on each floor can locate and scan the parked cars and then send the scanning results including the number and location of parking spaces to users as a reference for choosing parking lots.
6. The scanned parking information will be sent to the parking server for filing and storage, which allows users to fully understand information on the parking lot, reduce the cost and manpower used for parking lot management, and to send the information to the cloud server for storage.
7. Once the cloud server receives information on the parking lot, parking lots with vacant parking spaces and location information of users will be compared and analyzed to select five parking lots closest to the users. This information will then be provided to users as a reference. If there are less than five parking lots with available parking spaces, search scope will be expanded until a number of up to five parking lots are found.
8. After users receive information on the parking lot, mobile devices will display the number and location of parking spaces inside the parking lot and use the application to reserve parking spaces from the parking lot they chose.
9. Users can send the reservation and user information online to the cloud server via mobile devices. Then the information will be connected to the system center for searching and comparison and to determine if the user information is correct and does not appear more than once.
10. After receiving the reservation and user information, the cloud server will send the information to the parking server of the parking lot they chose for reservation. Then, upon receiving the information, the parking server will reserve the parking space for users.
11. Before users enter the parking lot they will be required to take a parking card (tag) by the entrance so that the RFID system installed in the parking lot will detect and locate the parking card. The parking server will then receive the location information of users and begin to determine the coordinate positions of the target location, which will be sent to the cloud computing system for storage and calculating.
12. The cloud computing system will simultaneously save, record, and transform information to convert the information it received into GIS format to send to smart mobile devices. The GIS system will display different pictures depending on if the car is moving or not for users to refer to when planning the way that want to go. Users can obtain information on the number of cars and facilities and equipment of the parking lot using their smart mobile devices.

Parking guidance system

Due to the prevalence of smart mobile devices in today's society, more and more people are using applications on mobile devices to solve daily problems. As a result, the application market is also heading for a gradually increasing growth. There is also a wider variety of applications, so the integration system of applications has become even more important.

The current study integrated the applications installed on smart mobile devices with Google Map. We used GPS to identify the location of users and the cloud computing system to determine the location of parking lots nearby users as well as the number of parking spaces available in the parking lots. Lastly, the cloud database will report the results to users and the system center, as shown in Figure 2.

The detailed procedures are as follows:

1. Once users download the application on their smart mobile devices, they need to turn on the application before finding a parking lot. When turned on, the

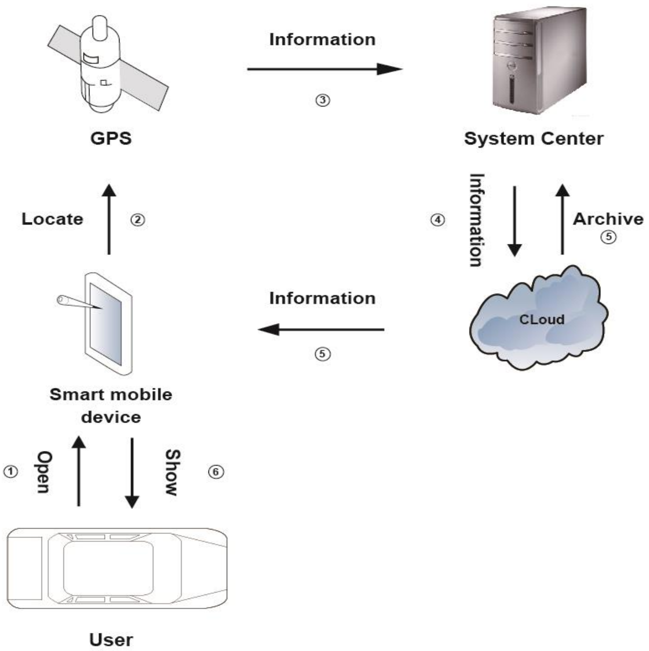

Figure 2. Diagram of the establishment of the parking guidance system

GPS will also be activated for location service.

2. Signals will be sent to the GPS after users turn on the application on their smart mobile devices, which will then display information such as "waiting to connect", etc.
3. After the GPS receives the request from the application on users' smart mobile devices it will begin to detect the current location of the device before sending out related messages to the mobile device and to the system center for filing and storage.
4. The system center will record users' location information and establish usage records and send them to the cloud computing system for storage and calculating.
5. After the cloud computing system receives the message from the system center, it will save and calculate the information on users and parking lot. The cloud computing system will compare and calculate related information on the current location of users and the parking lot to find five parking lots closest to users. This information will then be sent to users' mobile devices and system center for storage.
6. Users have to wait for the GPS to finish locating after the application on the mobile device is turned on before receiving information on vacant parking spaces in nearby parking lots via the cloud computing system and heading towards the parking lot closest to their destinations.

RFID parking navigation system

Recently, the use of smart mobile devices in daily life has become more and more common. People can download different applications on their mobile phones to solve little problems in life. Due to the variety of applications nowadays, the integration of the system and applications of smart mobile devices has become increasingly important.

The current study established a parking navigation program that can be applied to smart mobile devices combined with an RFID system, GIS system, and cloud computing technology. This structure used parking cards (tag) handed out to drivers when entering the parking lot to install a RFID-radar system in the parking lot for scanning. The scanned information was then sent to the parking server for filing

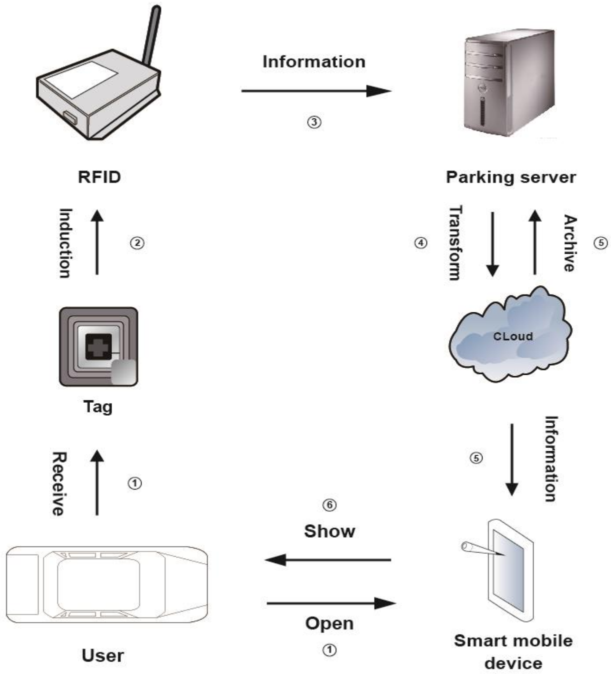

Figure 3. Diagram of the establishment of RFID parking navigation system

before being sent to the cloud computing system for storage, calculating, and converting into GIS format. After calculation and conversion of GIS were completed, the information was sent back to the parking server and users' smart mobile device again. After users enter the parking lot they can see the converted GIS image on the application they downloaded onto their smart mobile devices so that users can know their current location, vacant spaces in the parking lot, and moving vehicles as a reference for deciding on a route to take to the parking space. The detailed procedure is shown in Figure 3.

1. When users arrive at the entrance to the parking lot, they will be given a parking card (tag) with a unique binary digit so that the scanner can identify different users. Users are also required to download the application to their smart mobile devices and turn it on when entering the parking lot.
2. After users receive their parking card and enter the parking lot, the RFID system installed in the parking lot will begin to detect and locate the parking cards of users and other vehicles.
3. The parking server will receive the location information of users sent out by the RFID system and then begin to determine the coordinate positions of the target location. This information will then be recorded and sent to the cloud computing system for storage and calculation.
4. After the cloud computing system gets the message from the parking server, it will start to save and convert the received information into GIS format before sending it to smart mobile devices. The GIS system will display different images depending on whether cars are moving to serve as a reference for users when planning their route.

5. The GIS messages sent to the smart mobile device provide users with a reference for planning a route and are also sent to the parking server for storage and parking lot management, making it convenient for them to manage and reducing labor costs.
6. Users turn on the application by this system on their smart mobile devices and wait for the RFID system to complete locating, and then begin to drive into the parking lot. The GIS messages converted by cloud computing technologies are used as a reference for planning the route to users' parked cars. GIS information also provides users with information such as the entrance, emergency exit doors, and public facilities of the parking lot.

SYSTEM EFFECTIVENESS ANALYSIS

The current study used smart mobile devices and cloud servers to plan a set of city parking integration system to complete a platform with satellite navigation, indoor navigation, event data recording, route reference, parking information, and city parking services. This chapter explains how to make good use of value and convenience of the functions of smart mobile devices, how to connect to cloud servers via smart mobile devices, how to use RFID functions to enhance the accuracy of indoor positioning, and how to integrate city parking service and system center to enhance the service.

System analysis

Integration of cloud computing technologies

Cloud servers possess strong calculating abilities and a lot of room for storage. We used this distinguishing feature to save users' information and information of the parking lot in the streaming server after the cloud server has recorded it to set up a list for future reference. In addition, streaming servers also establish and read map information, which are established by reading and comparing the current location of users and parking lots with spaces available to produce information such as suggested parking lots and routes. Users can also reserve parking spaces from parking lots chosen by the cloud server. After the parking space is reserved, the information will be saved in the streaming server and related information on users will be sent to the system center of the parking lot to complete the reservation procedure. Users' information are identified and compared after entering the parking lot, then the map information of the parking lot that users take are calculated and converted into geographical messages and sent to smart mobile devices for users to refer to.

The current study aims to achieve the following through the combination of cloud servers:

1. Reduce the immense burden caused by calculation required by back end system processing.
2. Use the distributed computing function of cloud servers to calculate users' location and parking lot information to analyze the best parking information for users.
3. Use cloud servers to reserve parking spaces and digitally convert and send the reservation information to streaming servers and parking system for storage and future references.
4. The simulation and establishment of GIS need distributed computing of cloud servers for large amount of calculation and conversion function for completion.
5. Digitally convert the number of parking lots, parking spaces in parking lots, distance, and road statistics and send to streaming servers for storage and future reference. When related information is needed, users can read digital

information for searching.

RFID application

RFID-radar can identify and locate long-distance targets, emphasizing the importance of the target location as well as locate the positions of many tags. The time required from when the signal is sent from the tags to returning to the reader is used to measure the distance so that the system can measure the bearing and distance between the tags and readers more accurately. In addition, systems are able to accurately control all the vehicles in the parking lot to provide users with a reference for finding parking spaces and thus reducing the time spent during searching.

The current study aims to achieve the following through the application of RFID:

1. Using wireless network and infrared rays for indoor positioning is unable to locate the location of users accurately. RFID positioning and tracking system mainly uses the only characteristic of RFID tags on the object to accurately determine the location of the object based on the reader and radio frequency inter-communication signals.
2. Infrared rays are only limited to short-distance transmission. RFID can identify and locate long-distance targets and multiple targets.

Integration of city parking service

In the past, parking lot management systems only provide the remaining parking spaces in the parking lot and are unable to show users the exact location of vacant parking spaces and guide them. However, services for finding parking lots in the city and guidance services after entering the parking lot are necessary for users. Services include finding parking lots near users' destination and finding parking spaces in the parking lot. These problems we face and have to deal with in life require users to spend even more time finding parking spaces. Therefore, this system used integrated system service center to integrate city parking servers and analyze and compare the current location of users to find five parking lots with vacant parking spaces nearby for users to choose from. Users then enter the parking lot they chose and the indoor positioning system locates the available parking spaces for users. The location information is then converted to images as a reference for users to turn to when planning a route.

System effectiveness

This study used problems that exist in previous research on parking navigation system, indoor positioning, GPS, smart mobile device application, and cloud computing technologies to combine smart mobile devices, cloud servers, and city parking services to achieve the beneficial results of problem solving. The city parking integration system by this study has the following advantages compared to current parking lot management systems:

1. Compared to general parking search systems, users not only can obtain information on the location of parking spaces through their smart mobile devices, they can also get information on the parking spaces available in the parking lot.
2. Compared to general parking search systems, users can use their smart mobile devices to directly make reservations for parking spaces after finding a parking lot so as to avoid other drivers from finding the parking space before users arrive at the parking lot.
3. Compared to infrared indoor positioning systems, users can locate multiple targets from a longer distance without being limited by distance and worry about being interrupted.
4. Compared to ultrasonic indoor positioning systems, this city parking integration system is relatively lower in cost, reducing the fee required for

Table 1. Comparison of this system and current parking navigation systems

	This System	Infrared Detection System	Image Detection System	Smart Parking Card System
Real-time	Yes	Yes	No	No
Speed of finding parking spaces	Fast	Fast	Slow	Fast
Speed of retrieving cars	Fast	Slow	Fast	Fast
Monitor management	Yes	No	No	Yes
Setup cost	Low	High	High	High
User cost	Low	Low	Low	High
Maintenance cost	Low	High	High	Low
Additional services	Yes	No	No	No

consumables and maintenance.

5. Compared to general parking lot management systems, users can now get information on the location of vacant parking spaces via smart mobile devices rather than just the amount of parking spaces available, and also have routes to refer to when heading towards the parking space.
6. Compared to general GIS, calculating the parking spaces in parking lots no longer requires a lot of hardware, thus effectively reducing the cost and time spent and applying dynamic GIS.

System Analysis

This section explored and compared the establishment of this system and the three parking navigation systems, infrared detection system, image detection system, and smart parking card system. The results are shown in Table 1.

Detailed comparison is shown below:

Read-time

This system and infrared detection system can both implement real-time detection on cars leaving a parking lot so that information on the available parking spaces in the parking lot can be quickly updated. The image detection system and smart parking card system both require for cars to leave the parking lot before updating information.

Speed of finding parking spaces

This system uses smart mobile devices to fully obtain the number of parking spaces in a parking lot and arrive at ideal parking spaces users have chosen. The infrared detection system uses the red and green light above parking spaces to show users the location of the parking space. The smart parking card system displays the parking space and route on the parking card handed to users when entering the parking lot so that users can follow the route on the card to the parking space.

Speed of retrieving cars

This system uses smart mobile devices to display the location in which their cars are parked to speed up the time of retrieving cars. The image detection system uses parking cards (RFID tags) to display the parking location of cars and route to retrieve cars after touching the search system. The smart parking card system directs drivers to the parking location to retrieve their cars according to information shown on the parking card.

Monitor management

This system uses RFID indoor positioning information so that parking lot managers can fully grasp the situation in parking lots, monitor parking lots, and also reduce labor cost. For the smart parking card system, load-cell sensors are installed on each parking space to detect if cars are parked on the space. The scanned information is then sent to the management end. However, managers are only able to obtain information on vacant spaces; they cannot monitor the situation in parking lots.

Setup cost

This system established facilities mainly to setup and maintain positioning systems. Other related system hardware is only needed during the preliminary stages, so there is no other burden cost. The infrared detection system and image detection system are designed for short range detection so high-density advertising design is required to ensure the detection accuracy; thus these two types of detection systems require high setup costs. The management end of the smart parking card system needs to acquire information of the vacant spaces in a parking lot and display this information on the parking card to direct users to the parking space. Therefore, a load-cell sensor must be installed on each parking space to completely control the situation of each parking space (vacant or occupied).

User cost

This system uses smart mobile devices owned by users themselves so no additional costs and time spent for installation are needed. Other systems distribute parking cards as a basis for parking, so users do not have to worry about cost and spending time for installation.

Maintenance cost

This system only need to maintain the consumables of positioning systems, so maintenance costs can be saved. The infrared detection system and image detection system both locate multiple devices and therefore require higher maintenance cost.

Additional services

This system, in additional to navigation, also provides additional services that help users find parking lots with available parking spaces and reserve parking lots, while the infrared detection system, image detection system, and smart parking card system only provide navigation services inside parking lots.

CONCLUSION

Due to the rapid development of technology, the use of smart mobile devices and their applications has become increasingly common. The conveniences these technologies provide have also brought about the development of a variety of applications. In recent years, small urban areas have become more densely populated; therefore, this study planned a city parking integration system based on smart mobile devices and their applications so that parking management systems can offer other services, such as navigation and reservation functions, beyond simply providing the number of vacant parking spaces.

The current research ultimately aims to achieve real-time, convenience, and integrity of services to increase users' willingness to use the services and compensate for the insufficiency of systems in the past. Moreover, we also aim for users to be able to simultaneously use satellite navigation, indoor navigation, event data recording, route reference, parking information, and parking reservations through the system service to achieve the goal of using one device to accomplish multiple tasks. By doing so, users can quickly search for parking lots in the city and park their cars on the most suitable parking space in a short amount of time after entering large three-dimensional parking lots. Whether users are looking for parking lots, looking for a parking space, or retrieving their cars, smart mobile devices are able to direct users to their destinations using images. People living in urban areas no longer need to use different devices to solve different problems.

In this system, parking management systems not only provide users with the number of vacant spaces, they also provide real-time information on parking lots and guide users to open parking spaces, as well as reduce costs for labor management and positioning facilities. Furthermore, this system provides local governments with traffic flow information recorded by each parking lot as future references for planning and building parking lots in urban areas.

REFERENCES

Andrea, B., Matteo, D., Gian, M., & Giovanni, S. (2012). Enhancing eucalyptus community cloud, Intelligent Information Management, 4(3), 52-59.

Dakkak, M., Nakib, A., Daachi, B., Siarry, P., & Lemoine, J. (2011). Indoor localization method based on RTT and AOA using coordinates clustering, Computer Networks, 55(8), 1794-1803.

David, W., Jason, S., & Ming, C. L. (2012). Transforming GIS data into functional road models for large-scale traffic simulation, Visualization and Computer Graphics, IEEE Transactions, 18(6), 890-901.

Donato, W., & Pescapè, A. (2012). Cloud monitoring: A survey, Computer Networks, 57(9), 2093-2115.

Jaselskis, E. J., & El-Misalami, T. (2003). Implementing radio frequency identification in the construction process, J. Construction Engineering and Management, ASCE, 129, 680-688.

Juan, J., Alcaraz, Egea-López, E., Vales-Alonso, J., & García-Haro, J. (2011). Dynamic system model for optimal configuration of mobile RFID systems, Computer Networks, 55(1), 74-83.

Jürgen, B. (2008). Prototypical implementation of location-aware services based on a middleware architecture for super-distributed RFID tag infrastructures, 19th International Conference on Architecture of Computing Systems, 155-166.

Luis, B., & Alain, A. (2012). Design of a performance measurement framework for cloud computing, Journal of Software Engineering and Applications, 5(2), 69-75.

Moussa, T., Justin, Y. S., & Abdallah, K. (2012). Towards auction-based HPC computing in the cloud, Computer Technology and Application, 3(7), 499-509.

Muhammad, U. I., & Samsung, L. (2010). Privacy implications of automated GPS tracking and profiling, Technology and Society Magazine, IEEE, 29, 39-46.

Papapetrou, E., Vassiliadis, P., Rova, E., & Zarras, A. (2012). Cross-layer routing for peer database querying over mobile ad hoc networks, Computer Networks, 56(2), 504-520.

Pingley, A., Yu, W., Zhang, N., Fu, X., & Zhao, W. (2012). A context-aware scheme for privacy-preserving location-based services, Computer Networks, 56(11), 2551-2568.

Sarangan, V., Devarapalli, M.R., & Radhakrishnan, S. (2008). A framework for fast RFID tag reading in static and mobile environments, Computer Networks, 52(5), 1058-1073.

Su, L. (2008). RFID technology and some of its new applications.

Tsai, K. W., Yan, C. S., Huei, L. E., & Chang, C. K. (2012). A privacy-preserving grouping proof protocol based on ECC with untraceability for RFID, Applied Mathematics, 3(4), 336-341.

Zhengwei, S., Lun, W., Xiaolu, J., YeZhi, H., & Zhiyuan, Q. (2011). A visualization framework for cloud rendering in global 3D GIS, Geoinformatics, 19th International Conference, 1-4..

◈◇◈