Auditor Quick Dispatching Algorithm Practicing for iParking System

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Abstract: Intelligent Parking System (iParking) is an O2O realtime parking operational platform. Its roadside units work with Internet of Things (IoT) concept. It can not only conduct online payment, parking guidance, parking reservation, etc. to customers but also provide precisely monitoring and convenient management for the service provider. This paper particularly aims at describing its auditors' quick dispatching algorithm and simulation. The auditors work on the duty of ticketing to the vehicles whose owners are missing to register for occupying parking slots online. The fundamental algorithm applies Greedy algorithm combining with First in, First out (FIFO) principal. Take early start as the target and short working hours as secondary create the dispatching model.

Keywords: Intelligent Transportation System, Intelligent Parking System, Internet of Things, Dispatching Problem

1. Introduction

In recent, all kinds of technological advances. People prefer to make things become intelligent, for example on a toll road, traditionally tolls were paid by hand at tollgates. Although payments may still make exchange in cash, it is more common now to pay by credit card, by pre-paid card, by pre-paid ticket, and now an electronic toll collection system (ETC) is the mainstream of development. In terms of roadside parking, generally manual and parking meter are the main way of charging. These two methods have some disadvantage. Manual charging has high manpower cost and easily making mistake and affected by the weather condition. Parking meter set at the roadside, it is a conspicuous target for those who are malicious and this resulting in high failure rate. Moreover, both of them cannot accurate record parking time.

This is paper will first address how to use the concept of IoT building a parking operational platform which is intelligent for whether customers or operators. Secondly, this paper focus on proposing a quick auditors' dispatching model, which designs to accomplish the

parking auditor assignment.

In summary, through this system not only the customer will become more convenience while parking but also the operator can increase working efficiency and reduce costs.

2. Related work

Mahendran and Harris (2016) propose a cloud based system through detectors, which set at each parking slots, to get parking slots' status by using ultrasonic sensor. Then the status collected by the detector will transmit to the server. This system will provide an mobile app let user finding free parking slots in his parking area while provide available parking slot reservation service.

Adki and Agarkhed (2016) build an IoT device which monitor parking slots by using Light Dependent Resistor sensors (LDR). This IoT directly published message to the client through Message Queue Telemetry Transport (MQTT) protocol and connected with cloud through WiFi. Through this IoT device service provider can provide available slots inquiry, and parking slot reservation.

Guatieri, Badaracco, Defilippis and Barrettino (2016) design a parking sensor using pulse induction sensor monitoring parking slot and sending data to PC by ZigBee module. Their design completely immune to environmental factors like: water, snow, dirt (tree leaves), changes in the earth's field and temperature. And the sensor can work without changing battery for 1.5 to 3.4 years (depend on different measurement interval time setting).

These previous research carried out by many researchers to provide information about nearby parking areas by using different kinds of sensor and communication module. Some of them delivered these information to the driver and to make the reservations using end terminals like PCs, smartphones, etc. Some of them provide a charged reservation service and others have free reservation and online payment service. Their idea provide the service to their user but lack of the method for service provider to operate the system. This problem motivated to design a method for missing piece of operation of the intelligent parking services.

3. Intelligent parking system

First, this platform is named as Intelligent Parking System hereinafter referred to as iParking system. Figure 1 reveals the whole system architecture.

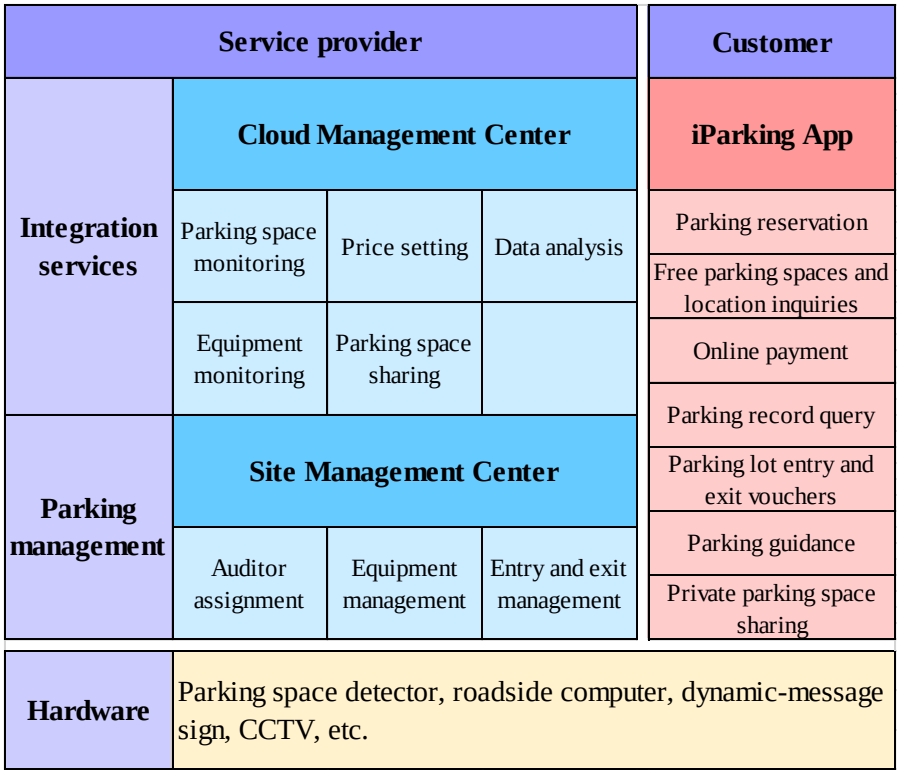

Figure 1. Intelligent Parking System Architecture

The system core includes four parts. First, Cloud Management Center, which is the backbone of the system, will receive the data update from detector and responsible for parking slots and equipment management. Cloud Management Center will record the use of time and the length of parking duration in the database. Therefore, through this database the manager can carry out some data analysis.

Second, iParking App is a communication interface between system and customers. It provides several services, include parking check-in, parking reservation, free parking slots and location inquiries, online payment, parking record query, parking lot entry and exit vouchers, and parking guidance.

Third, Site Management Center communicate with the Cloud Management center through the internet. Main task is to solve the problem which must to visit the site, such as detectors' replacement and maintenance, issuing parking ticket for those who didn't check-in or register for parking slot occupying.

Fourth, Hardware include parking slot detector (PD), roadside computer, dynamic-message sign, CCTV, etc. PD is the eyes of iParking system, responsible for detecting parking slots' situation and update data regularly. Figure 2 Can see each components interactive relationship.

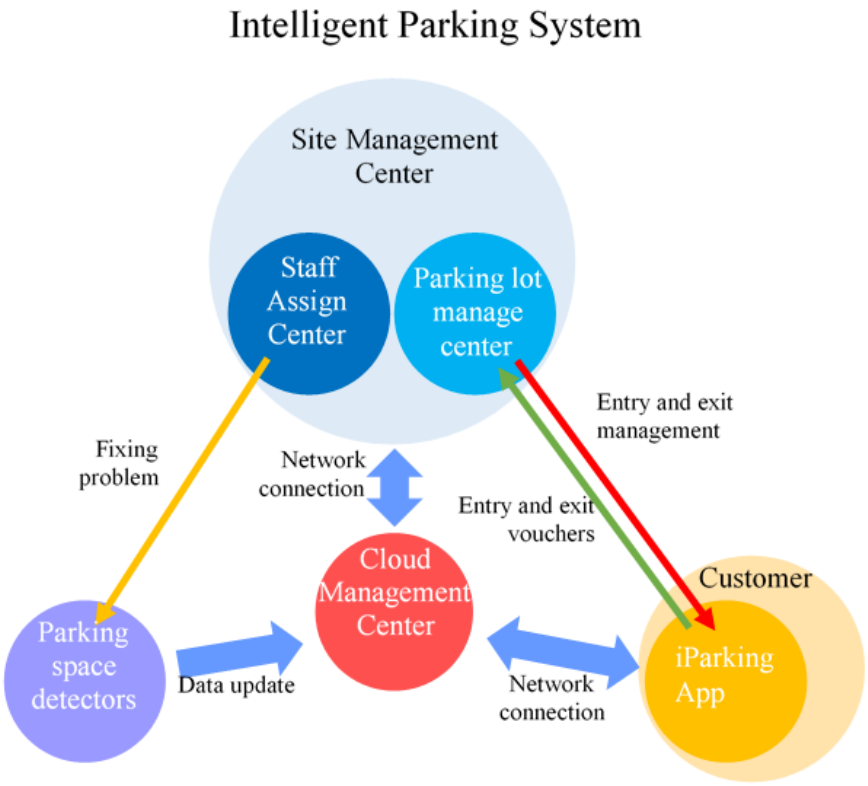

Figure 2. iParking system operating interactive relationship

4. Auditor dispatching problem

In Taiwan, currently auditors' working process, shown in Figure 3. The work is a highly repetitive and monotonous work. If we using iParking system (system operate process see Figure 4.), we have no need to check those invariant parking slot repeatedly. What we need to do is only issue a parking ticket to those customers who did not use iParking APP to register the occupying. Moreover, we can sure when the APP becomes popular, the auditors' workload will getting reduce.

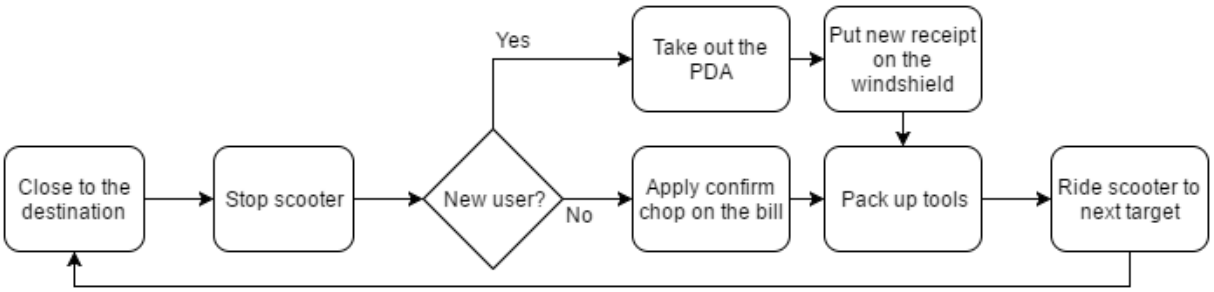

Figure 3. Current auditor working process

Combine Figure 2. and Figure 4, we can see that while the customer parking without iParking App, system can find out which parking slot didn't check-in through comparing the check-in data with variate parking slot. Therefore, now we know where have problem need to be solved. The question is how to assign the work to suitable auditor?

In assignment/ dispatching problem, there are several ways to solve the problem, like Hungarian algorithm or solve a Minimum-cost flow problem. However, we consider not only a good solution but also high operability and high instantaneity. Herein, we consider using Greedy algorithm combine with FIFO (First in, first out) to establish the dispatching model.

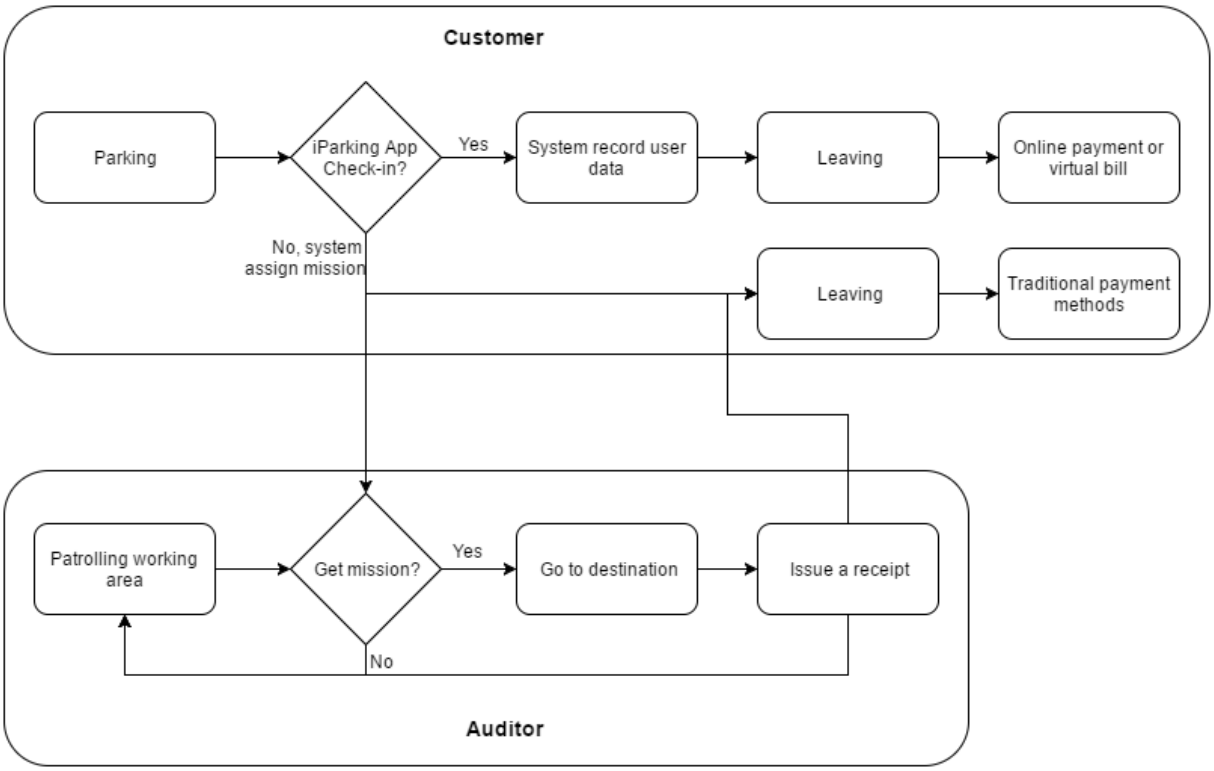

Figure 4. iParking system operate process

5. Dispatching model

First, the model follows several principles below.

1) Based on the principle of FIFO, system will store and assign works in sequence.
2) Consider who is the fastest start the work.
3) Consider who has the shortest new work expected working hours.
4) Consider who can be the fastest to complete the work.
5) Consider who have the smallest employee ID number.

Besides, in Figure 4, we can see that when the customer parking without using iParking App, the system will call an auditor attempt there and issue customer a ticket. In detail, this

action is because system cannot compare parking detector's update data with any customers' check-in/ register data. And, when it comes to the detectors maintenance term, they are the same situation. The proposed operation sequence is as follows (Figure 5).

Step 1: Sort all auditors on duty by current work expected completion time.

Step 2: Pick up several auditors on duty, who can finish current work faster than others and save as a waiting list.

Step 3: If there is an auditor can the earliest start the work and the fastest finish the work, assign the work to this auditor. If not go to step 4.

Step 4: If the worker who can earliest finish current work have the latest new work finish time, choose the second earliest and go to step 6, if not go to step 5.

Step 5: If there are several auditors can earliest finish current work at the same time, assign the work to who have the shortest new work expected working hours. If they have same new work expected working hours, assign the work to the auditor who has the smallest Employee ID number. If not go to step 7.

Step 6: If there are several auditors can second earliest finish current work at the same time, assign the work to who have the shortest new work expected working hours. If they have same new work expected working hours, assign the work to the auditor who has the smallest Employee ID number. If not go to step 8.

Step 7: Assign the work to the auditor who can earliest start the work.

Step 8: Assign the work to the auditor who can second earliest start the work.

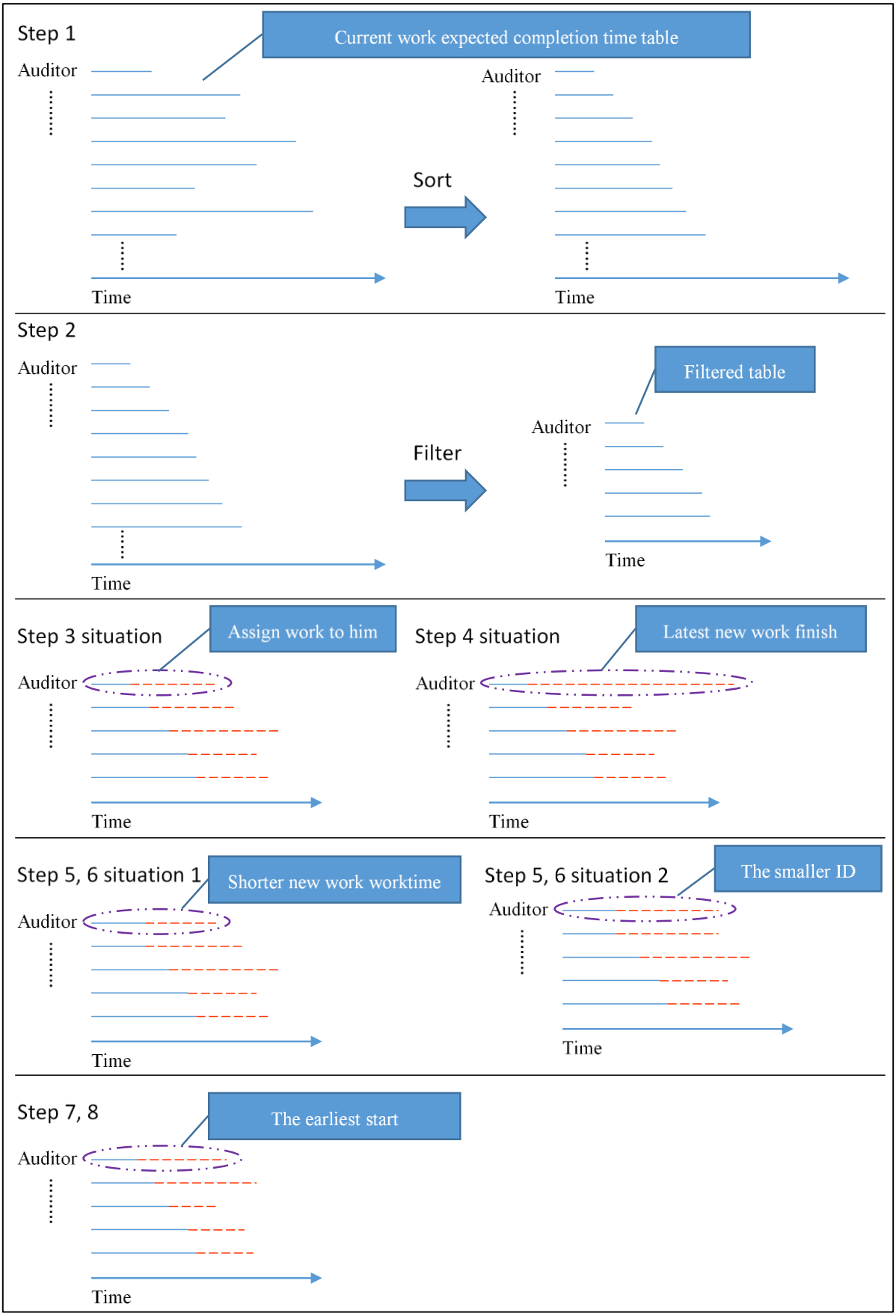

Figure 5. Operation sequence

6. Case study and Evaluation

In Figure 6 the colored line are the location of roadside parking slots, and different color represent the responsible area for different auditor. Each area have about 150~160 parking slots and the auditor will check through the area every 30 minutes. The differences between current method and iParking system solution are compared below.

Have a closer look in Figure 7. Here is an example, in the figure location A and B are the position of the auditor. Location C and D are the slots that a new user who just park his car, and C is 1 minutes earlier than D.

Current method, the auditor have fixed patrol path, patrol path of orange area shown in Figure 8. In Figure 7 case, the distance of A to D and D to C are 550m and 300m. And there are 80 parking slots between A and D, 4 parking slots between D and C. Assume that each parking slots average working time is 8 second and the auditor's travel speed is 20 km per hour. The auditor from A to D ticket the new user need about 740 second, and from D to C need about 86 second.

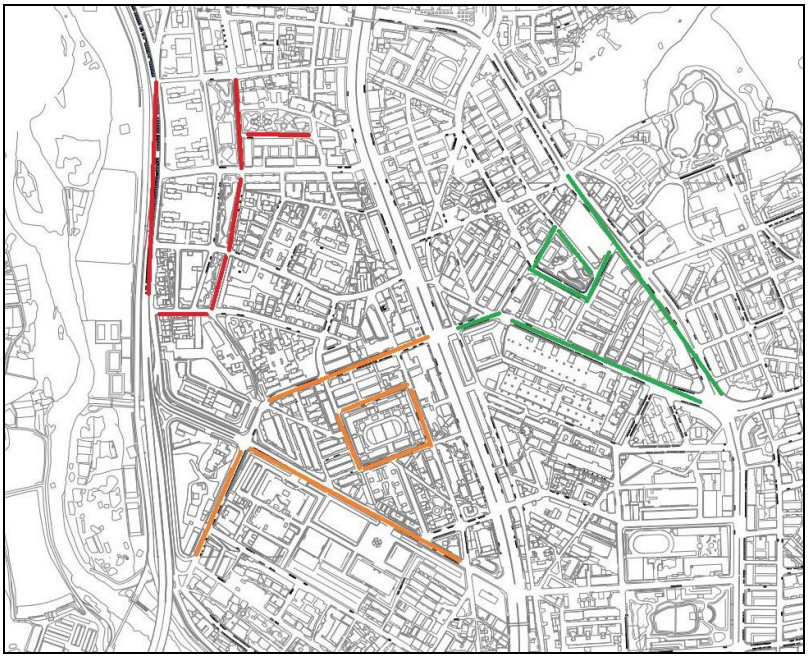

Figure 6. Current method's auditor work area

Figure 7. The example of comparison of two method

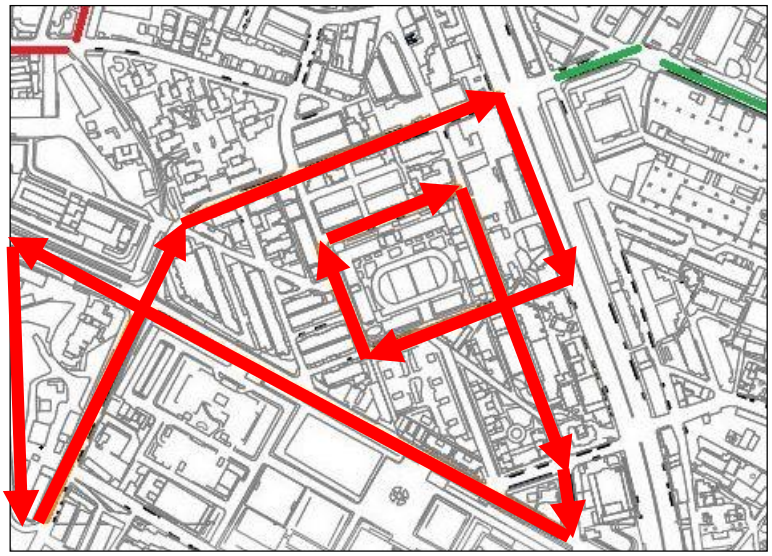

Figure 8. Patrol path of orange area

Using iParking system, Assume that both auditor are both free now.

First, step 1 and step 2, the both auditor can start the work at the same time. Than step 3 who can earliest finish the work, see Table 1.

Table 1. Work time of auditors in current method

	Distance to C	Travel time	Worktime	Total time
Auditor at A	500m	90 sec	20 sec	110 sec
Auditor at B	450m	81 sec	20 sec	101 sec

For work at location C, the system will assign the job to the auditor who at location B. And 1 minutes later a new work appear at location D. At this moment, auditor at B need 41 second to finish current work but auditor at A is free now. So the system will assign the job at

D to auditor who is at A now. And the distance is 550m, work time is 99 second.

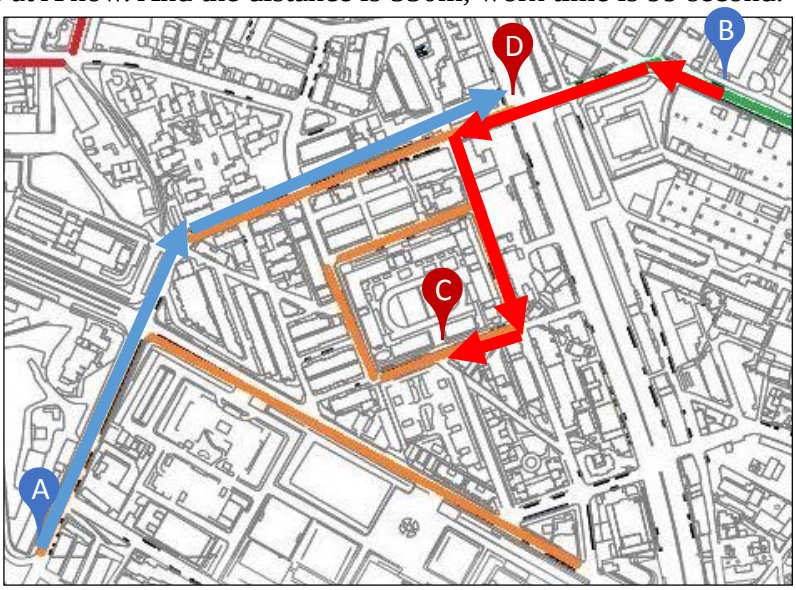

Figure 9. iParking system assignment

Compare two methods, we can see the Table 2 below.

Table 2. Two methods results

	Location C work time	Location C auditor	Location D work time	Location D auditor
Current method	740 sec	Auditor at A	826 sec	Auditor at A
iParking system	101 sec	Auditor at B	99 sec	Auditor at A

We can faster process the work than current method. Because of iParking system's time saving, the auditor respond larger area than using current method.

7. Conclusions

The iParking system can not only provide customers an intelligent parking service but also help parking service provider easier manage parking lot. Furthermore, iParking system can also reduce staff demand.

If the iParking system and the iParking App can widely promoted, the operator may have save the demand of parking auditors as well as reduce the manpower expenditure. Besides, the operator can also set dynamic parking fare rate through the iParking system to promote the use and turnover of parking slots. iParking system will serve in commerce in short coming future.

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