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NFC based parking payment system

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Abstract:
All people want to improve their quality of life and this can be achieved only by technology. Many problems are faced by daily vehicle users in payment based parking systems, both in open air parking system where the parking is done along the streets and in closed parking system where parking is done in closed infrastructure added with entry and exit points.

Delays (long queues) and accuracy in fares are the main problems faced by the users. Many solutions are proposed to solve this problem but all have their own drawbacks. In this paper a new solution is proposed based on Near Field Communication (NFC) which makes the payment system reliable and easy.
Keywords: NFC, Closed parking, Open parking, Parking Payment.

I. Introduction:

The number of vehicle users especially car is increasing rapidly year by year along with the parking areas especially in cities. Nearly 40 to 50% of the families have their own vehicles and apart from this there are tourist cabs and taxis. Number of parking areas has also been increased not only in cities even in towns where some tourist attraction places are there.

In cities and tourist places parking is provided to users with fees. There are some free parking areas provided by the governments in public places but the safety of the vehicle which is parked in those free parking areas is not assured. So many people are ready to spend some money for safety of their vehicles.

In our normal day to day life, lots of problems have been faced due to the payment system in parking's. During peak hours a long queue will be created due to payment delay and also there is chance for miscalculation of parking fees may occur. And it's not that safe to carry cash to all places and using credit cards and debits in all locations may welcome cyber thieves and it is also not safety to use our cards in unknown places.

To avoid all these problems and to make the life a lot easier and simpler a technique is discussed in this paper which uses a smart phone embedded with NFC technology in it.

II. What is NFC?

Near Field Communication (NFC) is a wireless communication technology which operates at a frequency of 13.56MHz and transceives the data between two NFC enabled devices within few centimeters at the rate of 424Kbps. NFC is an advanced version of Radio Frequency Identification (RF-ID) and which combines the operation of both smartcard and reader.

Generally NFC applications are based on smart phones enabled with NFC technology. Nowadays many smart phones are enabled with NFC technology. Some applications of NFC are purchasing travel ticket and its payment, as electronic keys for vehicles and houses, as identification device combined with a smart phone.

Since NFC is a short range communication technology, it can be assured that this technology is more secured when compared with other communication mechanisms such as radio frequency identification, infra red and Bluetooth.

Two different communication modes are there in NFC namely active and passive communication mode. An active mode device generates its own RF field whereas a passive mode device has to be powered by using the RF field of an active mode device and data transfer will be done by using load modulation.

In table 2.1 the mode of communication between two NFC devices are illustrated.

Communication Mode	Explanation
Active mode	When two active devices communicate with each other
Passive mode	When an active device and a passive device communicate between them

Table 2.1 Communication modes

In active mode of communication two active devices are able to communicate with each other, whereas in passive mode of communication, the active device can able to communicate with many passive devices by using time slot method which uses single device detection (SDD). In passive mode there is a chance of collision which will be avoided by following listen and talk technique.

Since it is a short range communication method which will be operated within few centimeters the chance for hackers is also very minimal. Cyclic redundancy Check (CRC) is used by Near Field Communication devices as an error detecting mechanisms.

III. Existing system

Fee based vehicle parking can be divided into two types. One is closed parking which is infrastructure based and is equipped with entry and exit points. The steps which will be followed in this type of parking are explained below.

- The user arrives at the entrance point and receives a ticket from the person who is at the entrance which contains the time at which the user entered.
- The user parks the vehicle in the parking area.
- After finishing his works, he comes back to his vehicle and picks his vehicle and goes to the exit point and shows his ticket which he collected at the entrance point.
- In exit point the authorized person will calculate the fees based on the time printed on the ticket and then the user has to pay the amount and then he can leave the place.

For initial looking everyone may think that this is the best system but still it has his own problems which are listed below.

- Delay: Some amount of time will be wasted during the printing and reading of tickets at the entrance and exit points of the parking. During normal times it will not be a big problem. But during peak hours and festival times, this delay may create longer queues.
- Payment: The person who is the exit point may do some mistake while calculating the exact fee for parking. If the user identifies it then some argument may occur between them which are not good. If the user doesn't notice it then the accuracy of the system becomes a big question.
- Payment delay: It's not that much safe to carry cash always with us and if the person at exit point doesn't have change to give to his customers and again this may create delay which in turn causes large queues.

The second type of parking is on open air type in which the parking is done along the streets. In this type of parking there will not be any entry or exit points. The main problem in this type of parking is its very difficult to identify whether the user is paying or not for the parking. The steps which will be followed in open type of parking are explained below.

- The user arrives with his vehicle to the parking area and parks in an empty place or wherever he wants.
- Then the fee collector person has to come near to the vehicle and has to collect the fees if it is a fixed rate parking system or gives a ticket which contains date and time.
- After finishing his works the user comes back to the vehicle and shows the paid ticket to the fee collector if it is fixed type parking system or he has to show the ticket to the fee collector and he will say the amount based on the time parked
- Then the user has to pay the money and has to leave the parking area.

The problems in open air type parking are listed below.

- Delay: After parking the vehicle the user has to wait for the fee collector which may lead to some delay. If more mare vehicles arrive at the same time then it may lead to longer delay.
- Payment: It's not safe to carry cash to all places especially to tourist spots. When the user pays the fees to the collector he may expose his cash to the public which attracts the thieves towards him. If the fee collector doesn't have exact change to give to user then it creates longer delays.
- Identification: During rush hours, function times or festival days large number of vehicles may come to this type of parking places. During these times it's very difficult to identify which user has paid and which user hasn't. And also it's not possible to ask all the users whether they paid the fees or not which may create big problems.

In both type of parking's if the user of the vehicle misses the ticket then it will become more difficult for both users and fee collectors. In this type of situation the fee collectors usually charge more money from the user which is around ten times more than the actual fee.

IV. Proposed System:

All the problems mentioned in the above two cases can be solved technologically. NFC is far better when it is compared with other technologies in terms of contactless ticket generation and secure payment by using mobiles.

V. Closed type parking:

The proposed solution is based on a NFC enabled phone which is going to be used as an access device to the parking and then as a payment device also. Apart from the NFC enabled phone some other devices are required to develop the system. Those devices are; two NFC readers, one at the entrance point and other at the exit point, and a kiosk which will be used to recharge the virtual money from the users debit or credit card to NFC phone.

The procedure for entering the parking area using NFC technology is explained below.

- The user arrives at the entrance point in his vehicle and shows the NFC enabled phone to the reader at that point.
- The reader reads the data from the phone such as ID of the phone which will be stored as an identifier to identify the user.
- Along with the identifier the other parking data's such as date and time at which the user enters the parking area will also be stored.
- Then the entrance point will be opened and the user can enter the parking with his vehicle and parks it.

The user parks his vehicle by following the above procedure and after finishing his works, reaches the parking area and arrives at the exit point with his vehicle and follows below listed procedure.

- The user shows the same phone to the reader at exit point which he showed at the entrance point previously.
- The reader reads the ID of the phone and searches for the previously stored data's such as date and time, based on the amount of time vehicle parked fare will be calculated.
- Then the reader checks whether the virtual money stored in the phone is enough to pay the fare or not. If it is enough then the system will automatically deduct the amount and the exit point will be opened and the user will be allowed to go out of the area.
- If the virtual money is not enough then the user will be advised to go to the near kiosk to recharge the virtual money. In the kiosk machine recharge can be done by using credit/ debit cards and also by using cash itself.

During the previous visits if the user is having low virtual money then the system displays the information which enables the user to recharge his virtual money which in turn will avoid unnecessary delays.

VI. Open air parking:

In open air type parking the NFC enabled phone is not going to work as an access device but instead it will work as electronic ticket and as payment device. The procedure which has to be followed in open air type parking is listed below.

- The user parks the vehicle in the parking area.
- The fee collector for that particular area will come near to the vehicle with the NFC reader and asks the user to show his NFC enabled phone to the reader.
- The NFC reader reads the ID of the phone and stores the data's such as time and date accordingly.
- Now the user can leave his vehicle and leaves the parking area.
- After finishing his works reaches back to his vehicle which is parked and again the fee collector will come near to the vehicle.
- Then the user has to show the same phone which he showed previously.
- The system searches the previously stored data and calculates the exact fare based on the amount of time parked and deducts the exact fare from the virtual money which is stored in the phone if the phone has sufficient balance in virtual money and the user can leave the place.
- If the virtual money is not enough then the user has to go near to kiosk and has to recharge his virtual money.

VII. Conclusion:

The proposed solution solves all the problems which are described in existing system part by using NFC technology. The proposed solution works very well especially for closed type of parking's. Since all system is of electronics, delay will be reduced largely and the fare will be exactly calculated and collected from the users without any mistakes. Even though the system does not suit well for open air type of parking still the proposed solution is far better when compared to the existing systems. Based on time the exact fare will be calculated and will deduct the same from the user. The problem of carrying cash and exact change issues will be removed. If the fee collector is having a doubt on a particular user whether he paid the parking fee or not, then the fee collector can ask the user to show his phone to the NFC reader which will inform whether the user has paid the fee or not. The only limitation is the fee collector has to come near to the vehicle in proposed system as like existing systems.

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