Intelligent and Standardized Parking Solution

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Summary

Due to the increasing number of vehicles and urbanizations, managing parking has become an issue. One main reason is that the current infrastructure facilities are not efficient enough to manage increasing demand. Although there are several systems to solve this issue, standardization and interoperability has not been achieved yet. Therefore everyone has to subscribe or use parking systems according to the service provider's proprietary systems. On the other hand, providing prior information about idling parking lots and navigation towards the idling parking lot in controlled entrance parking blocks, and preventing illegal parking and automatically enforcing parking regulations in free entrance parking lots hasn't also been achieved yet. In this paper we will introduce a novel RFID tag architecture and composition that can solves the most of the current parking issues while realizing potential benefits in intelligent transportation systems. The proposed solution allows real time, efficient, effective and hassle free parking systems, enables dynamic parking management, provides information and directions on idling lots, automate collecting of charges and prevents illegal parking in both free entrance and controlled entrance parking lots.

Key words:
Intelligent Transportation System, RFID, Parking Management System.

1. Introduction

Modern parking requires seamless integration of different areas, personnel and vehicle management, data processing, billing and accounting in order to provide high quality, efficient services to the customer [1, 2]. Similarly it is necessary to allow standardized usage for customers without adopting several proprietary systems.

There are two main types of parking lots: free entrance parking lots and controlled entrance parking lots. Free entrance parking lots do not have any entry control system or locking system to enforce the rules and regulations [1, 3]. Some of them even do not use any mechanisms to collect money. Parking lots in highways, along the main streets, hospitals and government service centers comes under this category. Mostly these types of parking lots are governed by the city offices or the government. Main concepts in this type of parking lots are to manage the traffic and allow smooth and efficient services to the consumers without expecting much economical benefits [3, 4].

Controlled entrance parking lots are the parking lots that are mostly aiming to achieve the economic benefits. They are installed with one of the well known entry control mechanisms at the point of entrance and exit to monitor and control the incoming and outgoing vehicles. Most of these parking lots are run by commercial companies. The main concepts of these parking lots are to achieve the economical benefits and allow smooth and traffic control over the congested areas.

Aim of simplest parking management system is to managing parking lots by facilitating vehicle parking and collecting money according the price plan before leaving the lot. But if we use the proper technology combination with efficient and effective manner it opens up the possibilities beyond controlling and monitoring parking lots or collecting parking charges automatically.

Like in automated toll collection, automated parking management systems offer great benefits to owners, operators, and patrons. Some of the main benefits include reduced cash handling and improved back-office operations, high scalability, automatic data capture and detailed reporting, improved traffic flow at peak hours, improved customer service, cash-free convenience, and also provinces to arrange special privileges for VIP customers such as volume discounts, coupons, and other discounts for daily parkers.

One of the best candidate technology used in parking systems is the Radio Frequency Identification (RFID) technology because it enables carrying data in suitable transponders. A RFID system typically comprises of RFID tags and a tag reader that work together to provide a noncontact solution to uniquely identify objects tagged with RF tags. The non-contact short-range communication makes it suitable for implementing an electronic, automatic identification mechanism for vehicles at parking lots and toll gates. Hence industry is working on RFID based solution to improve parking systems enabling automatic parking and toll applications minimizing delays and hassles while providing efficient service to customers.

Once the unique ID in RFID tag is read the database system will check for its validity and allow vehicle to enter to the premises. When the vehicle leave parking premises vehicle is identified and billed to the pre-registered account by back office system. The advantages of this type of system include not only easy access for the customer, but the elimination of staffing at entry and exit points.

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Thus RFID enabled automated parking access control systems eliminates customers' need to fumble for change, swipe cards, or punch numbers into a keypad. Vehicles can move smoothly through controlled entrances, and more parkers can be accommodated, thereby increasing revenues. As there are no cards or tickets to read, the whole system is a convenient, hassle free and easy vehicle parking. Furthermore the delay time can be reduced to the minimum when entering and leaving the parking lots.

1.1 Existing Systems

Rasilant Technologies, EasyPark Solutions, PARKTRACK, Essen RFID, TagMaster North America, Inc., Macroware Information Technology, Infosys Solutions, TransCore, and ActiveWave are some of the leaders in the industry to provide RFID enabled parking management systems.

TransCore is one of the pioneers to provide parking access control systems which offer using RFID technology. They uses proven eGo® and Amtech®-brand RFID technology to deliver reliable, automated parking access control systems solutions. TransCore's parking control systems facilitate airport security parking and parking at universities, corporations, hospitals, gated communities, and downtown parking facilities.

ActiveWave is another company who provide such systems using RFID technology. In their system, surveillance cameras or video recorders can be triggered whenever a vehicle enters or exits the controlled area.

1.2 Motivation, Goal and Objectives

According to our study we found that there is no standard and interoperable solution developed to control both the free entrance and controlled entrance parking systems instead the trend is to commercial parking systems to improve their management process and customer convenience to achieve the maximum economical benefits. Though it is possible to request a customer to adopt the requirements of the commercial parking lot if they wish to subscribe their services, similar requests cannot be made to enforce the rules and regulations in the country by the city governing authorities or police to manage free entrance parking lots.

Additionally the companies who provide RFID based parking management systems are proprietary, and provide no interoperability. Almost all the cases they only uses unique ID to identify and billing the vehicles. Furthermore, they are unable to provide interoperability. Thus customers have to have different devices installed for different subscriptions such as one for electronic toll collection and another for parking access. Additionally no existing system provides support to enforce the rule and regulations of the country. Hence, all the existing and previously proposed RFID based parking management systems has no support towards the standardized and interoperable parking management systems for both free entrance and controlled entrance parking lots while providing the facility of rules and regulation enforcement of the country.

Thus we proposed novel tag architecture and its composition on vehicles to enable large array of applications in Intelligent Transportation Systems (ITS) including parking management systems. The proposed tag architecture involves new tag design and common communication platform to enable interoperability. This composition was made to fulfill the future needs extensively without creating any inconvenience to the service providers or to the consumers.

We strongly believe that this process should start at the time of vehicle manufacturing as it enables the standardized and interoperable systems. Therefore our architecture starts from the point of manufacturing.

The remainder of this paper is organized as follows. Chapter 2 describes the vehicle and its composition of tag and reader. The proposed solution is explained in Chapter 3. Potential Applications of the proposed architecture in ITSs are described in Chapter 4. Finally the Chapter 5 concludes the paper with future works and remarks.

2 Vehicle and Its Compositions

For the first place, to work out the proposing method there should be a tag and reader installed in vehicle. To maintain the consistency and standard, vehicle manufacturers should install a tag and an interrogator (reader/writer) for each vehicle at the time of manufacturing. The tag, hereafter called vehicle tag should contain all the necessary information in ITS. Further more such tag should be secured and allow role base accessing methods to open up a large array of applications from manufacturing to recycling.

Since there is no such tag, we designed a vehicle Radio Frequency (RF) tag which could fulfill above requirement. A vehicle tag design supports various applications on intelligent transportation systems (ITS) including intelligent parking management system. It has role base accessing systems and almost all the required information in ITSs. Information stored on the tag can only be accessed by the authorized readers. Novel tag has four roles: public, friendly, protected and private. Each role protects the accessible information. Logical structure of the vehicle RF tag is illustrates in figure 1.

Figure 1. also illustrates the memory types, access modifiers, and respective keys of each role. Encryption algorithm used hers is AES-128 stream cipher. Vehicle tag contains methods, data “Initial”, AES-128 algorithm and processing module. A, B, C, and D represents the access modifier private, protected, friendly, and public areas. Four areas of the vehicle tag can be used as follows.

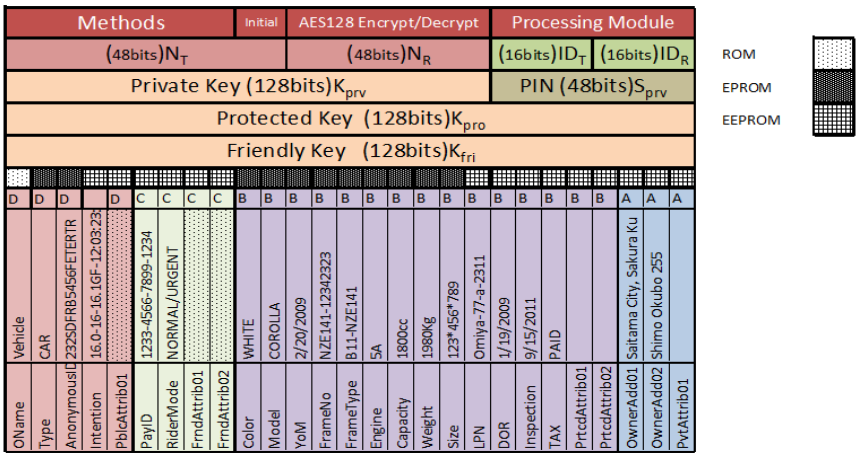

Fig. 1. Illustrate the logical structure of the vehicle tag.

Information stored in the public area can be read by any reader whereas the friendly, protected and private areas are secured with reading and writing permission. Only the vehicle owner who is granted with private role can, write in public area. Private role is also granted to read any attribute value of own vehicle's tag though the writings of protected attributes are restricted. The protected area is used by a government authority such as department of motor vehicle registration. Attributes in friendly area can be read or written only with the friendly key. The owner of the vehicle has to manage the friendly area in addition to private area. Therefore the owner of a vehicle needs to keep private key, friendly key and PIN with him. Private key and PIN are used to secure the ownership of the vehicle. If the owner needs to change some attribute value in friendly area such as his "WalletID", he must use the friendly key.

Vehicle tag generates nonce N_I whereas the reader generates three nonce values N_T, ID_I, and ID_T to carry out proper mutual authentication. In addition that three role keys and PIN are stored to ensure the security of data. Four areas of four roles are marked with A, B, C and D. Each area is used by different agents throughout the lifecycle of the vehicle.

Public area stores the object class name, type, anonymous ID, intention and customizable attribute called PblAttrib01. Information stored in this area can be used to understand object and its movements. Identifying those public information leads to create applications like collision avoidance, traffic signal management, vehicle to vehicle communication, road congestion management, road rule enforcements, driving assistant systems, etc.

Protected area stores the color, model, manufactured year, frame number and type, engine, capacity, weight, size, license plate number, date of first registration, inspection validity, and tax payment status. Additionally it also has got two customizable attributes named as "PrtcdAttrib01" and "PrtcdAttrib02". Information stored in this area is devoted to the vehicle governing authority. Therefore, after first registration the data stored in this area can only be manipulated by government authority. Protected information can be read only by the owner or police. Inspection validity, insurance, tax, etc. help to identify the current status of the vehicle. Recognizing illegal, fake, clone, stolen or altered vehicles, issuing fines for inspection expired vehicles, verification of tax payments, management of carrying garage, temporary and brand new vehicles are some of the main applications using this area.

Friendly modifier allows several services to be catered to the user in effective manner. This area stores the pay ID or wallet ID, rider mode, two customizable attributes named as "FrndAttrib01" and "FrndAttrib02". Information stored in this area can be used to subscribe variety of services provided by companies. Any registered service provider can use this information to provide the comfortable service to the vehicle user. Electronic fee collection systems like toll collection and parking can use "WalletID" to collect the fee only after prior registration with relevant authorities. Furthermore, the emergency vehicles like ambulances can use this area to prioritize traffic signals by using the value of "RiderMode" attribute.

Private area stores owner name, address and one customizable attribute named as "PvtAttrib01". Information stored in this area is to prove the ownership of the vehicle. No one can read or write data into this area without the permission of the owner. When the vehicle is sold the ownership information will be changed.

Unlike conventional RFID tag, vehicle tag can manage its access depending on four roles: public, friendly, protected and private. Thus it provides role base access control mechanism. Additionally, vehicle tag eliminates the necessity of accessing database by keeping its own data with it and thereby guarantees the stand alone

capability. Similarly such tag assures ability of self-describing using the characteristics and behaviors of RF technology. Furthermore the interoperability is guaranteed by providing the common communication interface. Therefore the plug and playability is supported using the above three main points allowing any actor in ITS to communicate with vehicle tag.

2.1 Communication Protocols

Vehicle tag has five main protocols: non-secure reading, non-secure writing, secure reading, secure writing and key updating. Transferring ownership of vehicle tag is a combination of above protocols. It is only used in authorized centers with the specific readers. Since the page limitation the details of the protocol passes are omitted here.

2.1.1 Non-secured (public) reading protocol.

Non-secure reading protocol is used for public reading. Any reader can query the public attribute values by passing the attribute name to the vehicle tag. For that attribute names of the given object class must be available for the reader to query the attribute value. For instance, attribute name list of vehicle class should be available with the interested readers, which can query "Type" attribute value from vehicle tag. Then the vehicle tag will answer with value "CAR".

2.1.2 Secured (private, protected and friendly) reading and writing protocol.

Each role attribute value should be managed securely. Only successful mutual authentication allows reading. Reading is only granted for authorized parties and they can only read the data which belong to them. To ensure security of each reading messages are encrypted with authorization key.

2.1.3 Secure Key Updating.

Unlike secure writing, it is necessary to confirm the keys to be updated before actual key updating because the communication will be impossible if a wrong key is set. Therefore, there are two more passes in this protocol other than secure writing.

2.1.4 Transferring the Ownership.

This process will be carried out by specific readers after deleting all the personal information of the predecessor and updating the ownership to successor without creating any security and privacy issues.

2.2 Lifecycle of Vehicle Tag

Very first step of tag lifecycle is creating fresh vehicle tag. Vehicle tag contains the vehicle class attributes. At the time of fresh tag creation only the "OName" and "AnonymousID" attribute values are filled with values. In vehicle class "OName" is "VEHICLE" and "AnonymousID" is a random unique number. Next the vehicle tag is passed to the vehicle manufacturer. Once the vehicle manufacturer receives the fresh vehicle tag instances, other relevant attribute values are filled according to the instance characteristics. For example Toyota may request 1000 vehicle tags to attached in brand new vehicles and then feed the instance attribute values such as vehicle type, frame number, engine etc. Additionally, three role keys and the PIN are set to manufactures secrets. Finally the tagged vehicles are passed to the dealers after transferring the ownership to them by changing those three role keys and PIN to deals own secrets.

When a customer bought a brand new vehicle from a dealer, first registration will be carried out. By that time the protected role key will be handed over to the vehicle governing authority while friendly, and private role keys with PIN will be changed to the customers' secrets by transferring the ownership. Since the customer has the friendly key to allow secure communication between desired service providers and his own vehicle, services like electronic toll collection, parking payments, gasoline payments, etc. can be subscribed easily.

During the usage of the vehicle customer may extend the validity of inspection period, pay taxes, etc. Then the relevant vehicle tag attribute values will be updated. When the customer needs to sell the vehicle to someone, ownership should be transferred by visiting the authorized centers' readers by protecting the predecessors and successors secrets.

When the customer decides to throw away the vehicle, cancellation of registration can be done visiting an authorized center and then pass the vehicle for recycling company. By the time of de-registration only the minimum required information will be kept and other information including personal data will be deleted to protect security and privacy of users. Then the recycling company also can use RF communication to improve their process of gathering information on recycling units. Note that each user's ability of writing is also controlled by using three memory types: ROM, EPROM and EEPROM throughout the lifecycle.

2.3 Expressing Intended Movement of a Vehicle

Using the above mentioned composition it is possible to detect the intended movements of a vehicle. This can be achieved only by retrieving the value of "Intention" public attribute on the vehicle tag. For this each vehicle should

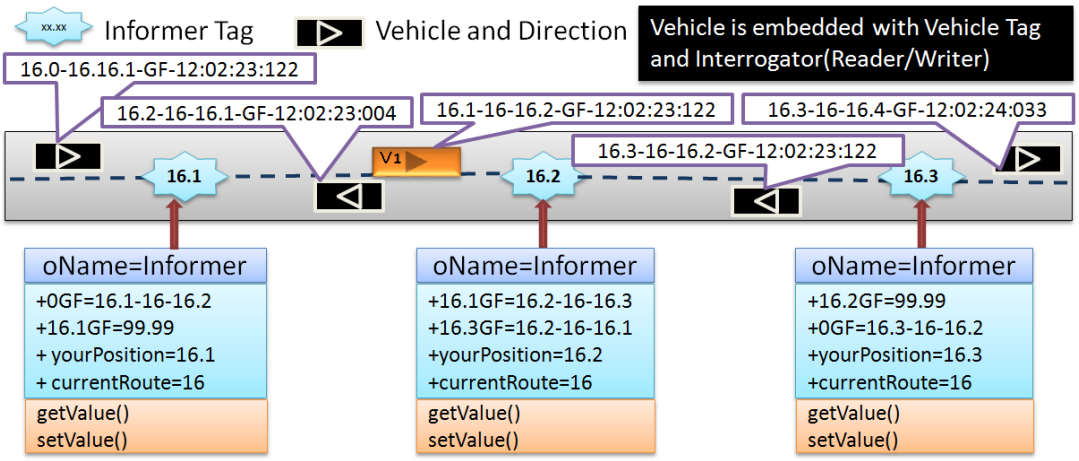

Fig. 2. Illustrate the identification layout of intended movements of vehicles.

express their intended movements to others at least within a given block or time slot. The following section explains how a vehicle can express its intention using a tag and interrogator.

Assume that there is another type of tag called Informer. Informer instances are positioned in the center line of the road in a way that can be read by vehicles running towards the both directions. Those tags contained the next target, current position, current route, and next crossing lane, etc. as shown in Figure 2. Once the immediate previous 16.1 Informer tag position is passed by a vehicle, intended action "16.1GF" of that vehicle is sent to the 16.2 Informer tag via the vehicle reader requesting the next target information. Then the Informer tag sends the next target information to the vehicle. If there is no previous Informer, the reader in the vehicle requests "yourPosition" attribute of first Informer tag to understand the current position.

When a vehicle passes the very first Informer, the interrogator in the vehicle gets to know the next immediate target. After that, the interrogator writes that information with intended action, running speed, and expected reach time of current immediate target and lane number if it exists, to the public area of the vehicle tag. If there is no lane number, or previous position information before the Informer, the predefined not applicable dummy values will be used to compose the intention attribute. Once the vehicle tag is filled with intention, it will start expressing the intended movements as shown in Figure 2. This process continues until the no Informer tag is found. Whenever changes happened to the values relevant to the parameters used to compose above message, recalculation is done and vehicle tag starts retransmitting the new message. For instance, if the speed is changed the recalculation is done and retransmission starts. A target message interpretation is represented in Figure 3.

Here the intended action is divided to eight categories: Turn Left (TL), Turn Right (TR), Go Forward (GF), Go Backward (GB), U-Turn (UT), Hazard Stop (HS), Emergency Accident (EA) and Parked (PK).

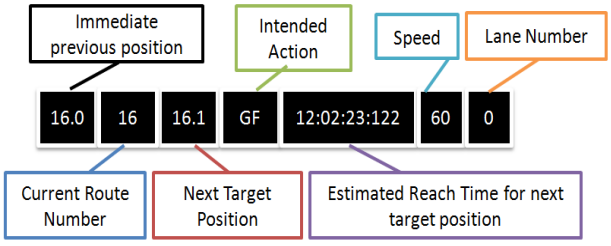

Fig. 3. Target message expressed by moving vehicle.

The message in Figure 3. is interpreted as a vehicle is moving over the route number 16 by passing the Informer position 16.0 and heading forward (GF) to 16.1. Current estimated reach time to the 16.1 is 12:02:23:122 and the vehicle is running at a speed of 60kmph in lane 0. Here the lane 0 means that the road 16 has only one lane for one side. Therefore as explained in the above message, one vehicle can understand the intended movements of surrounding vehicles and thereby collisions avoidance can be achieved when crossing an intersection and merging lanes.

3. Parking Management System

Once the vehicle tag and interrogator is installed into vehicles, optimal automation could be achieved in parking management system while providing better services to the customers.

Our aim was to develop a parking management system which works on both free entrance and controlled entrance

parking lots. To enable such parking management system it is necessary to identify the arriving and departing vehicles, detect the idling parking lots, support navigation towards the idling or reserved parking lot, bill parked vehicles, allow inquiring availability and reserve parking lot and enable enforcing of parking rules and regulations.

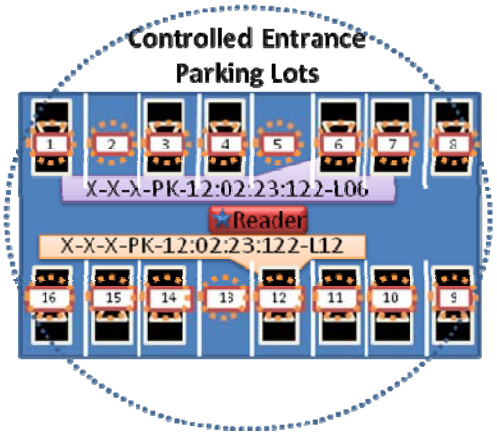

Fig. 4. Illustrate controlled entrance parking block numbers represents the Lot tags installed in each lot.

Figure 4 and 5 explained controlled entrance parking area and free entrance parking area respectively. Both of them should be equipped with Lot tag instances and Readers. Each Lot tag on each parking block is uniquely named. Since it is necessary to cope with the vehicles which do not have installed a vehicle tag and interrogator, sensing system is used to detect the occupancy of the parking lot. When a vehicle is parked to a parking lot, the sensor will check the occupancy and informed the control system that there is a car in its lot.

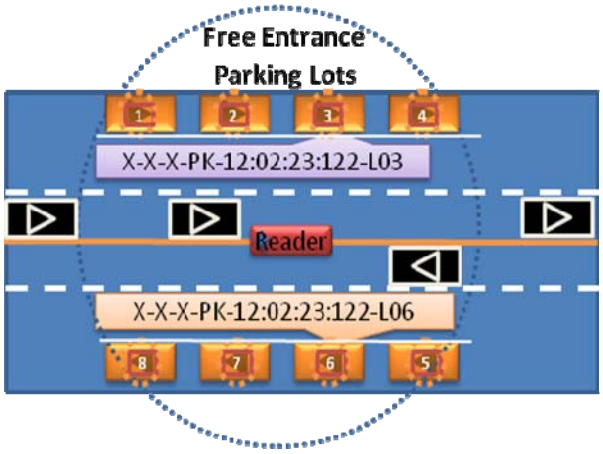

Fig. 5. Illustrate free parking area and the numbers represents the Lot tags installed in each lot.

3.1 Structure of the Lot Tag

Lot tag contains the following attributes to identify the lot number, occupancy and reservation information. Figure 6. Illustrate some of the key attributes of Lot tag.

Oname	Lot
LotNumber	1
LotFloor	2
LotStatus	Idle/occupied/reserved
Occupant	AnonymousID
StartTime	2009-April-13 12:06:25 PM
EndTime	2009-April-13 12:42:20 PM
ParkerID	1230u22hsdfoIJHFI23

Fig. 6. Illustrate key attributes of Lot Tag.

3.2 Identification of Arriving and Departing Vehicles

Automatic Vehicle Identification (AVI) is the solution to secure and convenient hands-free access control. In parking AVI is used to automatic identification of vehicles for safe access control and correct billing of parking fees.

There can be two main types of vehicles entering to the parking premises: pre-registered vehicles (service subscribers) and other vehicles. To subscribe the services provided by the park operator, vehicle must be equipped with a vehicle tag and interrogator. Such vehicles become service subscribers when they are registered with the park operators. On the other hand, vehicles that are not subscribed but installed with above composition can use most of the services other than automated parking fee payment. Pre-registered vehicles can enter and leave the parking lot without any hassle whereas others need to pick a ticket at the entrance to enter the premises and made the payment when leaving the premises by inserting the parking ticket like in existing systems.

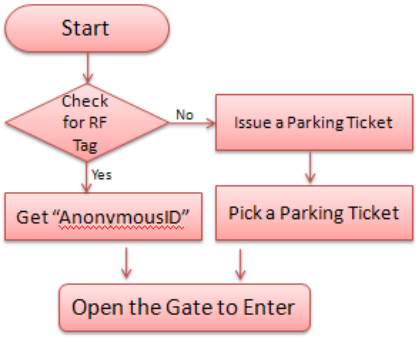

Fig. 7. Illustrate the flow chart of entering controlled entrance parking lot

A vehicle enter to the controlled entrance parking premises will first identify by its "AnonymousID" and check for the validation of the subscription and allowed to enter smoothly like in automated toll collection gates. If

the vehicle is not a service subscriber, parking ticket will be issued before opening the entering gate. Similarly the vehicles that are not embedded with vehicle tag and readers are also issued such ticket to enter the premises as shown in figure 7.

When pre-registered vehicle leaves the parking premises fee will be collected automatically and allowed to pass the gate smoothly. When charging the fee, pre-registered vehicle tag's "WalletID" will be read securely by using the friendly key and request the confirmation from the driver. Once the confirmation is given the credit limit will be checked and charged accordingly. Note that the "WalletID" attribute value will be taken from a credit card or debit card. Therefore drivers are advised to insert the card to vehicle tag system just before the payment to keep high security.

In free entrance parking lots, pre-registered vehicles are charged then and there by requesting confirmation whereas the others have to pay the money to nearby control box. If they neglect the payment fine can be issued as it is possible to identify the vehicle using "anonymousID" and "type" attribute values. Vehicles that are not embedded with such tag are still allowed to use the parking lot but need to make the payment manually.

3.3 Detecting Idling Parking Lots

Detection should be possible in both free entrance and controlled entrance parking lots. As shown in figure 4 and 5. each parking lot should be tagged with a Lot tag with a infrared sensor. Both the free and controlled entrance parking lots have to have a sensor to detect the unregistered subscribers or untagged vehicles. Whenever a vehicle is parked to the parking lot LotStatus attribute value will be changed to occupied status by the sensor as shown in figure 8.

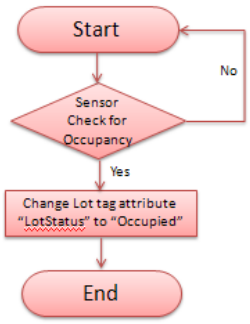

Fig. 8. Illustrate flow chart of sensing the occupancy of a parking lot.

When a tagged vehicle is parked to a lot, the reader in the vehicle read the Lot tag and writes its position to the intended movement message for expressing its action as explained in the section 2.3 and the figure 3. Here the last pass Informer, route number, next Informer may be blank as shown in the figure 4 and 5 messages. Then the control system can identify the vehicle in that particular parking lot as shown in figure 9.

The message in figure 5, "X-X-X-PK-12:02:23:122-L06" means that the car is parked (PK) in lot 6 and start time is 12:02:23:122.

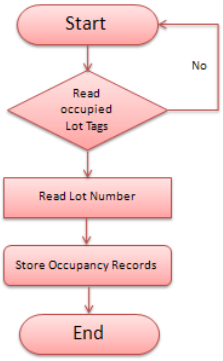

Fig. 9. Illustrate flow chart of identifying occupied lot number.

Then the interrogator in the center of the parking lot start reading the vehicle tag at the occupied parking lot and writes the start time to relevant Lot tag after verifying the vehicles identity by reading the "AnonymousID" as shown in figure 10. Same way when the customer leaves the parking lot, end time of the Lane tag is updated by the interrogator in the parking block. Just after leaving the place, billing will be started.

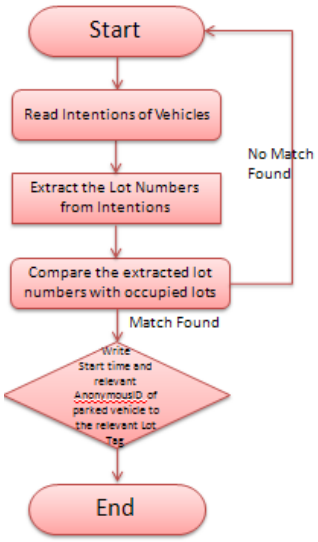

Fig. 10. Illustrate flow chart of identifying the parked vehicle.

Using the sensor installed in the parking lot and Lot tag, it is possible to detect the occupancy of the lot and thereby the idling lots can be identified in both free and controlled entrance parking lots.

3.4 Navigation towards the Idling or Reserved Parking Lot

Navigation towards the idling parking lots or reserved parking lots can be provided by proposed solution. For that the One Informer tag at the point of entrance and several Position tags must be installed strategically according to the shape of the parking block in addition to the lot tags with sensors. Figure 11. illustrates a parking block with Informer, Position, and Lot tags and their placement strategy example for such shape.

Just after passing the main entrance gate vehicle meets the Informer tag and read the destination details including the idling lot. After that the vehicle meets a position tag and asks for the directions. For instance when a vehicle get the idling lot number 21, direction provided by the position tag is go straight and turn after 2nd position tag. When the 2nd position tag is passed the idling arrow to the left can be depicted with the log number 21. This way it is possible to arrange the navigation assistance system towards a given parking lot.

When a vehicle needs to reach the reserved parking lot, reserved lot number must be given to the reserved vehicle by reading its "AnonymousID". Writing to Informer tag at the entrance gate must be completed just before the reserved vehicle come closer to the Informer tag.

Irrespective of the subscription, when a vehicle with vehicle tag and interrogator enters to the parking premises, guidance to the closest idling parking lot can be provided. Note that the reservations are only possible with controlled entrance parking blocks.

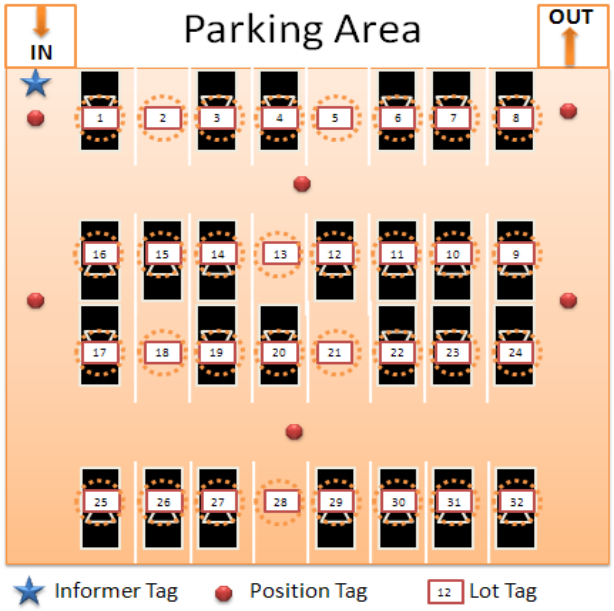

Fig. 11. Illustrate parking area and infrastructure setup for navigation towards the reserved or idling parking lot.

Vehicles that are not having vehicle tag can not be guided instead the ticket can be printed with available parking lot numbers to assist finding an idling parking lot and also to reduce the traffic congestion inside the parking block.

3.5 Billing of Parked Vehicles.

Process of billing differs to two ways in controlled entrance parking blocks. If a customer is a service subscriber, parking management system can read the "WalletID" from their vehicle tag. Parking charge can be calculated according the time frame and the discount options available to that vehicle. Then the system read the "WalletID" and charged. Note that the customer should set the "WalletID" attribute value by inserting a credit card. If there is no enough credit to make the payment, customer may pay the full amount or the rest by cash to fulfill the payment. Once the payment is successful gate will be released automatically enabling smooth and fast exit. The other way is for the customer who has not subscribed the service. They must make the payment before leaving the exit gate by card or cash.

When it comes to the free entrance parking lots, everyone is treated same irrespective of the subscription. The billing process here works on the unique combination of the "AnonymousID" and "VehicleType". In these lots, there is no restriction applied before leaving since the billing will be done later in the month to the owner or to the driver if it is a rental vehicle. But if a rule is breached, a fine will also be issued with the bill. For patrons subscription of free entrance parking can also be done after prior registration.

3.6 Inquiring Availability and Reserving Parking Lots.

Checking availability of a parking lot can be achieved by integrating the parking system to a web based system which can be access via system in vehicle, mobile phone, or over the web. Dynamic update of idling lots should be passed to such integrated system to make this information available. This is a merit to the park operator as it acts as sort of advertising on their business. On the other hand customers are provided with enough knowledge to find the suitable parking lot without any inconvenience even while driving. Once the customer found a suitable parking lot, reservation can be done through the same integrated system.

Reservation is allowed only with controlled entrance parking lots. Once the instruction to reserve a parking lot is received from integrated system, the "status" attribute of the Lot tag in a parking block will be filled with the value "reserved", with the expire time. If the time expires same vehicle cannot reserve another lot in the same company

within the same day instead vehicle has to be present or there may be an option to extend the reservation by making an extra payment. On the other hand, Lot tag itself inform other vehicles about its reserved status by expressing value of "LotStatus" attribute value as "reserved" as shown in figure 6.

3.7 Enforcing of Parking Rules and Regulations

Enforcing rules and regulations had become a serious issue and big overhead to the government authorities. So far there were no automated system to enforce parking rules and regulations. Instead there are checkers or police officers to find the illegal parking. Difficulties arise in both free entrance parking lots are greater than the controlled entrance.

Mainly it is necessary to prevent illegal parking. Illegal parking can be defined as parking in no parking areas and roadsides. By this system the vehicles can be informed if they stop in no parking area or no parking roadsides to prevent illegal parking. If they do not adhere to the rules, vehicles can be identified automatically and fined accordingly. In addition to that some vehicles may use some free parking lots beyond the permitted number of hours. Using proposed composition it is possible to detect such parking and fine accordingly.

Other scenario is the misusing of reserved, elderly, and disabled parking lots. These scenarios can be detected through the proposed system and pre-inform or warn the drivers to avoid such misuse. This way the discrepancies can be eliminated and thereby unnecessary expenditures can be reduced.

3.8 Web based Parking Management

Citywide parking blocks can be integrated to one central system to pass their idling lot information and price plans. At the same time there must be province to make the reservation. Once such integration is made a driver can made reservation desired or closest parking block to their destination. Each park operator must update their status whenever the changes happened attract more customers. Thus the drivers are provided with real time information to take better decisions by reducing the air pollution and unnecessary traffic congestions.

Furthermore, the web based system must provide interface to check the availability and status of parked vehicle even using a portable devices like cell phone. In addition to this the web based system must provide support to take decision on multi mode transportation options to assist the drivers to take the best possible decision when reaching their destinations. For instance the web based system may suggest the driver with several options when reaching a given destination by different modes of transportations even with easy and economical parking options.

3.9 Benefits of the Proposed System.

The benefits of proposed parking management system are specific to the stakeholders involved: drivers, park operators and jurisdictions.

The benefits that drivers can enjoy are reduction in time spent looking for parking and placing vehicles even inside a parking premises, reduced frustration, prior understanding of idling lots, ability of prior reservation, gaining the easy access up to parking lot, assistance towards the idling or reserved parking lot, easy payment, no need to roll down window, swipe card or punch key pad, can stay inside a locked vehicle and drive through non-stop exit gates, no cash involved, Increased traffic flow during peak hours and support on multi mode transportation.

Park operators can gain increase in patronage, customer satisfaction, optimize space usages, categorize and manage individual parking lots automatically and associated increase in revenue, identify true demand, change prioritizations dynamically, charge according to the individual parking lot, manage disable and reserved parking lots, prevent improper parking, manage seasonal demands with increasing density, gain advantage on marketing of idling lots through city wide integrated web based city wide parking management system, increase in patronage and customer satisfaction, charge automatically, provide secure access control, support VIP customers and issue discounts to attract customers reduce back-office operations, and analyze utilization systematically .

The jurisdiction can manage disable and elderly parking lots automatically, prevent improper parking, reduce monopoly and enable decentralizations, improved traffic flow, reduce sound and air pollutions, assist in enforcing rules and regulations, reduce in the number of patrons circulating through the street network looking for a parking spaces, and also illegal parking on local streets or no parking areas.

4. Potential Applications with Embedded Vehicle Tag and Interrogator

As explained in chapter 2, the ability of interrogator and tag composition in vehicle allow other possibilities too. Some of the main possibilities of them are vehicle to vehicle (V2V) communication and vehicle to infrastructure (V2I) communications.

4.1 V2V and V2I Communication

When a vehicle is installed with a RF reader and an active tag, it become an intelligent agent enabling V2V

and V2I communication. Thus this composition enables large array of applications to improve future ITSs. One of the main applications is collision detection.

Prior detecting collisions at intersections can prevent fatal accidents or injuries. If one vehicle can understand how other vehicles' move, the collisions can be detected. Though the prior detection is very important, guaranteeing the avoidance is not an easy task but the consequences due to collisions can be reduced.

4.4.1 Detecting Collisions.

Collision detection at intersection is briefly discussed here and the same method can be used to avoid collisions when merging with different tag installation strategy. Once the road infrastructure is installed with 9 Informer tags each vehicle can express its intended movements to other vehicles. For instance vehicles moving towards the intersection express their intention as explained in section 2.3 figure 3. Therefore one vehicle can understand how other vehicles are moving and what will be their next movement.

In each vehicle's system screen, real time representation in aerial view can be shown to understand the movements of the surrounding vehicles. Since the real time calculation is done and also every change is calculated once change occurs to any of the parameters used to create the intended movement message, reach time of each vehicle can be estimated accurately. If two or more vehicles are reaching a same target by the exact time, there is very high possibility to collide them. Therefore once the reader in the vehicle could understand such situation, the driver can be warned or asked to take precautionary steps to avoid the predicted collision.

In case of turning vehicles, the message explains their intentions by setting the composed value with TL or TR. Therefore most appropriate decision can be taken while realizing smooth, safe and fast crossing of intersections.

4.4.2 Prioritizing Emergency Vehicles.

Suppose there is a reader in the intersection traffic signal post and it knows the friendly keys of the emergency vehicles. In an emergency situation the vehicle tag in emergency vehicle can change its "RiderMode" attribute value to "URGENT" to describe its urgency. When an emergency vehicle is reaching the intersection, the public attribute values of Intention and the Type describes its intention and the type to surrounding readers. Then the reader in the intersection signal post can understand the vehicle type and intention of the emergency vehicle. If the vehicle type describes one of four emergency vehicles such as ambulance, rescue, fire brigade or police, signal post reader will check the urgency by reading emergency vehicles "RiderMode" attribute after carrying out proper authentication using the registered friendly keys. If the verification process could pass, the signal post reader understands the situation and change the color to green depending on the intended moving direction of the emergency vehicle to pass the intersection as fast as possible.

On the other hand drivers in the normal vehicle are informed that the emergency vehicle is approaching using vehicle to vehicle communication described in above sections. Thus they can cooperatively help to pass the emergency vehicle without any tension, delay or accident.

4.4.3 Improving the Traffic Signals.

Varying traffic volumes during the peak hours and midday makes it very difficult to enhance traffic signals. Similarly the areas that experience heavy traffic congestion, needed traffic signal timing improvements to implement effective traffic flow as well as air quality and fuel consumptions. Currently several methods are being used to detect and count the vehicle coming towards the intersection. Several systems are capable of monitoring the traffic arrivals and adjusting timings based on the detected inputs. Traffic detectors may range from metal detectors, infrared readers, image detectors, etc. Metal detectors are the most popular in use though they provide minimum information. Image detection devices exhibit numerous problems including degradation during bad weather and lighting.

Consider that there is a reader who has a reading distance of 100 meters radius is installed in the traffic signal post. All the vehicles are embedded with vehicle tag and they are expressing intended movements. By reading this message the reader in the traffic signal post understands the number of vehicles, in its range, their intended directions and the number of vehicle types including the availability of emergency vehicle or common transportation units such as bus, etc.

Depending on the policy of the country, traffic optimizing algorithm can be implemented considering above knowledge. Unlike in other conventional intelligent traffic systems, an extra knowledge can be mined and that knowledge can be used to optimize the traffic signal adaptively because vehicle tag can provide detail information to take a better decision. Additionally if a tag is installed in the signal and set to describe starting and ending phases of transition to incoming vehicles, vehicle stopping can be made smooth and collision due to misinterpretations can be minimized.

5 Concluding Remarks

A novel RF tag design, common communication protocols and composition on vehicles are proposed to achieve the intelligent and standardized parking management system. This system can manage free entrance and controlled entrance parking lots and assist enforcing rules and

regulations automatically while providing better services to the drivers, car park operators and also for the jurisdictions. In addition to that some of the potential applications on collision detection in intersections and merging points, traffic signal prioritizing for emergency vehicles and enhancing intersection traffic signals are discussed to justify the resource usage.

Since this composition can solve the most unsolved issues in parking management and provide interoperable, intelligent and standardized usage, no doubt that proposed system become a better parking management system enhancing the future of ITS.

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