Smart Parking Applications Using RFID Technology

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Abstract - There has been a considerable amount of reduction in transaction costs and decrease in stock shortage with the use of Radio Frequency Identification (RFID) technology in automation. Most of the RFID networks include a wide range of automation technologies. These technologies are RFID readers, RFID writers, RFID barcode scanners, RFID smart sensors and RFID controllers. In this study, a solution has been provided for the problems encountered in parking-lot management systems via RFID technology. RFID readers, RFID labels, computers, barriers and software are used as for the main components of the RFID technology. The software has been handled for the management, controlling, transaction reporting and operation tasks for parking lots located on various parts of the city. Check-ins and check-outs of the parking-lots will be under control with RFID readers, labels and barriers. Personnel costs will be reduced considerably using this technology. It will be possible to see unmanned, secure, automized parking-lots functioning with RFID technology in the future.

Check-ins and check-outs will be handled in a fast manner without having to stop the cars so that traffic jam problem will be avoided during these processes. Drivers will not have to stop at the circulation points and parking tickets will be out of usage during check-ins and check-outs. It will be avoided ticket-jamming problems for the ticket processing machines as well. Vehicle owners will not have to make any payments at each check-out thus a faster traffic flow will be possible. Since there won't be any waiting during check-ins and check-outs the formation of emission gas as a result of such waiting will be avoided. An automized income tracking system, a car tracking system for charging and a central parking-car tracking system have been developed and utilized. Instead of cars' parking on streets, a more modern and a fast operating parking-lot system have been developed.

Keywords: RFID, Automation, Parking-Lot

I. INTRODUCTION

RFID is a technology that helps to identify the animate or inanimate through radio waves.

RFID is one of the most fundamental technologies that enables wireless data transmission. Although it has been known for a long time, has not been very often used in industry. Because it was expensive and there was no standardization among the manufacturing companies. It took a long time to be widely utilized.

The intentions of the utilization of the RFID technology have been encouraged in the following ways: by the use of RFID technology, manually achieved workloads will be decreased considerably [1]. RFID technology is universal, useful and efficient [2]. RFID technology increases company efficiency and provides advantages on both company and client-wise [3]. RFID technology is much more secure compared to other networks [4]. RFID labels play an important role as an inventory tracking technology [5].

RFID technology is an automized vehicle identification system that is useful and requires no personnel. Vehicles are identified and parking-lot fees are collected automatically via this system [6]. RFID system enables vehicles to check-in and check-out under fast, secure and convenient conditions. Most of the gate controlling systems includes barriers. The timing of the gates and additional sensors enables a one by one parking-lot circulation thus preventing multi check-ins or check-outs at a time [7]. RFID readers control check-in and check-out barriers. RFID is a technology that collects parking fees without having to stop vehicles [8].

It is the sole purpose of this study to utilize such an important technology with an application. In this study, via RFID technology, some solutions are provided for the problems encountered in parking lot management systems to the present and some important results have been gathered. In this study, the main components of RFID technology which are RFID readers, RFID labels, a barrier to control the gate and software have been utilized. The software aimed to handle the management, controlling, transaction reporting and operation tasks for parking lots located on various parts of the city.

As for the hardware requirements, by the utilization of RFID readers, barriers and labels, parking-lot check-in and check-out controls have been achieved. In that way, as an alternative to personnel-controlled traditional parking-lot operations, an unmanned, automized vehicle control and identification system has been developed.

Necessary precautions have been taken programmatically just in case of a parking-lot's running out of parking space problem during the process of this application. That way vehicles that are about to check-in will not be let in, thus, there will not be any time-loss to look for parking space.

Another problem is the application's disconnection to the central database during its operation. This is basically the result of the internet infrastructure breakdown. To avoid such a problem, necessary precautions were taken to run the database on both a local and a remote server simultaneously.

II. GENERAL STURUCTURE AND DESIGN OF THE SYSTEM

In this study, controlling of three parking-lot check-ins and check-outs has been achieved by using a central database system. The parking-lots are located on various parts of the city (Fig 1).
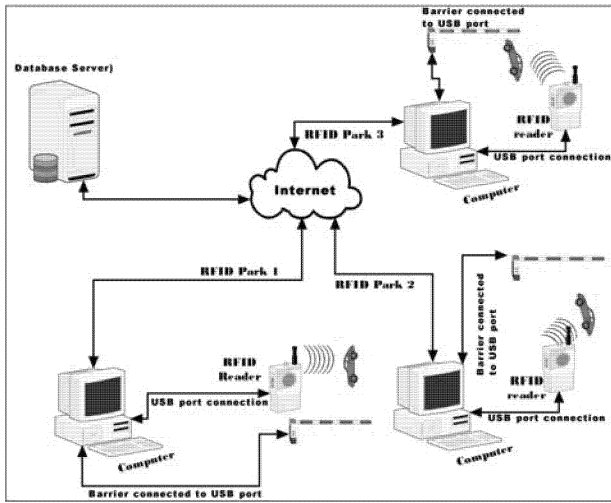

Fig. 1 Application Scheme

While using hardware for the central management of the parking lots, software to control the hardware has been used as well. RFID readers, labels, USB cables, toy cars, barriers with USB port connection and laptop computers have been utilized for hardware requirements.

To store and manage the vehicle tracking data, a database management system has been used as software requirements. A visual programming language has been used for operating the parking-lots and to reach the collected data.

The utilized RFID reader is a Phidget branded board operating with USB port and EM Marrin Protocol (EM4102). EM Marrin is a protocol that is read-only and works on a 125 kHz low frequency. By using the above mentioned RFID reader, RFID labels were managed to be read from approximately 7.62 cm distance.

The read data was a 40-bit identification data. The reader did not have a read-and-write property. The utilized RFID readers are considerably small with circular shapes. That way they could easily be attached to the vehicles.

The computers used in this application were connected over the internet. A database titled as RFIDDATA was used to store data coming from the parking-lots in the city. In the database, as the main table, "VehicleInformation" and as a sub table "VehicleCirculationInfo" tables were created. The general information about a vehicle is stored on the main table and its circulation information is kept on the sub table. The main table consists of the fields such as vehicleID, platenumber, type, and model. To monitor a vehicle's inner city parking-lot movements, its check-in and check-out attempts, the dates, the time, the parking-lot information and total parking fee, "VehicleCirculationInfo" table was used.

These two tables were prepared by a database management system and administered via the software developed. RFID reader was connected to the computer's USB port by the USB cable to provide communication between the developed software and RFID reader. Another USB connection was established for the barrier as well. For each of the parking-lots, one barrier and one RFID reader were utilized.

A. How does the system work?

The system stores all the necessary information about the vehicle, which explained at the time of the purchase process of the RFID labels, to the "VehicleInformation" table of RFIDDATA in database. In that way, all the information about a vehicle possessing an RFID label will be accessible through the system.

When a registered vehicle comes to any parking-lot to check-in, the system checks whether it is registered to the system or not. If it is registered, and it doesn't have any check-in or check-out records available, the check-in information is stored in the database and the barrier will lift off for the vehicle to drive in (Fig 2).
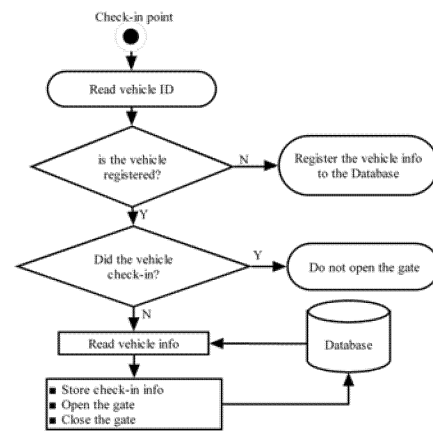

Fig. 2 Parking-lot Check-in Process

A checking-out vehicle's identification information is searched on the database first. If it is a registered vehicle and it didn't have an unauthorized access the system will allow its check-out. During the check-out, the system finds its check-in date and time and updates it with the check-out date and time (Fig 3).
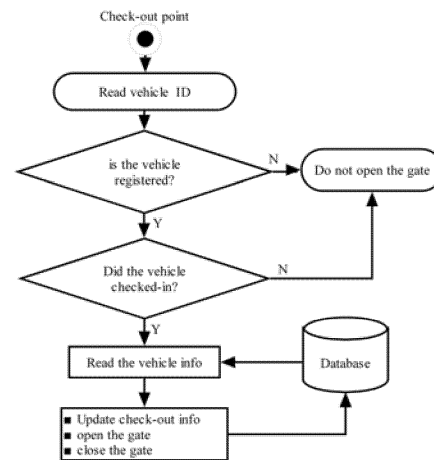

Fig. 3 Parking-lot check-out process

III. DISCUSSION AND RESULTS

A. Discussion

In this application, a vehicle's identification information is searched on the central database first, if a vehicle doesn't have any previous records registered to the database, the initial entry level information of a vehicle is stored in the database. If a vehicle has a previous record stored on the system, there won't be any secondary information entries thus duplicate entries will be avoided.

Under normal circumstances, if a vehicle checks-in to a parking-lot without RFID notification, that vehicle will not be able to check-out afterwards. In that way, unauthorized entries will be avoided.

If a checked-in vehicle does not get checked-out, it won't be able to check-in to any of the parking lots in the city. Only the administrator of the central database could bring a solution to this problem.

Identification information of the registered vehicles within the coverage area of an RFID reader will constantly be read. If in this process, a vehicle's information is recorded into the database there will be duplicate entries and this will cause problems within the system. To avoid this problem, reading task is done when the vehicles gets out of the range of the RFID reader.

If two vehicles enter a parking-lot side by side, being within the range of the RFID reader, the system will not read their identification information and process it. To avoid such problems, parking-lot entrances should be designed to enable passage for one vehicle at a time.

Spot lights directly connected to the RFID reader to be located at the entrances of parking-lots to notify drivers about the availability of parking space in the lot will provide great convenience. In that way, there will not be any waste of time looking for park space.

Internet disconnection during the processes will shut down the connection to the central database as well. In such cases, a local database system will be enabled. Upon the internet connection is restored, the system will switch back to the remote database again.

B. Results

In this project, it is proven that by utilizing RFID readers and RFID labels with a centralized database system, all the parking-lots in a city could be operated in an economical and fast way.

This prototype will provide an automized operation and controlling ability for all of the parking-lots in a city by using standardized devices. At the end of each month, the total fees for each of the parking-lot member drivers will be calculated. Then these fees could be drawn from their bank accounts and transferred to the parking-lots' accounts automatically, issuing an invoice for each transaction.

Thanks to the system's easy installation and operation, automized data gathering and reporting will be possible. With a centralized management system, both the unity and security of the gathered data will be possible.

By a centralized database system, a remote access and administration of the system will also be possible. Over the internet, administrators will be able to view identification and dept information of any vehicle and monitor the efficiency and functionality of RFID-enabled parking-lots.

Via such a system, personnel costs will be cut off. As is in the case of ATM machines, realization of unmanned, completely automized parking-lots will be possible in the future.

Without having to stop vehicles, check-ins and check-outs will be possible. In that way, there won't be any traffic jam problems. As is in the traditional parking lot systems, drivers will not have to take and process parking tickets during check-ins and check-outs. Moreover there won't be any ticket-jamming problems either.

Vehicle owners will not have to make payments upon every check-out. This will provide a smooth traffic flow within the parking-lot thus preventing the emission gas formation.

With this system an automized income reporting and a centralized vehicle monitorization will be possible. A pre-determined price-range will both relieve the city traffic and provide security for vehicles. In that way, cities will have a more modern look.

Instead of parking vehicles on streets and put them into risk, drivers will be able to leave their vehicles to these parking-lots with contentment.

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