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RFID-based Parking Management System

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Abstract: In this project, 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, auto-mized 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.Vehicle owners will not have to make any payments at each check-out thus a faster traffic flow will be possible.The slot availability details are collected using an RFID system and are updated periodically into a Web server via Internet for a registered user. If needed, the user can reserve his parking slot either way since we have both website application and Android app. 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.

Keywords: Automatic Control, Control systems, Radio frequency Identification, Personnel cost, parking-lot management system

I. INTRODUCTION

Current parking experience may range from delayed meetings to deflated tyres (the act of angry residents); fines in no-parking zones, stolen valuables to even vehicles getting towed away from that no-man's land — the space that borders on the parking and no-parking zone. With 800,000 cars and 15 million two-wheelers being added to Indian roads every year, finding a place to park is an everyday battle.

One of the most prevalent forms of parking in India is the availability of absolute free parking.

A. High cost of free parking

India suffers from chaos associated with too many parked cars. When street parking is free, but there are no vacant spaces, many people drive around hunting for a space. Studies for the past 80 years on four continents show that about 30 per cent of cars that comprise traffic are cruising for parking.This wastes valuable time and fuel. It interferes with pedestrians, congests roads and pollutes the air.

If you can get the right price for parking and remove these cars from the road, you'd greatly improve traffic conditions. Our parking management system provides features like accounting, dynamic allotment of slots, security management, statistical reporting along with detecting the count of vehicles inside a parking zone. Timeliness, accuracy, reliability, and security, some of the important characteristics in a parking management system are considered.

II. CURRENT WORKS

The parking management technologies, in general, may be grouped under different communication techniques. Each communication technique performs the main functionalities such as providing parking lots to users, updating the status of parking lots, accounting and billing, collection of payment either at the entry or exit.

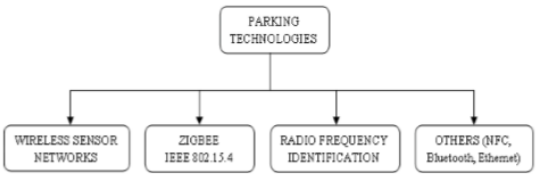

Fig. 1. Different Parking Technologies

A. Wireless Sensor Networks

WSNs are now also employed in vehicle parking systems because of its high performance. Any parking system using WSNs include different type of sensors to sense the information, gather the data and transmit them to their nearest control centre or a base station. The sensor nodes communicate with the base station through their neighbours.

The position of each parking slot is informed to base node through neighbouring nodes. The status is sent to its next nearest node. The neighbour node passes the data to the next nearest node. This process continues till the data reaches the base station. The state of parking space is denoted as a binary value which may be either 0 or 1. When the state value of parking space is 1, it indicates the car is been parked. Similarly, when the parking space is 0, it shows an empty lot. All these information is updated in the base station regularly. Users are connected to parking management system through internet. The method is simple to execute but has a severe disadvantage of energy and bandwidth consumption[1].

B. Zigbee

Another important wireless communication technology is Zigbee communication, which uses a higher level of communication protocol.

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The system uses Zigbee serial network. Terminal nodes are the Zigbee modules that are placed in parking lots. For every three parking lots, one Zigbee module is used in the system. Terminal nodes act as end devices that gather information from parking slots and pass them to their coordinator. The data transmission between terminal nodes and coordinator takes place using routers in order to speed up the transmission process. The information is transferred from the coordinator to the control centre through data concentrators.

The vehicle is detected using Zigbee module, and the parking information is sent to the coordinator through routers. The control centre has a database that saves all these information. The communication system consists of host controller and Zigbee network. IEEE 80.15.4 is used as a communication protocol. The function of a host controller is to connect the control centre and communication system. Zigbee terminal node is present in client side and a network of Zigbee nodes is fixed inside the parking spaces. Information about the vehicle and the user is saved stored in the client side. All these details are finally stored in the control centre for further processing. Though the method is simple to use, yet it makes the system more complex. The functioning of the system using such architecture becomes difficult and cannot be used in very big parking slots[1].

C. Bluetooth

This method explains an innovative design for the parking management system that relies on E-commerce Solutions to Parking Space Optimization (ESPSO) and uses Bluetooth.

Users log on to ESPSO system through their mobile phones from any spot. The parking space availability is sent to the user through Bluetooth. The camera captures the vehicle's number from the license plate using Automatic License Plate Identification System (ALPIS),when it enters the parking entrance. Optical character recognition (OCR) is used to separate the alphabets and numbers from the number plate. Image information is sent to ESPSO server gateway. The system sends a response to the mobile phones equipped with Bluetooth technology. A copy of the information is recorded as a database in the server. The display at the entrance shows the picture and license plate number. The barrier is opened after registration process. The user can park the vehicle in the available slot. The same procedure is repeated at the exit point. The image of the car and the license number plate is compared. If it matches, the user has to pay the parking fees. After this, the barrier opens for the vehicle to leave the parking zone. The system improves security by placing wireless video cameras inside the parking lots. ESPSO can be accessed through Web, SMS, WAP[1].

D. RFID Technology

Coming to our system, it is based on RFID Technology. RFID is used as the technologies that support the parking system here. RFID issued the radio waves within massive waves that vary according to the used RFID and after that the generated waves will be captured by RFID tags. RFID system will first gather information from any existing readers and the RFID server will then communicate with the circulation system[1].

III. BASIC CONCEPTS

A. What is automatic identification?

Automatic identification, or auto ID for short, is the broad term given to a host of technologies that are used to help machines identify objects. Auto identification is often coupled with automatic data capture. That is, companies want to identify items, capture information about them and somehow get the data into a computer without having employees type it in. The aim of most auto-ID systems is to increase efficiency, reduce data entry errors and free up staff to perform more value-added functions, such as providing customer service. There is a host of technologies that fall under the auto-ID umbrella. These include bar codes, smart cards, voice recognition, some biometric technologies (retinal scans, for instance), optical character recognition (OCR) and radio frequency identification (RFID)[2].

B. What is RFID?

RFID is a valuable Business and Technology Tool comprising

-an Electronic Product Code (EPC)

-a NVRAM storing User Data

-a RF system allowing wireless EPC & User Data exchange.

A RFID system engages a set of Tags, Interrogators, as well as controlling Middleware.

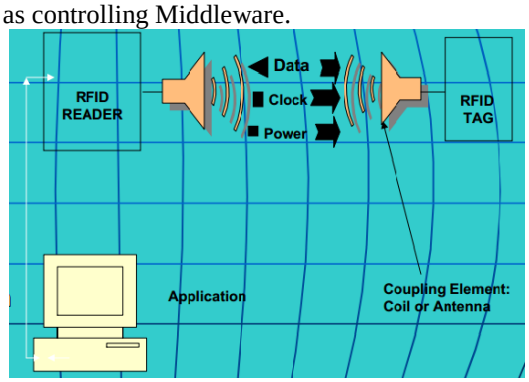

Fig. 2. RFID tag-reader interaction

C. Physics behind RFID

An RFID system is just a reader and a tag communicating over the air at a certain frequency.

Parts of a RFID System are:

– Readers

– Antennas

– Tags

An RFID solution uses a radio frequency (RF) signal to broadcast the data captured and maintained in an RFID chip.

An RFID system is composed of three components:

– a programmable transponder or tag

– a reader (with an antenna), and

– a host

1) RFID Tags and Readers:

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Radio Frequency Identification - RFID – Chip + antenna + packaging substrate = Tag
The chip is a tiny computer that *unique* identification number (ID).The antenna enables the chip to receive power and communicate, enabling the RFID tag to exchange data with the reader.
Readers use radio waves – non line-of-sight technology.
RFID reader is a radio that picks up analog signals .The reader not only generates the signal that goes out through the antenna into space, but also listens for a response from the tag. Receives analog waves and then turns them into bits of digital information. Each reader is connected to one or more antennas[3].

2) Carrier Frequencies:
Today, there are four carrier frequencies implemented for RFID that are popular globally: 125 KHz, 13.56 MHz, UHF ranging from 866 to 950 MHz depending on national radio regulations, and microwave frequencies of 2.45 GHz and 5.8 GHz. There is also the frequency range 430-440 MHz, which is allocated to amateur radio usage around the world. The ISM band 433.05-434.790 MHz is located near the middle of the amateur radio band. The amateur radio band has emerged as an RFID channel in a number of applications. The frequency range has been called the 'optimal frequency for global use of Active RFID.

D. Passive RFID Systems
There are two types of RFID tags: Active tags and Passive tags. The choice of Active versus Passive tags has consequences on the overall systems cost, initial tag cost, tag life, and battery life, communication range, data storage, multi-tag collection.

TABLE I
Comparison of Active versus Passive RFID

	Active RFID	**Passive RFID**
Communication range	Long range(100m or more)	Short Range(3m or less)
Tag Power Source	Internal to tag	Energy transferred from reader via RF
Tag Battery	Yes	No
Availability of Tag Power	Continuous	Only within field of reader
Required Signal Strength From Reader to tag	Low	High (must power tag)
Available Signal Strength from Tag to Reader	High	Low

In passive RFID systems, the reader and reader antenna send a radio signal to the tag. The RFID tag then uses the transmitted signal to power on, and reflect energy back to the reader.
As passive system ranges are limited by the power of the tag's backscatter (the radio signal reflected from the tag back to the reader), they are typically less than 10 m. Because passive tags do not require a power source or transmitter, and only require a tag chip and antenna, they are cheaper, smaller, and easier to manufacture than active tags.
Passive tags can be packaged in many different ways, depending on the specific RFID application requirements. For instance, they may be mounted on a substrate, or sandwiched between an adhesive layer and a paper label to create smart RFID labels. Passive tags may also be embedded in a variety of devices or packages to make the tag resistant to extreme temperatures or harsh chemicals.

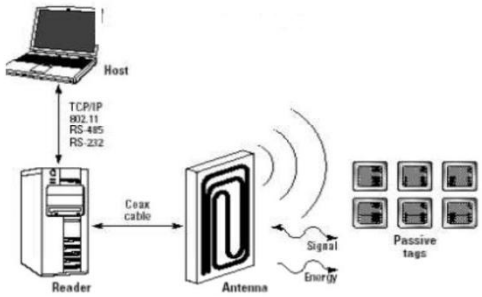

Fig. 3. Working of a passive tag

Passive RFID solutions are useful for many applications, and are commonly deployed to track goods in the supply chain, to inventory assets in the retail industry, to authenticate products such as pharmaceuticals, and to embed RFID capability in a variety of devices. Passive RFID can even be used in warehouses and distribution centers, in spite of its shorter range, by setting up readers at choke points to monitor asset movement. These RFID applications are meant for automatically managed parking lots .They are better with improved traffic flow , more security , optimized fuel consumption and saving considerable amount of time. RFID is used to automatically identify the account holder and make faster transactions.

E. GSM
Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. GSM is a common European mobile telephone standard for a mobile cellular radio system operating at 900 MHz. Throughout the evolution of cellular telecommunications, various systems have been developed without the standardized specifications resulting in many problems directly related to compatibility. The GSM standard is intended to address these problems. In the current work, SIM300 GSM module is used. The SIM300 module is a Triband GSM/GPRS solution in a compact plug in module featuring an industry-standard interface. It delivers voice, data and fax in a small form factor with low power consumption[4].

IV. DESIGN AND IMPLEMENTATION

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

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handle the management, controlling, transaction reporting and operation tasks for parking lots located on various parts of the city.

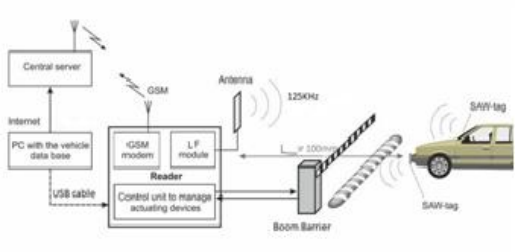

Fig. 4. Design of the system

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 alter- native to personnel-controlled traditional parking-lot operations, an unmanned, automated 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.

The server software which is Windows based and developed by dot net framework 4.5, has been installed on each computer at the parking lots.

The objective of the client software is to monitor and control RFID readers and barriers automatically. The vehicle data processed by RFID readers is transferred to the central server. Thus the server and client computers are in a synchronized state at all times.

To store and manage the vehicle tracking data, a database management system(Microsoft SQL Server 2008) has been used as software requirements. A visual programming language (Microsoft C#) has been used for operating the parking-lots and to reach the collected data. The communication process between RFID reader to PC is done through serial port RS232. Hyper Terminal is the communication program used in windows to transfer data between the serial port on the PC and the kit. Multiple connections can be established at a single time. [5].

TABLE II
RFID reader technical specifications[6]

Model Number	EM-18 rfid reader module
Specification	
Card format	125kHz
Reading distance	100mm
Card format	EM4100 or compatible chip
Interface	Wiegand 26 , RS232
Output	RS232 and WG26
Power supply	5V DC 35mA
Range of power sup ply	+4.6V to +5.4V
Encoding	Manchester 64-bit,modulus 64
Size	
Dimension	32mm(L)*32mm(W)*8mm(H)

A. How does the System works?

The system starts working as soon as RFID labels are acquired by the members of the client's enterprise. A lot of information concerning the member and vehicle is recorded to *ismember* table. In-case of visitors, temporary tags are assigned to monitor their movements and make appropriate changes in the *isvisitor* table. In that way, every one of RFID-enabled vehicles will easily be identified and their check-ins and check-outs to the determined parking lots will be monitored. When an RFID-labeled vehicle attempts to check-in to a parking-lot, the system queries if the vehicle is registered to the database or not. If it is a registered vehicle and it has not checked out of an unauthorized RFID-enabled parking-lot, the system will allow its entrance. Upon the entrance, the vehicles identification information, entrance date and time and current parking-lot title are recorded in the *tagentry* table of the database. The check-in information carries great importance since it will be compared to the check-out information of the vehicle. If a vehicle has made an unauthorized check-out of a parking-lot, the vehicle will not be able to check-in to any of the RFID-enabled parking-lots. The only solution for the vehicle to check-in is for the owner to pay the fine to the fine office.

V. CONCLUSION

This paper discusses the importance of using a RFID based Parking Management System. This system facilitates faster user authentication and hence results in reduced waiting time and increases the efficiency of the parking space.

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