IMPLEMENTATION OF RATS FOR THE PURPOSE OF VEHICLE TRACKING & TOLL TAX COLLECTION

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Abstract:

This paper focuses on use of radio frequency identification (RFID) technology for electronic toll collection (ETC) system. Research on development of ETC has been around since 1992, during which RFID tags began to be widely used in vehicles to automate toll process. It is required to eliminate the need for motorists and toll authorities to manually perform ticket payments and toll fee collections, respectively. The proposed RFID system uses tags that are mounted on the windshields of vehicles, through which information embedded on the tags are read by RFID readers. Data information also easily exchanged between the owner of vehicle and toll authorities. It enables a more efficient toll collection by reducing traffic congestion and eliminating possible human errors.

Keywords: *RFID, Tags, Antennae, Middleware*

1. Introduction:

Million of drivers/consumer passes through toll booths paying toll tax. The past toll payment system was manual and drivers are using manual system using coin or cash by hand to cross the toll plaza gate. Manual process is too much time consuming and drivers have to wait in row for long time for crossing the toll plaza. In waiting time fuel of vehicle is also consuming. Now days this manual toll deduction system is changed to automated system. Where driver no wait for pay cash or get token to cross the toll plaza. This automatic system used the technology of RFID. This new automated system works very fast with best results. RFID based automated Toll Collection system (RATS) is a fairly mature technology that allows for electronic payment for motorways and expressways. An Electronic Toll Collection system is able to determine if a car is registered in a toll payment program, alerts enforcers of toll payment violations, and debits the participating account [2]. ETC is fast becoming a globally accepted method of toll collection, a trend greatly aided by the growth of interoperable Electronic Toll Collection technologies. Radio frequency identification (RFID) technology is a non-contact method of item identification based on the use of radio waves to communicate data about an item between a tag and a reader. It uses the unlicensed spectrum space of the electromagnetic radio wave frequency and this band is the Industrial Scientific Medical (ISM) range.

1.1 Motivation

Radio Frequency Identification (RFID) is an auto identification technology which uses Radio Frequencies (between 30 kHz and 2.5GHz) to identify objects remotely. The system does the job of detecting, billing and accounting for vehicles as they pass through a tollgate using RFID as the identification technology [3]. The system is a great investment in the transport industry. It reduces the common hustles in accounting for the movement of goods from point to point. The design can be further developed to aid the satellite surveillance systems once all toll gates are networked. An RFID tag is programmed with information in the form of an Electronic Product Code (EPC), which can be read over a considerable distance so that its contents identify the vehicle and enhance a transaction to be undertaken with respect to the specific tag identity taking advantage of radio frequencies, ability to travel longer ranges with better data capacities and high speed attained with maximum accuracy.

1.2 Objective & Scope

1. RFID (radio frequency identification) is one of the system solutions for tracking and tracing objects both globally and locally using RFID tags. It is an auto-ID procedure for identifying objects automatically within a geographical area. It allows information about an object to be collected automatically without having to handle the object or enter its data manually.

2. RFID uses tags which communicate information by radio wave through antennae on small computer chips attached to objects so that such objects may be identified, located, and tracked. This technology has found a significant areas of application in business supply chains, in medical line, in security applications, and in fact many areas of human endeavor.

3. Auto-ID and RFID technologies are developing at an alarming rate around the world with new information appearing daily, particularly on the

Internet, describe the technology of RFID, the areas of applications of this technology particularly in industries, security and health care management and the potential benefits of adopting the technology.

2. Literature Survey

2.1 RFID Applications: An Introductory and Exploratory Study

RFID is not a new technology and has passed through many decades of use in military, airline, library, security, healthcare, sports, animal farms and other areas. Industries use RFID for various applications such as personal/vehicle access control, departmental store security, equipment tracking, baggage, fast food establishments, logistics, etc. The enhancement in RFID technology has brought advantages that are related to resource optimization, increased efficiency within business processes, and enhanced customer care, overall improvements in business operations and healthcare. This approach is part of a big project; its aim is to produce a model for mobile technology implementation of hospital patient's movement process. However, the focus of this is to explore the main RFID components, i.e. the tag, antenna and reader. The results of the investigations conducted on the three RFID components will be used to develop our research model. RFID stands for Radio Frequency Identification and is a term that describes a system of identification [8]. RFID is based on storing and remotely retrieving information or data as it consists of RFID tag, RFID reader and back-end Database [4]. RFID tags store unique identification information of objects and communicate the tags so as to allow remote retrieval of their ID. RFID technology depends on the communication between the RFID tags and RFID readers. The range of the reader is dependent upon its operational frequency. Usually the readers have their own software running on their ROM and also, communicate with other software to manipulate these unique identified tags [4].

2.2Challenges in RFID Deployment –A Case Study in Public Transportation

This approach focuses on how RFID Technology can be used to solve problems faced by public transport in metropolitan cities of the country. Automated tracking of buses can be used to provide useful estimates of arrival times and enhance commuter convenience. There are, however, formidable obstacles in the way of widespread RFID deployment. From a systems perspective, this highlight and explore the problem of data capturing, storage and retrieval and how Event, Condition and Action (ECA) rules developed for active databases can help in managing the huge number of events generated each day[6]. It also highlights how the collected data can be used to predict bus movement timings in order to provide better service. The primary focus of this paper is the use of RFID technology to solve problems faced by commuters and bus (transport) operators in many metropolitan areas. We will use Brihanmumbai Electric Supply and Transport undertaking (popularly known as BEST) which operates in Mumbai is used as a case study. The Mumbai bus system is one of the largest in the country in terms of number of buses and its operation. Often the buses are overcrowded. As a result commuters usually spend long hours at bus stops waiting. The bus arrivals at a particular stop are stochastic variables thanks to traffic congestion. This unpredictability can be partly alleviated by deploying a bus tracking and reporting system.

2.5 Tollgate Billing and Security of Vehicle Using RFID.

This approach deals with an improved form of tollgate billing system. An efficient utilization of communication link between RF Modems over a wireless channel to facilitate vehicle monitoring, vehicle authentication and automated toll collection on the highways is proposed. The system is implemented to automatically register vehicles getting on or off a motorway or highway, cutting the amount of time for paying toll in large queues. In this we are using active RFID tag. This takes power supply from vehicle battery itself. Mainly concentrate on the security of the vehicle and authentication process whether the driver is correct person or not to use the vehicle [8]. This is an improved form of tollgate billing system. It contains two modules Base module, and vehicle module. The base continuously transmits an interrogation message over its range so that if any vehicle enters the range it must get registered with the base. The vehicle module receives the interrogation message and sends the data stored in microcontroller.

2.7 RFID Tags

2.7.1 Active Tag:

An RFID tag is an active tag when it is equipped with a battery that can be used as a partial or complete source of power for the tag's circuitry and antenna. Some active tags contain replaceable batteries for years of use; others are sealed units. (Note that it is also possible to connect the tag to an external power source.) Active tags have not only a battery, but also some form of transmitter on the

tag. The disadvantage of having a battery is twofold. One, it adds cost to the tag, and two they run out of power eventually. The decision on which one to use will depend on your application. The tag is made of an IC and an antenna. The IC will include memory and some form of processing capability. The memory may be read only or read/write, the type selected will depend on the application.

❖ **The advantages of an active RFID tag:**

- It can be read at distances of one hundred feet or more, greatly improving the utility of the device
- It may have other sensors that can use electricity for power.

❖ **The disadvantages of an active RFID tag:**

- The tag cannot function without battery power, which limits the lifetime of the tag.
- The tag is typically more expensive.
- The tag is physically larger, which may limit applications.

2.7.2 Passive Tag:

A passive tag is an RFID tag that does not contain a battery; the power is supplied by the reader. When radio waves from the reader are encountered by a passive RFID tag, the coiled antenna within the tag forms a magnetic field. The tag draws power from it, energizing the circuits in the tag. The tag then sends the information encoded in the tag's memory. As well as using this radio wave to carry the data, the tag is able to convert it into power. This means that the tag is only powered when it is in the beam of the interrogator.

❖ **Advantages of a passive tag:**

- The tag functions without a battery; these tags have a useful life of twenty years or more.
- The tag is typically much less expensive to manufacture.
- The tag is much smaller (some tags are the size of a grain of rice). These tags have almost unlimited applications in consumer goods and other areas.

❖ **Disadvantages of a passive RFID tag:**

- The tag can be read only at very short distances, typically a few feet at most. This greatly limits the device for certain applications.
- It may not be possible to include sensors that can use electricity for power.
- The tag remains readable for a very long time, even after the product to which the tag is attached has been sold and is no longer being tracked.

2.7.3 Parameterized Comparison between Active & Passive Tag

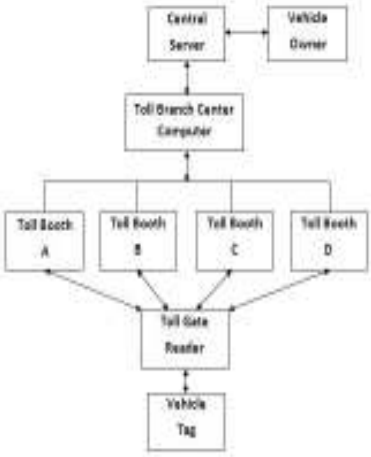
Sr. No.	Parameter	Passive Tag	Active Tag
1	Read Range	Up to 40 feet	Up to 300 feet or more
2	Power	No Power Source	Battery powered
3	Tag Life	Up to 10 years depending upon the environment the tag is in	3-8 years depending upon the tag broadcast rate
4	Tag Cost	Low	High
5	Ideal Use	For inventorying assets using handheld RFID readers. Can also be used with fixed RFID readers to track the movement of assets as long as security is not a requirement	For use with fixed RFID readers to perform real-time asset monitoring at choke-points in within assets. Can provide a better layer of security than passive RFID
6	Readers Cost	Typically higher cost	Typically lower cost

3. Propose System Design

In here, we put forward highway radio frequency identification toll system based on RFID technology. It can achieve the collection of charges without stopping in the condition of vehicle running in high speed. And tracking of vehicle can be done by browsing the data stored in the central database which can be requested with the help of SMS. The concrete operations are as follows: It is need to install equipment required by the system in each expressway toll station, namely, installing reader, intelligent controller, the data transmission unit, intelligent remote non-contact charging machines and other facilities in the room of toll station, installing antenna and installing the electric fence, lights, alarms and other devices in the side of road to realize automatically the release or block of vehicle after the payment [8]. When a high-speed vehicle drives into the work area of antenna in toll station through the traffic lane, the reader automatically identifies information such as the code of electronic tag, the code of vehicle type, the information of ownership, the code of toll station in entry ways, the date and time of getting through toll station in entry ways that is carried by the vehicles electronic tag, and simultaneously carries on the confirmation of the vehicle identity, then the data information will be transmitted to toll collectors in the toll station using the data transmission unit after that confirmation is not wrong. By now, the toll collector in toll station will

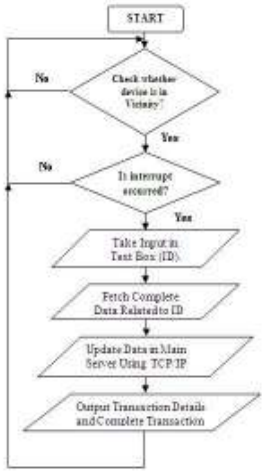
carry on automatic collection according to the amount of collection that is confirmed by the centre toll collection system in the total management centre. After the success of collection, it opens the signal green light and directs the vehicle to pass normally. If no signal is received or the information of vehicle type is not legal, then the warning will be given out and the toll station will execute the manual handling. Simultaneously, charging information is automatically uploaded to the total management centre system to store, preparing for others use.

3.1 System design

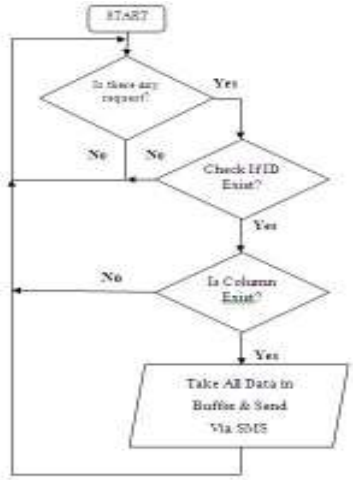


3.2 Flow Chart

3.2.1 Flow Chart for Toll Gate Point:



3.2.2 Flow Chart for User Data Browsing:



3.3 Modules

3.3.1 The Identification module

The system was developed in a modular-based method. It contains an identification module, which has the RFID hardware to read tags as vehicles pass through the tollgate. This module sends information to the software module through RS232 serial connection. There are seven data lines from the RFID read/write module. The important ones for reading and writing are the lines for transmitting and receiving data in a two way communication between the RFID reader and the computer system. A RS232 connector is used to enable connect the RFID module to the Personal Computer. A tag is passed in the region of the magnetic field produced by the RFID module and a beep sound is produced signaling its detection [10]. The RFID module needs to be configured with certain communication parameters. This can be done using the given Specific instructions and can be achieved by using the Demo Application or an independent developed application. The RFID module is connected to the PC via the RS232 port.

- **Components of an RFID Read/Writer system:**

To have a complete RFID system, an interrogator, a transponder, an antenna and some tags were used. These form the RFID hardware which is used in an information processing system (IPS) to acquire the total benefit of RFID. An RFID system can detect many different RFID tags simultaneously as long as they are within the read range of the interrogator. The interrogator acts as the sensor as well as an interface between RFID transponders and the IPS. Antennae are attached to the interrogator and perform the actual Radio

Frequency communication [11]. A computer hosting the IPS application pilots the interrogator and processes the data it sends. The IPS application monitors, configures and coordinates readers for data collection as well as the execution of business programs as dictated by programmed business rules and logic. The IPS normally is also referred to as the middleware and can be addressed as the intelligent sensor network platform after configuration of parameters meaningful information has to be taken from the tag [12].

3.3.2 Software Module:

The informatization and intelligence are the development direction of highway management. We are based on the gathered information about vehicle, highway toll and traffic surveillance from the above sub-system as well as the real-time history data information related with road network, using the computer networking technology and the database technology to build a comprehensive information management platform. With the application of this platform, it can achieve resources sharing and full use of information. For this system, we will use Windows XP as the operating system platform and adopt object-oriented programming method to build. Its background database is Microsoft SQL Server2005 and its application mode is Client/Server mode. The system has great stability, scalability and maintainability. It is worth mentioning that individual privacy and security are very important. Thus, the system has a security mechanism that refers to a security matrix to set up personal privileges. Thus, the system only allows access to authorized data.

Visual Basic Communication Application:

The Visual Basic Communication application consists of four different parts; the part which communicates with the RFID hardware, the part which communicates with the database, the part which communicates with the Programmable Interface Controller (PIC) and the part which enables addition of new users. The system will be developed with an aim towards enabling it to indicate the registration number of a car as it passes, according to the RFID details taken from the database. It also displays the current account balance from the database. There will be automatic deduction of balance which works according to an algorithm in the Visual Basic (VB) code. The deduction occurs with respect to the type of car which has passed.

5. Conclusion:

The RFID Automatic tollgate system designed could automatically detect the identities of the vehicles and performed the billing in accordance to the identity of each vehicle as prerecorded in the database. The system could automatically inform the owners of the vehicles. These were the major achievements met in the project, among other objectives also achieved which include tracking of the vehicles and remote database connection. Reading items and objects in motion can be done accurately using RFID. A system developed with a log in windows enables security and the overall cost of implementing the system may seem high but after a year of running the system, very high benefits will be realized.

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