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NFC Based Toll Management System

Rohan Kelkar[1*], Abhishek Bharambe[2], Akshaykumar Prajapati[3], Mansi Kambli[4]

[1*, 2, 3, 4] Department of Computer Engineering,
K.J.Somaiya College of Engineering, Vidyavihar, Mumbai, Maharashtra, INDIA

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Abstract— **The NFC based toll collection system can be used in places like toll-naka, police check-naka, license or vehicle paper checking, insurance and other vehicle related paper checking .It will be useful in reducing the time required for each vehicle at such places. This will help in reducing the jams and pollution caused by vehicles at places like highways. Architecture for collecting vehicles toll using Near Field Communication (NFC) is presented in this paper. This is a completely automated system where the driver just needs to swipe his card; no real money or other papers will be needed. A PC connected to the system will display the driver details. The booth-operators can also click on a button to collect the money from the driver. The money will be debited automatically from the card. After the tax is collected, the booth operators can then open or close the door. The performance of the system is evaluated in VB.NET.**

Keywords- NFC, automated, toll collection, VB.NET

I. INTRODUCTION

The toll collection was started traditionally to ensure funds for the proper maintenance of roads with a huge amount of traffic like highways. They were collected for either a specific access like a city or for a special type of infrastructure like bridges and highways. However, nowadays, due to massive increase in the number of vehicles, the manual toll collection system has not only resulted in a huge wastage of time for the vehicle holders but also caused traffic congestion and jams on busiest roads like highways. The term tolling is used for charging a well-defined special and comparatively costly infrastructure, like a bridge, a tunnel, a mountain pass, a motorway concession or the whole motorway network of a country. Classically a toll is due when a vehicle passes a tolling station, be it a manual barrier-controlled toll plaza or a free-flow multi-lane station. In kilometre or area charging system concept, vehicles are charged per total distance driven in a defined area.

II. RELATED WORKS

A. CANADA

The Electronic Toll Collection (ETC) system used in Canada is known as the Canada 407 Express toll route (ETR).It is one of the most sophisticated toll roads in the world. The 407 uses a system of cameras and transponders to toll vehicles automatically. There are no toll booths, hence the name "Express Toll Route" (ETR). It is one of the earliest examples of a highway that exclusively uses open road tolling. Highway 407 is designed as a normal freeway with interchanges connecting directly to surface streets, without the need for toll booth intermediaries (typically via a trumpet interchange) which could otherwise take up significant land. A radio antenna detects when a vehicle with a transponder has entered and exited the highway, calculating the toll rate. For vehicles without a transponder, an automatic number plate recognition system is used. Monthly statements are mailed to users. A small electronic 'transponder' is attached to the windscreen behind the rear-view mirror. The system automatically matches transactions at entry and exit ramps to form 'trips' supporting a distance-based tolling policy. The electronic sensors located on each overhead gantry log the 407 ETR entry and exit point. On exit, a green light on the transponder and four short beeps indicate the toll transaction has been successfully completed. In this system, cameras are equipped with Optical Character Recognition (OCR). The OCR cameras are used to photograph license plate numbers of vehicles that do not have transponders. The toll bill will then be sent directly to the registered address of the vehicle owners. Other than that, two laser beam scanners are placed above the roadway to detect the types of vehicles passing through the gantries. Nevertheless, this toll road bears a very high infrastructure cost, and the users are the ones who help recover the cost through increments in their toll bills.The figure of Canada 407 Express toll route is given below-

Fig. 1 Canada 407 ETR for ETC

B. ITALY

Telepass is the brand name for an electronic toll collection system used to collect toll on motorways in Italy.

Fig. 2 Telepass in italy

Telepass can be used for all types of vehicles which can travel on Italian motorways. Telepass consists of an On-Board Unit (OBU) mounted at the top of the vehicle's windscreen. The OBU is battery-powered. The OBUs communicate with the electronic toll booths by dedicated short-range communications. Telepass is used on motorways in the open and the closed systems. In both systems, the toll varies according to the type of vehicle (car, bus, lorry etc.) and to the upkeep for the motorway. Telepass users travel no faster than 30 km/h when in the Telepass lane. Once the OBU has been identified and verified, the OBU emits a single high beep, and the barrier blocking the lane is lifted. When the user exits the toll lane, the OBU emits a second single high beep. The number plate is then photographed, and the vehicle is allowed to continue. The vehicle is subsequently identified by its number plate, and the owner is sent a bill for the toll which could not be collected automatically.

C. SINGAPORE

The Electronic Road Pricing (ERP system is an electronic toll collection scheme adopted in Singapore to manage traffic by way of road pricing. The gantry system is actually a system of sensors on 2 gantries, one in front of the other. Cameras are also attached to the gantries to capture the rear license plate numbers of vehicles. A device known as an In vehicle Unit (IU) is affixed on the lower right corner of the front windscreen within sight of the driver, in which a stored value card, the Cash Card, is inserted for payment of the road usage charges. When a vehicle equipped with an IU passes under an ERP gantry, a road usage charge is deducted from the Cash Card in the IU. Sensors installed on the gantries communicate with the IU via a dedicated short-range communication system, and the deducted amount is displayed to the driver on an LCD screen of the IU.

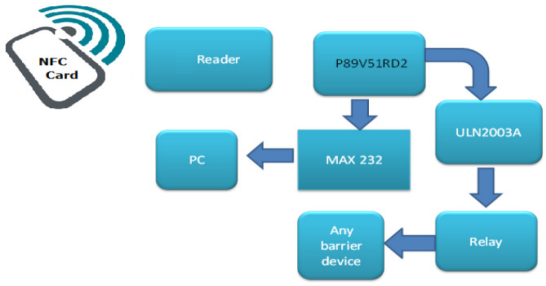
D. US

EZ TAG is an electronic toll collection system in Houston, Texas, United States that allows motorists to pay tolls without stopping at toll booths. To participate, drivers sign up through the EZ TAG website, via telephone, or at one of the store locations. Next, the customers receive a small, white radio frequency transponder which must be affixed to the insides of their windshields behind their rear view mirrors. Finally, when passing through a toll plaza, drivers choose lanes specially equipped with sensors that can read EZ TAG transmitters and deduct the appropriate amount from their accounts.

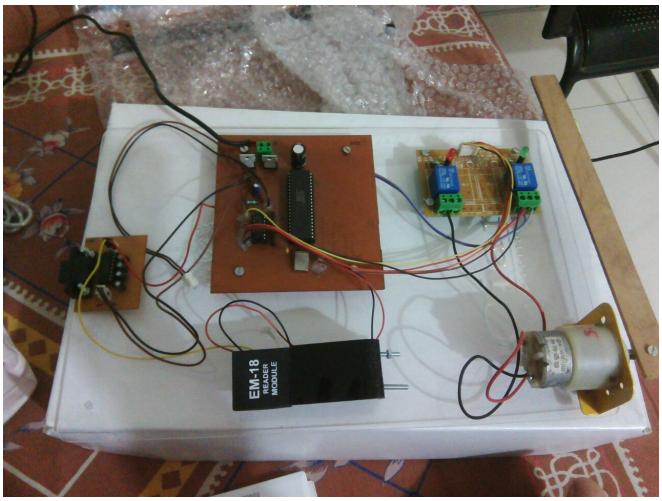
III. SYSTEM DESIGN

System Overview

Block Diagram



Actual Working Model



Working of System

The basic principal of working of this system is based on NFC. The user has NFC Card which consists of a unique customer number. The card number is used as an identity of user. The system installed on Toll plaza has already stored Vehicle information and balance of each card user. That system is connected with the centralized server.

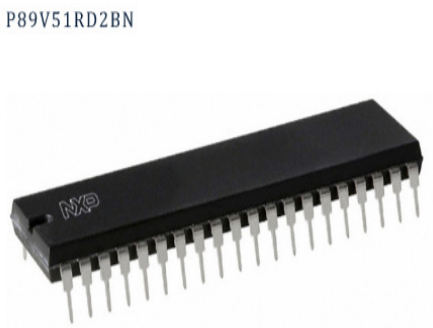
1. When user put his card near reader it accesses its ID number.
2. The reader sends this number to the system.
3. The system searches for vehicle information and balance of the user.
4. It deducts the toll amount as per vehicle model.
5. And it gives command to the relay to OPEN gate.
6. Finally the reader resets and get ready for next access.

System Components

I. Microcontroller IC 8051

This is a 8051 microcontroller. We are using it because it's economical, easily available (we have many such microcontroller e.g. AT89C51). We can use any 8051 based controllers. This is a NXP's (formally Phillips Semiconductor) 8051 core family microcontroller. Any similar microcontroller can be used; this is quite widely available in market; and almost the latest in production. This contains the main firmware (ALP program, we use C for ALP programming) that runs the hardware. We are running this controller at 11.0592 MHz; it can be run on any crystal up to 40 MHz .Any IC can be interfaced to this IC; this is simply

connecting pin of that IC to pin of microcontroller. The Pin number should be mentioned in Keil (C language) program.



Example:

#Define Relay1 P1^0

Relay1=1; // this causes pin 0 at port 1 to go high

II. MAX232

When a MAX232 IC receives a TTL level to convert, it changes a TTL Logic 0 to between +3 and +15 V, and changes TTL Logic 1 to between -3 to -15 V, and vice versa for converting from RS232 to TTL. It operates at 5 Volt DC. There are always 4 capacitor with this IC, they are used as voltage multiplier.

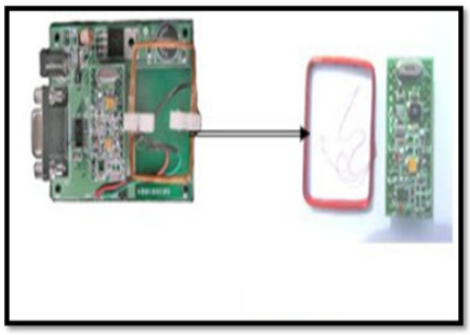
III. ULN2003A

The ULN2001, ULN2002, ULN2003 and ULN2004 are high voltage, high current Darlington arrays each containing seven open collect Darlington pairs with common emitters. Each channel rated at 500 mA and can withstand peak currents of 6mA. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout. The versions interface to all common logic families:

– ULN2001 (general purpose, DTL, TTL, PMOS, CMOS)
– ULN2002 (14 - 25 V PMOS)
– ULN2003 (5 V TTL, CMOS)
– ULN2004 (6 - 15 V CMOS, PMOS)

These versatile devices are useful for driving a wide range of loads including solenoids, relays DC motors, LED displays filament lamps, thermal print heads and high power buffers. The ULN2001A/2002A/2003A and 2004A are supplied in 16 pin plastic DIP packages with a copper lead frame to reduce thermal resistance. They are available also in small outline package (SO-16) as ULN2001D1/2002D1/2003D1/2004D1.

IV. NFC Card and NFC Tag



NFC Reader (NC-87D97 13.56 MHz) brings the efficiency in industrial automation, process control, warranty management, etc. The micro reader is based on NFC technology. It operates at 13.56 megahertz frequency and compliance with the ISO/IEC 15693 vicinity card standards. The NFC reader has an on board antenna and it can be used to NFC enable the existing electronics systems. The reader has CMOS compatible UART communication port interface for interfacing the with any existing compatible electronic hardware system with configurable baud rate. The reader has an on board led for visual indication; depending upon model. An NFC system consists of two separate components: a tag and a reader. Tags are analogous to barcode labels, and come in different shapes and sizes. The tag contains an antenna connected to a small microchip. The reader, or scanner, functions similarly to a barcode scanner; however, while a barcode scanner uses a laser beam to scan the barcode, an RFID scanner uses electromagnetic waves. To transmit these waves, the scanner uses an antenna that transmits a signal, communicating with the tags antenna. The tags antenna receives data from the scanner and transmits its particular chip information to the scanner.

IV.HARDWARE DESCRIPTION

The selection of hardware is very important in the existence and proper working of any software. When selecting hardware, the size and requirements are also important.

Minimum Requirements:

Processor : i3/i5/i7, +2 GHz
RAM : 2 GB
Hard Disk Drive : 1GB
Video : 1024*786, full colors
The proposed system is developed on:
Processor: i5, 2.7 GHz
RAM: 4 GB
Hard Disk Drive: 40 GB
Key Board: Standard 101/102 or Digi Sync Family
Monitor: Display Panel (1024 X 764)
Display Adapter: Trident Super VGA
Network Adapter: SMC Ethernet Card Elite 16 Ultra

Mouse: Logitech Serial Mouse

SOFTWARE DESCRIPTION

Operating System: Windows XP/7/8 32 bit
Front- End: Visual Studio / C#. NET with ASP. NET
Back- End: if required, MS SQL SERVER 2005 EXPRESS

V.ADVANTAGES

1. No "line of sight" requirements: Bar code reads can sometimes be limited or problematic due to the need to have a direct "line of sight" between a scanner and a bar code. NFC tags can be read through materials without line of sight.
2. More automated reading: NFC tags can be read automatically when a tagged product comes past or near a reader, reducing the labour required to scan product and allowing more proactive, real-time tracking.
3. Improved read rates: NFC tags ultimately offer the promise of higher read rates than bar codes, especially in high-speed operations such as carton sortation.
4. Greater data capacity: NFC tags can be easily encoded with item details such as lot and batch, weight, etc.
5. "Write" capabilities: Because NFC tags can be rewritten with new data as supply chain activities are completed, tagged products carry updated information as they move throughout the supply chain.

VI. DISADVANTAGES

Some common problems with NFC are reader collision and tag collision. Reader collision occurs when the signals from two or more readers overlap. The tag is unable to respond to simultaneous queries. Systems must be carefully set up to avoid this problem. Tag collision occurs when many tags are present in a small area; but since the read time is very fast, it is easier for vendors to develop systems that ensure that tags respond one at a time.

VII. CONCLUSION

We have thus designed an NFC based toll management system that keeps a track of the toll collected and checks the validity and authenticity of the vehicles passing the toll using the NFC Reader and NFC Tags.

VIII. ACKNOWLEDGEMENTS

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