Micro controller Based Automatic toll collecting system

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Abstract

This paper will provide a basic overview of today's Electronic Toll Collection systems. It doesn't aim to be complete but gives a good starting point for further information. An electronic toll collection (ETC) system collects tolls from vehicles driving on toll roads without making the vehicle stop at a tollbooth. This is accomplished by installing wireless devices in both vehicles and tollbooths to exchange toll-related information using RF sensors. Through these efforts, it aims to make a significant contribution to the construction of secure and reliable ETC systems.

Introduction

People hate the delay at tollbooths. This idea should eliminate the problem. Transportation Departments and various toll bridge and toll-road jurisdictions have begun to deploy various kinds of automated toll-collection systems. Tolls are a common way to fund highway and bridge improvements. Such tolls are a fee-for-service, with revenues dedicated to roadway project costs. Tolling is often proposed in conjunction with road privatization (i.e., highways built by private companies and funded by tolls). Tolls are often structured to maximize revenues and success is measured in terms of project cost recovery. Automatic toll System assists in the management of toll operations by providing valuable data such as traffic volume, vehicle classification, and fare expected / collected. Multiple payment methods are supported using Cash, Smart Cards and Bar coded tickets. The adoption of this system is expected to bring a number of significant advantages. It will
(1) Relieve congestion,
(2) Be more convenient to drivers since they do not have to carry cash,
(3) Streamline toll collection operations,
(4) Provide user friendly environment.

Automated Toll Collection System (ATC)

Electronic Toll Collection (ETC) is a fairly mature technology that allows for electronic payment of highway tolls.

ETC systems take advantage of vehicle-to-roadside communication technologies (traditionally via microwave or infrared communication, more recently via GPS technology) to perform an electronic monetary transaction between a vehicle passing through a toll station and the toll agency. ETC systems require onboard units (OBU), vehicle detection and classification as well as enforcement technologies.

Essentially, ETC equipment substitutes for having a person (or coin machine) to manually collect tolls at toll booths. In addition, it allows such transactions to be performed while vehicles travel at (almost) highway cruising speed.ETC systems will also soon emerge as the most efficient way to implement congestion pricing.

Key Benefits :

- Increase in toll lane capacity.
- Reduction in motorist waiting time.
- Convenience for toll payers.
- Fuel savings and a decrease in mobile emissions by reducing or eliminating waiting times
- Reduction in toll collection costs and enhancement of audit control by centralizing user accounts.
- Greatly enhances the possibility to implement congestion pricing by breaking technical barriers: non-intrusive toll collection requires much less infrastructure, automatic vehicle counting and classification and automated accounting systems.
- Digital license plate recognition devices can accurately and efficiently identify toll violators.

Costs

Installation and maintenance of vehicle-to-roadside communication technologies, onboard units, vehicle detection and classification as well as enforcement technologies. Standardization and technical interoperability of systems will also impose costs.

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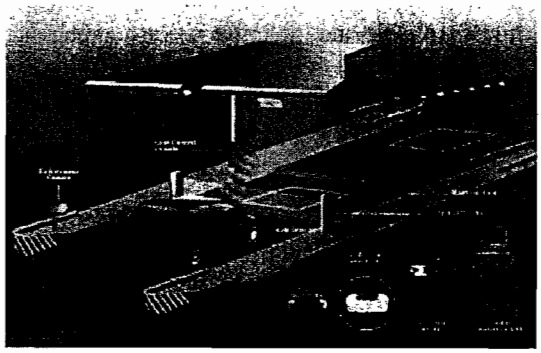
Implementation Challenges

Most technological components for electronic toll collection systems that are based on radio or infrared communication have been tested and demonstrated throughout the world and are ready for widespread deployment. The chief barriers to implementation are political (user acceptance, particularly of congestion pricing) and institutional (*standardization and administrative and technical interoperability of systems).*

New Developments

- A new class of ETC systems based on Vehicle Positioning Systems (VPS) seems very promising in terms of delivering ETC via Global Positioning Systems technology. The main advantages are: the absence of the need for ETC road infrastructure and the much greater flexibility in defining or changing payment systems by simply redefining the "virtual" toll areas.

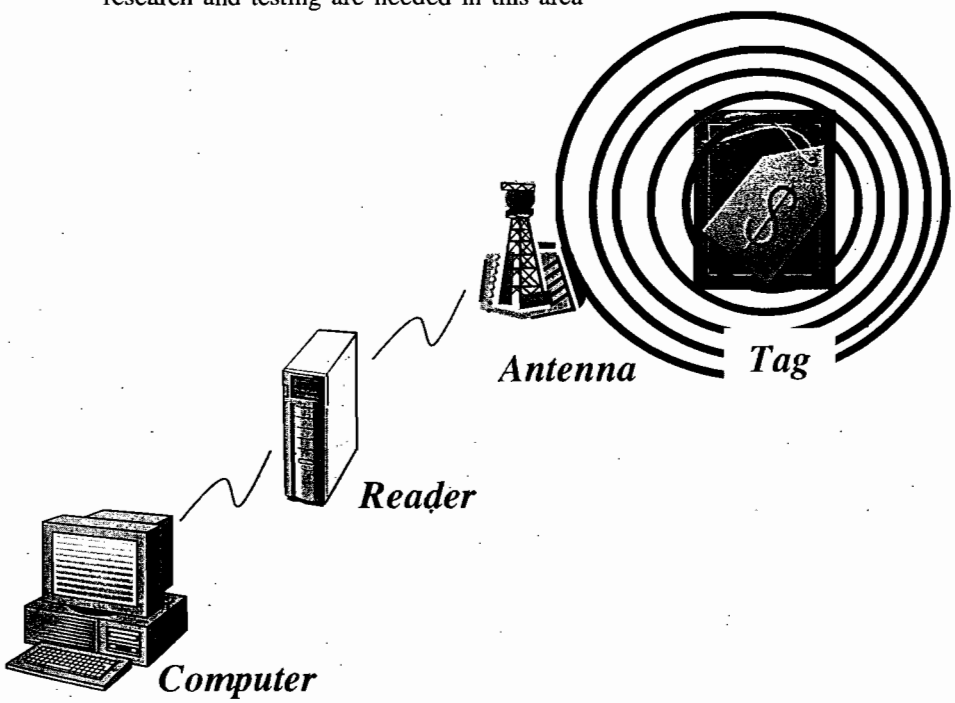
- ETC systems are also emerging as a very cost-effective and efficient manner of implementing traffic surveillance. For the time being, this is done primarily via toll tags and roadside infrastructure. In the future, GPS-based ETC may emerge as a more efficient manner of implementing surveillance for a host of reasons. More research and testing are needed in this area to compare the relative advantages of these two types of surveillance.



RFID Technology

RFID technology uses frequencies within the range of 50 kHz to 2.5 GHz. An RFID system typically includes the following components:

- an RFID device (transponder or tag) that contains data about an item
- an antenna used to transmit the RF signals between the reader and the RFID device
- an RF transceiver that generates the RF signals
- a reader that receives RF signal from RF device and pass it to host processor



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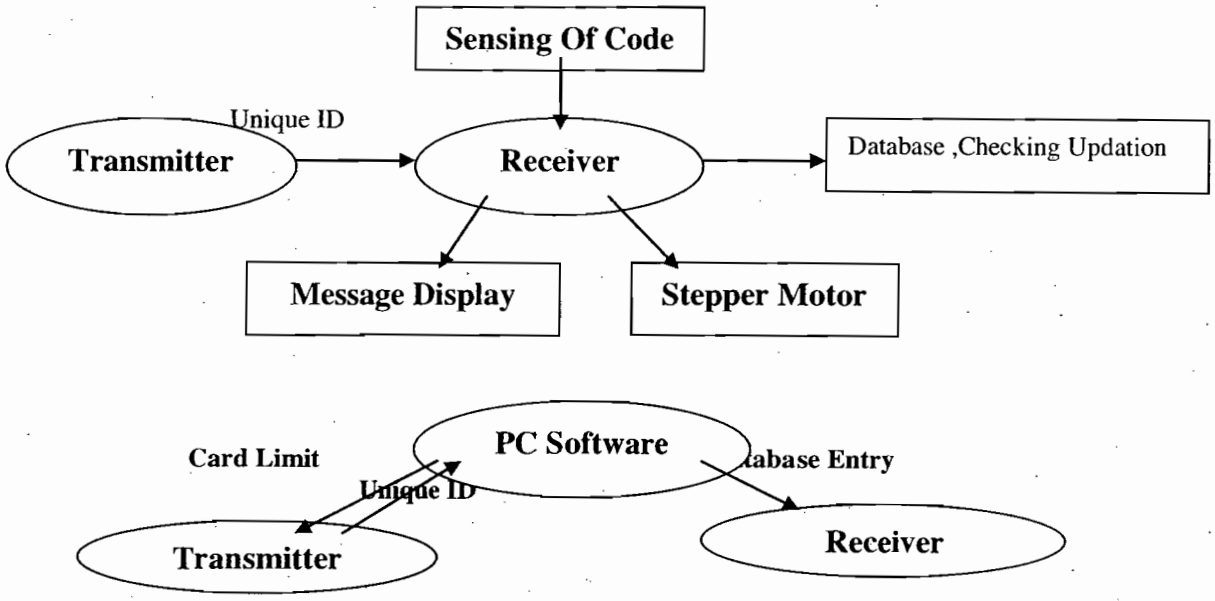
- **Overview of ATC system**

To design an automatic toll collection system, we will make use of RF sensors. We will use RF sensors, as these have good range, long tag life, readers are highly reliable and the information can be read much faster A system has been designed to collect toll as a user enters into the some other state like Himachal .For every vehicle class, toll tax will be different as for car it will be Rs30 and for bus (other than CTU) it will be Rs 40 and so on. Each vehicle will have to get the transmitter either from the main booth office and can online recharge it with the help of credit card .The toll operator will maintain a database in a microcontroller. The database will be maintained with the help of Microsoft access.An antenna at the toll gate communicates with a transponder on the vehicle via Dedicated Short Range Communications (DSRC). RFID tags have proved to have excellent accuracy, and can be read at highway speeds. The data will be transferred from antennas to RF readers. Two antennas have been used one at the entrance and other at the exit. As the vehicle passes, a signal will be passed from transponder to the RF reader with the help of it antenna mounted at the entrance from some distance away. It is a wireless communication link between a transponder on a vehicle and RF readers mounted at toll plaza and provide real-time information service. The data transfer will take place; automatically money will get deducted. The barrier gate will get open to allow the vehicle to pass. The vehicle is allowed to move anywhere in a state. In this system one timer has been used which will keep account, whether the vehicle exit is on the same day or some other day .If some other day, a toll tax will be deducted for every extra day.



Benefits :

Toll Lane Capacity

Vehicles equipped with ETC require less time than all other vehicles to conduct a toll transaction. When exclusive ETC lanes are provided, the total number of vehicles serviced by all of the toll lanes could be higher than it is when all lanes are mixed.

Vehicle Waiting Times

An increase in a toll lane service rate should cause a decrease in the average waiting time of vehicles at the toll plaza.

Reduction of Vehicle Emissions

Vehicle emissions are reduced because vehicle speeds through the toll plaza are increased and accelerations and decelerations reduced.. With ETC, vehicles will decelerate to higher speeds, or may not decelerate at all.

Reduction of Toll User Costs

ETC can potentially reduce the cost of processing toll transactions.

Simplified Infrastructure and Accounting System

ETC requires far less roadside infrastructure than manual tollbooths.

By automating toll collection and vehicle counting, ETC simplifies the accounting system as well as the allocation of revenue between peak and non-peak hours.

Vehicle Positioning Systems (VPS) require less infrastructure

VPS-based ETC systems have notable advantages over standard dedicated short-range communication

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(DSRC) systems. One advantage is that road infrastructure, which can be expensive and often infeasible due to space constraints, is no longer needed. Another advantage is that vehicle positioning systems offer greater flexibility in defining or changing payment systems.. The main disadvantages of VPS-based systems are its higher costs of implementation.

Wireless communications have greater data capabilities

Currently developing next generation wireless technologies (referred to as 3G, or third generation) are expected to greatly benefit ITS wireless applications because of their powerful data capabilities. Wireless communications also reduce component costs for electronic tag systems like ETC.

Toll Agency Costs

Cost per transaction of an ETC system reduces in comparison, the cost per transaction in a manual collection system. While a conventional interchange requires 25 full-time employees (assuming four toll booths), at a cost of up to one-third of the toll collection revenue, the ETC option would require only one maintenance person and account support.

Conclusion

These system significantly contribute to improve travel conditions by addressing delay
caused by both recurring and nonrecurring congestion. Significant progress has been achieved in implementing freeway, incident, and emergency management and ETC systems, with many benefits realized from these investments. Various new techniques have been emerged in this field to make his system more reliable and efficient. The same idea can also be used to improve car parking, traffic control and security systems.

References :

* Takeshi Horie, Takahiro Saida," Hitachi Makes a Significant Contribution to the Construction of Secure and Reliable ETC Systems in Japan",2000
* "Toll Operations For Tacoma Narrows Bridge", Briefing paper prepared for October 2004 TRANSPORTATION COMMISSION MEETING, Prepared By: David Pope, Tacoma Narrows Bridge Toll Systems Manager ,Reviewed By: Randy Hain, Olympic Region Administrator ,Approved By: John Conrad, Asst. Secretary Engineering and Regional operations.
* Thomas Kallweit," Exacting a Toll ",GPS, Microwaves Precise Swiss System, *GPS World Magazine, June 2003.*
* IRD iTOLL ,Integrated Toll Collection and Auditing Systems.
* Electronic toll collection system, Intelligent transportation society of Canada ,1996
* Tom Wright Coimmissioner,"Intelligent transportation system and Society ",March 1995
* ASELSAN A.Ş,"Apass electronic toll collection system", Microwave and system Technologies division.
* Giovanni Iachello, Gregory D. Abowd , "Security requirements for environmental sensing technology" ,College of Computing & GVU Center ,Georgia Institute of Technology
* Ascher, M., "E-ZPASS–Putting ITS In the Hands of the People," *Proceedings of the6th World Congress on Intelligent Transport Systems* (Toronto, Ontario, Canada: ITS World Congress, November 1999).
* Burris, M., *The LeeWay Electronic Toll Collection System, Florida* (Tallahassee, FL: Leeway Authority, February 1998).
* Harris, M. and O. Choudhry, "FasToll: Virginia's Electronic Toll Collection User
Survey Response Summary," *Proceedings of the 1998 ITS America Annual Meeting*
(Washington, DC: ITS America, May 1998).
* Al-Deek H.M, A.E. Radwan, A.A Mohammed and J.G. Klodzinski. Evaluating the Improvements in Traffic Operations at a Real-Life Toll Plaza with Electronic Toll Collection. *ITS Journal*, Vol. 3, No. 3, 1996.
* Alvisi M. Lessons from History: Development of Toll Collection in Italy. *Traffic Technology International*, December 96 / January 97.
* Bates, timothy. Accuracy is everything: perfecting the license plate reader. Traffic Technology International: the international review of advances traffic management. 1999. p.199-202.
* Blythe, P.T. and P.J. Hills. The Use of Smart Cards in Road Pricing and Tolling Systems. *Colloquium on Electronic Techniques for Road Pricing and Tolling*, (London, England: 1995). London: Institution of Electrical Engineers, 1995.
* Cadwell, M.L and M. Zimmerman. Things to Consider when Multiple Toll Agencies share ETTM customers. *Proceedings of the 1995 International Electronic Toll and Traffic Management Symposium*, (New York, New York: 1995). Washington D.C: International Bridge, Tunnel and Turnpike Association, 1995.

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