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Intelligent Toll Charge Collection System with Safety Features using Arduino

M. Subramani[1], Kaarthikeyan S[2], Kabeena K J[3], Mohan R[4], Someshkannan V[5]
[1] Assistant Professor, Electrical and Electronics Engineering, K.S.R College of Engineering, Tiruchengode, TamilNadu, India.
[2,3,4,5] Electrical and Electronics Engineering, K.S.R College of Engineering, Tiruchengode ,Tamil Nadu, India.

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Abstract: *Developing countries like India needs a significant improvement in infrastructure such as Roads or Highways. Construction of these highways is a costly affair, which can't be invested by the government alone. Normally Public private partnerships are made to construct such a huge project. The money spent on these projects can be regained by collecting toll from the passengers who use the roads. The toll collection system, especially in India faces some problems such as long queue lines, escaping from toll plazas etc. These systems can service only 300 vehicles per hour, and if more than that number of vehicles arrive at that plaza, server traffic jams may occur. To solve this, we are proposing to create geo-fences using global positioning system (GPS) by giving latitude and longitude of the corner of the toll plaza. By comparing the position of the vehicle and toll plaza, the owner of the vehicle can be charged from the bank account and all this information can be provided to the user as messages using the Global System for Mobile communication (GSM) module.*

Key Word: *Toll Gate; Toll collection system; Global Positioning System (GPS); Global System for Mobile communication (GSM);*

I.INTRODUCTION

Road transportation is a leading part for development of the country. In India day-by-day number of vehicles on roads are increasing which results in traffic jam. While travelling we often visit toll booths where we see a long queue of vehicles. The Toll is the system of fee collection from vehicle owners who used roadway facilities. The toll fee collection is done manually via cash or cards at toll booths. Toll booth system in late 90s requires two persons for opening and closing of the gate. Two more persons are required for the collection of the money. Later on, the development of Express Highway Systems introduced semiautomatic toll plazas in the year of 1995. In this system data is stored in computers and operation of gate is automatic. The paper-based ticketing system is used at many toll booths presently. In this system manual toll collection system is used. Each vehicle must stop on arrival at the toll booth. Then the toll collector determines the amount to be paid by each vehicle based upon its classification. Then the vehicle owner pays the fare and was then allowed to pass the toll booth. The above system is time consuming, creating long queues at toll booth. It also results in wastage of fuel and air pollution. Human errors may also lead to the incorrect toll collection. Some people may run away without paying the toll also. This can be overcome by automating the manual toll booths into GPS or Global Positioning System based toll collection system. The Global Positioning System is a satellite navigation system that furnishes location and time information in all climate conditions to the user. We have designed a useful and convenient application which spares people the trouble of stopping their vehicle and waiting in queues for hours at toll locations.

II.LITERATURE REVIEW

William Vickrey, who suggested to equip all cars with an electronic identifier. The electronic identifier refers to a transponder that allows personalized signal to be delivered to a central computer from specific road sections for bill calculation (Kelly, et.al.,2006). This idea was first adopted at toll booths in Norway in the year 1986. By 1991, Trondheim in Norway became the world's first city that implemented the unaided full-speed electronic tolling. This system is advantageous as it significantly reduced time delay due to toll payment. As popularity grew with this concept, gantries gradually replaced the traditional toll booths, allowing sensors to be installed for easier detection.

GPS-based road pricing was accompanied with a field test in Hong Kong in 1997 (Catling, et.al.,2000). In 1998, the European Union published a report that proposed the usage of Global Navigation Satellite System (GNSS) to charge vehicles by distance (Brussels, et.al.,1998). These early works gave rise to more concepts and variations of GPS-based road pricing. (Lee Et.al.,2004) and (Xu et.al.,2005) both provided comprehensive investigations and reviews on the architecture of GPS-based toll collection system as well as addressing possible design issues. (Srinivasan et.al.,2003) proposed a GPS-based road pricing system using map matching method. Moreover, Ren and Xu (Et.al.,2010) proposed another system rooted upon node matching. Not least, (Dias, et.al.,2014) came up with the concept of a smartphone-based toll collection system which was interoperable between traditional ETC and new GNSS tolling. Interesting as these concepts may seem, their implementations, however, require sophisticated algorithms and complex system setup, resulting in commercialization challenges. Hence, through this research, we demonstrate for the first time that a GPS-based highway toll collection system which can be easily commercialized can be developed using a microcontroller with third generation (3G) and GPS connectivity.

III. EXSISTING SYSTEM

Revenue generated from toll is used for road construction, extension, and maintenance. The most common methods used for collecting the toll from the road user are manual method. In India three toll systems exist via Open system contains mainline barrier toll plazas; closed system which has entry/exit and Electronic toll collection system which has no toll booths having only electronic toll collection gantries at entrances and exits on the road. In an Open toll collection system, all vehicles stop on roads for paying toll. This causes traffic jams. Drivers may be able to avoid tolls by exiting and reentering the highway. In a closed system, vehicles collect a ticket when entering the highway. In some cases, the ticket displays the toll to be paid on exit.

Upon exit, the driver may lose the ticket. In an electronic toll collection system tolls are usually collected with the use of a transponder placed before the Gate. As soon as the vehicle reaches near the transponder the amount is deducted and gate will be opened. But many vehicle owners may not have a debit card which does not allow them to pass the toll. Hence, all above methods of toll collection have a disadvantage. Toll fee is collected manually via cash or card transaction which consumes time. The stopping of vehicles results in traffic jam at the toll booths during peak hours. This results in fuel inefficiency and wastage of time. An Electronic system is not usable for vehicle owners who are not having debit cards.

IV.PROPOSED SYSTEM

The proposed setup consists of a small kit with GPS and GSM module, LCD display connected to a vehicle. To make it as a tamper resistance a limit switch is provided to find the status of the device. An emergency switch also provided with the kit to intimate the patrol units about the breakdown or emergency during travelling. This proposed system reduce the construction of toll booths and expenditure & maintenance of the electronic devices. If the device is removed from the vehicle manually the limit switch will deactivate and inform to the local police to book a complaint on the registered vehicle to avoid the forgery by removing the device and travelling. The LCD module attached to the kit will provide the information about the upcoming toll booth, charge for crossing that toll plaza, current balance on your wallet to the user. This system will reduce the waiting time in the toll booth, can save the fuel by avoiding the waiting time.

This system will also reduce the human resource and operating cost in a toll plaza. This also reduce the cash handling as there is a wallet in the system. So, no need to carry extra cash in hands during long travel. When a vehicle's GPS enters the particular range the toll charge deduced automatically from the wallet. Before this, a intimating is sent to the user as a toll plaza is ahead in 1km. if the wallet balance is low the user is intimated as your wallet balance is too low to cross this toll. If, the balance is sufficient to cross the toll, the toll charges are deduced from the wallet. The wallet can be recharged by the application provided to the user at the time of purchase with the registered mobile number.

This device is compact and works in a 5v DC battery so we can place it in any vehicle easily. No damage is produced to the vehicle by placing this device in a vehicle. If the user crosses the toll without the minimum balance the user must pay the toll charge within 1 hour of crossing that toll plaza otherwise a police complaint will automatically booked on the registered vehicle. If three fine is standing on that registered vehicle then the vehicle is issued with a seize warrant. The seize warrant will cancelled automatically after the user paying all the toll charges and the fine for late paying that toll charges.

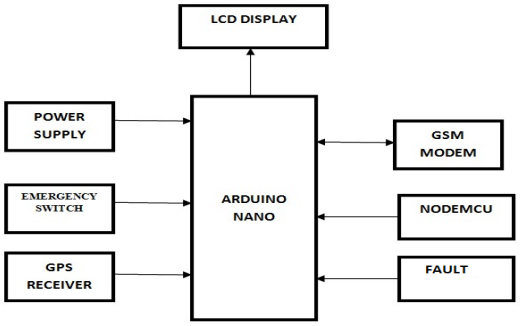

Figure 2: Block diagram of proposed system

V.RESULTS AND DISCUSSION

The operation principle of the developed GPS-based highway toll collection system was easy to follow. The system tracked the travels of a moving vehicle from the acquired GPS coordinates. The acquired coordinates were constantly compared with the predefined coordinates of the toll collection points in the database (sqlite database). Whenever a match was detected, the toll collection for the matched destination was performed through debit transactions. User would be notified on the toll location and payment details through the LCD module. History of all toll payments were then recorded in the sql. Moreover, an additional feature of speed tracking was implemented. For instance, whenever the moving vehicle exceeded the presumed limit of 60 km/hr, the instantaneous time, location and speed will be recorded in the speed (sqlite database). The speed tracking feature can be utilised for speed limit enforcements and directly incurs a fine when a speed limit is exceeded. In addition, in case of the unavailability of debit transactions, these travel histories can be referred for a one-off periodic billing.

VI.CONCLUSION AND FUTURE SCOPE

This paper tells us about the application of the automatic toll collection system on toll gates. This paper investigates how to use GUI for collection of tolls, the real time management and monitoring is done. It has expanded capacity for vehicle without building the big infrastructures. It has improved efficiency and reliability of toll plazas and traffic abilities of highways. This paper has proposed to collect toll fees from the owners of the vehicle. It helps to avoid wastage of time and fuel

because of the large traffic jams has been solved by implementing toll collection using GPS. All vehicles are identified uniquely by the GPS, and the amount is debited from the respective account of the vehicle's owner, which is acknowledged by the SMS to owner of the vehicle. Since everything is computerized, the undercharge or over charge collection of toll by private agencies is solved.

The proposed system is based on a combination of mobile communication technology (GSM) and a satellite based global positioning system (GPS). An innovative log on unit OBU, which automatically calculate the amount of charge due and take into account, depends on the type of the vehicle. It will also act like a platform for vehicle identification and prove effective in tracking stolen vehicles. With regard to future expansion and development, the satellite-based toll collection system will be a better solution, especially with regard to flexibility when it comes to extending toll collection to every road category.

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