



# RFID Based Automated Smart Toll Collection System

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## ABSTRACT

With the continued development and economic growth of all countries needs to be digitalized in every way possible. In this paper, RFID based Automated Toll Collection System is introduced as a solution of the traffic problems and also to maintain transparency in the toll collection system. The proposed system aims to make a digital toll collection system which can eliminate the delay on toll roads, toll bridges and toll tunnel without cash and without requiring cars to stop. This paper focuses on an automated smart toll collection system which uses radio frequency identification (RFID) technology to identify a vehicle specifically for collecting toll. The proposed RFID system uses tags that are mounted on the digital number plate of the vehicles, through which information embedded on the tags are read by RFID readers. It is possible to reduce the need for vehicle owners and toll collection authorities to distribute tickets and collect tolls manually in this system. Information on the toll payment can also be easily exchanged between the vehicle owners and toll authorities. As a result, transparency in toll payment can be ensured with reduced manual labor and human errors. Thus, building smart transportation system will become easier.

**Keywords:** RFID tags, Radio frequency identification, GSM, Arduino

## I. INTRODUCTION

The transportation is the backbone of any country's economy. Improvement in transportation systems result into the good lifestyle in which we achieve extraordinary freedom for movement, immense trade in manufactured goods and services, the higher rate of employment levels and social mobility. In fact, the economic condition of a nation has been closely related to efficient ways of transportation. Increasing number of vehicles on the road, result into number of problems such as congestion, accident rate, air pollution etc. All economic activities for different tasks use different methods of transportation. For this reason, increasing transportation is an immediate impact on productivity of nation and the economy. Reducing the cost of transporting resource at production sites and transport completed goods to markets is one of the important key factors in economic competition. Automatic toll collection is a technology allows the automated electronic collection of toll costs. As it is studied by researchers and also applied in various expressways, bridges, and tunnel require such a process of Automatic Toll Collection System. It is capable of determining if the vehicle is registered or not, and then informing the management center about to process violations, debits, and participating accounts. The most excellent advantage of this system is that it is capable of eliminate congestion in toll plaza, especially during those seasons when traffic seems to be higher than normal.

The benefits of the system for users are shorter queues at toll plazas by increasing toll booth service rates, faster and more efficient service, the ability to make payments by keeping a balance on the card itself and the use of postpaid toll statements. Other general advantages include minimization of fuel wastage and reduced emissions by reducing deceleration rate, waiting time of vehicles in queue, and acceleration. For Toll Operators, the benefits include lowered toll collection costs, better audit control by centralized user account and expanded capacity without building more infrastructures. Thus, the Automatic Toll Collection system is useful for both the motorists and toll operators.

The main objective behind this proposal is to create a suitable Automatic Toll Collection system to be implemented. The term suitable here refers to minimal changes in the current infrastructure with maximum increase in efficiency.

The base idea behind implementing RFID Based Toll System is to automate the toll collection process and to reduce manual operation

in toll booths and the long queues at toll booths using RFID tags installed on the vehicles. In addition to collecting toll, it not only helps the vehicle owners and system administrators from vehicle theft detection but also can track over speeding vehicles, and crossing the signals. Automatic Toll Collection system using RFID in our day to day life avoids the fuel loss, saves time in collecting toll, avoids financial loss and monitors the traffic.

## II. LITERATURE REVIEW

[1] RFID Based Toll Deduction System,

Authors: Asif Ali Laghari, M. Sulleman Memon and Agha Sheraz Pathan.

Literature publishing year: April 2012. International Journal of Information Technology and Computer Science 4(4):40-46

DOI:10.5815/ijitcs.2012.04.06

Development of RFID based toll deduction system is proved that RFID technology have good results in implementing in different applications but the standard company have develop the framework of applications. In this toll deduction system RFID is used permitted frequency bands by using high power levels, then system will be successful. The companies which have permissions from the authorities because tag is use the bank account and registration numbers of vehicles. For this application passive tag are better then to active tag because of low cost and also radio signals environmental factors. For the future work RFID speed controlled system vehicle can be save from the accident due to high speed. Some works will be done auto steering system of vehicle which can be controlled by using RFID technology installed on the complete track. This will be beneficial if bus driver have serious problem of heart attack or other disease suddenly then control transfer to automatic RFID communication system.

[2] Automation of Toll Gate and Vehicle Tracking,

Authors: Janani Krishnamurthy, Nitin Mohan, Rajeshwari Hegde.

Literature publishing year: August 2008. SourceIEEE Xplore DOI:10.1109/ICCSIT.2008.148

Computer Science and Information Technology, 2008. ICCSIT '08. International Conference on Toll gate Automation and Vehicle Tracking is designed to automatically keep track of the vehicle's movement, record the time and the details like Owner's name, date of registration, vehicle model etc. This system is very useful for automatic vehicle tracking, time management and also for automation of Toll gate. This paper explains the implementation of Toll Gate Automation which is a step towards improving the Tracking & monitoring of vehicles, traveling in predetermined routes. In this system, a computerized system automatically identifies an approaching vehicle and records the vehicle number & Time. If the vehicle belongs to the authorized person/group, This paper explains the implementation of Toll Gate Automation which is a step towards improving the Tracking & monitoring of vehicles, traveling in predetermined routes. In this system, a computerized system automatically identifies an approaching vehicle and records the vehicle number & Time. If the vehicle belongs to the authorized person/group, it automatically opens the Toll Gate and a predetermined amount is automatically deducted from its account.

[3] The automation of toll-collection and road-use pricing systems,

(Authors: P. Hills, P. T. Blythe.)

literature publishing year : March 1989. SourceIEEE Xplore

Following recent experiments in Hong Kong on road-use pricing, and in Berlin and London on route-guidance, it is clear the technological advance in the fields of data-communications and road traffic 'informatics' (RTI) will reopen the longstanding debate as to how use of the road system should be charged for. In particular, if vehicles can be charged for road-use automatically, without stopping them to do so, then policy towards road-use pricing could be significantly changed, although the strong social and political objections may still remain to be overcome. The paper is not just centred on the technical issues posed by automatic toll-collection but clearly set within the social/political context surrounding any widespread implementation of such a policy.

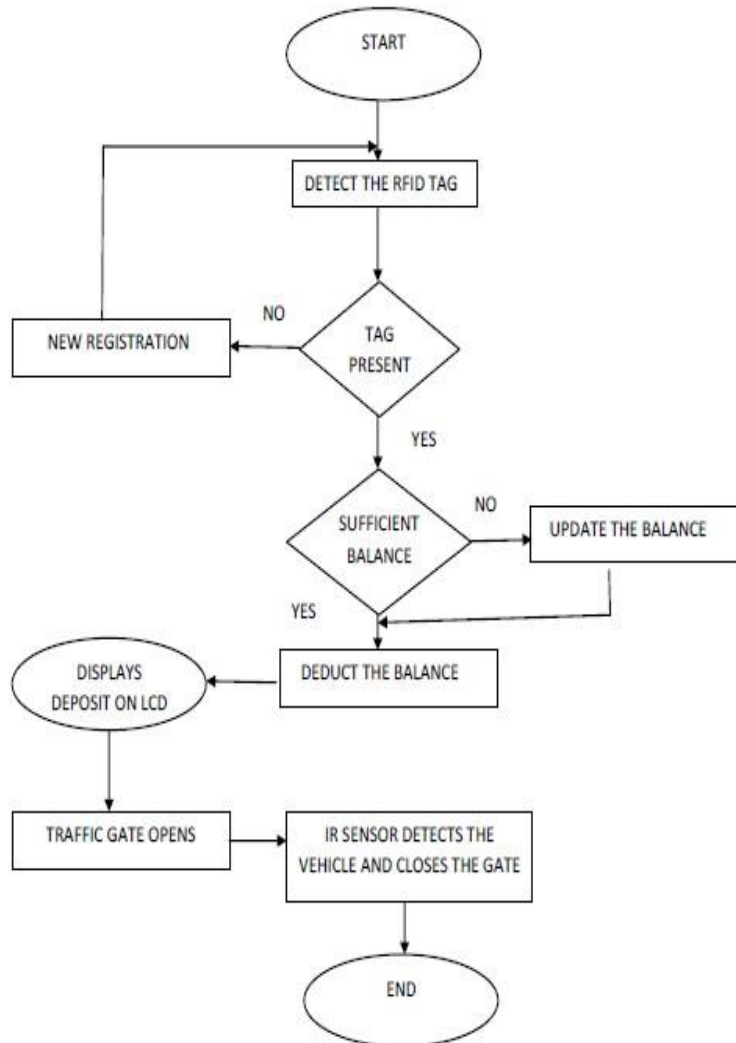
So in the proposed system, the passive tags are used to overcome from these disadvantages. A passive tag is an RFID tag that does not contain a battery. The power is supplied by the reader. The main advantage of a passive tag is that the tag functions without a battery. Passive tags have a useful life of twenty years or more. The tag is typically much less expensive and smaller.

## III. METHODOLOGY

Flow of RFID based automated smart toll collection systems are:

- Detection of vehicle
- Display of toll
- Transaction processing

Whenever any person buys a vehicle, first he/she need to do her vehicle registered at the RTO office. RTO people will assign a number plate to it along with it they will give a RFID enabled tag. This card will have a unique ID feasible to use with that vehicle only. They will also create an account for that particular smart card and maintain transaction history in database. Owner of the vehicle needs to deposit some minimum amount to this account. Every time a registered vehicle approaches the toll booth, first the Infrared sensors will detect the presence of the vehicle which in turn activates the RFID circuit to read the RFID enable smart card fixed on the windscreen of the vehicle. Transaction will begin, depending upon the balance available toll will be deducted directly or the vehicle will be directed towards another lane to pay tax manually. The software further updates the details in the Centralized database server. It also triggers mechanism to generate the bill and will be sent to user as a text message. On the other hand, whenever any vehicle owner registers a complaint at the RTO office regarding theft of the vehicle respective entry is made in the database. Now any vehicle arriving at toll booth with same ID as already present in stolen vehicle category will be easily identified as the ID assigned with it is unique. All the toll plazas will be connected to each other along with the centralized server in the form of LAN. Updates of any sort of transaction will be immediately updated to local database and centralized server.



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Fig 1: Methodology of RFID based automated smart toll collection systems

#### IV. AIM AND OBJECTIVES

In this project we address the problems faced at toll plaza & also introduce identification system for vehicles against which stolen and accident cases are registered using RFID. The owner has to create an account through mobile application & register his RFID tag.

When vehicle passes through Toll Collection Unit (TCU) it is classified as passenger or goods carrying vehicle based on its Unique Identification Number (UIN). A goods vehicle is weighed at TCU & if it is overloaded then charged with extra tax. UIN is passed to Central Server Unit (CSU) where the balance gets deducted from account.

Once the balance is deducted at CSU it will indicate TCS to open the barricade and vehicle is allowed to pass. If vehicle is detected to be stolen at CSU it will indicate TSC not to open the barricade. Also to overcome the problem of hit & run cases collision detection mechanism is implemented using piezoelectric sensor in vehicle to identify RFID of collided vehicles. These details can be used for further action. The main objective of the project is to develop an efficient module for automatic toll tax collection. The proposed objective is based on three modules

Sensor technology- it is used to detect vehicle arrived and the speed is also detected using ultrasonic sensor. If the speed of the vehicle and if the speed exceeds then vehicle must pay the fine along with toll tax.

RFID technology- it mainly aims for identifying the card sensed on the toll plazas. RFID tag is scanned through RFID reader, by Radio frequency in the form of waves within a particular distance. The RFID tag is linked with owner account, each RFID tag has a wallet to which the owner has to top-up with prepaid amount.

#### V. SYSTEM ARCHITECTURE

In this system GSM module is used to send balance deducted and remaining balance on user's cell phone. So that user has information of transaction done at toll plaza. Central Server Unit also keeps the record of stolen vehicles and also vehicles against which accident cases are registered. Central Server Unit is also used to keep the record of online bank transaction of user and payment transaction at toll plaza.

The VCU consists of RFID reader and RFID card. The vehicle doesn't start until RFID reader detects valid RFID tag. If vehicle is stolen the case is registered against it, and vehicle is added to black list. When stolen vehicle which is black listed arrives at toll plaza, CSU detects it as a stolen vehicle. CSU then sends message to TCU that vehicle is invalid and doesn't allow vehicle to pass.

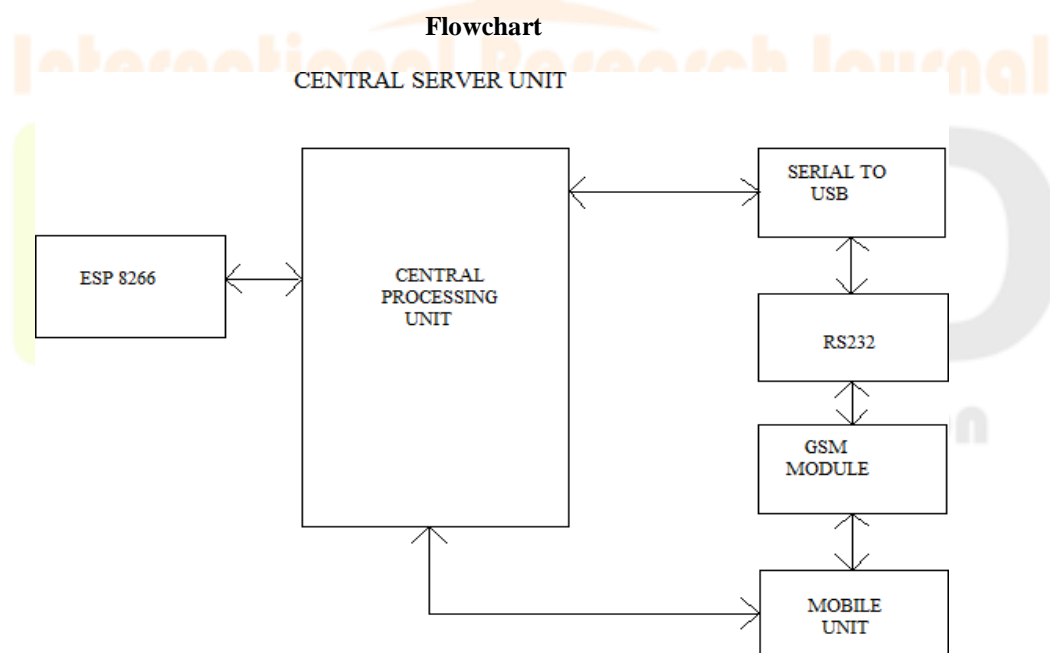


Fig 2: Toll Collection Unit



## VI. MODULES AND PROJECT DESCRIPTION

**Arduino Uno:** The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC to-DC adapter or battery to get started.

**LCD Display (16x2):** A liquid crystal display (LCD) is a flat panel display, electronic visual display, based on Liquid Crystal Technology. A liquid crystal display consists of an array of tiny segments (called pixels) that can be manipulated to present an information. Liquid crystals do not emit light directly instead they use light modulating techniques. LCDs are used in a wide range of applications, including computer monitors, television, instrument panels, aircraft cockpit displays, signage, etc. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones.

**Global System for Mobile (GSM):** GSM stands for Global system for mobile communication formerly called as Groupe special mobile. This is a standard set developed by the European Telecommunication Standards Institute (ETSI) to describe technologies for digital cellular networks. The GSM standard circuit initially was used originally to describe switched circuit network for full duplex voice telephony to replace analog cellular networks.

**RFID Card:** RFID stands for Radio-Frequency Identification. The acronym refers to small electronic devices that consist of a small chip and an antenna. The chip typically is capable of carrying 2,000 bytes of data or less. The RFID device serves the same purpose as a bar code or a magnetic strip on the back of a credit card or ATM card; it provides a unique identifier for that object. And, just as a bar code or magnetic strip must be scanned to get the information, the RFID device must be scanned to retrieve the identifying information.

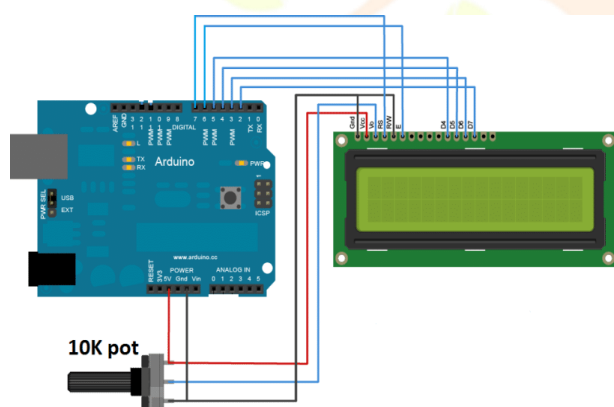


Fig 3: Arduino to LCD display connection

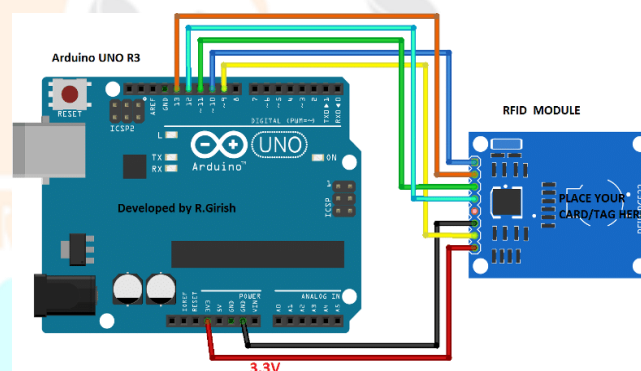


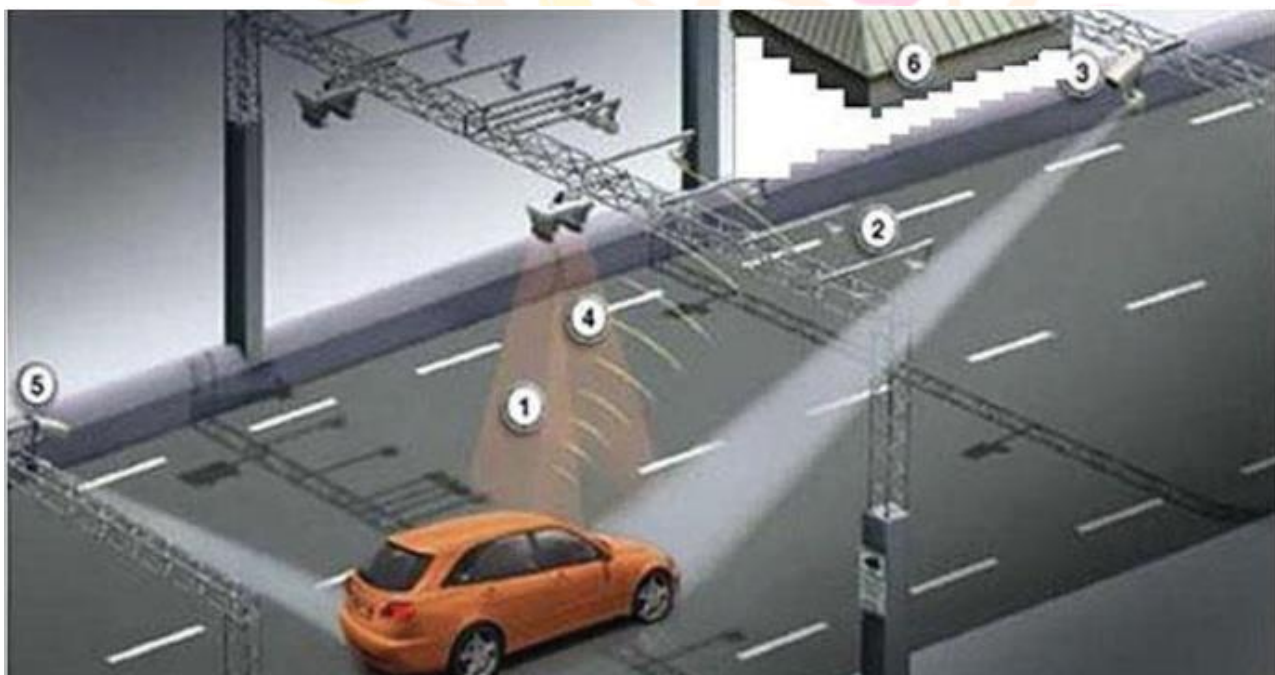
Fig 4: Arduino to RFID module connection

## VII. IMPLEMENTATION

When a new vehicle is purchased, an RFID tag is attached to the vehicle, and the associated data is uploaded to the RTO office database. The RFID tag is linked to a prepaid account, through which the amount will be deducted while passing through a toll plaza. When a vehicle reaches a toll plaza, Firstly, the RFID tag on the vehicle is scanned, if the tag is present then the vehicle moves to the further process.

If the card has no complaints (stolen), then further moves on to the payment process. If the vehicle is stolen then the toll will remain closed and a message is sent to the vehicle owner through GSM. If it contains maximum amount to pay the toll fee then the amount is deducted and the toll gate opens for that vehicle. If the card contains insufficient balance then vehicle owner had to pay money at the toll and move on.

If there is sufficient balance in the registered prepaid account, the toll amount will be detected, and the toll gates will open. At the time of successful toll amount deduction, Arduino uses the GSM module and a SIM to send a deducted amount message to the driver. The deducted amount will also be displayed on the screen at the toll plaza.



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## VIII. RESULT

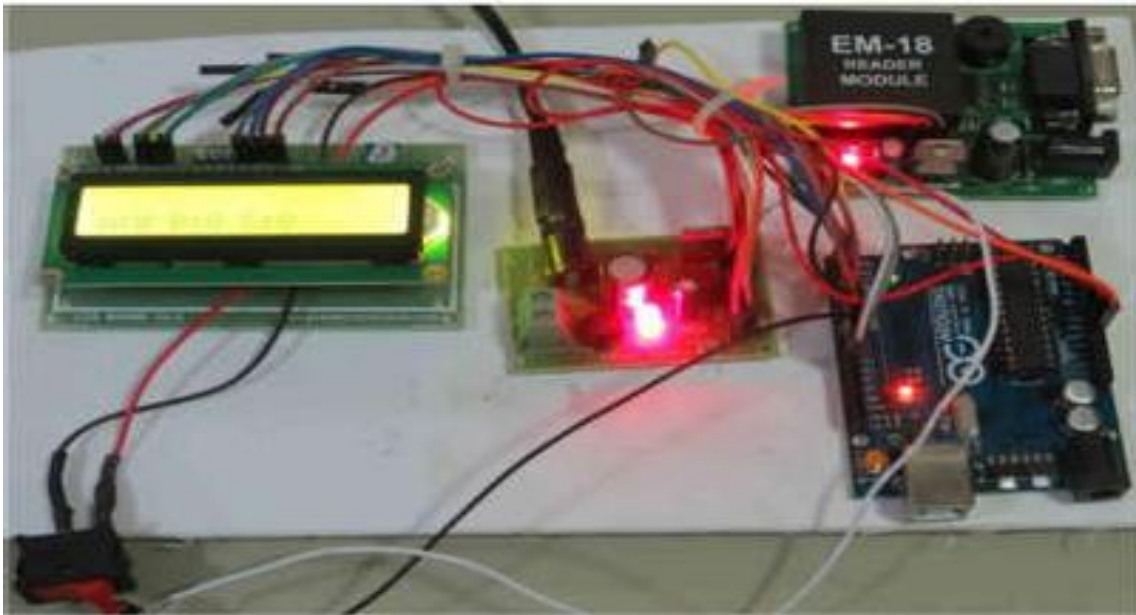


Fig 5. After connecting module when system is on state

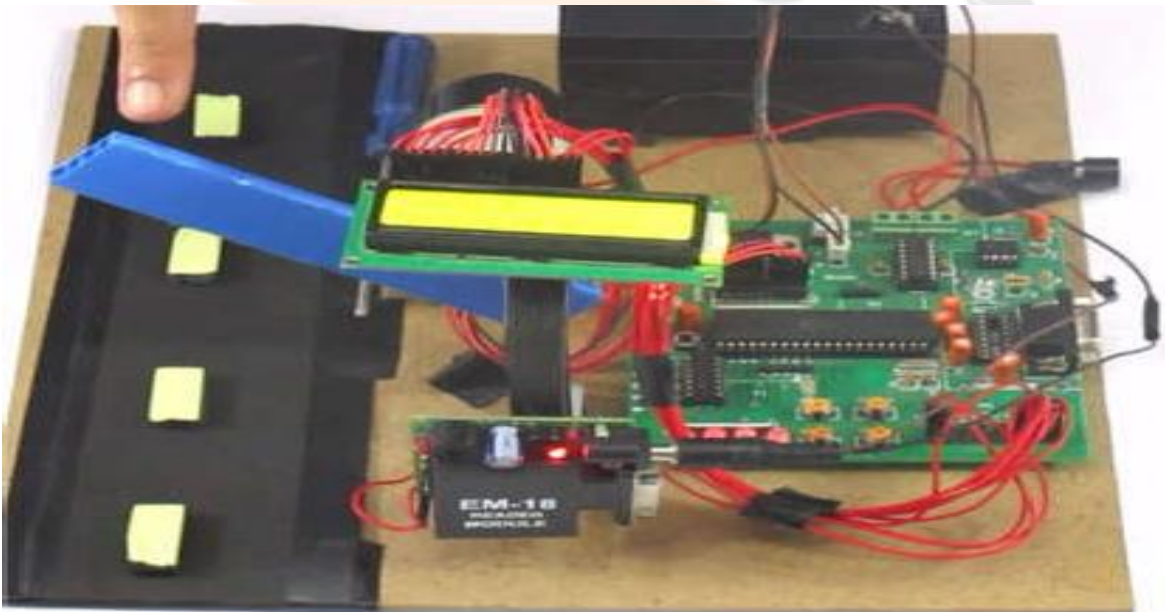


Fig 6. Gate open when access granted

## IX. CONCLUSION

The Automated smart toll collection system in expressway based on RFID, a design scheme was put forward. It has characteristics of low cost, high security, far communication distance and high efficiency, etc. It not only can improve technology level of charge, but also improve passage ability of expressway. Automated smart toll collection system is an effective measure to reduce management costs and fees, at the same time, greatly reduce noise and pollutant emission of toll station. In the design of the proposed automated smart toll collection system, real time toll collection and anti-theft solution system have been designed. This reduces the manual labor and delays that often occur on roads. This system of collecting tolls is eco-friendly and also results in increased toll lane capacity. Also, an anti-theft solution system module which prevents passing of any defaulter vehicle is implemented, thus assuring security on the roadways.

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