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Design of an Intelligent Transportation System Using Electronic Toll Collection

D.PRATHYUSHA [1], SHABAZ KAZI [2], B.SATYANARAYANA [3]

***Abstract* :** *The main theme of the project is to avoid human existence at the toll gates and it plays an automatic role in permitting the vehicle to go/stop by taking the payment. This project plays a vital role now a day because we use RFID technology with GSM to develop the Application.*
The role of RFID is to identify the vehicle. When the Vehicle is entered then RFID will be active and the reader reads the tag and microcontroller checks with the database for the balance for the balance enquiry. If sufficient amount exits in the card then the gate will be opened and whenever the vehicle crosses then with in 2min automatically gate will be closed. If the balance is not available in the card then gate will not be opened.
This also has GPS in the project to locate the vehicle. GSM is used to know that where the vehicle is located exactly by sending a message. The controller receives it and responds back with values of latitude and longitude given by GPS.
In the above, ARM7 processor is used for the vehicle section of the system, which is a high end 32 bit microprocessor, executes the instructions very fast and PIC microcontroller is used for the transmitting section of the system.

Keywords*: RFID technology, GSM, GPS, 32 Bit Microprocessor, ARM7 Processor*

***** Correspondence Author
D.PRATHYUSHA[1]
SHABAZ KAZI [2],
B.SATYANARAYANA [3]
[1,2,3] *Assistant Professor, Department of ECE*
Holy Mary Institute of Technology and Science, Telangana, India

I. INTRODUCTION

The Electronic Toll Collection (ETC) is a technology that permits vehicles to pay highway tolls electronically. E-Z Pass is the nation's first toll collection system. This automation has replaced live attendants at toll stations that collect fees manually. Electronic Toll Collection is a concept that is being readily
accepted globally. Some tags are designed to communicate with other kinds of roadside readers as well, making interstate and intrastate toll payments accessible. Toll agencies are interested in developing these tags and readers because they can simplify the tolling system.
The evolution of communication technology has brought ETC systems from SLFF (Single Lane Free Flow) to MLFF (Multi-Lane Free Flow), and area wide integrated MLFF road charging system is now currently on its development. DSRC-based ETC systems will gradually evolve to the area wide integrated road charging solution based on mobile communication technology. Most of the current ETC implementations are based on RFID, the vehicle positioning system using global positioning system (GPS) and mobile communication technique.

II. OBJECTIVE OF THE CONCEPT

The main objective of this concept is to ease the collecting toll and reduce traffic and improve service. The RFID card will be given to the user which contains the digital code, which has the corresponding details stored in the centralized database system which can be accessed in the relevant office as and when required.
The ETC can be used in any kind of environment. At the toll gates, instead of a person collecting the amounts of vehicles, Use of an automated system helps us to reduce the man power. A system with RFID (radio frequency identification) is used to identify the vehicle. When the vehicle is identified, then the next step the controller will check for the balance in the card. If there is a sufficient amount in the card, then vehicle are allowed to move forward means the gate will be opened automatically and if the card does not have balance then vehicles are not allowed means gate will not be opened.
Tracking of vehicle is done using GPS and GSM in this project. The coordination can be provided with above in the real criteria. The GSM (Global Standard for mobile communication) which is used to send the message for retrieving the longitude and latitude values from GPS. Therefore, it can track the vehicle location with the GPS values.

2.1 RFID

As an evolutionary automatic identification technology, RFID was considered a niche technology a few years ago. As the costs associated with RFID hardware have decreased, and standards defined for managing data, RFID has gone main stream. It has the potential of powering business systems such that they become the competitive backbone of organizations. Radio-frequency identification (RFID) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders.
An RFID tag is an object that can be applied to or incorporated into a product, animal, or person for the purpose of identification using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader.
Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a (RF) signal and can also be used for other specialized functions. The second is an antenna for receiving and transmitting the signal. A technology called chip less RFID allows for discrete identification of tags without an integrated circuit, thereby allowing tags to be printed directly onto assets at lower cost than traditional tags.

2.2 ETC

Transmitting Module: In a typical RFID based ETC system, individual objects will be equipped with a small, inexpensive tag. The tag contains a transponder with a digital memory chip that is given a unique electronic product code. The interrogator, an antenna packaged with a transceiver and decoder, emits a signal activating the RFID tag so it can read and write data to it. When an RFID tag passes through the electromagnetic zone, it detects the reader's activation signal. The reader decodes the data encoded in the tag's integrated circuit (silicon chip) and the data is passed to the host computer.
Vehicle Module: A GSM modem is used to send the position (Latitude and Longitude) of the vehicle from a remote place. The GPS modem will continuously give the data i.e. the latitude and longitude indicating the position of the vehicle. The GPS modem gives many parameters as the output, but only the NMEA data coming out is read and displayed on to the LCD. The same data is sent to the mobile at the other end from where the position of the vehicle is demanded.

2.3 Working of ETC

Initially the gates at the tollgate will be closed and it will be opened when the payment will be made. So when the vehicle is identified then the RFID will fetch the unique id from the vehicle and gives it to the microcontroller. The microcontroller always monitors the RFID reader. When any data is received by controllers then it will checks for it details from its database. If the vehicle is having sufficient amount. Then the controller will deduct the amount according to the norms and make the gate to open and after 2 minutes then microcontroller closes the gate. This will be done automatically.
The ETC system has GPS and GSM technology's which plays a major role in locating the position and transmission and reception of the data. This is useful when want to know the position of the vehicle. The GPS Contained by the vehicle will tell us about the vehicle location by giving the LATITUDE and LONGITUDE values and this is done when send message to the

GSM modem which is also contained by the vehicle. So whenever the controller receives the data from the GSM modem. It will reply back to the number with GPS values.

2.4 Global Positioning System

The Global Positioning System (GPS) is a Global Navigation Satellite System (GNSS) developed by the United States Department of Defense. It is the only fully functional GNSS in the world. It uses a constellation of between 24 and 32 Medium Earth Orbit satellites that transmit precise microwave signals, which enable GPS receivers to determine their current location, the time, and their velocity. Its official name is NAVSTAR GPS . GPS is often used by civilians as a navigation system.
A GPS receiver calculates its position by precisely timing the signals sent by the GPS satellites high above the Earth. Each satellite continually transmits messages containing the time the message was sent, precise orbital information, and the general system health and rough orbits of all GPS satellites. The receiver measures the transit time of each message and computes the distance to each satellite. Geometric trilateration is used to combine these distances with the location of the satellites to determine the receiver's location. The position is displayed, perhaps with a moving map display or latitude and longitude; elevation information may be included. Many GPS units also show derived information such as direction and speed, calculated from position changes.

2.5 Introduction to tracking system:

A GPS tracking unit is a device that uses the Global Positioning System to determine the precise location of a power lines, person, or other asset to which it is attached and to record the position of the asset at regular intervals. The recorded location data can be stored within the tracking unit, or it may be transmitted to a central location data base, or internet-connected computer, using a cellular (GPRS), radio, or satellite modem embedded in the unit. This allows the asset's location to be displayed against a map backdrop either in real-time or when analyzing the track later, using customized software.

RFID Module

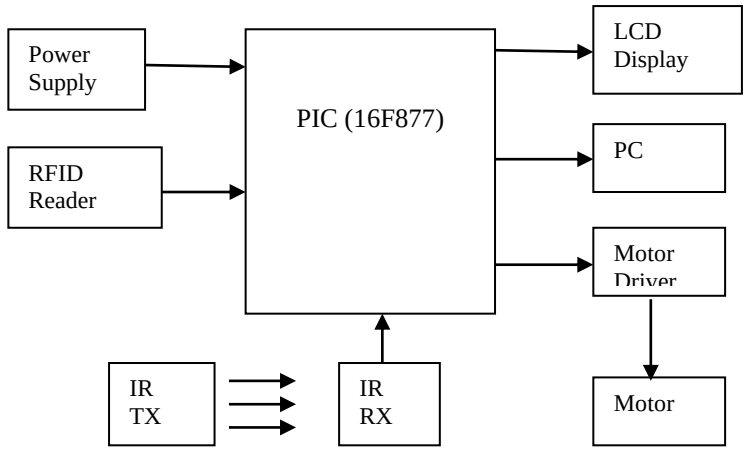
Radio-frequency identification (**RFID**) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders. The technology requires some extent of cooperation of an RFID reader and an RFID tag.

An RFID tag is an object that can be applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader.
Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, and other specialized functions. The second is an antenna for receiving and transmitting the signal.

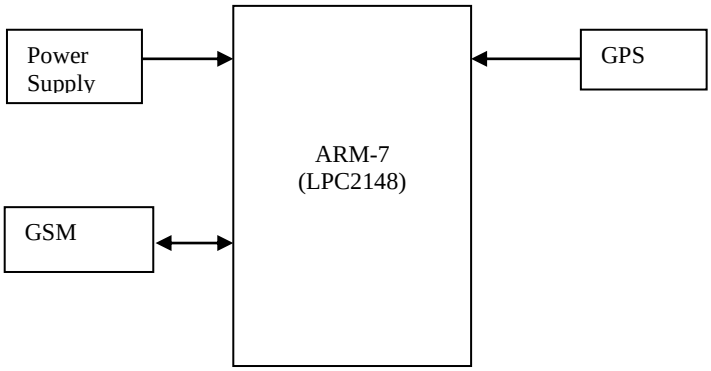
III. DESIGN OF THE SYSTEM

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. The software module uses the information from the identification module to determine the actual physical identity of the vehicle using its EPC code and the information is used to tell the boom gate whether to open or not. The boom gate system makes up the mechanical module.

Toll Section:

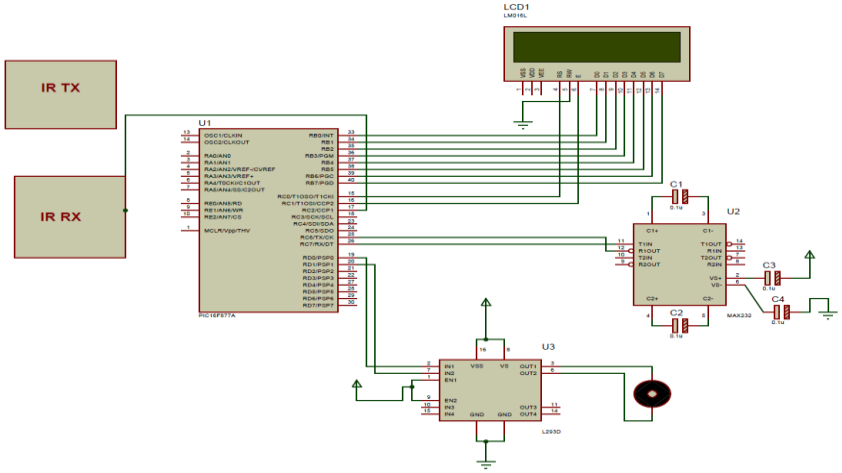


Vehicle Section:



IV. HARDWARE DESIGN

This involved the designing of the mechanical part, with the aim of having a stable, cheap, light and reliable design. For the prototype, wood was used but aluminium can be used for real life boom. After successful building of the gate system the whole system was integrated for testing. The RFID, server (computer and database), PIC control, power supply and the gate system were joined together.



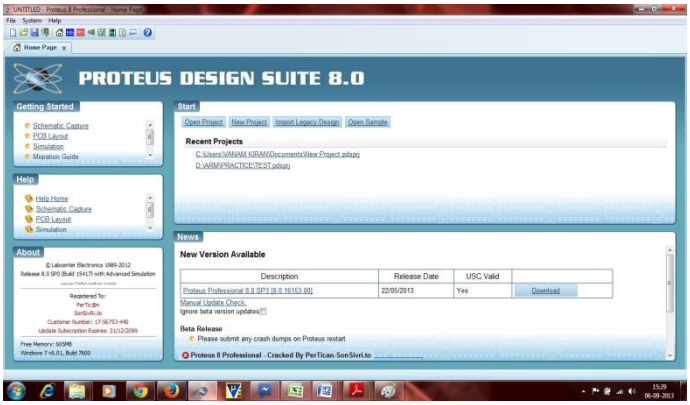
V. ETC CIRCUIT DIAGRAM

5.1 SOFTWARE MODULE

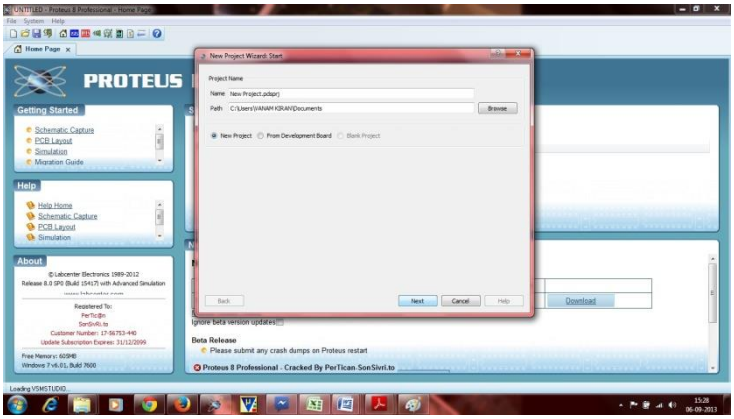
The microcontroller was programmed using the C programming language and Visual Basic was used in the serial communication between the computer and the RFID as well as with the PIC. A database was developed using Microsoft Access since it can contain up to 32768 records of objects, a size of about 2GB memory space which is sufficient for demonstration. Synchronizing software called Sync Toy was used to demonstrate exchange of data between.

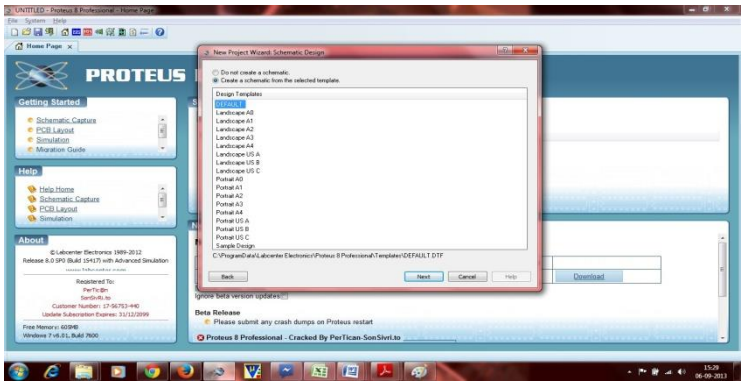
5.2 USING PROTEUS SOFTWARE

When we double click on Proteus Simulation software icon, this is 1st window will appear in your screen. And In the "Start window", we have to click on "New Project" to create new project

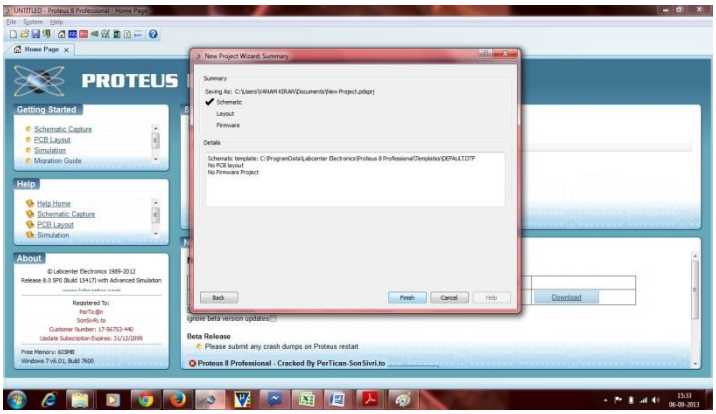


After clicking on "New Project", the above shown window will appear on your screen. There we have to select the path (i.e., on which location we want to save our project file) and the name of the project. After that select "New project" radio button and Click on "next"

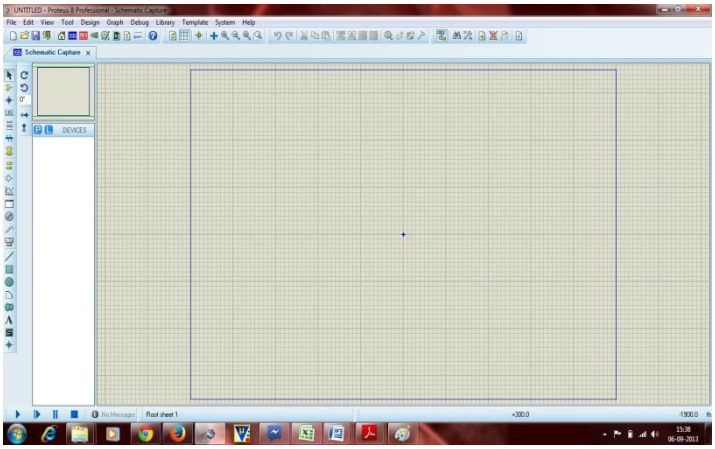




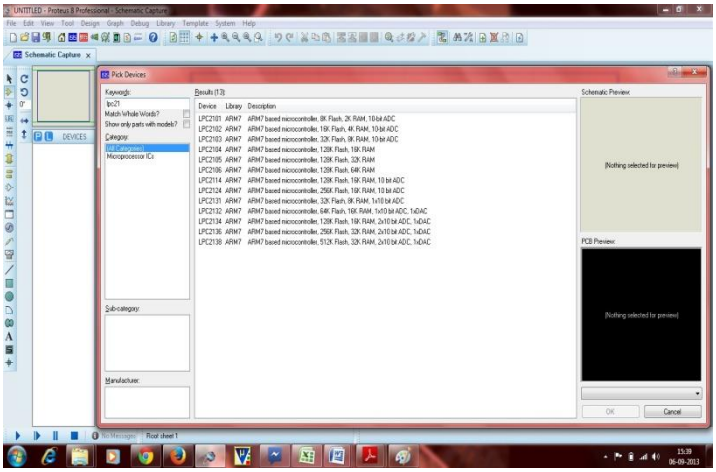
"New Project work schematic designs" window will open, there we have to select "Create a schematic" radio button and Design template as "Default" then click on "Next" button.



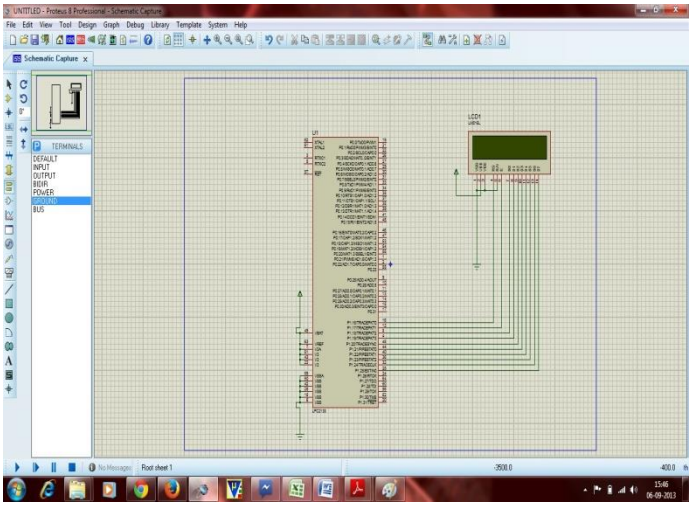
This is the final window in the process of creating project. It shows the" New project work summary" and there we have to click on "Finish" button.



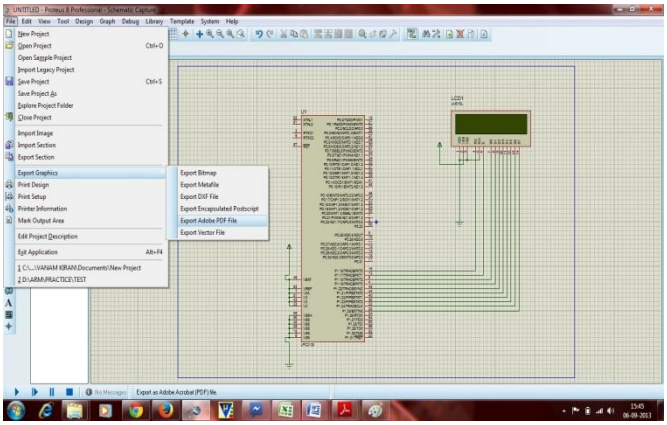
This is the new created project window for our design.



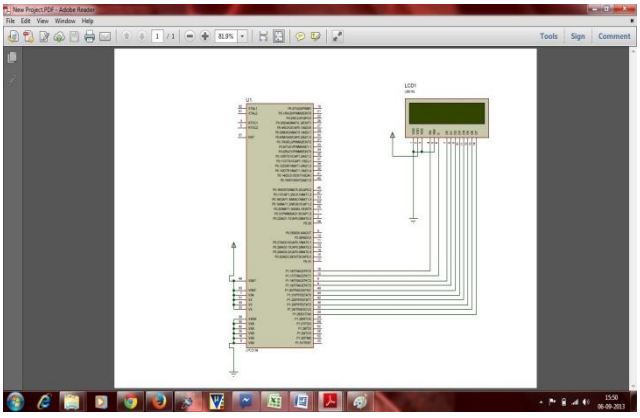
Here, we are selecting the devices for the project design. Click on the "P" button to pick the devices for our design. And enter the keywords for device. The results space shows the devices matches to your keyword.



This is the screen shot of proteus design after connecting LPC2148 controller with 16x2 LCD.



Here, we are converting proteus design to the PDF file. For that go to file menu and then to export Graphics and then to Export to PDF File.



This is Output PDF File.

VI. RESULTS

Diagram of the system hardware is illustrated in figures.20, The Hardware of An Electronic Toll Gate System includes MCU control Module, Stepper motor and Signal Processing module, GPS module, GSM communication Module.

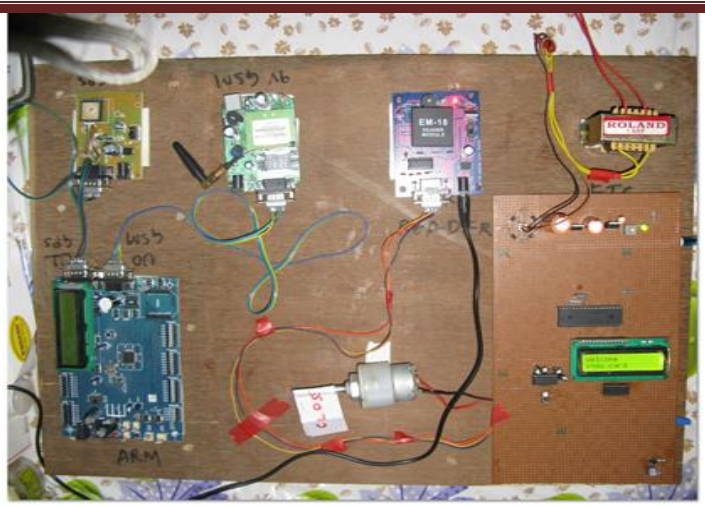


Figure: ETC Toll gate Closed

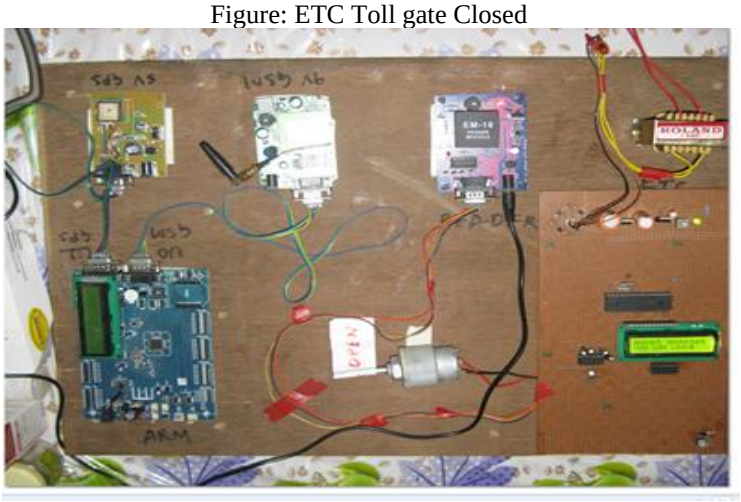


Figure: ETC Toll gate Opened

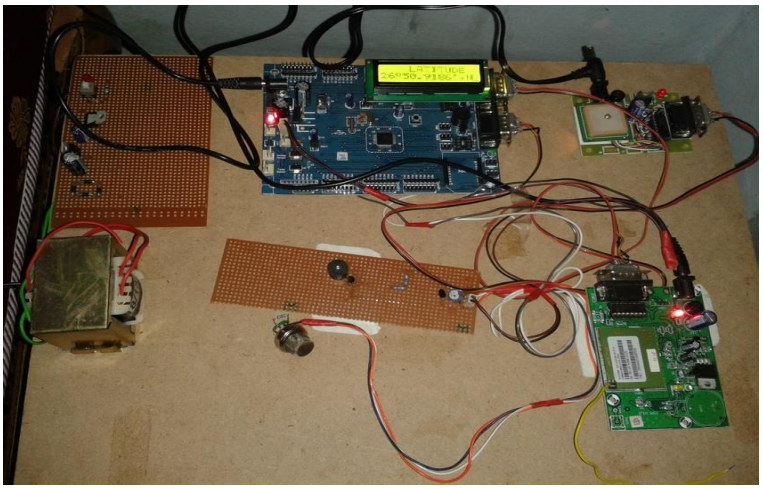


Figure: Vehicle Tracking System with Latitude and Longitude Values

VII. CONCLUSION

Presented an active RFID system platform including tags and the reader were I describe the detailed design and implementation of the platform. The active RFID system has features such as high identification rate of multiple tags, reliable energy budget. The tag and the reader are effective for development and evaluation of prototype applications because of the flexibility of the design of both hardware and software. So, the platform will be suitable for versatile item management applications

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