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AUTOMATIC TOLL COLLECTION USING MICROCONTROLLER AND RFID

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Abstract

To reduce the traffic jam at toll plazas and to save time, & also to decrease the wastage of money of almost 300 crores per annum, this paper is designed for the "toll tax payment automation using Radio Frequency Identification (RFID)". Automation of toll plaza is made using combination of microcontroller and RFID technology. Using RFID technology, priority of the vehicle (ambulance or fire brigade) can also be calculated to give free and easy access through toll plazas. This paper aims to design a system, in which vehicles reaching the toll booth and vehicle number and it's time are automatically identified. The electromagnetic signal received from a reader is worked upon by the passive tag on the vehicle. An internal capacitor on the tags is charged by the electromagnetic signals that are received, that seems like a source of power and supplies it to the chip. The RF signal from the tag is then amplified and is forwarded to microcontroller through the reader. ID is displayed on the LCD using microcontroller and based on the balance, decisions are made.

Key Words: RFID, microcontroller, internal capacitor, electromagnetic signal

INTRODUCTION

It is found that manual toll collection (MTC) vehicles are very much prone to crashes at the toll plazas and it is more dangerous when toll plazas are surrounded by heavy traffic [1,2]. Radio-frequency identification (RFID) is an identification technique that is automated, that depends upon storage and retrieval of information using RF tags. Automatic toll collection (ATC) model using RFID technology is focussed in this paper. RFID system includes transponder (tag), writer/reader and computer host. A tag is a microchip that is combined in a compact package. It contains of "memory and logic circuits" to get and the send back the information to the reader. They are classified as active or passive tags. The tag reads only one target at one time and hence is useful when we compare it to other already existing systems. "The RFID tag is used as a unique identity for a particular user". When a vehicle comes to the toll plaza, RFID tag is scanned by the RFID reader. If the identity (serial number of the tag) is matching with the one already stored in the database, the toll amount is deducted from his account. Post this, the vehicle gets immediate access to through the plaza.

The system also detects the priority of the vehicle using RFID technology. Vehicles have been classified into four categories:

1) Fire Brigade vehicles, Ambulance, and V.I.P vehicles. Their priority is the topmost.

2) Buses and school & college buses which are needed to be reached on time to their destination, so fast service of these vehicles are needed.

3) Car, scooters and motorcycles

4) Heavy vehicles

Proposed System

Flow of the model:-

- Detection of the vehicle
- Weighing and priority checking
- Display of toll
- Payment through the smart card

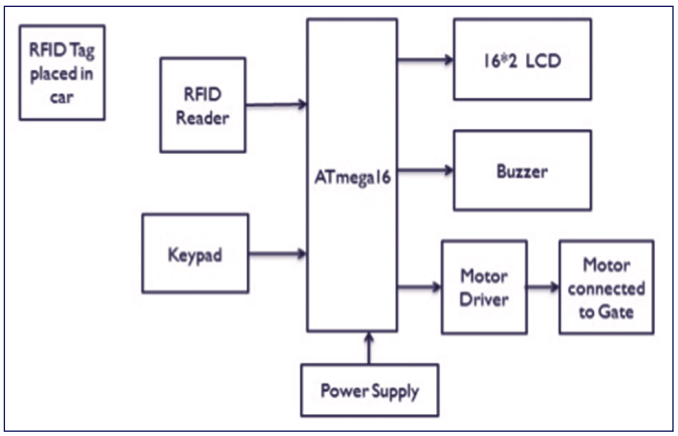
Every vehicle will have an RFID tag with a unique ID. ID can be vehicle number which is unique for every vehicle. When the vehicle approaches the toll booth, the RFID reader there can detect the RF signals from the tag in the vehicles. These signals are forwarded to the microcontroller after amplification. The LCD displays the ID. From the database all the information about the vehicle is shown in the screen. A stollen vehicle can also be detected using the existing information. Date and time of crossing the toll plaza also gets recorded in the database. The information including the image of the car is sent to the mail of the owner.

RESEARCH OBJECTIVE

The main objective of this research paper is to study the components, architecture and working of an ATC System. This paper shows how the embedded systems is used to implement the model of ATC. For this, technology of RFID based on micro-controller was studied in this paper. Here we are going to see some points regarding to purpose behind choosing this topic & what is the requirement of this type of the project in our day to day life. · Avoid the fuel loss. · Saving of time in collecting toll. · Avoid financial loss. · To monitor the traffic.

System Architecture

Figure 1 : Architecture of RFID based toll collection system



The "RFID based Toll Collection System" consists of following main elements:

1. RFID card: RFID cards have many functions, they ensure easiness, these cards must simply be shown before a reader, no need swiping. These cards are used in security systems, attendance time systems, biometric, payments etc.
2. RFID reader: An RFID reader scans an RFID tag. Radio waves are emitted from the antenna in the reader to which the tag responds the data back.
3. Micro controller: Microcontroller is the one to decide the mode of operation by sensing the signals from switches. Data is sent to output devices (display, motor driver, buzzer) from the memory location.
4. Liquid crystal Display: Details like valid card, invalid card, permitted access, manual access etc are displayed on LCD. "16x2 alphanumeric displays" are used.
5. Motor Driver: It is used to convert 5V (microcontroller) to 12V (DC motor) so as to drive the motor.
6. DC Motor: Gates at the toll booths are opened using a DC motor after the RFID functioned are performed successfully.
7. Buzzer: Buzzer is turned on when balance is insufficient or the card details does not match any of the existing database, i.e. The card is invalid.
9. Keypad: For offline recharging the RFID cards, Keypad is provided at the booths for the vehicles that has less balance and can recharge by changing the lane then and there.

HARDWARE DESCRIPTION

AVR ATMEGA16 Microcontroller

The AtmelATMEGA16 (commonly known as AVR ATMEGA16) is a "Harvard architecture", a microcontroller (µC) with a single chip series which was developed by Atmel in 1980 for embedded systems.

Radio-frequency identification

RFID is an automatic data-capturing technology which is accustomed in electronically identifying, tracking, and storing information there in a tag. A radio frequency reader scans the tag for information and sends it to a database, which stores the data contained on the tag. Some tags can be read from several meters away and beyond the line of sight of the reader. Frequency hopping is a technique accustomed to keep two or more RFID readers from interfering with one another while reading RFID tags within the area.

The chances of interference (of two readers attempting to interrogate the identical tag) are small if the band of the reader is wide enough.

An RFID system has 3 elements:

a) An antenna in the tag in the vehicle

b) A transceiverr (with decoder)

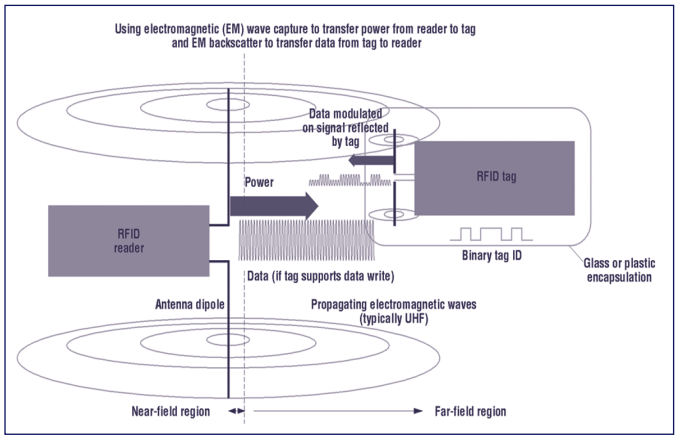
c) A Radio Frequency tag

Various alternative varieties of RFID systems exist, keeping in mind their ranges of frequency. These are the RFID bags used frequently:

1. "Low-frequency" (30 K.Hertz to 500 K,Hertz)
2. "Mid-Frequency" (900 K.Hertz to 1500 MHertz)
3. "High Frequency" (2.4 GHertz to 2.5 GHertz)

These frequency ranges mostly tell the RF ranges of the tags from low frequency tag that ranges from 3m to 5m, mid-frequency starting from 5m to 17m and high frequency ranging from 5ft to 90ft. The cost price of the system depends on their "ranges with low-frequency from some hundred dollars to a high-frequency system that ranges somewhere near 5000 dollars".

Figure 2: Far field Technique of RFID working



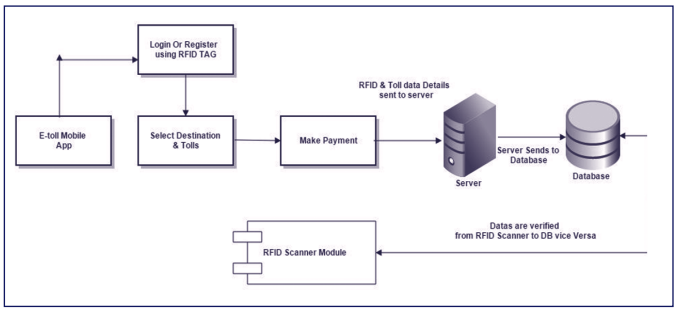
In the far field technique, "the tag captures EM waves transmitted from the dipole antenna which is attached to the reader. The small dipole antenna receives this energy in the form of alternating potential difference that appears across the arms of the dipole. After the rectification it is linked to the capacitor which results in accumulation of energy in order to supply power to the tags".

WORKING OF ATC

Vehicles use an "electronic tag" which is around the size

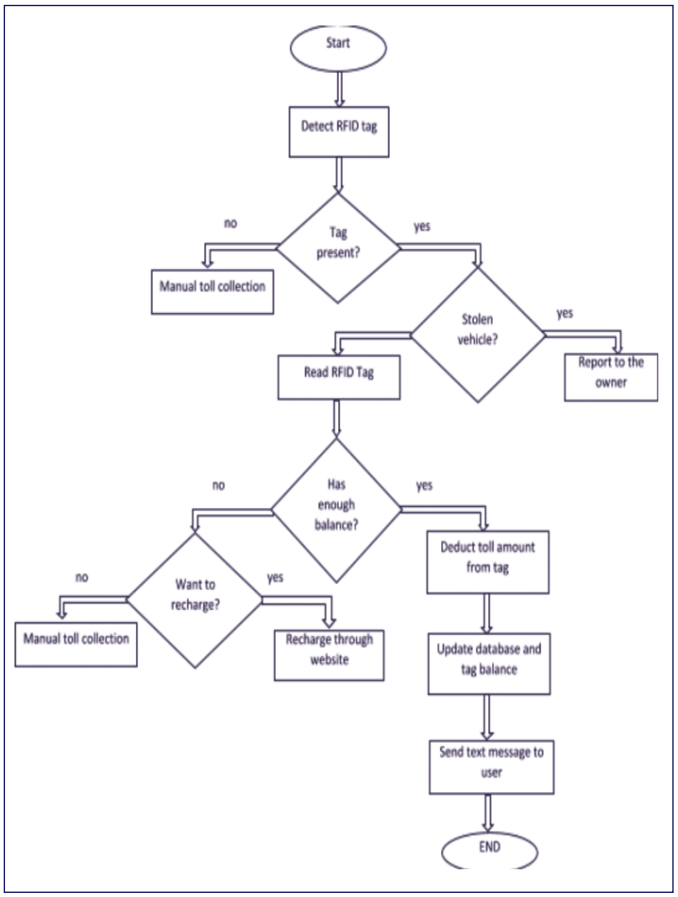
of an ATM card, the tag is fitted in the vehicle. The vehicle when reaches the toll plaza, an "RFID Reader" in the toll plaza reads the vehicle and account data and scans the unique RFID number. This data is sent to the computer system in the control room that validates the data against the already existing data and existing accounts, and the required amount is deducted from the vehicle's account. If the vehicle account doesn't have sufficient balance, a buzzer can be used as an alarm. Such vehicles can form different lane for recharging and then passing through the plaza. Each tag consists of an identification number, data showing the issuing agency, type of the tag, vehicle information, etc. The tag ID, agency ID, and tag type cannot be changed or manipulated. ATCSR vehicles can be read while vehicles are in motion, ATC promises to reduce lengthy traffic lanes at toll plazas.

Figure 3 : ATC Working



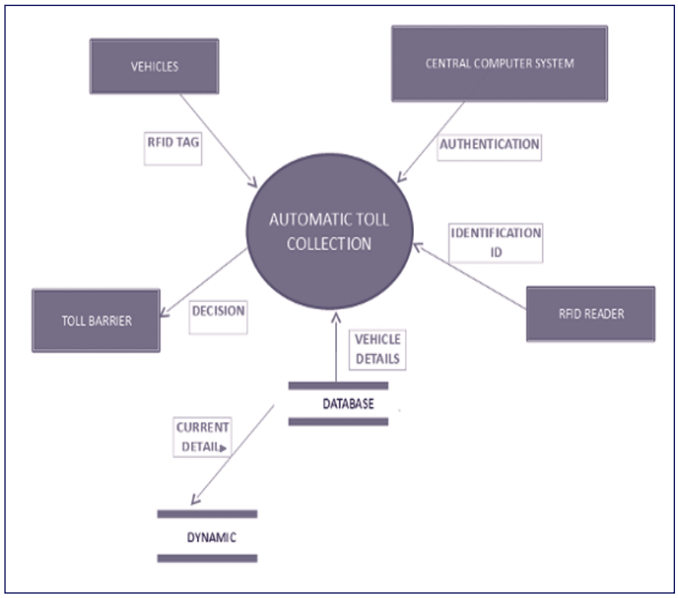
SYSTEM DESIGN

FLOW CHART



Data Flow Diagram

Data flow diagram (DFD), is a graphical representation, in which flow of is depicted and when data is input and output, transformers are used.

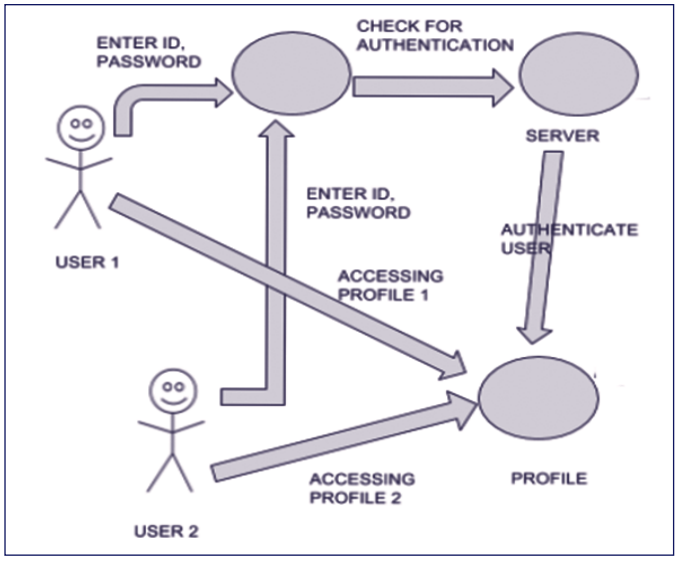


Behavioural Modeling Use case Diagram:

It shows a set of use cases and enactors. Static use case view of system is depicted in the use case. Organization and modelling of the system behaviour are done by the diagrams.

In below diagram a user can be anyone using the system.

Figure 4 : Use Case

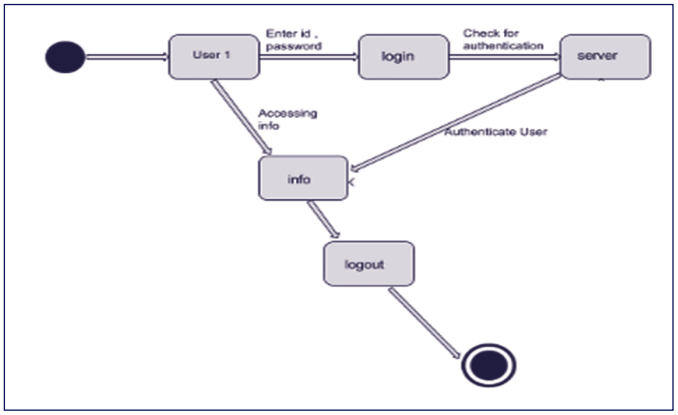


State Diagram

State diagrams describe the behaviour of the system. This behaviour is examined and constituted as a sequence of events that happen in various states.

Dynamic structure of a system is looked upon in the state diagrams.

Figure 5: State Diagram of the system



CONCLUSIONS

To implement this model of "Automatic Toll Collection using RFID" the embedded systems platform has been used. For this, technology of RFID based on micro-controller was studied in this paper. The advantages of the presented model are. It has database of RFID card of the user. It acts as user interface whenever user shows RFID card it will read out by MCU using RFID card reader then it transfer those thing to PC interfacing/ front end software. A kind of radio frequency chip was used to design electronic toll collection system. Structural and process designs were made, in addition, a new RFID authentication and authorization protocol model was used to guarantee system security, reliability and saves time.By this automation, money loss problem at toll plazas can be solved by reducing manual workers required for toll collection and also decrease the traffic and hence the time wastage can also be decreased.

IMPLICATIONS OF THE STUDY

In our paper, we have introduced "Radio Frequency Identification". This model consists of the "RFID tag & reader" which together can be used in detecting the different vehicles. The IR Transceiver is used to find the vehicle at various areas which acts as a permit to pass the toll booth. By productively using these techniques, we are able to constitute the "automation in toll plaza" that can help in reducing the complete processing time to few seconds which is very necessary and also will help in reducing money wastage in a "very cost effective manner". It also helps in reducing the fuel consumption and of course pollution reduction.

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