Automated Toll Collection System Using RFID

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Abstract— ATCS known as "Automatic Toll Collection System" is a technology used to reduce the amount of time spent in toll queue, provide traveler ease of toll payment, illegal entry and to detect stolen vehicle. In order to cut down the manual work at toll plazas, an Radio Frequency Identification (RFID) based concept is used to carry out the entire process within a second. The system uses passive tag. This tag is a unique ID of the owner. All required information of the respective owner will be store in accordance with the ID. A reader antenna is normally assembled above the lane. It receives the transponder's signal. The serial number is send to the computer through local area network, along with toll-location and perhaps lane information. The system then matches the ID number and deduction takes place through the e-wallet assigned to the concerned RFID tag that belongs to the owners account. In case a stolen vehicle passes through the toll collection center, it is detected and the notification is sent to the Police admin module. All currently running vehicles will be served through image processing.

Keywords— ATCS; RFID; e-wallet;

I. INTRODUCTION

As we drive over the highway, we all find single or multiple cabins where we have to pay a fixed amount. These cabins are known as tollbooths and the money we pay is the tax for using the road, known as a toll road or toll road. Since then, most roads are built with the money raised by the state or national government through taxes. So, toll is a type of tax we pay the government for the maintenance of highways. When the vehicle arrives at the cab, a sensor installed on the cab detects the label or a card embedded in the vehicle. This tag is known as an RFID card. This RFID card has a unique identity for each user and thus the information about the user. The system reads the card and authenticates the person to go through the toll after a fixed amount has been deducted from the user's bank account. Payment in the ATCS system is via wireless mode. There is an antenna at the toll booth which establishes a wireless connection with the on-board unit when the RFID card of the vehicle is detected, thus automatically deducting the amount from the account leading to cashless pickup.

Electronic / automatic toll systems take an hour. They don't need manual collection and operation of toll barriers. The need for manual toll systems is completely reduced in this process and the toll system uses RFID. The details about the vehicles and the payment are stored in an RFID-based system.

The idea behind the RFID-based toll collection system is to automate the toll collection process by reducing the long queues at the toll booths using the RFID tags installed in the vehicle. In addition, it can not only help detect vehicle theft, but also track vehicles passing the signal and vehicles driving at high speed. Other general benefits for motorists include fuel savings and reduced mobile emissions by reducing or eliminating the delay.

II. LITERATURE SURVEY

Kamarulazizi & Ismail, 2005 [1] the newspaper mentioned the benefits of Electronic Toll Collection System, often abbreviated as ETC, through the manual toll collection system. It noted that the former helps to control traffic jams, which are generally caused by traffic during festivals. In addition, it also benefits operators, as it helps central auditing.

Chhoriya, Paliwal & Badhan, 2013 [2] was shown in the paper that the use of image processing tools can be used for toll collection. The license plate on the vehicle can be edited and checked to fit any inventory in the database; from which the toll can be deducted, making it superior to manual toll collection.

Salunke, Malle, Datir & Dukale, 2013 [3] The following paper has highlighted the use of RFID, i. H. Radio Frequency Identification, designed for toll collection, making the entire system simple and viable. The use of ATCS extended to Automated Toll Collection System is an effective way to reduce government losses. The idea proposed in the work, because of its flexible nature and ease of implementation, had an advantage over other electronic methods.

Aphale, Chaudhari & Bansod, 2014 [4], the article has introduced the use of an ATMega328PU microcontroller, which is the centralized unit that controls the proposed system that uses RFID to detect short - range tags and asks the database for the amount I would deduct from the account connected to the internet.

III. Problem Statement

TO designing and develop an automated toll booth based on RFID technology to save time at the toll booth and ensure cashless operation. The RFID reader attached to the Tollgate frame reads the mark on the front glass of the vehicle. The object recognition sensor in the reader recognizes the license plate number and the toll collection takes place via an e-wallet which is assigned to the relevant RFID tag belonging to the owner's account.

IV. Objectives

The distinct objectives of this system are to ensure:

- Smooth traffic flow.
- Convenient toll collection without cash and reduced administrative costs.
- Smart Comfortable and fast service for vehicle owners and Smart City Development.
- Detect stolen vehicles.

V. Proposed Methodology

A. Arduino

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

B. RFID Tag

RFID tags are mainly classified as active tag and passive tag. The active tags are one with internal power supply. So it doesn't require any external source. Passive RFID tags require an external power supply. In this system we use passive RFID tags as they cost less and partly maintenance free. It is powered by using RFID readers. Here we use Class-0 Gen-1 RFID tags.

C. RFID Reader

Reader uses electromagnetic fields to automatically identify and track tags attached to objects. In this systemEM-18 reader module is used. It is a low cost low frequency(125 kHz) RFID reader.

VI. Scope

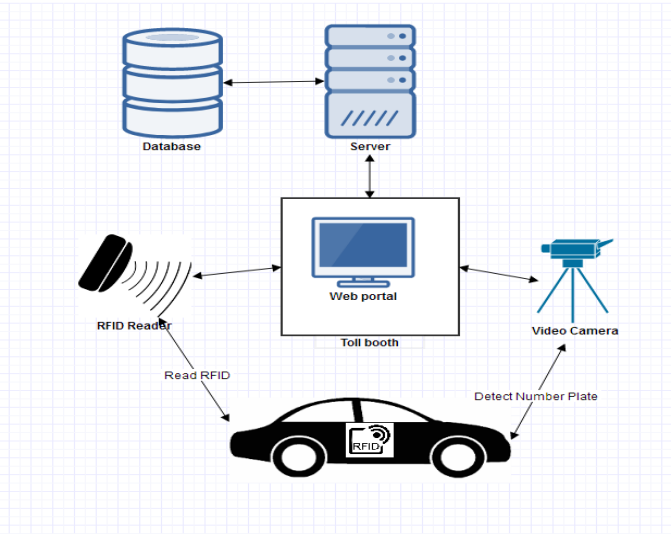
The system provides a base for implementing RFID based toll collection system to automate the toll collection process by monitoring vehicle at toll collection. Using this system, all problems related to manual toll fee collection will be eliminated, thereby achieving a higher efficiency rate per transaction.

Following are some highlighted scope:

- This project deals with the simplification of procedure followed by passengers to pay toll at toll collection booths.
- RFID reader fixed at Tollgate frame reads the tag attached to the windshield of a vehicle.
- The object detection sensor in the reader detects the approach of the incoming vehicle's tag and toll deduction takes place through e-wallet assigned to the concerned RFID tag that belongs to the owner's account.
- In case a stolen vehicle passes through the toll collection center, it is detected and the notification is sent to the Police admin module.

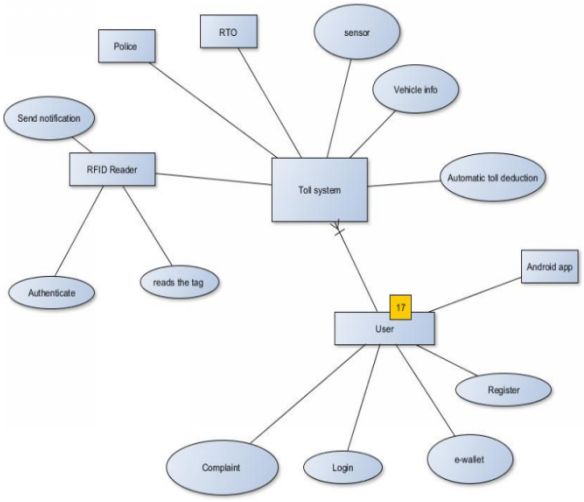
VII. Working Principle

In our project, we have a vehicle equipped with an RFID tag and a computer connected to the Transceiver placed on the charging station. Whenever the vehicle enters the range of the radio-telephone, locates the tag and decodes the code assigned to that specific tag. After receiving the code, it is sent to the computer located at the charging station. The computer then recognizes the code and automatically accesses the database, and if the vehicle has a valid prepaid account on toll station, the appropriate toll is deducted from this account and the gate is opened. And if the vehicle does not have a valid prepaid account or is not daily traveler, will have to go through the manual inspection station, which will be on a different lane. Using the database, we can avoid having to send entire data from the tag which allows us to use tags with less demand for memory, i.e. we store only 4 or 6-digit code number in the tag. And this 4 or 6-digit code is associated with a database that is associated with database that is present on your computer. Each Tag has a different code number. It also decreases Probability of error and saves processing time.



VIII. DATA MODEL AND DESCRIPTION

A. *Data objects and Relationships*



- Toll Admin: It is the entity that represents an authorized user of the system who has the central responsibility for handling the system and managing the database.
- User: The user is an entity that has all personal information as attributes. This is stored in the user's database, which is handled by the central responsibility. ,
- RFID Reader: Reads the tag, authenticates the user and sends a notification after the appropriate deduction has taken place

IX. NAÏVE BAYES ALGORITHM

A. *Naïve Bayes Classifier*

In machine learning, naive Bayesian classifiers are a family of simple probability classifiers based on Bayes theorem with strong (Naive Bayes is a simple method for constructing classifiers: models that assign class labels to instances of a problem represented as vectors of characteristic values where class labels are taken from of a finite set. This is not one algorithm for teaching such classifiers, but a family of algorithms based on a general principle: all naive classifications Bayes' s assume that the value of a particular function does not depend on the value of any other function, given the class variables.For example, a fruit can be considered an apple if it is red, round and about 10 cm in diameter. The naive Bayesian classifier treats each of these functions independently of each other so that the probability that this fruit is an apple, regardless of the possible correlations between color, roundness and diameter characteristics.

For some types of probabilistic models, naive Bayesian classifiers can be trained very effectively in a controlled learning system. In many practical applications, the parameter estimation for naive Bayesian models uses the maximum likelihood method; in other words, it is possible to work with a naive Bayesian model without taking Bayesian probability or using any Bayesian methods & independent assumptions between functions.

Naive Bayes is a sort of classifier that uses the Bayes theorem. It predicts membership probabilities for each class, such as the probability that a given record or data point belongs to a particular class. A class with the highest probability is considered the most likely class. This is also known as Maximum A Posteriori (MAP).

The MAP for a hypothesis is:

MAP(H)
=max(P(H|E))
=max((P(E|H)*P(H))/P(E))
= max(P(E|H)*P(H))

P(E) is evidence probability, and it is used to normalize the result. It remains same so, removing it won't affect.

Naive Bayes classifier assumes that all the features are unrelated to each other. Presence or absence of a feature does not influence the presence or absence of any other feature.

Naive Bayes is a conditional probability model: given a problem instance to be classified, represented by a vector $\mathbf{x} = (x_1, \ldots, x_n)$ representing some n features it assigns to this instance probabilities .

$$p(C_k \mid x_1, \ldots, x_n)$$

The problem with the above formulation is that if the number of features n is large or if a feature can take on a large number of values, then basing such a model on probability tables is infeasible.

We therefore reformulate the model to make it more tractable. Using Bayes' theorem, the conditional probability can be decomposed as

$$p(C_k \mid \mathbf{x}) = \frac{p(C_k)\, p(\mathbf{x} \mid C_k)}{p(\mathbf{x})}$$

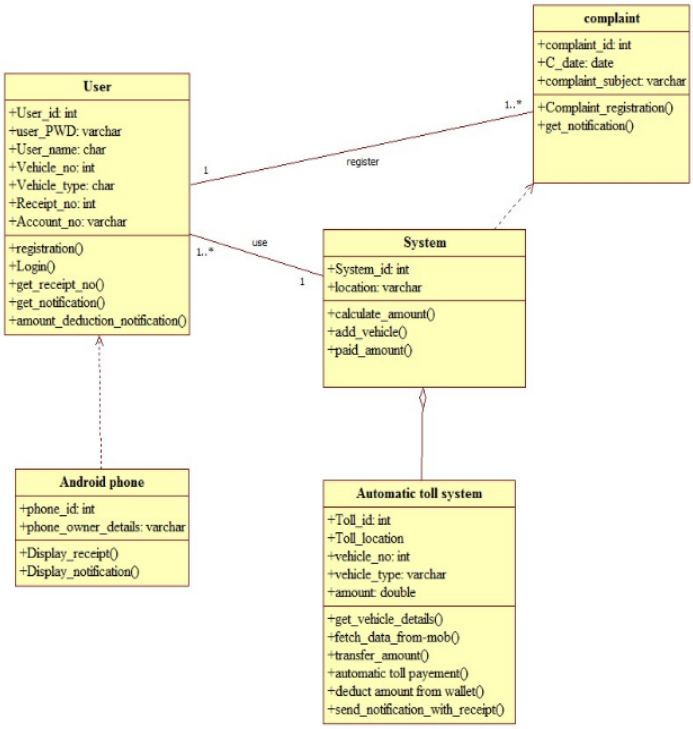
In plain English, usingBayesian probabilityterminology, the above equation can be written as

$$\text{posterior} = \frac{\text{prior} \times \text{likelihood}}{\text{evidence}}$$

B. Advantages

- The Naive Bayes algorithm is a fast, highly scalable algorithm.
- Naive Bayes can be used to classify Binary and Multiclass. It provides various types of Naive Bayes algorithms, such as GaussianNB, MultinomialNB, BernoulliNB.
- This is a simple algorithm that depends on the execution of multiple samples.
- Excellent choice for problems with text classification. This is a popular choice for the classification of spam e-mail.
- It can easily be trained on a small set of data

X. FUNCTIONAL MODEL AND DESCRIPTION



A. Non Functional Requirements:

i) Interface Requirements

There are many types of interfaces such as supported by the ATCS viz., User Interface, Admin Interface.

ii) User Interfaces

The user interface will be friendly so user can access to the system.

- Login with valid user ID and Password.
- Automatic deduction of money from E-Wallet depending on vehicle type at toll centers.
- Video selection from any location.

iii) Admin Interfaces

- Vehicle registration by RTO admin.
- Toll registration by Super admin.
- Stolen vehicle registration by Police admin

iv) Constraint:

Improper type of Number plate (Fancy, Damaged) cannot be detected.

B. Performance Requirements

i) Reliability & Availability

- Back-end Internal Computers: The system shall provide storage of all databases on redundant computers with automatic switchover.
- Internet Service Provider: The system shall provide a contractual agreement with an internet service provider who can provide 99.999% availability through their network facilities onto the internet.

ii) Usability

- Graphical User Interface: The system shall provide a uniform look and ease through application on device.

iii) Accessibility

The system shall provide multi language support.

iv) Performance

The performance shall depend upon hardware components of the client/customer.

v) Security

Data Transfer: The system shall automatically log out all customers after a period of inactivity. The system shall confirm all transactions with the owner's account. The system shall not leave any cookies on the customer's computer containing the user's password. The system shall not leave any cookies on the customer's computer containing any of the user's confidential information.

XI. CONCLUSION

The common problem of skipping fees is reduced for paid tariffs by automatically keeping payments through E-Wallet. Long queues on the toll plaza and the need for human intervention are significantly reduced. This system will provide a smoother and safer journey for passengers.

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