

Automatic Toll Collection System using RFID

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Abstract:- Automatic Toll Tax systems have really helped a lot in reducing the heavy congestion caused in the metropolitan cities of today. It is one of the easiest methods used to organize the heavy flow of traffic. When the car moves through the toll gate on any road, it is indicated on the RFID reader that it has crossed the clearing. The need for manual toll based systems is completely reduced in this methods and the tolling system works through RFID. The system thus installed is quite expedient reducing the time and cost of travelers since the tag can be deciphered from a distance.

General Terms:- RFID,JVM, CGI , RTO, CLI

Keywords:- RFID: Radio frequency Identification. JVM: Java virtual machine. CGI: Common Gateway Interface. RTO: Regional Transport Office. CLI: command-line interface.

1. INTRODUCTION

1.1 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 tunnels 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.

1.2 Problem Statement

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.

1.3 Existing System: There are two methods of collecting tax presently used they are First is the traditional manual method where one person collects money and issues a receipt. The other one is the Smart Card method where the person needs to show the smart card to the system installed at the toll tax department to open the Gate.

1.3.1 Drawbacks Of Existing System: Both the above mentioned method for collecting tax is time consuming method. Chances of escaping the payment of tax are there. It leads to queuing up of following vehicles.

1.4 Proposed System

1.4.1 Automatic Toll Collection: The RFID Readers mounted at toll booth will read the prepaid RFID tags fixed on vehicles' windshield and automatically respective amount will be deducted. If the tag is removed from the windshield then cameras fixed at two sites at toll plaza take snaps of the front and back number plate. Since every vehicle registration ID is linked to users account, toll can be deducted from the account bank directly.

1.4.2 Vehicle Theft Detection: When vehicle is stolen the owner registers complaint on the website with its registration ID and unique RFID tag number. Now when stolen vehicle passes by the toll plaza, the tag fixed on it is matched with the stolen vehicle's tag in the database at the toll booth. .

- Automatic collection of toll tax.
- Free flow of traffic.
- Time saving.
- Record maintenance.
- Problems with pursuing toll evaders.
- Avoid the fuel loss.
- Avoid financial loss.
- Higher efficiency in toll collection.
- Cheaper cost.
- Smaller in size compared with the existing system.
- Durable tags.

2.LITERATURE SURVEY

The Toll Collection System has changed drastically over the years; from being a single borderline, a small passage booth to the huge toll collection infrastructure that has a key role in the revenue generation as well as the working of the traffic of a city or even a state. While the majority of the population is travelling vs different means it has become a necessity and regulatory method to control traffic.

Sachin Bhosale et.al discuss about RFID technology for automating the process of tollbooth system. RFID stands for Radio Frequency Identification. The components of the RFID System basically include RFID transmitter, a RFID receiver and some processing machine. The paper then goes on to discuss about the types of RFID tags. Types of RFID tags include Active Tags and Passive Tags. An active RFID tag is equipped with a battery. It can be used as a source of power for the tag's circuitry. It has better identification range and larger capacity. Active tag is able to send a strong signal to the reader because of the presence of battery. The major advantages of an active RFID tag are that they allow a read range of about one hundred feet and hence providing a high sensing range. It allows other sensors that can use electricity for power.

Then goes on to discuss about the components of the toll collection system. An RFID reader is a device used to communicate with an RFID tag. The reader has an antenna which emits radio waves. The tag responds by sending back its data. The GSM module is used for connecting the entire system through the Internet. When the vehicle passes through the tollgate the LCD system displays the information about that vehicle. The Motor Drive controls the gate of the system. IR sensor is used to detect the presence of the vehicle. The alarm indicator indicates the illegal passing of vehicles through the tollgate. Then the paper describes the working of the system. When vehicle cross the sensor which are fixed at some meter distance from the tollbooth, Tag will read by RFID Reader. TAG houses unique identification number. The data read by the RFID reader will be send to Microcontroller (8051). Then the microcontroller will

process the data for authentication. If the user is valid, then data will send to processing unit. It then checks the account of that user from database. If sufficient amount, then user is allowed to pass. If amount is not sufficient to pay toll, then user must have to pay the toll manually. The system has some disadvantages because of the use of active tag.

The problems of an active RFID tag are that the tag cannot function without battery power, which cause reduced lifetime of the tag. On the other hand, the tag is typically more expensive. The tag is physically larger, which may limit applications.

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.

Asif Ali Laghari et.al discusses another system which solve the problem of waiting period and payment issues in the conventional manual toll collection system. This proposes a system which contains transponder, Antenna, Traffic Controller System & Central Server. Transponder is the RFID tag which houses a unique identification number. The Traffic Controller System makes the system different from others. This system manages the distribution of vehicles incoming across a set of parallel toll gates. It uses a Lane Allocation Algorithm. This algorithm allocates the cars approaching the toll gate among the set of the toll gates. The system also employs traffic speed controller. Once the RFID tag comes into the range of the Toll Plaza, the ECU (Electronic Computer Unit) is directed to reduce the speed of the vehicle. The problem with the system is that, once the algorithm fails the entire system fails and leads to huge traffic overhead.

Abhishek Sharma et.al.is also based on RFID. In addition to that it uses load sensing technology. It first discusses about the operation of RFID. As discussed in the previous paper, the proposed RFID system uses tags that are mounted on the windshields of vehicles, through which information on the tags are read by RFID readers. In each automated toll booth, there will be a RFID sensor and a load sensor. Control booth will house a computer and an operator. Then discussed each operation step by step. First step is reading the card. RFID works in radio frequency. When a vehicle with TAG approaches a toll booth the RFID sensor detects it. Then it sends the detected tag id to the server through MAX232 serial communication.

3. SYSTEM REQUIREMENT SPECIFICATION

3.1 Hardware Requirements

- CPU type : Intel Pentium 4
- Clock speed : 3.0 GHz
- Ram size : 512 MB
- Hard disk capacity : 40 GB
- Monitor type : 15 Inch color monitor
- Keyboard type : Internet Keyboard
- Mobile : Android Mobile
- EM 18RIFD Reader module

- ATmega328
- ESP8266 WiFi Module
- RIFID TAG

3.2 Software Requirements

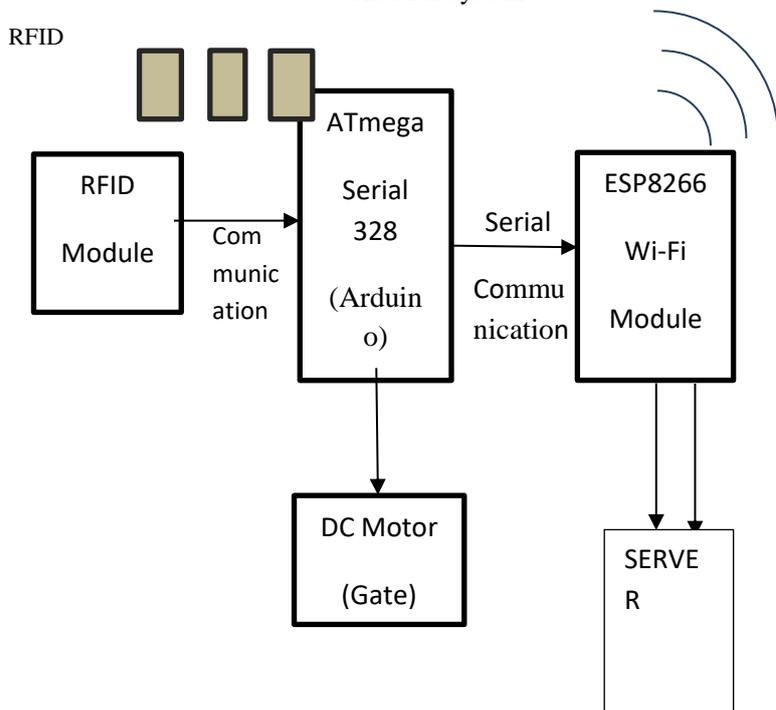
Software	Description
Operating System:	Windows
Language :	Java, XML, PHP, HTML,CSS
IDE :	Android Studio, Dream
WeaverWeb Server :	eu5
Database :	My SQL
Java Version :	JDK 1.8

4.SYSTEM DESIGN

4.1 System Development Methodology

The basic methodology for the project is designed so that the system can be available to everyone who needs it and can be installed anywhere by anyone. The principle of the project is RFID i.e. Radio Frequency Identification is used to find which vehicle has reached the toll and using its pre fed information to carry out further functions like allowing the vehicle to pass or not. The system is mostly dependent on microcontroller i.e. ATmega328 embedded on ARDUINO board. The owner of the vehicle has a RFID tag, which is read by the RFID reader. On reading the tag, the tag ID obtained is sent to microcontroller after which it analyses the tag ID and matches it with the IDs saved in the database, and further actions will be taken based on the status of the tag.

Figure 4.1: Block diagram of RFID based automatic toll collection system



The RFID based Toll Collection System basically consists of following main blocks,

- **RFID Tag:** An RFID tag, or transponder, consists of a chip and an antenna. A chip can store a unique serial number or other information based on the tag’s type of memory, which can be read-only, read-write, or write once read-many(WORM). The antenna, which is attached to the microchip, transmits information from the chip to the reader. Typically, a larger antenna indicates a longer read range. The tag is attached to or embedded in an object to be identified, such as a product, case, or pallet, and can be scanned by mobile or stationary readers.
- **RFID Reader:** In order for an RFID system to function, it needs a reader, or scanning device, that is capable of reliably reading the tags and communicating the results to a database. A reader uses its own antenna to communicate with the tag. When a reader broadcasts radio waves, all tags designated to respond to that frequency and within range will respond. A reader also has the capability to communicate with the tag without a direct line of sight, depending on the radio frequency and the type of tag (active, passive, or semi passive) used. Readers can process multiple items at once, allowing for increased read processing times. They can be mobile, such as handheld devices that scan objects like pallets and cases, or stationary, such as point-of-sale devices used in supermarkets.
- **Arduino Board with ATmega328 Microcontroller:** The ARDUINO is an electronic multipurpose board based on ATmega 328 microcontroller. It has 6 Analog input pins and 14 digital IO pins, out of these 14 pins 6 can be used as PWM outputs as well. It contains lot of components. It already has all the things embedded in it which are needed for proper working of the microcontroller. It can be directly connected to the computer through USB cable or can be used either by giving power through AC/DC adaptor. The ATmega328 is a unity chip microcontroller manufactured by “Atmel” in its megaAVR chip family. This microcontroller is usually used in projects and automated systems in which cheap.
- **ESP8266 WiFi Module:** The ESP8266 is a very cheap yet really effective platform for communicating over the internet. It is also easy to use with an Arduino. It helps the admin to control the hardware through the internet from anywhere.
- **DC Motor:** DC Motor is used to open or close the gate on basis of the command from the controller.
- **Power Supply:** This unit will supply the various voltage requirements of each unit. This will be consisting of transformer, rectifier, filter and regulator. The rectifier used here will be Bridge Rectifier. It will convert 230VAC into desired 5V/12V DC.

4.2 DATA FLOW DIAGRAM

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 activate 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.

DATA FLOW DIAGRAM

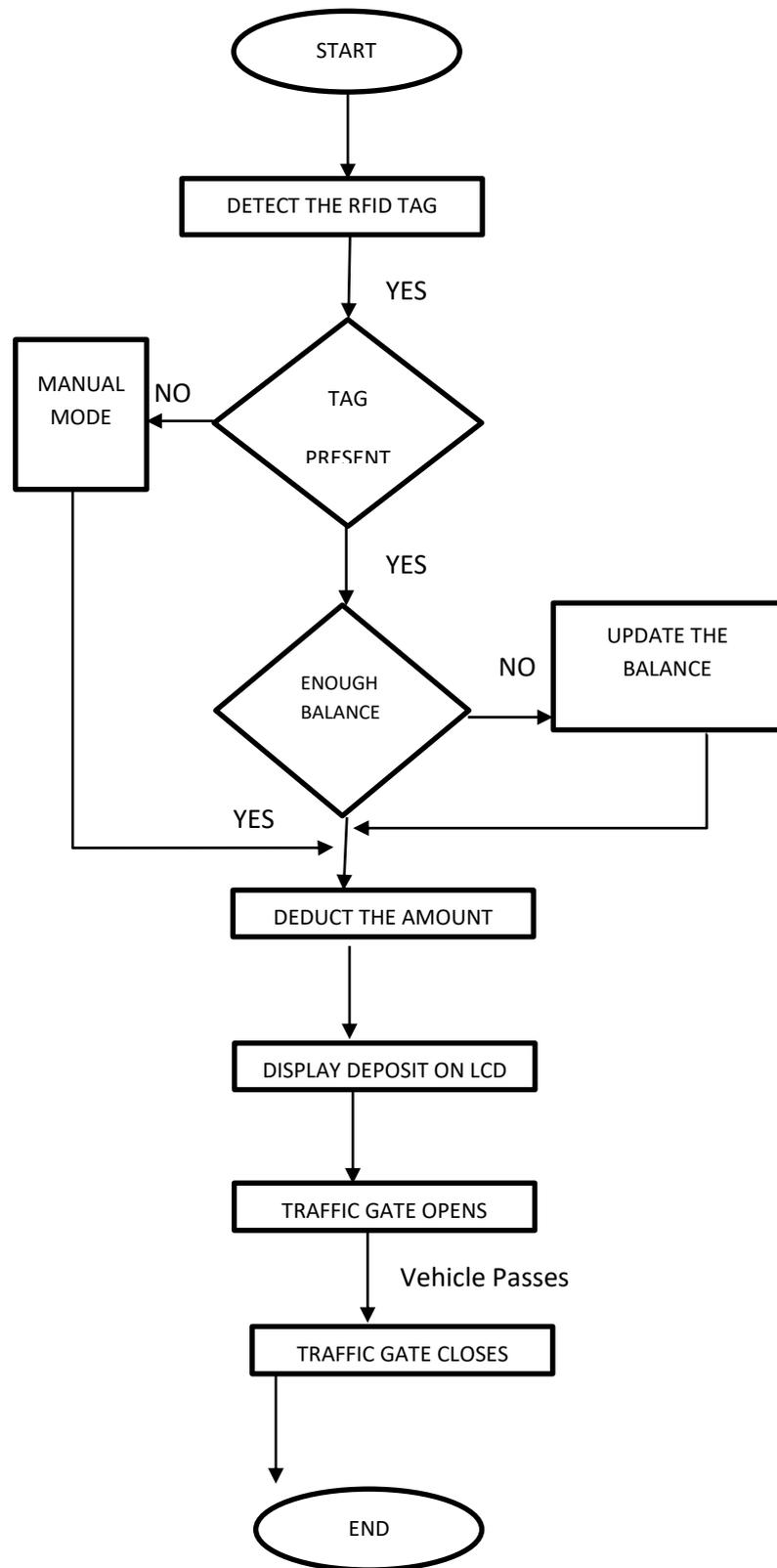
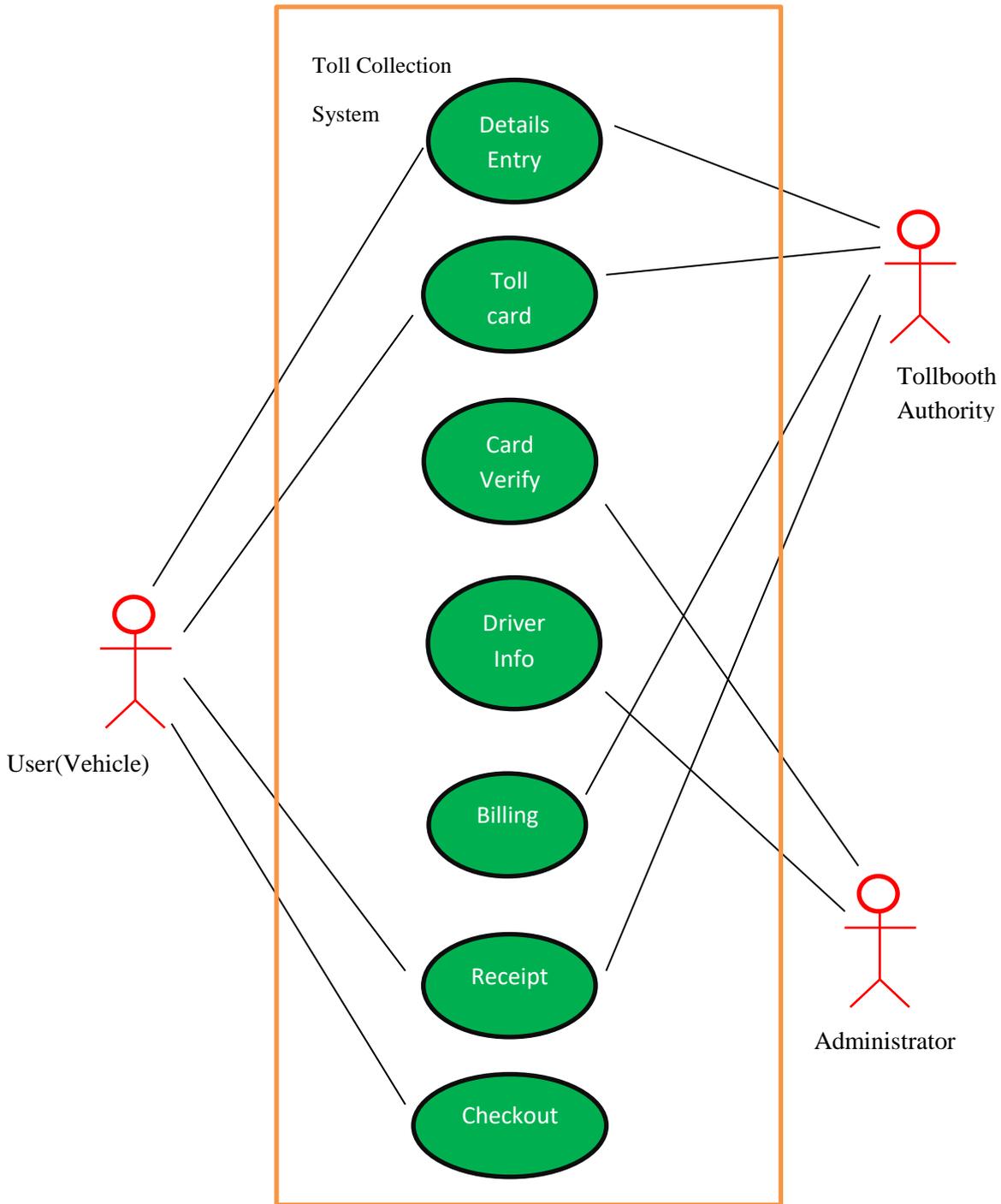


Figure 4.2: Working of RFID based toll collection system

Figure 6.1: Use case diagram



4.3 SEQUENCE DIAGRAM

UML sequence diagram are used to represent or model the flow of messages, events and action between the objects or components of the system. Sequence diagram are used primarily to design, document and validate the architecture interface and logic off the system by describing the sequence of action that need to be performed to complete a task or scenario.

UML sequence diagram are useful design tools because they provide a dynamic view of the system behavior which can be difficult to extract from the static diagram or specification. A sequence diagram shows objects interaction arranged in the time sequence.

Sequence diagram shows the message exchange between several object in a specific time-delimited situation. Sequence diagrams put special emphasis in the order and the times in which the messages to the objects are sent. In sequence diagrams objects are represented through vertical dashed lines, with the name of the object on the top. The time axis is also vertical, increasing downwards, so that messages are sent from one object to another in the form of arrows with the operation name and optionally the actual parameter values.

When drawing the sequence diagram, lifeline notation elements are placed across the top of the diagram. Lifeline represents either roles or object instance that participate in the sequence being modeled. Lifelines are drawn as a box with a dashed line descending from the center of the bottom edge to show an object sending a message to another object, draw a line to the receiving object with the solid arrow head or with the stick arrow head.

There are three sequence diagrams for the crime detections system, the sequence diagram for the admin, the user and the station. The admin has the authority to add the city, district, area details. Then he can also view the complaint that has been lodged by the user. User can lodge complaints online, withdraw complaints, view status and can search the details of the criminal. Station approves the complaints that user has lodged and lodges the FIR, then he can upload the status of the complaints and can add the criminal details. All three actors can take out the print of the complaints.

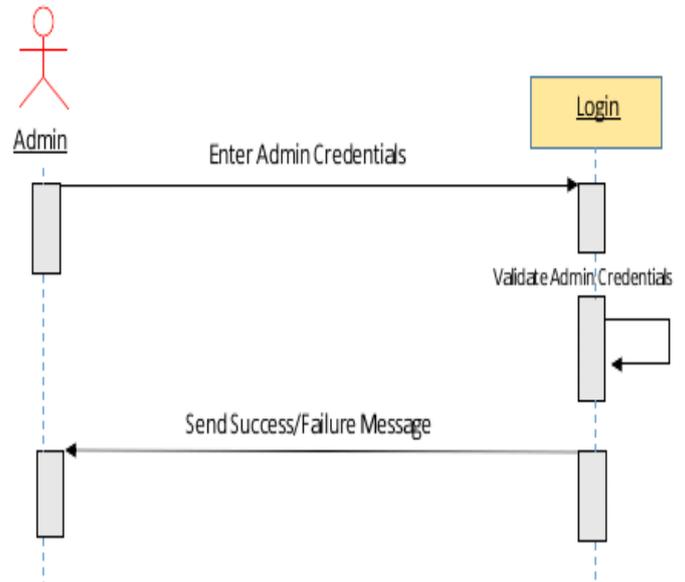


Fig 4.3 Sequence diagram for admin login

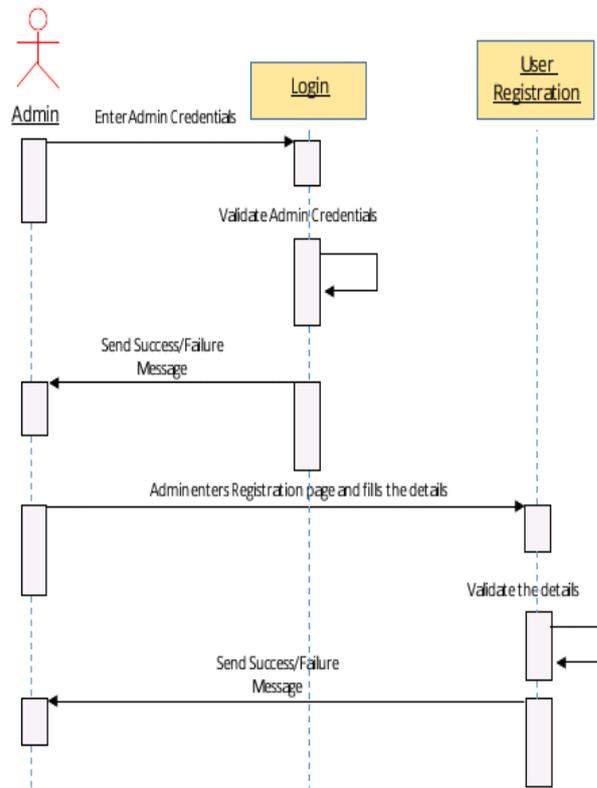


Fig 4.4 Sequence diagram for user registration

5. IMPLEMENTATION

Implementation plan is to be made before starting the actual implementation of the system. Implementation is the stage where the theoretical design is converted into a working system, the new system may be totally new, replacing an existing manual , or automated system or it may be a major modification to an existing system.

5.1 ALGORITHMS

Login for User

Step 1: Start
 Step 2: Enter user name and password
 Step 3: if(user name and passwords are valid)
 Login
 Else
 Re-enter the valid username and password
 Repeat step 3

Step 4: Stop

Login for Admin

Step 1: Start
 Step 2: Enter user name and password
 Step 3: if(user name and passwords are valid)
 Login
 Else
 Re-enter the valid username and password
 Repeat step 3 Step 4: Stop

Registration for Admin

Step 1: Start
 Step 2: Enter details (email, username, password etc)
 Step 3: if(data valid)
 Redirect to Login Page
 Else
 Re-enter the valid details
 Repeat step 3
 Step 4: Stop

5.2 Language Used For Implementation

5.2.1 JAVA

Java is a general-purpose computer-programming language that is concurrent, class-based, object-oriented, and specifically designed to have as few implementation dependencies as possible. It is intended to let application developers "write once, run anywhere" (WORA), meaning that compiled Java code can run on all platforms that support Java without the need for recompilation. Java applications are typically compiled to bytecode that can run on any Java virtual machine (JVM) regardless of computer architecture. As of 2016, Java is one of the most popular programming languages in use, particularly for client-server web applications, with a reported 9 million developers. Java was originally developed by James Gosling at Sun Microsystems (which has since been acquired by Oracle Corporation) and released in 1995 as a core component of Sun Microsystems' Java platform. The language derives much of its syntax from C and C++, but it has fewer low-level facilities than either of them.

5.1.2 PHP

PHP is a server-side scripting language designed for web development but also used as a general-purpose programming language. Originally created by Rasmus

Lerdorf in 1994, the PHP reference implementation is now produced by The PHP Group. PHP originally stood for Personal Home Page, but it now stands for the recursive acronym PHP Hypertext Preprocessor.

PHP code may be embedded into HTML code, or it can be used in combination with various web template systems, web content management systems, and web frameworks. PHP code is usually processed by a PHP interpreter implemented as a module in the web server or as a Common Gateway Interface (CGI) executable. The web server combines the results of the interpreted and executed PHP code, which may be any type of data, including images, with the generated web page. PHP code may also be executed with a command-line interface (CLI) and can be used to implement standalone graphical applications.

6.RESULT

Whenever the vehicle enter the toll gate, the RFID reader will check whether the RFID tag is valid or not card is valid it will allow the vehicle to move and reduce the toll tax from user account automatically .if user is don't have sufficient balance message will be sent to his mobile saying in sufficient balance or else respected amount will deducted from his account and message will sent his mobile. The card is not valid depending upon the above process the message will g to the vehicle owner.

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