ASHESI UNIVERSITY

AN AUTOMATED TOLL COLLECTION SYSTEM

CAPSTONE PROJECT

B.Sc. Electrical and Electronic Engineering

Yvette Umwamikazi

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Capstone Project submitted to the Department of Engineering, Ashesi University in partial fulfilment of the requirements for the award of Bachelor of Science degree in Electrical and Electronics Engineering.

Yvette Umwamikazi

2019

DECLARATION

I hereby declare that this capstone is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature:

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Candidate's Name:

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Date:

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I hereby declare that preparation and presentation of this capstone were supervised in accordance with the guidelines on supervision of capstone laid down by Ashesi University.

Supervisor's Signature:

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Supervisor's Name:

……

Date:

……

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ABSTRACT

An Automated toll collection system is the system that helps in eliminating the heavy traffic caused in the Metropolitan countries. It is one of the flexible methods used to manage the flow of traffic in big cities of today. An Automated toll collection system is proposed, and the RFID technology is used. It is an innovative method that uses electromagnetic waves to easily identify and track the tags that are attached to the windshield of the vehicle. The main focus of this project is to design a system that automatically identifies the unique tag number on the windshield of the vehicle and be able to deduct the money on the tag. When the transaction is done, the system must be able to send the message to owner of the vehicle to notify how the transaction happened and also be able to automatically open the gate for the vehicle to pass.

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Chapter 1 : General Introduction

1.1 Background

There are two main methods of collecting the toll tax which are currently used [1]. The first method is the traditional manual way of collecting tax on the toll booth. The owner of the vehicle must stop at the toll gate and give the money to the person at the toll booth and the person issues the receipt to the owner of the vehicle and the vehicle can be allowed to pass through the gate [2]. The second method is the smart card system where the owner of the vehicle has to show the card to system installed at the toll plaza so that he can be allowed to pass [2]. The Methods mentioned are both time consuming and as well as increase in queuing of the vehicles [2]. Designing and developing an automatic toll booth system will drastically save time at toll gate therefore less traffic.

1.2 Problem Definition

An automatic tollbooth is a technology that enables electronic toll collection or payment. Automatic toll collection system helps to collect tolls from the vehicle without stopping at a tollbooth [3]. Studies have shown that this technology can be applied in various highways and bridges that require such a system. This system can determine if the car is registered or not, and then informing the authorities of toll payment violations, debits, and participating accounts [4].

The automatic tollbooth system will ensure optimal toll collection, reduction of traffic at tollbooths and avoid the inconveniences normally associated with the manual toll collection system [3].

This system has proven to be of immense success in countries such as the United States of America, Canada, Poland, the Philippines, Japan and Singapore [1]. A widely used of this

technology is the Radio Frequency Identification (RFID) technology system. This project report shall concentrate on a Microcontroller – RFID based technology tollbooth system.

Employing this automatic tollbooth system in a developing country such as Ghana will therefore be of great benefit. Hence the need to undertake this project.

1.3 Project Objectives

1. Design an automatic toll booth system
2. Optimize toll tax collection by automation
3. Reduce vehicular traffic congestion
4. Avoid inconveniences created by the manual system

1.4 Scope of Work

This project report is limited to the automation of a microcontroller-based toll tax collection system.

1.5 Project Organization

This project consists of five chapters. The first chapter discusses the general overview of the project. This chapter defines the problem, states the project objectives as well as the research methodology, scope of work and the work organization.

The second chapter focuses on literature review. This chapter discusses RFID technology, incorporates a review of microcontrollers which forms the heart of the entire system. Stepper motor for barricade control as well as a survey of related works on automatic tollbooth system is discussed.

The third chapter concentrates on the design methodology of the automatic tollbooth. The hardware design as well as the software implementation is discussed. The fourth chapter gives the

results and discussion of the design. Finally, chapter five gives the conclusions, limitations and future work.

Chapter 2 : Literature Review

2.1 Background to the Research

Most toll taxes of today are collected manually in most countries [5]. In this manual system, drivers of vehicle pay coin or cash by hand to cross the toll plaza gate. This system of toll tax collection is inefficient, time consuming, fuel consuming, inconvenient and also, is the main cause of heavy vehicular traffic at tollbooths [6].

Suppose the manual toll collection system is very efficient then for one vehicle to stop and pay tax, the average time taken is 50 seconds. And suppose 300 vehicles cross the toll plaza per day. Then, time taken by one vehicle with 50 seconds average stop in a month is:

$$50 \times 30 = 1500\ seconds \tag{2.1}$$

Therefore, yearly total time taken is:

$$1500 \times 12 = 18000\ seconds = 5\ hours \tag{2.2}$$

The number of vehicles that pass through in a year is:

$$300 \times 360 = 10800\ vehicles \tag{2.3}$$

On the average therefore, 108000 vehicles just stand still for 5 hours in engine start condition for just a given one plaza. Assuming they are 50 given plazas then the number of vehicles that stand still for 5 hours in a given year is:

$$50 \times 10800 = 5400000\ vehicles \tag{2.4}$$

Assuming that a unit cost of fuel is Gh¢ 3.46 and each vehicle consumes one liter in that 5 hour waiting time, then the results can be tabulated as in table 2.1 [7].

Table 2.1: Fuel Consumption and Amount (Gh¢) by Vehicles

Number of vehicle	Fuel Consumed (Litre)	Amount (Gh¢)
1	1	3.46
5400000	5400000	18, 684,000.00

It means that in 50 tollbooths for a given one year, 5400000 vehicles waste 5400000 liters of fuel in waiting 5 hours to pay toll tax. This wastage is translated to Gh¢ 18, 684, 000 loss of money. It also results in air pollution. This study is when the system is very efficient but what if the vehicle has to wait for 5 minutes? And if the tolling points are more, then the situation will drastically increase [7], [8].

Therefore the need for an automated toll tax collection system has become paramount by many researchers to curb the situation [4], [7], [9].

2.1.1 Types of Tollbooth System

Mainly, there are three methods of toll collection; open, closed and Electronic Toll Collection (ETC) [7].

In the open toll system, all vehicles stop at the various locations along the highway to pay toll. While this may save money from the lack of need to construct tolls at every exit, it can cause traffic congestion, and drivers may be able to avoid tolls by exiting and re-entering the highway [7], [8].

With a closed system, vehicles collect a ticket when entering the highway. In some cases, the ticket displays the toll to be paid on exit. Upon exit, the driver must pay the amount listed for the given exit. Should the ticket be lost, a driver must typically pay the maximum amount possible for travel on that highway. Short toll roads with no intermediate entries or exits may have only one

toll plaza at one end, with motorists travelling in either direction paying a flat fee either when they enter or when they exit the toll road. In a variant of the closed toll system, mainline barriers are present at the two endpoints of the toll road, and each interchange has a ramp toll where toll is paid upon exit or entry. In this case, a motorist pays a flat fee at the ramp toll and another flat fee at the end of the toll road; no ticket is necessary [7], [8], [10].

In an electronic system no cash toll collection takes place, tolls are usually collected with the use of a transponder placed before the Gate as soon as the vehicle reaches near the Transponder the amount is deducted and the gate will be opened. Customer account is debited for each use of the toll road. On some roads automobiles and light trucks without transponders are permitted to use the road. A bill for the toll due is then sent to the registered owner of the vehicle by mail; by contrast, some toll ways require all vehicles to be equipped with a transponder. Modern toll roads often use a combination of the three, with various entry and exit tolls supplemented by occasional mainline tolls. Open Road Tolling (ORT), with all-electronic toll collection, is now the preferred practice, being more efficient, environmentally friendly, and safer than manual toll collection [7], [8].

2.2 RFID Technology

RFID is a complete system solution that operates in the electromagnetic spectrum to transmit data without contact or line of sight. It is an automatic identification and data collection technology utilizing electronic programmable tags for tracking, tracing and identification of objects. The underlying operating principles of RFID are similar to bar code technology and the applications are also similar [6], [7] , [11], [12].

The drivers for using RFID are in applications and environments where barcodes do not work well. RFID is a system with the following components. Radio Frequency Identification is

the more effective technology compared to barcodes, which allows labeling of electronics and wireless identification using digital communication system. The RFID tags have the capacity of accumulating up to 32 Megabytes of data information which makes the information to be harder to counterfeit than barcodes. RFID tags are beneficial in reading, writing, transmitting, storing and updating information. RFID technology can be easily programmed so that it can perform other great works apart from being a transponder and data carrier. The RFID technology has the capacity of synchronize the hardware and software part to make the system perform well [6], [7], [13].

The transponder is at the heart of the system and consists of a small electronic circuit with an attached silicon chip. RFID tags are powered and classified as active or passive. Active tags have an internal battery that allows for long-read ranges. They are typically read/write capable and are often seen in toll collection applications. Passive tags do not have a battery and powered by a separate source typically the interrogator.

A typical reader contains an antenna to transmit information to the tag as well as receive it from the tag. The size and form of the antenna will be dependent on the specific application as well as frequency chosen. It typically houses a decoder and RF module as well as the antenna. Readers can be fixed, that is mounted, or portable such as a handheld depending on the application.

An RFID system can be stand - alone or interfaced to an IT platform for exchange of information. In either situation, a host system is needed to collect the data to convert into useful information for the end-user. RFID can also be used in conjunction with installed bar code systems to extend their functionality [6], [7], [13], [14].

2.2.1 Principle of Operation of an RFID System

Figure 2.1 [15] illustrates the operating principle of an RFID system. The tag is activated when it enters the RF field. The tag then transmits identification and data contained in it to the

reader through the antenna. The reader sends this information to the host computer which determines the action to take. The computer again instructs the reader to send data back to the tag [16]. This is clearly a closed loop system.

2.2.2 Classification of RFID Tag

Tags could be classified based on the content and format of information. The classification is determined by the Electronic Product Code (EPC) Global Standard. Table 2.2 shows the various classifications by the EPC Global Standard [4] , [6].

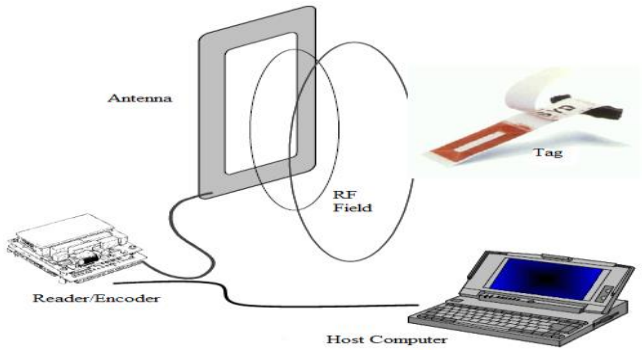

Figure 2.1: Principle of Operation of an RFID System

Table 2.2: Classification of RFID Tag

Type of Tag	EPC Class	Memory Type	Radio Frequencies Used	Word length (Bits)	Power Source	Reading Distance (Meters)
Passive	0	ROM	138 KHz 13.85 MHz	64	Reader EMF	0.04 – 3.0
Active	4	ROM	13.85 MHz	64	Battery	003 – 10
Passive Programmable	1	EEPROM	138 KHz 13.85 MHz	96, 128	Reader EMF	0.04 – 3.0
Active Programmable	2, 3, 4	EEPROM	138 KHz 13.85 MHz	>128	Battery	003 – 10
Data	2, 3, 4	CMOS RAM FLASH RAM	13.85 MHz 985MHz (UHF)	>128	Battery	003 – 10
RF Location	-	EEPROM OR CMOS RAM	303MHz, 2.4/5.8 GHz, UWB	64	Battery	001 – 100

2.3 Stepper Motor for Barricade Control

The stepper motor is defined as a synchronous servomotor in which digital signals generated in the form of a series of pulses of current and sequentially applied to the stator windings are used to control the rotor which moves through a fixed angle for each pulse. The stepper motor is the actuator element of incremental motion control systems. The frequency of the applied current pulses to the stator determines the speed of rotation of the rotor, the number of pulses determines the angular displacement/rotation of the rotor and the sequence of applied pulses determines the direction of rotation of the rotor. The stator is pulse excited, the rotor is unexcited [16], [17].

Constructional, the stepper motor has a stator containing several poles carrying field windings, together with a rotor which, in most cases, is a permanent magnet or which is slotted and made from soft iron or a combination of both. By energizing the stator windings in sequence, the axis of the magnetic field is stepped around and the rotor axis tracks this motion. The drive circuits normally accept a train of current pulses, each pulse representing one quantum step in shaft angle, together with a signal indicating the direction of motion required. The circuits use this information to establish a pattern of voltages, which is then applied approximately to the stator windings [18].

Stepper motors are characterized by step angle, resolution and shaft speed. They could be of the variable reluctance type, permanent magnet or hybrid or by stator winding configuration; they could be unipolar or bipolar. Use of stepper motors in barricade controls have been highly acknowledged as compared to the use of DC and AC servomotors. The unique merits of using stepper motors over other applicable motors are three-fold: control signals determine the rotor position as opposed to the rotor speed, so that the stepper motor is used in position servo systems

without the necessity for servo-control systems and position feedback transducers such as encoders.

Secondly, they are directly controlled by computers, microprocessors and programmable logic controllers. Thirdly, they give significant cost savings. However, the Achilles heel of stepper motors is the tendency of inherent missing of steps which are usually unaccounted for [19].

2.4 Survey of Related Works

Kamarulazizi [6] reported an electronic toll collection system using passive RFID technology. The proposed RFID system uses tags that are fixed on the windshields of vehicles. The information contained in the tags is sensed by RFID receivers. The system eliminates the need for motorists and toll authorities to manually perform ticket payments and toll fee collections respectively. Data information are exchanged between the motorists and toll authorities without difficulty, thereby enhancing a more resourceful toll collection by reducing traffic and eliminating possible human errors.

Chapate [17] presented an automatic toll tax collection using RFID. The system consisted of a transponder (tag), reader/writer, antenna, and computer host. Each vehicle was provided with an RF TX tag containing a unique ID. This tag will continuously emit RF signals. When the vehicle reaches a toll booth the RF receiver will detect these RF signals. The signals are amplified and passed to a microcontroller. The microcontroller displays the ID on an LCD. A computer interface unit collects the data through serial port.

Developed software was used to show all the details about the vehicle on the screen. Details like date, time and ID were stored in access database. Based on these details a report will be prepared. At the end of the month the system will print the detailed bill and the total amount of the

toll tax. This bill will be sent to the user for payment. The system eliminated human interactions at the toll roads and improved the efficiency at toll stations and traffic abilities of the toll roads.

Chapate [17] designed and developed a microcontroller based automatic toll collection system. The microcontroller based automatic system used infrared sensors. In this system, the user only has to get the transmitter from the main toll office. The transmitter will be charged by the operator of the booth office and the data will be stored in the microcontroller. Visual Basic 6.0 was used to feed the various details of the users and database was maintained in Microsoft Access. The user will mount this transmitter on its car. The transmitter gets sensed by the IR receiver mounted at the toll plaza and then the fare will be deducted automatically according to the toll charged and the remaining amount will be displayed. Stepper motor was used to open and close the gate.

Katkar [20] designed an RFID based automatic tollgate system (RATS).The report describes a system which bills, identifies and account for vehicles as they pass through a tollgate by means of RFID technology. The design used a frequency of 928MHz as it is in the Industrial Scientific and Medical (ISM) band. The system was seen to be of a great investment in the transport industry. It reduces the common hustles in accounting for the movement of goods from one point to another. The design could be further developed to aid the satellite surveillance systems provided the system was networked. An RFID tag was programmed with information in the form of an Electronic Product Code (EPC), which could be read over a considerable distance so that its contents identify the vehicle and enhance a transaction to be undertaken with respect to the specific tag identity. The design was implemented as a miniaturized prototype.

Gunda [21] reported an electronic toll collection using active RFID system. The design made use of the PIC17F73 for control. The communication subsystem of the active RFID system was based on the XEMICS's XE1203F radio, which was connected to the processor through a serial peripheral interface (SPI). The XE1203F is 433, 868, and 915MHz compliant single-chip RF transceiver, which is designed to provide a fully functional multi-channel FSK communication. The processor could completely turn off the radio or simply put it in sleep mode through the SPI interface, while the XE1203F could wake up the processor when an RF message was successfully received.

Developed software for the active RFID system was separated into three types: a host program, a reader program, and a tag program. They finally concluded that the active RFID system has features such as high identification rate of multiple tags, reliable energy budget, and standard compliance with ISO/IEC18000-7.

Rafiya [22] presented an electronic toll collection system (ETC) based on a wireless communication system to execute automatic payments of transportation fee without stopping at toll gate in express roads. Reflection, distraction and shadowed waves interferences were suppressed by radio absorbers installed on the whole surfaces of toll gates. The thesis proposes the radio propagation paths measurement system for the maintenance of the radio absorbers. The hardware module made use of a microcontroller 8052 for process control.

The system operated based on a contact type communication between a smart card and a reader. Whenever the smart card is inserted in to the smartcard reader the reader will read the data which is present on the smartcard, and this information is transferred to the microcontroller through RS232 communication. The microcontroller checks the balance present on the smartcard and displays the information on an LCD. A linear keypad was provided to select the type of the vehicle

with the given keys and the amount will be deducted from the smartcard and the microcontroller sends a signal to an H-bridge which will in turn rotate a motor in anticlockwise and after some delay will rotate clockwise.

Aniruddha [7] designed an automated toll collection system using RFID (ATCSR) for collecting tax automatically. A dedicated GSM module was interfaced to a main server which sends SMS to car owners for deduction in balance or less balance or deposited balance amounts. Camera was used to take images of cars. A 2 x16 LCD display was interfaced to a microcontroller, AT89S51 for information display about RFID tag status.

They used BASCOM for programming the microcontroller. The software has a fast machine code instead of interpreted code. Visual Basic 6.0 was used to create graphical user interface (GUI). Rather than writing numerous lines of code to describe the appearance and location of interface elements, you simply add prebuilt objects into place on screen.

Rafiya [22] presented a development of a model for electronic toll-collection system. The paper presented a new method for electronic toll collection system and also matching of car number plate detection system. The electronic toll collection system (ETS) was designed based on microcontroller. The system was developed to collect tolls according to the weight of the vehicle. The car number plate detection method utilizes template matching technique to approximate the location of car number plate. By using the output from the template matching method, color information was used to eliminate unwanted color areas from the approximate number plate region without affecting the correct color regions. Therefore, the number plate region was determined more accurately. MATLAB was used for image processing. Rafiya finally concluded that the method has a low complexity and reduced processing time. The automated system also showed a

better performance in highway traffic management and also could be the gateway to fabricating a highly automated toll-plaza.

Dilrukshi [16] reported an RFID based toll deduction system. The research examined RFID based toll deduction system and how to make it efficient and perfect [16]. The research paper focused on an automatic toll deduction system with more features for consumer/driver convenience and time saving. The vehicle is equipped with radio frequency (RF) tag, which is detected by an RF Reader, located on toll plaza. The amount of toll tax is automatically deducted from the bank account of the user. A camera installed on the toll plaza is used to take pictures of number plates of vehicles which are used to detect theft vehicles. Speed of vehicles can be controlled using the RFID. The speed limit for passing through the toll plaza was set to 5 km/h.

Central server was used to store the data which comes from all different toll plazas. A local computer of every toll plaza is connected to central server through Internet. Consumer/drivers must purchase and deposit money for a tag. The tag contains all the necessary information of the vehicle and bank account deposit of the consumer/driver.

Chapter 3 : Design Methodology

3.1 Introduction

The design of the automated toll collection system consists of two main parts which are hardware and software. The hardware part consists of materials such as the microcontroller, RFID reader, RFID tags, DC stepper motor, power supply, jumper wires, LCD display and bread board. The software part of this system consists of Database (server) and ESP 8266 module which is mainly for sending the data to the database using Wi-Fi module. The below are descriptions and specifications of the materials used.

3.2 Materials

The designed system consists of various key components [23] such as RFID reader, RFID tag, jumper wires, ESP8266, bread board, LCD display and DC stepper motor.

3.3 Hardware Design

The hardware implementation of the project is designed on the main principle of Radio Frequency Identification (RFID) which is basically for checking if the vehicle has reached the toll gate and allows the owner of the vehicle to pass through the toll gate. The system is depending on AT89S52 microcontroller with Arduino code embedded in it [25].

Figure 3.1 shows the block diagram of the hardware design.

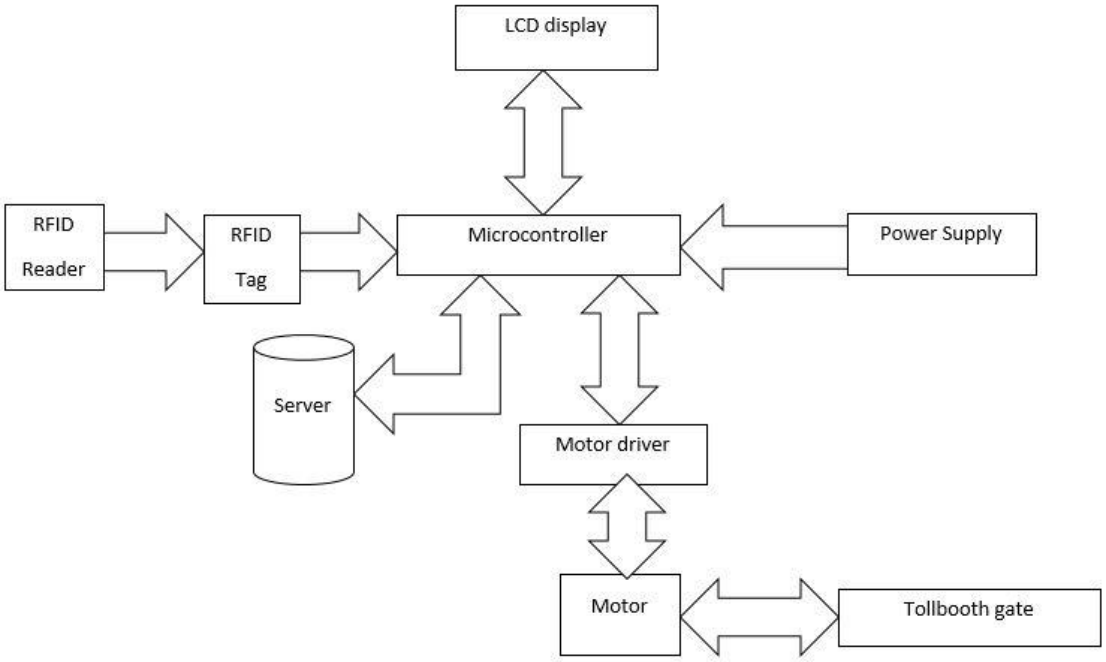

Figure 3.1: Block Diagram of the Design

3.2.1 The ESP8622 RFID

The ESP8622 RFID is a less costly but effective platform for communicating over the internet. It is very flexible to use with Arduino. It helps the admin to control the hardware through the internet from anywhere [24]. The features of ESP8622 are 802.11 b/g/n protocol, Wi-Fi direct (p2p), soft (AP), Integrated TCP/IP protocol stack, Integrated TR switch, balun, LNA, power amplifier and matching network, Integrated TR switch, balun, LNA, power amplifier and matching network, +19.5dBm output power in 802.11b mode, Integrated temperature sensor, Supports antenna diversity, Power down leakage current of < 10Ua and Integrated low power 32-bit CPU could be used as application processor. In this project, ESP8622 will be sending the data to the database using internet and acts as a microcontroller chip that is capable of being programmed used Arduino. The pins with arrows are used in this project to connect the ESP8266 to RFID reader.

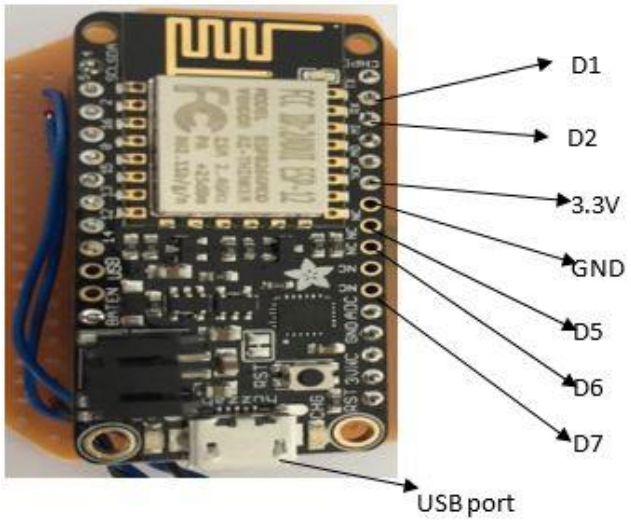

Figure 3.2: ESP8622

3.2.2 RFID Reader (MFRCC522 13.56 MHz)

The MFRCC522 is a cheap RFID reader and is easy to be accessed. It is used for several applications. It is an integrated transmission module for contactless communication at 13.56MHZ. MFRCC522 has a module with a special modulation and demodulation. It is encountered for various contactless communication methods and protocols of 13.56MHZ [5]. In this system, the RFID Reader is used to send the data and commands to the tag and be able to detect the tag attached to a particular vehicle. The features of RFID reader used in this system includes the operation frequency of 13.56 MHZ with MFRC522 chip-based board. It supplies voltage of 3.3 V with the current range of 13-26 mA. It has the capacity of reading an object in range of approximately of 3cm with supplied card and fob. RFID reader used in this system interfaces with SPI with maximum data transfer of 10 Mbit/s and dimensions of 60 mm×39 mm. The arrows show the pins that have been used in this project while doing the connection.

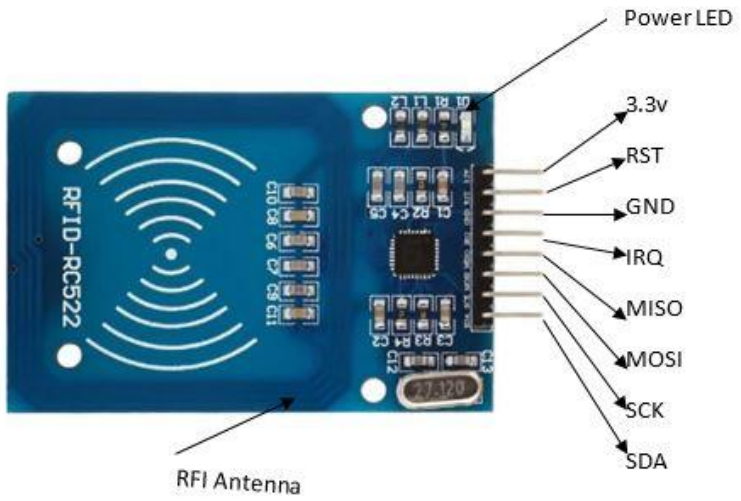

Figure 3.3: RFID Reader

3.2.3 RFID Tag (EM4001 64-bit RFID Tag compatible)

RFID transponders or tags are electronic devices carrying the information that can be read from far distance by a RFID transceiver (reader). The reader has to know how the information is stored so that it can be able to read it. The reader should also be aware of protocol used to extract information [24]. This tag is main based on the controller chip from EM microelectronic. The use of the tag in this project is to detect the reader activation signal and send radio waves to the reader.

Figure 3.4: RFID Tags

3.2.4 DC Stepper Motor

The stepper motor used has a battery-operated motor and rotates with angular fixed step for every single current pulse required by every controller. This motor is highly demanded on the market due to its robotics industry. Its functionality is much better than the others due to its direct operation to the computer and microcontrollers. The main purpose of this motor is to lift the toll plaza or toll gate to allow the vehicle pass on. When the RFID tag is valid, the owner of the vehicle receives the positive signal from the microcontroller to alert the owner when the transaction is done successfully. The main role of stepper in this project is to lift the gate in anticlockwise way to allow the vehicle to pass through and hold on until the vehicle passes and the stepper motor will rotate again clockwise to close the gate. This stepper motor has voltage rating of 10 V, current rating of 500 mA per coil, inductance of 13.5 MH per coil, resistance of 20Ω per coil, steps per revolution is 200 and the output shaft is supported by two ball bearings.

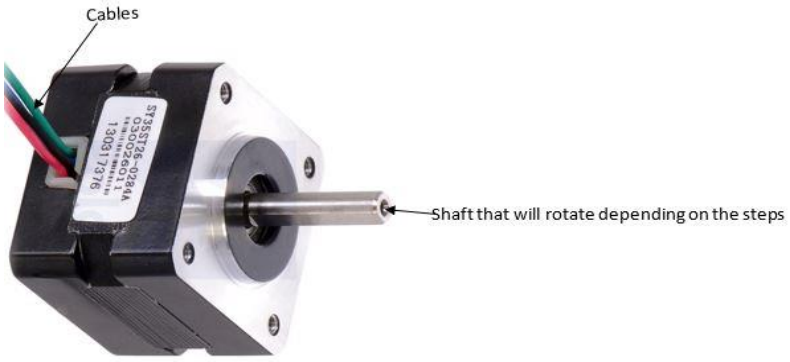

Figure 3.5: DC Stepper Motor (Nema14)

3.2.5 Power supply

The power supply chosen has the voltage range of 5 to 9 DC power supply though DC batteries. The power supply consumes the current of 2-mile Ampere. The microcontroller used has an integrated capacitor to keep power and release regulated supply as required by various components. In this project the two 5 volts DC batteries are used, one to enable the Arduino board accessing power and another one to allow the toll gate to open.

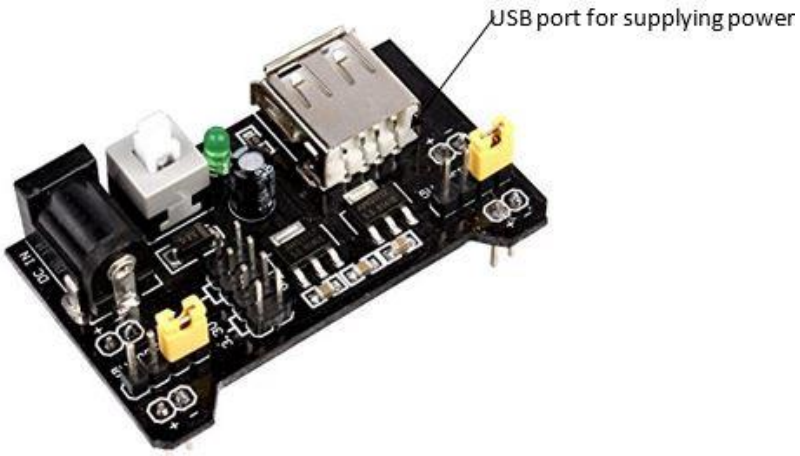

Figure 3.6: Power Supply

3.2.6 Jumper wires

The basic use of jumper wires in this project is connect the various modules to each other such as connecting microcontroller to stepper DC motor, connecting ESP8622 module interconnecting microcontroller to connecting microcontroller and other modules with the help of bread board. The jumper wires are tiny electrical wires which have solid tips at the both ends to connect various electronic components to each other. The wires have two types which are jumpers with crocodile clips and insulated terminals. There are also further sub-division of jump wires including female to female, male to male and male to female.

3.2.7 LCD Display

It is known as the Liquid Crystal Display. In this project 16x2 character LCD is going to be used and it will be connected to the microcontroller. A 16x2 character LCD is basically a module that is widely used in different modules of devices and circuit. These modules are highly recommended over seven segments and other various segment LEDs. The LDCs are cost effective, very easy in programming and less limitation in displacing special and custom characters. 16x2 character LCD can display 16 characters per each line and there consist 2 such lines. The main purpose of LCD in this project is to display all the system generated messages coming from the microcontroller and will also give user interface. This LCD requires +5DVfor its proper functionality [2].In this project, the 4 pins (GND, VCC, SDA, SCL) are used for LCD to be able to display data on the screen.

Figure 3.7: LCD Display

3.2.8 Bread Board

Bread board is used in this system as a construction platform for modelling circuits and systems. Solderless bread board is the preferred bread board to use in this project so that the whole circuit of the project can be made at initial stages.

3.4 Methods

The car has to be detected when the car enters the tollbooth field and check if the car has sufficient funds on the RFID tag. The next step is that the amount of toll will be sent to the database so that the deduction of the money can occur [7].When an individual buys a car he /she has to register it at RTO first [24].RTO will assign the ID on each vehicle and feasible for only that specific vehicle [24]. RTO will also create the account for each vehicle and the owner of the vehicle will be equipped with the transaction history in the database [24].Every time the owner of the vehicle approaches the tollbooth, the infrared sensor has to detect the presence of the car and enable the RFID reader to read the unique card attached on the windscreen of the car [24].After the detection ,the RFID reader will interface with a microcontroller and send the data to the database to check if the car has sufficient fund on the RFID tag. If a car has enough money, the deduction of the money will begin depending on the amount of the money to be deducted. When a car is done paying, the gate will automatically move and allow the person to pass. On the other hand if the money on the card is not enough, the owner of the vehicle will pay cash using Top Up section on the website. When he or she is done paying using the website, the push button is used to open the gate and allow the person to pass. When the payment is done the owner of the vehicle will receive message on the email notifying him or her how the transaction happened and balance on his or her card [24].

3.4.1 Circuit diagram

Figure 3.8 explains some components being used. The microcontroller is connected to the LCD. LCD display has 16 pins over all .There is back light and if there is no black light, the pins are 14 in total. It is an optional to power the black pins but in 14 pins there is 8 data pins (D0-D7),

2 power supply pins (VDD and VSS) and 3 control pins (RS&RW&E). The below circuit used (D0-D7) pins which is not always compulsory, but it makes the circuit more easily to understand.

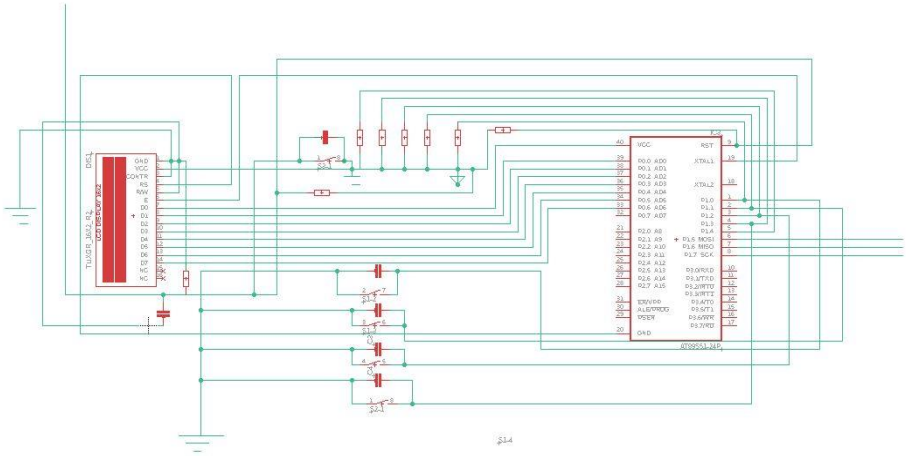

Figure 3.8: Circuit Diagram of the Design Implementation

3.4.2 Software Design

The software design for this project consist of various software requirements including the following. Operating system (windows), language (HTML, PHP, CSS, C++ and Java) and database (My SQL).

Figure 3.9 describes the whole idea of the project. The vehicle approaches and enters the toll booth field, the RFID reader is attached at the toll gate catches the signals from the RFID tag chip which is attached to windshield of the vehicle [26]. The RFID tag sends the signal information to the host computer. The host computer will gather the information of the vehicle stored in the database and detects the unique ID of the vehicle and the size.

Moreover, the toll for the vehicle is checked and a certain amount is deducted from the owner's account. If the owner's account has sufficient funds, then the money is deducted, and the gate is lifted thus the vehicle can be able to pass through.

Meanwhile the owner of the vehicle receives an email conforming the occurrence of the transaction. If the account has no sufficient funds, the host computer has to notify the person at the toll gate to collect the toll manually. Once the toll is collected, the gate is opened, and the vehicle can be easily allowed to pass. Here again the notification is sent to owner of the vehicle, alerting him to reload the account with money.

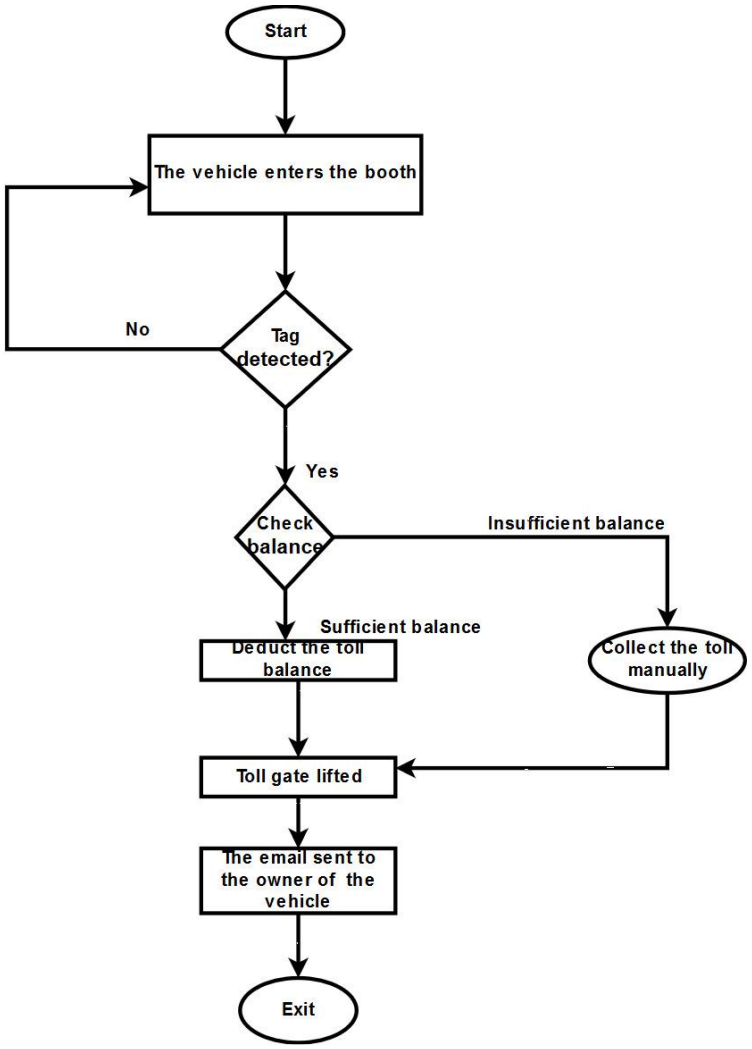

Figure 3.9: Flow Chart

As mentioned above the software design consists of database which is a server on figure 3.1 and ESP 8266 module to send the information received from the microcontroller to the server. ESP 8266 is a Wi-Fi module that is very efficiency on chip storage and processing capabilities

using low cost and high quality. ESP is mainly based on IEEE 802.11 Wi-Fi protocol and useful for supporting various network protocol. For connecting the machine to the server, the level shifter is mainly used [25]. The microcontroller is programmed to function a remotely in the satellite. The infrared radio(IR) signals from the remotely server(transmitter) is transferred and received by infrared radio(IR) sensor(receiver) which has been interfaced with the microcontroller to store the data [25]. The transmitter sent the encoded data and is received by the receiver sensor which is mainly stored on the microcontroller. The corresponding signal is sent by the microcontroller to the stepper motor [25].

Chapter 4 : Results and Discussions

4.1 Introduction

The results obtained for this project are in two parts. There are results obtained from the hardware implementation and results from software design. The hardware design includes the construction of an automated tollbooth using the components given. The software implementation consists of the construction of the database, simulation of the database and building of the website.

4.1.1 Results from Hardware Design

The hardware design is done into several parts. There is the first connection of testing the RFID reader and the tag. The physical connection of the RFID reader to the Arduino board and swipe the RFID tag in the range of 3 to 300 feet for the reader to gather the information from the tag. The RFID reader is connected to the microcontroller. The microcontroller stores the data from the reader when the card is swiped on it. The data taken by the microcontroller interfaces with the RFID reader. IR sensor will sense the unique tag number and the number will be displayed on serial monitor of an Arduino. The information gathered is the unique number of the tag and is seen on the serial monitor of the Arduino.

After identifying the unique tag numbers, the connection of ESP 8266 is used to send the data to the database. The ESP 8266 is connected to the RFID reader and radio waves are used to collect the data from the tag to the reader, then send the information to the database using ESP 8266 as a Wi-Fi. The whole system of an automated toll collection is constructed using RFID reader, RFID tag, ESP8266, Nema 14 stepper motor, ULN2003 motor driver, LCD display, a push button and a stick of 30cm.

After connecting the mentioned components, the stick is successfully moving at specified angle of 90 when the transaction is done in the database. The tag number is also displayed on the screen of LCD display. The push button is added to the circuit connection just in case the owner of the vehicle does not have inefficient balance on his or her card, the person can pay cash on the website and gate can allow him or her to pass by pressing the push button. The figure 4.1 illustrates the hardware connection of the whole system.

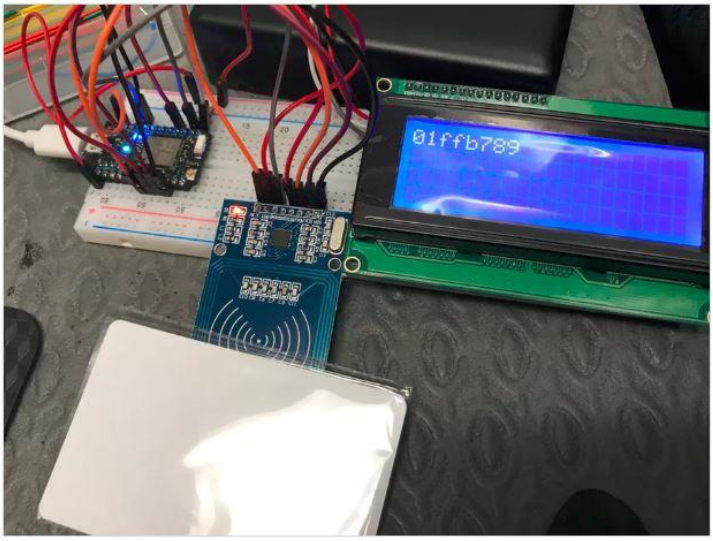

Figure 4.1: The Hardware Connection

4.1.2 Results from Software Design

The software design consists of the database which is mainly for storing the information and be able to carry out the payment process every time the vehicle is passing through the tollbooth. In this system the HTML, Java and PHP language are employed to develop the database [5]. To implement this system Microsoft SQL 2008 is used. Microsoft SQL is database management system that is mainly for storing and retrieving the information as requested by other software applications [2].In the database, car, owner, payment, toll, top-up, and users are constructed as a table. The figure 4.2 shows the various items in table.

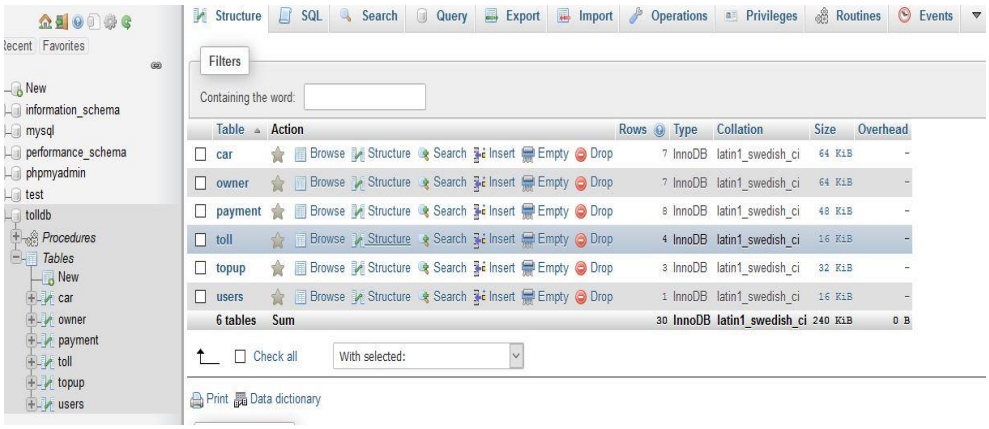

Figure 4.2: Recorded Data in SQL Server

In the software design, there is also the construction of the website which has the section of add driver, add payment, add car and Top Up. The website is to help individual who comes to the tollbooth without inefficient fund on his or her card. The owner of the vehicle will pay cash and the website will help to record the payment, the driver's name and the unique number of the car. The figure 4.3 shows the dashboard of the website.

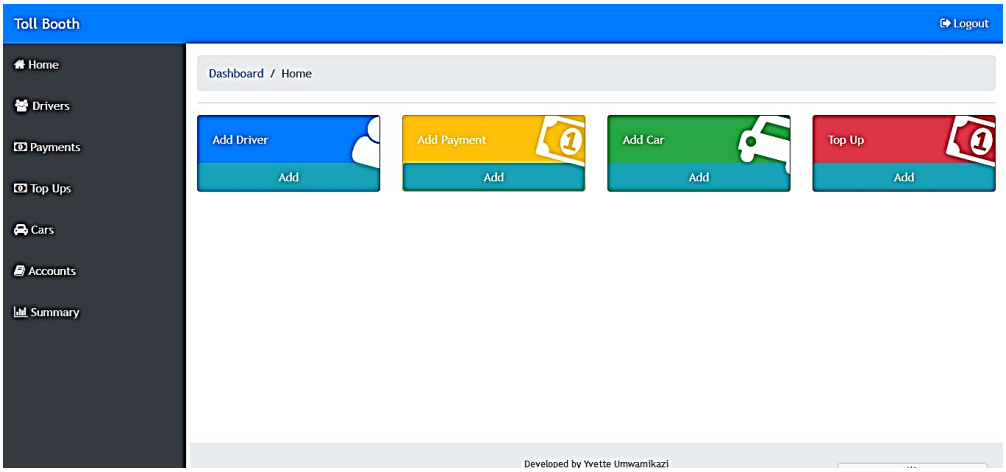

Figure 4.3: The Sections of the Website

The building of the database and the simulation is on the results obtained in the software implantation. After building the physical connection of the system, the radio waves transfer the data from the tag to the reader and data gathered is sent to the database through ESP8266 Wi-Fi.

The database is a server that stores the data and the payment of toll is done in the server. When the owner of the vehicle has reached the tollbooth, the RFID reader has to sense the unique tag number and send the information to the microcontroller. The microcontroller will process the information and send the data to the database for transaction to occur. When the transaction is done the notification message from the server is sent to the owner of the car. The notification message is to let the owner of the car know how the transaction happened and the balance remaining on his or her account. The software part of the system is successful working after connecting all the required hardware components. The figure 4.4 shows the message received by the owner of the car when the automatic deduction of the money is done.

Figure 4.4: The Notification Message from the Server

Chapter 5 : Conclusion, Limitations, and Future Work

5.1 Conclusion

The system of an automated toll collection is built to fasten the toll collection system and significantly contributing to the enhancement of travel conditions by tackling the delay caused by recurring and nonrecurring traffic. The system is able to collect the toll automatic and send the notification to the owner of the vehicle without the vehicle stopping at the tollbooth. The system is accomplished by the use of Radio Frequency Identification technology. The system provides the benefits to the owner of the vehicle and the country in terms of cost and time saving, reducing vehicular traffic congestion and avoiding the inconveniences created by manual system.

5.2 Limitations

The RFID reader used can only track the unique tag number at small range therefore reader which can read from a long distance can be used to improve the design.

In this system, the vehicle owners receive notification about their transactions via email. If the vehicle owners do not frequently check their emails, they might be unsure of the status of the transaction. Also, if the vehicle owners have limited internet access, they are not able to receive instant notifications about their transactions.

5.3 Future Work

This system explains the practical implementation of an automated toll collection system using RFID technology, whose downside is limited range of detection. To improve on this, a sensor with a longer range can be used to ensure better detection even for long ranges. This ensures the vehicles are detected from a longer distance hence increasing the reliability of the system. The system can be modified to use RF (Radio Frequency) for long range, making it is more effective in detecting vehicles long before they reach the toll gate.

The owner of the vehicle using this system receives the notification of their transaction via email. To make the system more effective, it will be more relevant if the person receives the notifications via short message service (sms) instead of email. This means the integration of GSM technology to enable sms communication.

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Appendix

```
<?php

      include 'config.php';
      require_once "libchart/libchart/classes/libchart.php";

      function test_input($data) {
        $data = trim($data);
        $data = stripslashes($data);
        $data = htmlspecialchars($data);
        return $data;
      }

      function queryMysql($query) {
            global $connection;
            $result = $connection->query($query);
            if (!$result)
                  die($connection->error);
            return $result;
      }

      if (isset($_GET['deldriver'])) {
            if (queryMysql("call delowner(".$_GET['id'].")")) {
                  echo "Driver deleted successfully";
            }
            else
                  echo "Deletion failed. Please try again later";
      }

      if (isset($_POST['updateDriver'])) {
            $fname = $_POST['fname'];
        $lname = $_POST['lname'];
        $gender = $_POST['gender'];
        $email = $_POST['email'];
        $phone = $_POST['phone'];
        $idtype = $_POST['idtype'];
        $idnumber = $_POST['idnum'];
        $oid = $_POST['id'];
            if (queryMysql("update owner set fname = '$fname', lname =
'$lname', gender = '$gender', email = '$email', idtype = '$idtype',
idnumber = '$idnumber', pnumber = '$phone' where oid = '$oid'")) {
                  echo "Driver information successfully";
            }
            else
                  echo "Update failed. Please try again later";
      }

      if (isset($_POST['addtopup'])) {
            $amount = $_POST['amount'];
            $owner = $_POST['owner'];
```

```
            $date = $_POST['datepay'] . " " . date('H:i:s');
            if (queryMysql("call addtopup('$owner', '$amount', '$date')"))
{
                  echo "Top up added successfully";
            }
            else
                  echo "Top up failed. Please try again later";
      }

      if (isset($_POST['addnewcar'])) {
            $brand = $_POST['brand'];
            $owner = $_POST['owner'];
            $regnum = $_POST['regnum'];
            $ctype = $_POST['ctype'];
            $tagnum = $_POST['tagnum'];
            $model = $_POST['model'];
            //echo "insert into car(brand, model, cnumber, ctype, tnumber,
owner) values ('$brand','$model','$regnum','$ctype','$tagnum','$model')";
            if (queryMysql("insert into car(brand, model, cnumber, ctype,
tnumber, owner) values
('$brand','$model','$regnum','$ctype','$tagnum','$owner')")) {
                  echo "Car added successfully";
            }
            else
                  echo "Addition failed. Please try again later";
      }

      function loadCarTypes(){
            $sql = "SELECT * from toll ";
            $ans = '';
            $result = queryMysql($sql);
            if($result -> num_rows > 0){
            while($row = $result -> fetch_assoc()){
                  $ans .= '<option
value="'.$row['tid'].'">'.$row['ctype'].'</option>';
             }
          }
          else{
            $ans = '';
          }
          return $ans;
      }

      function loadDrivers($query=''){
            $sql = "SELECT * from owner " . $query . " order by fname,
lname";
            $ans = '';
            $count = 0;
            $result = queryMysql($sql);
            if($result -> num_rows > 0){
            while($row = $result -> fetch_assoc()){
                  $count++;
                  $ans .= '<tr>
                              <td>'.$count.'</td>
```

```
                        <td>'.$row['fname'].'</td>
                        <td>'.$row['lname'].'</td>
                        <td>'.$row['gender'].'</td>
                        <td>'.$row['email'].'</td>
                        <td>'.$row['idtype'].'</td>
                        <td>'.$row['idnumber'].'</td>
                        <td>'.$row['pnumber'].'</td>
                        <td>'.$row['balance'].'</td>
                        <td><a href="javascript:void(0)"
onclick="update(\''.$row['oid'].'\', \''.$row['fname'].'\',
                        \''.$row['lname'].'\', \''.$row['gender'].'\',
\''.$row['email'].'\', \''.$row['idtype'].'\', \''.$row['idnumber'].'\',
\''.$row['pnumber'].'\')" style="font-family: \'Trebuchet MS\', Tahoma"
data-toggle="modal" data-target="#student"><i style="font-size:18px"
class="fa fa-pencil-square-o"></i></a>

                                            <a href="javascript:void(0)"
onclick="deleteDriver(\''.$row['oid'].'\')" style="font-family:
\'Trebuchet MS\', Tahoma"><i style="font-size:18px" class="fa fa-trash-
o"></i></a> </td>
                                </tr>';
            }
          }
          else{
            $ans = '';
          }
          return $ans;
      }

      if (isset($_POST['getcar']) && isset($_POST['car'])) {
            $sql = "select * from owner inner join car on owner.oid =
car.owner inner join toll on car.ctype = toll.tid where car.cid = " .
$_POST['car'];
            $result = queryMysql($sql);
            if($result -> num_rows > 0){
                  $row = $result -> fetch_assoc();
                  echo $row['fname'] . " " . $row['lname'] . "\t" .
$row['price'];
            }
            else
                  echo "no";
      }


      if (isset($_POST['addpay'])) {
            $sql = "select * from owner inner join car on owner.oid =
car.owner inner join toll on car.ctype = toll.tid where car.cid = " .
$_POST['car'];
            $result = queryMysql($sql);
            if($result -> num_rows > 0){
                  $row = $result -> fetch_assoc();
                  $date = $_POST['datepay'] . " " . date('H:i:s');
                  $amount = $row['price'];
                  if ($row['balance'] < $amount) {
```

```
                        echo "Insufficient balance";
                        return;
                  }
                  $cid = $_POST['car'];
                  $oid = $row['oid'];
                  $sql = "call addpayment('$oid', '$amount', '$cid',
'$date')";
                  $result = queryMysql($sql);
                  if($result){
                        echo "Payment has been recorded successfully";
                  }
                  else
                        echo "Payment failed. Please try again later";
            }
            else
                  echo "Payment failed. Please try again later.";
      }

      if (isset($_POST['addDriver'])) {
            $fname = $_POST['fname'];
        $lname = $_POST['lname'];
        $gender = $_POST['gender'];
        $email = $_POST['email'];
        $phone = $_POST['phone'];
        $idtype = $_POST['idtype'];
        $idnum = $_POST['idnum'];
        $balance = $_POST['balance'];
        $date = date('Y-m-d H:i:s');
        $sql = "call addowner('$fname', '$lname', '$email', '$gender',
'$phone', '$idtype', '$idnum', '$balance', '$date')";
            echo $sql;
            $result = queryMysql($sql);
            echo ($result) ? "Success" :  "Failed";
      }


      function updatePayment($paymentid, $date, $amount){
            $sql = "update payment set date = '$date', amount = '$amount'
where cid = '$paymentid'";
            $result = queryMysql($sql);
            echo ($result) ? "Success" :  "Failed";
      }

      function deleteStudent($studentid){
            $sql = "delete from payment where smfid = '".$studentid."'";
            $result = queryMysql($sql);
            $sql = "delete from owner where msisdn = '".$studentid."'";
            $result = queryMysql($sql);
            echo ($result) ? "Success" :  "Failed";
      }

      function deletePayment($studentid){
            $sql = "delete from payment where cid = ".$studentid;
            $result = queryMysql($sql);
```

```
            echo ($result) ? "Success" :  "Failed";
      }

      function loadDriverNames($query = ""){
            $sql = "SELECT * from owner " . $query . " order by fname";
            $ans = '';
            $result = queryMysql($sql);
            if($result -> num_rows > 0){
            while($row = $result -> fetch_assoc()){
                  $ans .= '<option value="'.$row['oid'].'">
                                    '.$row['fname']." ".$row['lname'].'
                              </option>';
            }
           }
           else{
            $ans = '<span>No driver has been added yet</span>';
           }
           return $ans;
      }

      function loadCarNames($query = ""){
            $sql = "SELECT * from car " . $query . " order by cnumber";
            $ans = '';
            $result = queryMysql($sql);
            if($result -> num_rows > 0){
            while($row = $result -> fetch_assoc()){
                  $ans .= '<option value="'.$row['cid'].'">
                                    '.$row['cnumber'].'
                              </option>';
            }
           }
           else{
            $ans = '<span>No car has been added yet</span>';
           }
           return $ans;
      }

      function loadAccounts(){
            $sql = "SELECT * from owner";
            $ans = '';
            $result = queryMysql($sql);
            $count = 0;
            if($result -> num_rows > 0){
            while($row = $result -> fetch_assoc()){
                  $count++;
                  $sql1 = "select sum(apaid) as total from payment where
oid = '".$row['oid']."'";
                  //echo $row['customerid'];
                  $result1 = queryMysql($sql1);
                  $cont = $result1->fetch_assoc()['total'];
                  if ($cont == '')
                        $cont = 0;

                  $ans .= '<tr>
```

```
                                    <td>'.$count.'</td>
                                    <td>'.$row['fname'] ." "
.$row['lname'].'</td>
                                    <td>'.$cont.'</td>
                                    <td>'.$row['balance'].'</td>
                                    <td><a
href="printStatement.php?q='.$row['oid'].'" style="font-size:16px; font-
family: \'Trebuchet MS\', Tahoma;">Print Statement</a></td>
                                </tr>';

            }
          }
          else{
            $ans = '';
          }
          return $ans;
      }

      function loadPayments(){
            $sql = "SELECT concat(fname, ' ' ,lname) as fullname, pid,
apaid, date, cnumber from payment
            inner join owner on owner.oid = payment.oid inner join car on
car.cid = payment.cid order by date desc";
            $ans = '';
            $count = 0;
            $result = queryMysql($sql);
            if($result -> num_rows > 0){
            while($row = $result -> fetch_assoc()){
                  $count++;
                  $ans .= '<tr>
                                    <td>'.$count.'</td>
                                    <td>'.$row['fullname'].'</td>
                                    <td>'.$row['cnumber'].'</td>
                                    <td>'.$row['apaid'].'</td>
                                    <td>'.$row['date'].'</td>
                                    <td><a href="javascript:void(0)"
onclick="editPay('.$row['pid'].', \''.$row['fullname'].'\',
\''.$row['apaid'].'\', \''.$row['date'].'\')" data-toggle="modal" data-
target="#payment" style="font-size:16px; font-family: \'Trebuchet MS\',
Tahoma;"><i style="font-size:18px" class="fa fa-pencil-square-o"> Edit
</i></a>

                                        <a href="javascript:void(0)"
onclick="deletePay('.$row['pid'].')" style="font-size:16px; font-family:
\'Trebuchet MS\', Tahoma;"><i style="font-size:18px" class="fa fa-trash-
o"> Delete</i></a>
                        </td>
                                </tr>';
            }
          }
          else{
            $ans = '';
          }
          return $ans;
```

```
      }

      function loadTopups(){
            $sql = "SELECT concat(fname, ' ' ,lname) as fullname, tid,
amount, date from topup
            inner join owner on owner.oid = topup.ownerid order by date
desc";
            $ans = '';
            $count = 0;
            $result = queryMysql($sql);
            if($result -> num_rows > 0){
            while($row = $result -> fetch_assoc()){
                  $count++;
                  $ans .= '<tr>
                                    <td>'.$count.'</td>
                                    <td>'.$row['fullname'].'</td>
                                    <td>'.$row['amount'].'</td>
                                    <td>'.$row['date'].'</td>
                                    <td><a href="javascript:void(0)"
onclick="editPay('.$row['tid'].', \''.$row['fullname'].'\',
\''.$row['amount'].'\', \''.$row['date'].'\')" data-toggle="modal" data-
target="#payment" style="font-size:16px; font-family: Tahoma;"><i
style="font-size:18px" class="fa fa-pencil-square-o"> Edit </i></a>

                                          <a href="javascript:void(0)"
onclick="deletePay('.$row['tid'].')" style="font-size:16px; font-family:
Tahoma;"><i style="font-size:18px" class="fa fa-trash-o"> Delete</i></a>
                        </td>
                              </tr>';
            }
          }
          else{
            $ans = '';
          }
          return $ans;
      }

      function loadCars(){
            $sql = "SELECT *, toll.ctype as type from car inner join owner
on owner.oid = car.owner inner join toll on car.ctype = toll.tid order by
brand";
            $ans = '';
            $result = queryMysql($sql);
            $count = 0;
            if($result -> num_rows > 0){
            while($row = $result -> fetch_assoc()){
                  $count++;
                  $ans .= '<tr>
                                    <td>'.$count.'</td>
                                    <td>'.$row['brand'].'</td>
                                    <td>'.$row['model'].'</td>
                                    <td>'.$row['cnumber'].'</td>
                                    <td>'.$row['type'].'</td>
```

```
                                    <td>'.$row['fname'] . " ".
$row['lname'].'</td>
                                    <td>'.$row['tnumber'].'</td>
                                    <td><a href="javascript:void(0)"
onclick="editPay('.$row['cid'].')" data-toggle="modal" data-
target="#payment" style="font-size:16px; font-family: \'Trebuchet MS\',
Tahoma;"><i style="font-size:18px" class="fa fa-pencil-square-o"> Edit
</i></a>

                                        <a href="javascript:void(0)"
onclick="deletePay('.$row['tid'].')" style="font-size:16px; font-family:
\'Trebuchet MS\', Tahoma;"><i style="font-size:18px" class="fa fa-trash-
o"> Delete</i></a>
                        </td>
                              </tr>';
            }
          }
          else{
            $ans = '';
          }
          return $ans;
      }


      function drawDriversPie(){

          //new pie chart instance
          $chart = new PieChart();

          //data set instance
          $dataSet = new XYDataSet();

          //query all records from tde database
          $query = "select gender, count(oid) as number from owner group
by gender";

          //execute tde query
          $result = queryMysql( $query );

          //get number of rows returned
          $num_results = $result->num_rows;

          if( $num_results > 0){
              while( $row = $result->fetch_assoc() ){
                  $dataSet->addPoint(new Point($row['gender'],
$row['number']));
                  //echo $row['gender'] ." " .$row['number'];
              }

              //finalize dataset
              $chart->setDataSet($dataSet);

              //set chart title
              $chart->setTitle("");
```

```
            //render as an image and store under "generated" folder
            $chart->render("1.png");

            //pull tde generated chart where it was stored
            return "<img alt='Pie chart'  src='1.png'/>";

        }else{
            return "No customer found in the database.";
        }
    }

    $a = date("Y");
    function drawPaymentsBarGraph($year = 2019){
          $sql = "SELECT month(payment.date) AS month, sum(apaid) as
number
                    FROM payment
                    where year(date) = '".$year."'
                    GROUP By month(payment.date)";
          $montds = array('Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun',
'Jul', 'Aug', 'Sep', 'Oct', 'Nov', 'Dec');

          $chart = new VerticalBarChart();
        //data set instance
        $dataSet = new XYDataSet();

        $result = queryMysql( $sql );

        //get number of rows returned
        $num_results = $result->num_rows;

        if( $num_results > 0){
            while( $row = $result->fetch_assoc() ){
                $montd = $montds[$row['month']-1];
                 $dataSet->addPoint(new Point($montd, $row['number']));
                 //echo $row['gender'] ." " .$row['number'];
            }

            //finalize dataset
            $chart->setDataSet($dataSet);

            $chart->getPlot()->setGraphPadding(new Padding(5, 30, 20,
50));


            //set chart title
            $chart->setTitle("");

            //render as an image and store under "generated" folder
            $chart->render("2.png");

            //pull tde generated chart where it was stored
            return "<img alt='Bar chart'  src='2.png'/>";
```

```
          }else{
              return "No payments found in the database.";
          }
      }

      function drawBarForWeek($year = 2019){
            $sql = "SELECT date, sum(apaid) as number FROM payment WHERE
date >= ADDDATE(CURDATE(), INTERVAL 2-DAYOFWEEK(CURDATE()) DAY) AND date
<= CURDATE() group by date";
            $montds = array('Mon', 'Tue', 'Wed', 'tdu', 'Fri');

            $chart = new HorizontalBarChart();
          //data set instance
          $dataSet = new XYDataSet();

          $result = queryMysql( $sql );

          //get number of rows returned
          $num_results = $result->num_rows;

          if( $num_results > 0){
              while( $row = $result->fetch_assoc() ){
                  $date = $row['date'];
                   $dataSet->addPoint(new Point($date, $row['number']));
                   //echo $row['gender'] ." " .$row['number'];
              }

              //finalize dataset
              $chart->setDataSet($dataSet);

              $chart->getPlot()->setGraphPadding(new Padding(5, 30, 20,
80));


              //set chart title
              $chart->setTitle("");

              //render as an image and store under "generated" folder
              $chart->render("4.png");

              //pull tde generated chart where it was stored
              return "<img alt='Bar chart'  src='4.png'/>";

          }else{
              return "No payments found in the database for this week.";
          }
      }

      function getDayPayment(){
            $sql = "SELECT sum(apaid) as amount from payment where
date(date) = '" .date('Y-m-d')."'" ;
            $result = queryMysql($sql);
            $amount = $result->fetch_assoc()['amount'];
            if ($amount == '')
```

```
                $amount = 0;
            return $amount;
      }

      function getWeekPayment(){
            $sql = "SELECT sum(apaid) as amount FROM payment WHERE
date(date) >= ADDDATE(CURDATE(), INTERVAL 2-DAYOFWEEK(CURDATE()) DAY) AND
date(date) <= CURDATE()";
            $result = queryMysql($sql);
            $amount = $result->fetch_assoc()['amount'];
            if ($amount == '')
                  $amount = 0;
            return $amount;
      }

      function getMonthPayment(){
            $sql = "SELECT sum(apaid) as amount from payment where
month(date) = '" .date('m')."' and year(date) = '" . date('Y') . "'" ;
            $result = queryMysql($sql);
            $amount = $result->fetch_assoc()['amount'];
            if ($amount == '')
                  $amount = 0;
            return $amount;
      }

      function getYearPayment(){
            $sql = "SELECT sum(apaid) as amount from payment where
year(date) = '" . date('Y') . "'" ;
            $result = queryMysql($sql);
            $amount = $result->fetch_assoc()['amount'];
            if ($amount == '')
                  $amount = 0;
            return $amount;
      }

      function overallcont()
      {
            $sql = "SELECT sum(apaid) as amount from payment" ;
            $result = queryMysql($sql);
            $amount = $result->fetch_assoc()['amount'];
            if ($amount == '')
                  $amount = 0;
            return $amount;
      }

      if (isset($_GET['tagnumber'])) {
            $sql = "select * from owner inner join car on owner.oid =
car.owner inner join toll on car.ctype = toll.tid where car.tnumber = '" .
$_GET['tagnumber'] . "'";
            $result = queryMysql($sql);
            if($result -> num_rows > 0){
                  $row = $result -> fetch_assoc();
                  $date = date('Y-m-d H:i:s');
                  $amount = $row['price'];
```

```
                if ($row['balance'] < $amount) {
                      echo "Insufficient balance";
                      return;
                }
                $cid = $row['cid'];
                $oid = $row['oid'];
                $sql = "call addpayment('$oid', '$amount', '$cid',
'$date')";
                $result = queryMysql($sql);
                if($result){
                    if(mail($row['email'],"Payment Successful - Ghana
Toll Booth", "Dear ".$row['fname']."., your payment has been recorded
successfully. Amount deducted was GHS". $row['price'] ." and your current
balance is GHS". $row['balance']))
                           echo "OK";
                       else{
                           echo "OK";
                       }
                }
                else
                      echo "Payment failed. Please try again later";
           }
           else
                echo "Payment failed. Tag number does not exist.";
     }


?>
```