International Journal of Engineering Processing & Safety Research
Published by Cambridge Research and Publications
Vol. 28 No.5
June, 2023.

DESIGN AND CONSTRUCTION OF A 1K BASED AUTOMATIC TOLL TAX SYSTEM: A CASE STUDY OF SECOND NIGER BRIDGE IN NIGERIA

K. U. UDEZE[1*], J.E. CHIEGBOKA[2]**
[1,2]Department of Electrical & Electronics Engineering, Federal Polytechnic Oko, Oko, Anambra State.

ABSTRACT
The developed system has the ability to collect toll fees from drivers directly from their bank account using a smartcard. The system is made up of a designed microcontroller based and has a barricade done with a servo motor to allow only vehicle with the approved collected toll fee to pass. The traditional development methodology was adopted for the development of this system. Top-down design approach was adopted for both hardware and software developments. The main sub units of the system include power supply unit, smart card unit, Keypad input unit, control unit, display unit and servo motor unit. This system works with the principle that when the driver swipes his card on the card reader, the system will request for a password, when the entered password is correct, it will deduct the cost of the gate fee directly from the driver's account. If this transaction is successful, a signal logic will be sent to the servo motor to remove the barricade so that the vehicle can pass.

INTRODUCTION
Before the third Republic in 1999 in Nigeria, there were toll gates at the entrance of the 36 states in Nigeria. However, due to corruption, the then president of Nigeria decided to dismantle all the toll gates because it was observed that the tax collected as a form of toll fee were not remitted to the Federal Government of Nigeria's account. However, dismantling the toll gates was not the best option as the purpose at which these toll gates were established were not looked into. Rather the corruption activities involved were the only thing that was considered. This paper suggests a better way of controlling the corruption activities if not completely eliminating the corruption activities completely while keeping the purposed establishing the toll gates flying; as the money collected at

each toll gates goes directly into the Federal Government account with the help of the designed system.

Tolls are fees collected for assessing a particular road, it is a kind of tax-like fee collected with the aim of helping to regain the cost of construction and maintenance of a road, such roads are called toll roads. Toll roads in some ways have existed before the advent of cars when travelers use such roads on foot or using animal means of transportation like horses and wagons, Fees were till collected before they are allowed to pass such route. Toll roads were constructed by inhabitants of neighboring settlements to the roads and use the toll system as a way of generating revenue to repay loans used in constructing the road and also for maintenance of the road. The toll system used at the time would arguably be made up of a wood block and some levers to ensure opening and closing after collecting fees from road users which later developed and today it is referred to as toll booth or toll gate.

The mobility of people in urban areas has increased in line with the country's development. As mobility increases, traffic demand also rises. Road infrastructures, including toll roads, need to be developed to address this demand. Toll road development is also intended to achieve equitable development to improve the efficiency of service distribution to support economic growth, especially in high-level region development like Nigeria [1]

But unlike the old system which coordinates the collection of tolls from individual on foot and horses arriving the toll point at relatively different times due to the population of people using the toll system at the time which implies lesser traffic, lower standard of living at the time which was not really time conscious.

The current toll system is faced with ever growing technologies which approaches evolution in their various areas with a methodology which looks for ways of doing things better by reducing the amount of time needed to carry out such operation. The advent of automobiles which unlike their predecessor have relatively high speed and contain ever growing technologies to meet the needs of this time, This cars makes use of these toll highways to access various urban locations for different important reasons which are time sensitive and cannot be subjected to the relatively slow running Toll gates which are coordinated by human who are not as operationally efficient as the machines they are up against thereby leading to various anomalies like traffic, time wasting etc.

In this project work, a toll system that will help reduce the traffic and congestion at toll roads and toll gates is developed. this device will also be adaptive to the CBN cashless money policy. This system will work with smart card. This will enable authentication

and the toll fee to be withdrawn directly from your bank account. The system will also aid in reducing the toll money theft by the toll collectors.

The proposed device will work with RFID which will serve as the smartcard, and a servo motor that will control the barricade on the road. When you swipe your card and it is being reorganized, you will be required to enter your pass word. when you have been authenticated, the exact toll fee will be deducted from your account and the barricade will open so that you will pass.

History of Toll system

A toll road, also known as a turnpike or tollway, is a public or private road (almost always a controlled-access highway in the present day) for which a fee (or toll) is assessed for passage. It is a form of road pricing typically implemented to help recoup the costs of road construction and maintenance.

Toll roads have existed in some form since antiquity, with tolls levied on passing travelers on foot, wagon, or horseback; a practice that continued with the automobile, and many modern tollways charge fees for motor vehicles exclusively. The amount of the toll usually varies by vehicle type, weight, or number of axles, with freight trucks often charged higher rates than cars.

Tolls are often collected at toll plazas, toll booths, toll houses, toll stations, toll bars, toll barriers, or toll gates. Some toll collection points are automatic, and the user deposits money in a machine which opens the gate once the correct toll has been paid. To cut costs and minimize time delay, many tolls are collected with electronic toll collection equipment which automatically communicates with a toll payer's transponder or uses automatic number-plate recognition to charge drivers by debiting their accounts.

Electronic toll collection (ETC) is a wireless system to automatically collect the usage fee or toll charged to vehicles using toll roads, HOV lanes, toll bridges, and toll tunnels [2]. It is a faster alternative which is replacing toll booths, where vehicles must stop and the driver manually pays the toll with cash or a card. In most systems, vehicles using the system are equipped with an automated radio transponder device. When the vehicle passes a roadside toll reader device, a radio signal from the reader triggers the transponder, which transmits back an identifying number which registers the vehicle's use of the road, and an electronic payment system charges the user the toll.

Electronic toll collection (ETC) aims to eliminate the delay on toll roads, HOV lanes, toll bridges, and toll tunnels by collecting tolls without cash and without requiring cars to stop. Electronic toll booths may operate alongside cash lanes so that drivers who do

not have RFID tags can pay a cashier or throw coins into a receptacle. Open road tolling is a popular form of cashless tolling without toll booths; cars pass electronic readers even at high way speeds without the safety hazard and traffic bottlenecks created by having to slowdown to go through an automated toll booth lane [3].

Due to the degree of complexity related to measuring the advantage of establishing Electronic Toll Collection (ETC) systems, literature generally stops short of modeling an all-inclusive set of benefits of the system. In this research, a model that incorporates the impact on both the users and the society as a whole and evaluates the financial benefits over the lifespan of the ETC investment is developed [4].

[5] in his study utilizes a quantitative method of econometric panel regression using data from selected toll gates in the Indonesia toll road network from January 2017 to December 2018 to analyze how the ETC deployment affects transport system efficiency. The findings indicate that the intervention of ETC implementation significantly decreases the transaction time in toll gates by 93.5%, catteries paribus. Thus, the intervention eases the accessibility and yield efficiency in transaction time. Furthermore, an adapted strategy after the implementation could be considered, especially regarding the trend of surging traffic on toll roads that may cause bottlenecks after entering toll gates [5].

[6] said that "toll road system has been historically accounted for the bulk of the financing of highway network." By building a toll roadway, it is possible to provide a number of improved services to the road users, which can be measured in order to ensure that they deliver the outcomes that are envisaged. In toll road sector, the major stakeholders, typically the Government and the contractors are responsible for development of the toll project and delivering operational services, using associated technologies, thereby fulfilling the primary objective of creating a tollway, being the customers satisfaction [6].

MICRO CONTROLLER (Arduino)

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions

of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

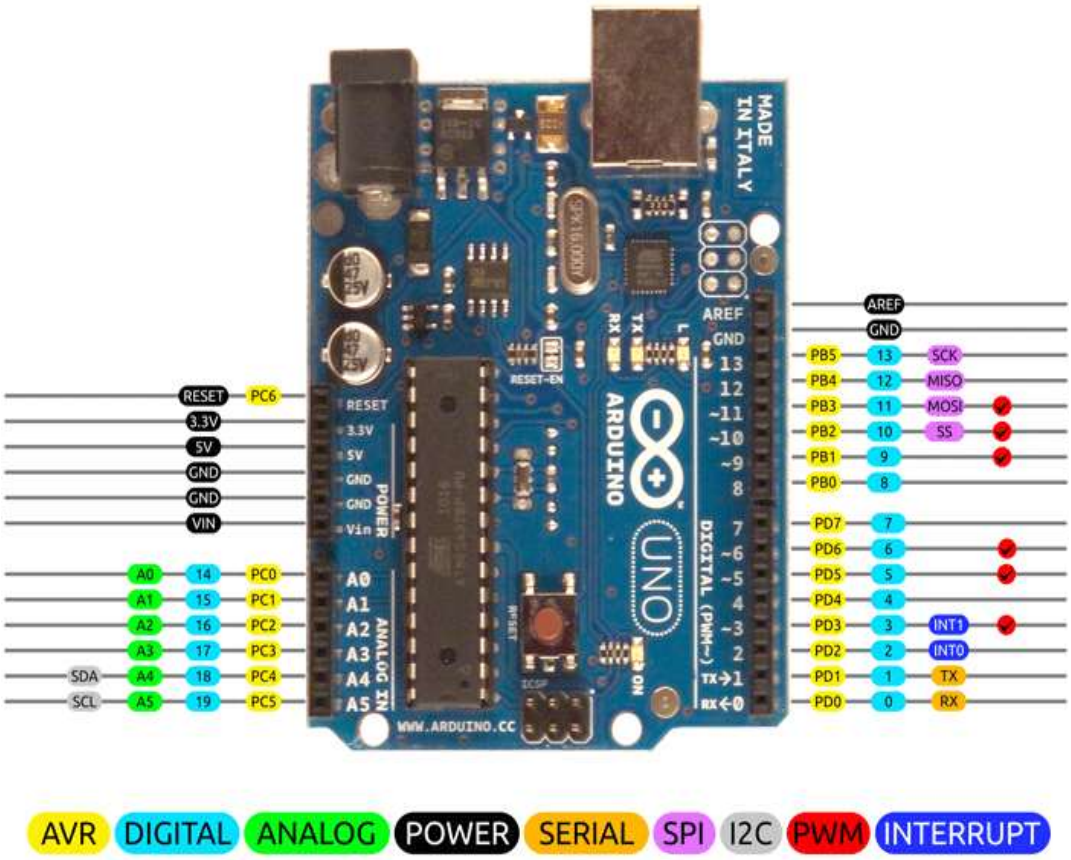

Figure1 DIAGRAM OF ARDUINO

Table 1 Pin Description

Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA.

		GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output Pins	Digital Pins 0 – 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

Table 2 Arduino Uno Technical Specifications

Microcontroller	**ATmega328P – 8 bit AVR family microcontroller**
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

When ATmega328 chip is used in place of Arduino Uno, or vice versa, the image below shows the pin mapping between the two.

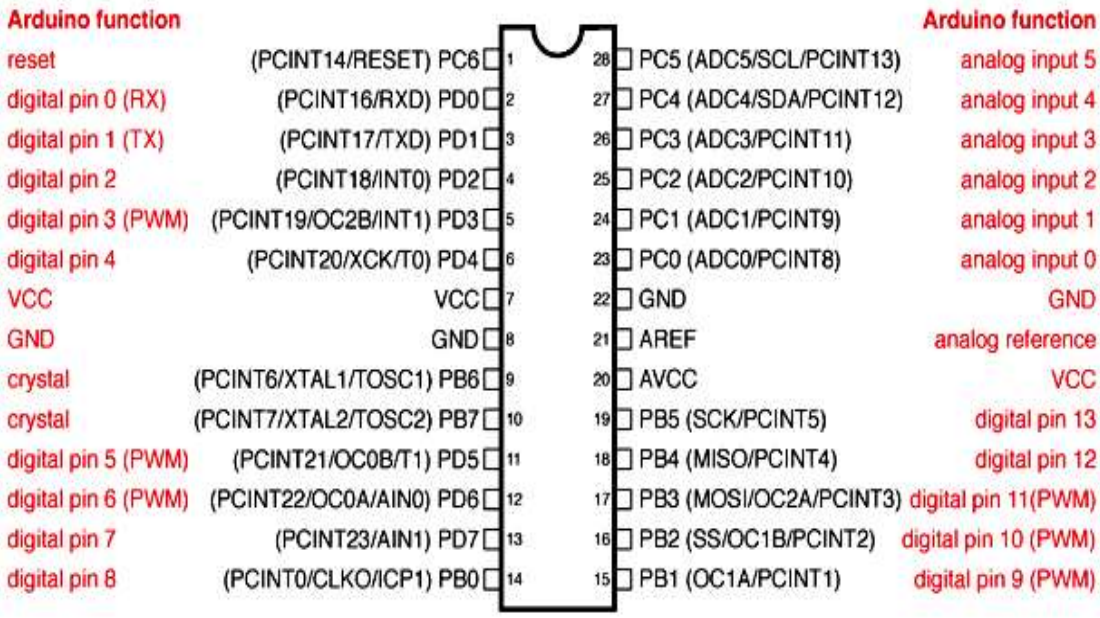

Figure 2 PIN DIAGRAM OF ATMEGA 328

Voltage Regulator 7805

- Output Current up to 1 A
- Output Voltages: 5, 6, 8, 9, 10, 12, 15, 18, 24 V
- Thermal Overload Protection
- Short-Circuit Protection
- Output Transistor Safe Operating Area Protection

The LM78XX series of three-terminal positive regulators is available in the TO-220 package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut-down, and safe operating area protection. If adequate heat sinking is provided, they can deliver over 1 A output current. Although designed primarily as fixed- voltage regulators, these devices can be used with external components for adjustable voltages and currents.

Bluetooth Module (HC-05)

HC-05 Bluetooth Module is an easy-to-use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Its communication is via serial

communication which makes an easy way to interface with controller or PC. HC-05 Bluetooth module provides switching mode between master and slave mode which means it able to use neither receiving nor transmitting data. The Bluetooth module HC-05 is a MASTER/SLAVE module. By default, the factory setting is SLAVE. The Role of the module (Master or Slave) can be configured only by AT COMMANDS. The slave modules cannot initiate a connection to another Bluetooth device, but can accept connections. Master module can initiate a connection to other devices. The user can use it simply for a serial port replacement to establish connection between MCU and GPS, PC to your embedded project.

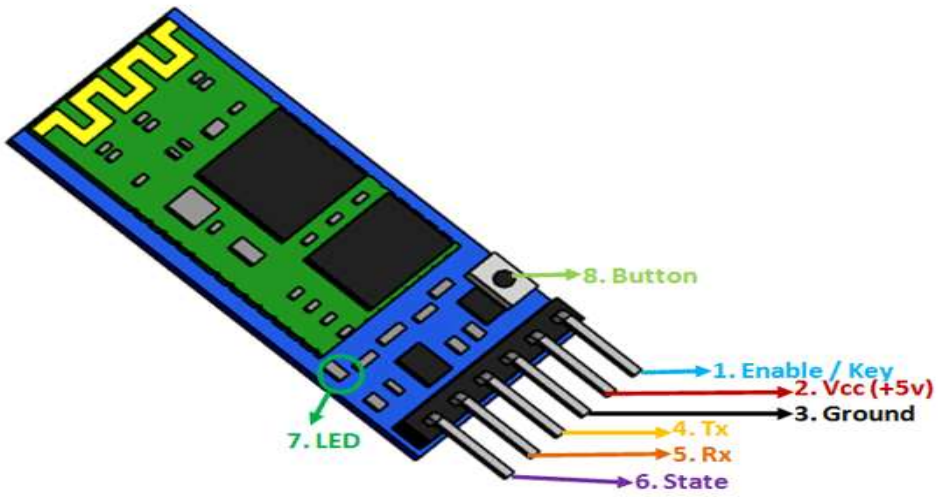

Figure 3 HC-05 Bluetooth Modules

RFID READER

The RC522 RFID module based on MFRC522 IC from NXP is one of the most inexpensive RFID options. It usually comes with an RFID card tag and key fob tag having 1KB memory. And best of all, it can write a tag.

The RC522 RFID Reader module is designed to create a 13.56MHz electromagnetic field that it uses to communicate with the RFID tags (ISO 14443A standard tags). The reader can communicate with a microcontroller over a 4-pin Serial Peripheral Interface (SPI) with a maximum data rate of 10Mbps. It also supports communication over I2C and UART protocols.

The module comes with an interrupt pin. It is handy because instead of constantly asking the RFID module "is there a card in view yet? ", the module will alert us when a tag comes into its vicinity.

The operating voltage of the module is from 2.5 to 3.3V, but the logic pins are 5-volt tolerant, so it can be easily connected to an Arduino or any 5V logic microcontroller without using any logic level converter.

The RC522 module has a total of 8 pins that interface it to the outside world. The connections are as follows:

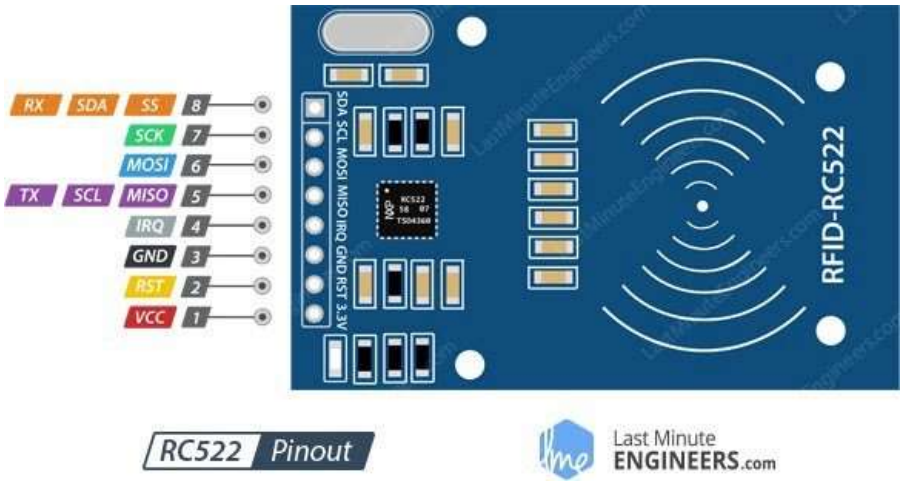

Figure 4 RFID READER

VCC supplies power for the module. This can be anywhere from 2.5 to 3.3 volts. It can be connected to 3.3V output from the Arduino.

RST is an input for Reset and power-down. When this pin goes low, hard power-down is enabled. This turns off all internal current sinks including the oscillator and the input pins are disconnected from the outside world. On the rising edge, the module is reset.

GND is the Ground Pin and needs to be connected to the GND pin on the Arduino.

IRQ is an interrupt pin that can alert the microcontroller when an RFID tag comes into its vicinity.

MISO / SCL / Tx pin acts as Master-In-Slave-Out when SPI interface is enabled, acts as serial clock when I2C interface is enabled and acts as serial data output when UART interface is enabled.

MOSI (Master Out Slave In) is SPI input to the RC522 module.

SCK (Serial Clock) accepts clock pulses provided by the SPI bus Master i.e., Arduino.

SS / SDA / Rx pin acts as Signal input when SPI interface is enabled, acts as serial data when I2C interface is enabled and acts as serial data input when UART interface is enabled. This pin is usually marked by encasing the pin in a square so it can be used as a reference for identifying the other pins.

SERVO MOTOR

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a servo mechanism. If motor is powered by a DC power supply, then it is called DC servo motor, and if it is AC-powered motor then it is called AC servo motor. For this tutorial, we will be discussing only about the DC servo motor working. Apart from these major classifications, there are many other types of servo motors based on the type of gear arrangement and operating characteristics. A servo motor usually comes with a gear arrangement that allows us to get a very high torque servo motor in small and lightweight packages. Due to these features, they are being used in many applications like toy car, RC helicopters and planes, Robotics, etc.

Servo motors are rated in kg/cm (kilogram per centimeter) most hobby servo motors are rated at 3kg/cm or 6kg/cm or 12kg/cm. This kg/cm tells you how much weight your servo motor can lift at a particular distance. For example: A 6kg/cm Servo motor should be able to lift 6kg if the load is suspended 1cm away from the motors shaft, the greater the distance the lesser the weight carrying capacity. The position of a servo motor is decided by electrical pulse and its circuitry is placed beside the motor.

Figure 5 SERVO MOTOR

2 The Proposed Toll Tax System

The major aim of this work is to develop a device that can automatically collect toll tax from drivers passing a toll gate, and deducting the fee from the driver's bank account through the help of a smart card.

MATERIALS AND METHOD

The materials used on this design includes:

- Microcontroller (Arduino)
- RFID reader
- LCD
- Servo Motor
- Keypad
- Resistors
- Capacitors
- Diodes
- Regulator
- Relay
- Transformer

The traditional development methodology was used for the execution of this project and the top-down design approach was adopted for both hardware and software developments. This method comprises of:

- Research and study
- Planning
- Designing
- Implementation
- Testing
- Improvement

The methodological flow diagram is shown below:

Figure 6 System functional development flow diagram

At the beginning of this work, several researches were carried out to make this work a possibility. The planning involved developing the circuit diagram and understanding how it works/functions to enable you builds the software. We started with the hardware, several problems were encountered, it was tested, and trouble-shooed to correct errors and was ascertained functional. The software was written in assembly language debugged to correct error and was confirmed functional. The software and hardware were combined tested, modified and confirmed to be accurate and functional.

HARDWARE INTERFACE MODULE

The hardware of this design comprises of the entire component put together to achieve this design. In this design, several components were put together. However, this section deals with the explanation of this hardware its various components and its hardware unit analysis.

The hardware aspect of this device comprises of the components used and the various connections of the components to form the device. In this design however various electronic components were put together to build a complete system. The various stages play a very significant role in the proper function of the system; in fact, any affected or malfunctioning part would have a drastic influence on the proper function of the device. The hardware implementation also deals with drawing the schematic on the plane paper according to the application, testing the schematic design over the breadboard using the various ICs to find if the design meets the objective of the design.

This device can be categorized into the various units:

POWER SUPPLY UNIT

RFID SMART CARD UNIT

KEYPAD INPUT UNIT

CONTROL UNIT

DISPLAY UNIT

SERVO MOTOR UNIT

The block diagram of the entire device is shown below:

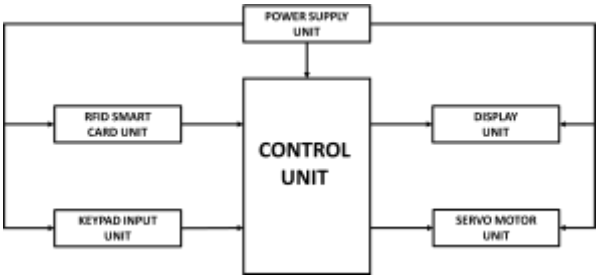

Figure 7 Block Diagram of the device

2.2.1 POWER SUPPLY UNIT

This is the unit that is responsible of providing power to all units of the system. It steps down and converts the 240v AC voltage from the power supply to a 5v DC voltage that is comfortable with the components in the system. The block diagram of the process involved in the /power supply unit is described below.

The step-down is the section responsible of stepping down the high voltage from the line transformer down to a considerable voltage of around 12v. This is achieved by the use of step-down transformer. The output of the transformer is being fed to the rectification unit. This is where the AC bi-directional voltage from the transformer is being converted to a one directional voltage. This is achieved by the connection of four diodes in bridge form to get a full wave rectification. This output is then passed through a capacitor to filter out the AC impurities in the signal and give a pure DC voltage. The filtered signal is then regulated to a particular voltage that is compatible with your design using an IC regulator (78xx). In this design, the voltage will be regulated to 5volts. The circuit diagram of the power supply unit is shown below.

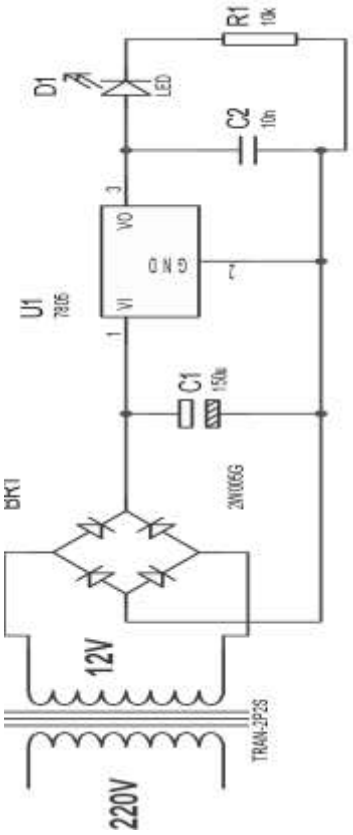

Figure 8 Schematic Diagram of Power Supply Unit

SMART CARD INPUT UNIT

This is the unit that detects the smart card. It is comprised of the MFRC522 Reader. This is an RFID reader that can read RFID tags and get their ID. The RFID white tag is being used as smart cards in this design. The major function of this reader is to read the tag and send the ID to the microcontroller. Once the tag is being brought close between 0.5cm to the reader, the reader will read the tag and pick its ID. This ID is what it sends to the microcontroller to check if it is among the reorganized card or not.

KEYPAD INPUT UNIT

this is the unit through which button input is made to the device. It is made of a 4x4 matrix keypad. The keypad was connected to the digital pins of the arduino. The keypad comprised of 16 pushbuttons connected in a

matrix form. this matrix pattern makes it posible to access the 16 push buttons with just 8 port pins. The keypad library was used in accessing the different keys of the keypad why programing.

CONTROL UNIT

This is the unit that controls the entire operation of the device. it is made of the Arduino microcontroller. the Arduino communicates with the RFID card reader through the SPI port, when the card reader detects card, it send the card ID to the arduino. the Arduino picks the card id, stores it in a location and compares if it matches to the already store id in the program. if it matches the ID, the starts reading the keypad input unit so that you can enter your password. Once the password is correct, the Arduino sends signal to the servo motor which will serve as a baricade to open so you can pass after deducting the sum of 1,000 form the amount allocated to the card.

DISPLAY UNIT

This is the unit that is in-charge of displaing the output information from the entire operation of the device. It is comprised of an Alphanumeric LCD. It is being connecte to the arduino, and it communicates with the arduino in a 4-bit address. After the arduino is done with the convertion and calibration of redings, it will send the equivalent data to display the equivalent value measured to the LCD to be displayed.

SERVO MOTOR UNIT

This unit controls the baricade that will be used to block the road. it comprices of a servo motor. A long rule will be connected with the handle of the motor. when it rotates, it will be able to lift the rule which will serve as baricade up. The servo will move the baricase up and down as it receives signal from the Arduino.

SOFTWARE MODULE

This is the writing of the program that will drive the circuit. This program is written so that the system can function to the intention of the programmer. With entire reference to this work the program is written so that it will respond to the correct code that is initiated in the program.

The Arduino program was written in the Arduino IDE. The program was program development flowchart is shown below;

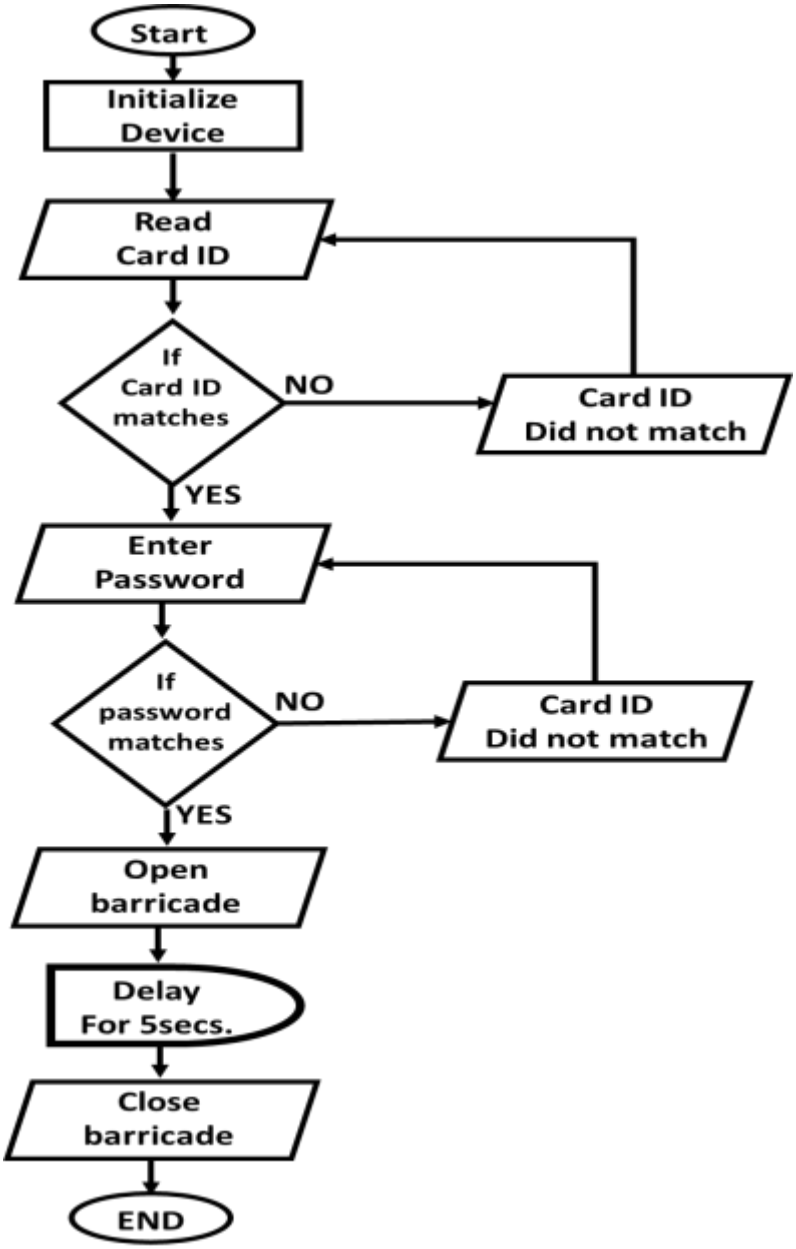

Figure 9 The flow chart of the Developed System Software

The software development was executed in the following phases;

- Writing of the source code in C++
- Compiling the source code using Arduino Sketch.
- Programming the microcontroller with the output hex file from the compiler using ISP flash programmer.

WORKING PRINCIPLE

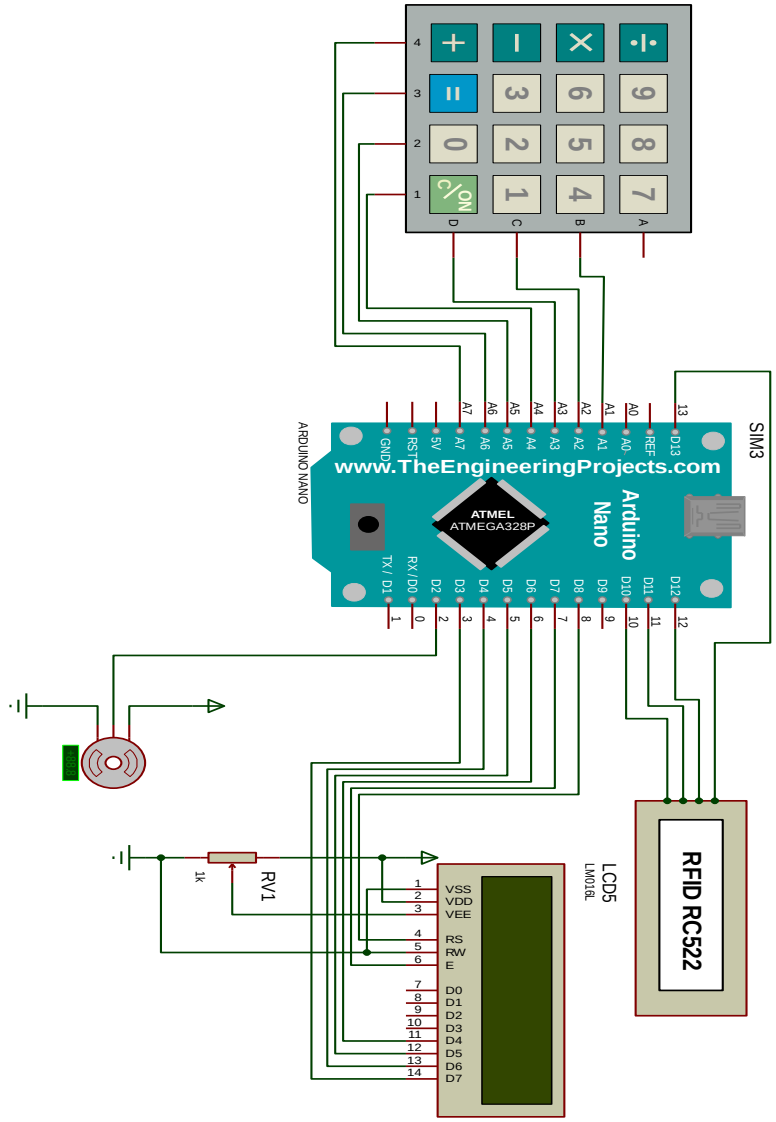

Figure 10 The Project Circuit Diagram

The device works with the RFID reader RC522. This reader can read the ID of an RFID tag. After reading the ID, it sends it out to the Arduino. It communicates with the Arduino using the SPI protocol. its pins MISO, MOSI, SCK and SS are connected to the Arduino SPI ports which are D10, D11, D12 and D13. When the ID is read by the Arduino, the Arduino compares the ID to see if it matches any of the ID being stored in it program ROM. If the ID matches, then the device will prompt you to enter password. The password is being entered through the keypad. as the password is being entered, the Arduino reads the input and stores it in a location. After entering the password, the enter

button is pressed. this will prompt the Arduino to compare the entered password to see if it matches the password of the particular card. Once the password is correct, the device will show you payment successful and turn the servo motor at 90^0 which will open the barricade. The servo motor returns to rest which is 0^0 after 5secs when the vehicle must have passed.
The RFID reader works with SPI protocol, so it was connected to the SPI port pins of the Arduino. RST to D13, MISO to D12, MOSI to D11, SDA to D10, SCK to D9. The LCD screen communicates with the Arduino through 4bit mode. The LCD data pins D4 to D7 were connected to Arduino D6 to D3. The servo motor was connected to D2. The Keypad was connected to Arduino analog pins A0 to A7.

RESULT AND DISCUSSION

The work carried out to achieve this design was done in two stages;
The components for the design of the hardware were gotten from nearby shops, several websites were visited to get and know the particular component to suit what you want. Several other books and sites were visited to generate the series of code program that will drive the hardware
The packaging was done using plastic packaging. Several other materials were used to make the lamp look neat and enticing in the eye.

EXPERIMENTAL SETUP

After the development of the device, it was tested to ascertain its functionality. A picture of the functional device is shown below.

Figure 11 Picture of the Constructed Toll Tax System

The device is AC powered so it was pugged into an AC source. The smart cards (RFID tags) for testing where also made handy and available for easy accessing.

RESULT

When the device was turned ON, the LCD screen started displaying showing there is power supply to the device, it is working and the Arduino is executing the instructions being

programed to it. The picture is shown:

Figure 12 The LCD Interface

When the smart card was swiped across the device for authentication, the device requested for password so that the payment can be authenticated.

Figure 13 Using the Card on the Card Reader

Figure 14 Entering the Password on the LCD Interface

After the password was entered authenticated and the password is correct, the device opened the barricade for vehicle passage.

Figure 15 the Servo is Witched on to Drive the Motor to Give Access

DISCUSSION

From the result obtained, when the designed Toll Tax Microcontroller based system was tested, it shows that this gadget worked based on designed specification and the device performed excellently with a 90% efficiency. The two smart cards with their respective password were a very good means of authentication for the device.

CONCLUSION AND RECOMMENDATION

FINDINGS

From researches carried out so far showed that there has been a tremendous change in technology which has brought about a lot of changes in human life and security. Many new inventions have been developed to make man's activities very easier.

Some roads still use the manual toll collection of cash, many has already started the use of toll collection with smartcard. The toll collection being done with smartcard has proved to be very efficient, easy to run with no theft of toll fees.

FURTHER STUDIES

This system can further be improved by developing a real time device that can be adopted on the 2nd Niger bridge for the collection toll fees by Julius Berger construction company.

COLCLUSION

This device will be able to tax all the vehicle passing through the toll gate very fast without human interference. it does this by charging you from your bank account through your card that you will provide.

REFERENCE

Sihombing, L. B. (2013). Critical Toll Road Infrastructure in Indonesia – A System Dynamics Perspective, 833–837. https:// doi.org/10.3850/978-981-08-7920- 4_i-16-0447

Hensher, David A. (1991). "Electronic toll collection". Transportation Research Part A: General. 25.

Md Lalchan, Md Asraful Islam, S. M. Al-Masud, and MD. Sabed banani khan (2018). "Electronic Toll Collector with GSM notification" submitted to Department of Electrical and Electronics Engineering-(EEE), EUROPEAN UNIVERSITY OF BANGLADESH.

Rajesh H. Chaudhary (2003). A Model for the Benefits of Electronic Toll Collection System. *A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Industrial Engineering Department of Industrial & Management Systems Engineering College of Engineering University of South Florida.*

RAHMAWATI Alfi Hidayatu (2019). "How Electronic Toll Collection Deployment Affects Transport System Efficiency: The Study of Indonesia Toll Road Network" *Master Thesis Presented to Ritsumeikan Asia Pacific University in Partial Fulfillment of the Requirements for the Degree of Master of International Cooperation Policy*

Nagarjuna Pilaka (2018). "Performance Assessment of Toll Road System: A Study in Pune Region" Submitted in Partial Fulfillment of the Requirement of the Degree of Doctor of Philosophy to ICFAI University Jharkhand Ranchi