Automated Toll Collection System Based on RFID Sensor

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***Abstract*—With the continued development and economic growth, Bangladesh needs to be digitalized in every way possible. In this paper, RFID based Automated Toll Collection System is introduced as a solution of the traffic problems and also to maintain transparency in the toll collection system. The proposed system aims to make a digital toll collection system which can eliminate the delay on toll roads, toll bridges and toll tunnel without cash and without requiring cars to stop. This paper focuses on an electronic toll collection system which uses radio frequency identification (RFID) technology to identify a vehicle specifically for collecting toll. The proposed RFID system uses tags that are mounted on the digital number plate of the vehicles, through which information embedded on the tags are read by RFID readers. It is possible to reduce the need for vehicle owners and toll collection authorities to distribute tickets and collect tolls manually in this system Information on the toll payment can also be easily exchanged between the vehicle owners and toll authorities. As a result, transparency in toll payment can be ensured with reduced manual labor and human errors. Thus, building smart transportation system will become easier.**

Keywords—Arduino, Traffic problems, RFID Reader, RFID Tag, Toll Gate, Servo motor.

I. INTRODUCTION

In this century, people live a life which is solely dependent on technology. New innovations are made to make out life less demanding, calm and more agreeable. The primary goal of advancement has been to extend capability and diminishing effort. In the present scenario, the world is straightly moving towards automation. Automation is the use of various management systems for running instruments such as-machinery processes in factories, boilers, and heat treating ovens, change on telephone networks, steering and stabilization of ships, craft and different applications and vehicles with possibly reduced human interventions and better accuracy . Highways or Toll Roads are provided to enhance the traffic, improve the distribution of goods and services, and increase mobility and accessibility of people. The problem starts when there is long queue. This queue occurs because the arriving rate of vehicles to toll gates is much higher than the servicing rate . This congestion will lead to wasting time for wait, incendiary fuel combustion, and air pollution caused by vehicleexhaust . Utilization of automated toll collection gate will help to improve the toll service by saving time, saving fuel & reducing gas emission. In the proposed system RFID reader will read the RFID tags that are mounted on vehicles and the system will automatically deduct a specific amount of toll from the scanned tag id with the help of the database. As there is no need for vehicles to stop or toll authorities to manually collect the tolls, this system eliminates the traffic jam and possible human errors that normally happen in a toll collecting system making it a more efficient process.

The rest of the paper is described as follows: Section II discusses about the background study on various existing or proposed models, Section III discusses about the hardware implementation, Section IV discusses about the experimental setup and finally Section V concludes the paper.

II. LITERATURE REVIEW

Automated toll based collection system has helped a lot in reducing heavy congestion which has caused in front of the bridges of busy cities of the world. It is also the easiest method to control heavy flow of traffic. Digitally it captures the radio frequency by means of RFID technology. In this method a RF tag along with a unique code will be attached to the vehicle which emits RF signals. Every owner has to have an account with RFID tag attached to their vehicle. Whenever the vehicle reaches nearer to the entrance toll gate the signals will be detected and passed to the controlling device. If the vehicle owners are found with sufficient amount of balance in their account, only then they will be allowed to pass . Again digital toll based collection system has also been found in developed countries like Canada which is known as Canada 407 Express toll route (ETR). In this system they introduced opticalcamera with Optical Character Recognition (OCR) which captures images and recognizes license plates without any tag. In Gujrat, a state of India there is electronic toll collection system using radio frequency and tag operates commercially onexpressway where all needed equipment were supplied by Mitsubishi Heavy Industries . Again India has got its first interoperable RFID based electronic toll system in Ahmadabad-Mumbai National Highway which enables automobiles having electronic tags operates at frequency of (850-950 MHz) with distance up to 90 feet where response time is 10 milliseconds . This system can be considered as cost efficient but the driver has to get the receipt and pass through the gate. Furthermore, an institution named Active wave Inc. has come up with a system which monitors active tagged vehicles. These automobiles have active wave ranging 30 meters operating (916-917 MHz) for operation transmit and (433MHz)for receiving the link. Here, in form of blinking LEDS and beeping sounds the signals are observed. Moreover, the user interface has been designed using Microsoft .NET Framework.The tag uses car battery for power and two modules through RFmodem transfer signals among themselves over the ISM

frequency range of about (902-928) MHz. Another proposed model of digital toll collection has been developed in Poland which has got a combination of GSM and satellite based global positioning system . Here the system has got sensors and camera which captures and detects number plate. In addition, itcaptures the distance, evaluates the fees and rates transmitting them to the System Centre.

III. DESIGN AND HARDWARE IMPLEMENTATION

A list of the hardware components of our project is narrated in Fig. 1.

Fig. 1 Automated Toll Collection System

Arduino Mega R3 2560: Arduino Mega R3 2560 is the microcontroller used for the project. The Arduino Mega R3 2560 is a board based on the ATmega2560 microcontroller. It is the most important component of our system all processing takes place in these block. Different microprocessors and controllers are component of various models of Arduino. The board supplied has many pins that can be used to interact with various appliances and boards.

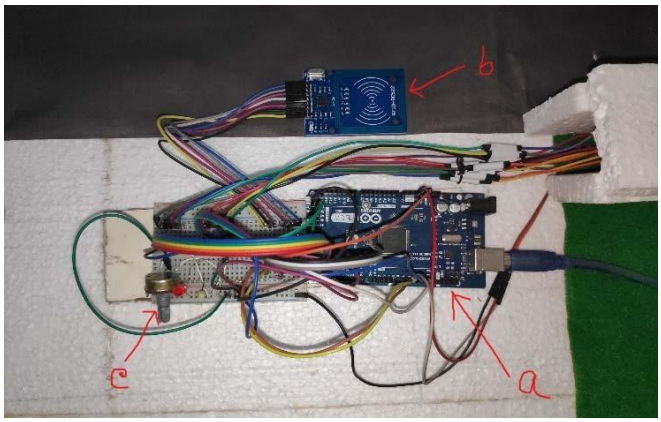

Fig. 2 (a) Arduino Mega R3 2560 (b) RFID Scanner (c) Potentiometer

It comprises of a programmable circuit board and an integrated development environment to write the code and add the code to the circuit board afterwards. For a constructed feature or a particular task, Arduino can be coded. The Arduino has a USB port for connecting to the laptop and uploading programs to the laptop. Arduino also provides a dedicated Integrated Development Environment (IDE) to compile and upload our Sketch (Program) to the board based on the Language Processing project.

RFID Reader: A RFID reader is a tool used to gather data from an RFID tag to track individual items. This low-cost MFRC522-based RFID reader module is simple to use and canbe used in a variety of applications. Performance of an RFID system depends on several factors such as the orientation of tag, the material of the item to which a tag is attached, and the environment in which the system operates. RFID tags contain a distinctive code that distinguishes the vehicle class that passes through the tariff port. The RFID tag is inserted in the vehicle. Every vehicle has a distinctive identity that can be readily identified by the RFID reader. On the other hand, the RFID reader reads all RFID tags to get their unique ID numbers, and the Arduino is programmed to recognize only some RFID tags, enabling only registered tag cars.

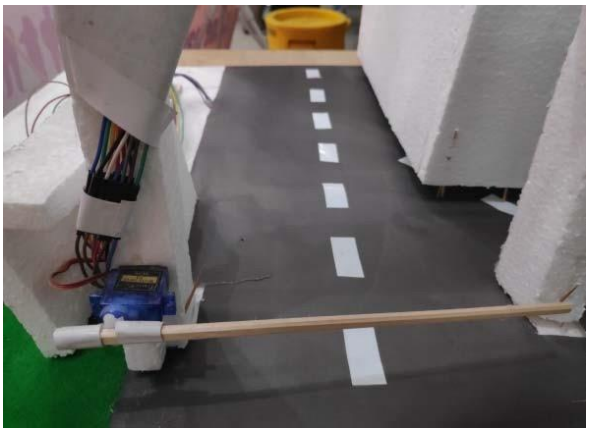

Fig. 3 Servo Motor as toll gate

Servo Motor: A servomotor is a rotary actuator or linear actuator enabling accurate angular or linear position, acceleration speed and control. It is an appropriate position feedback engine in combination with a sensor. Motor driver is an IC which is used to drive the motor. We also use it to pull up and down the toll square's passing door. It is an engine with 3-pin energy, cable control and hardware mounting. It is rotating at 180 degrees.

Fig. 4 LCD Display (16*2) on the Gate

*LCD Display (16*2):* An LCD is an electronic screen module that uses liquid crystal to create a visible picture. This 16x2 LCD display is a very fundamental module that is very frequently used in various systems and circuits. The job of LCD will be to display all the system generated messages coming from the controller. These modules in various sections are preferred over 7 sections and other LEDs. There are two registries in this LCD, Command and Data. The LCD command register primarily stores the instructions provided to the LCD while the information register allows the information to be displayed on the LCD.

IV. Experimental Setup

In our proposed model, we have built a suitable computerized Toll Collection System. The RFID implanted car number plate is allocated to the system. Our prototyped Digital Toll Plaza is made up with Arduino Mega, RFID reader, Display and servo motor for the Toll gate. We have used Arduino IDE programming language to run the system of our Toll plaza.

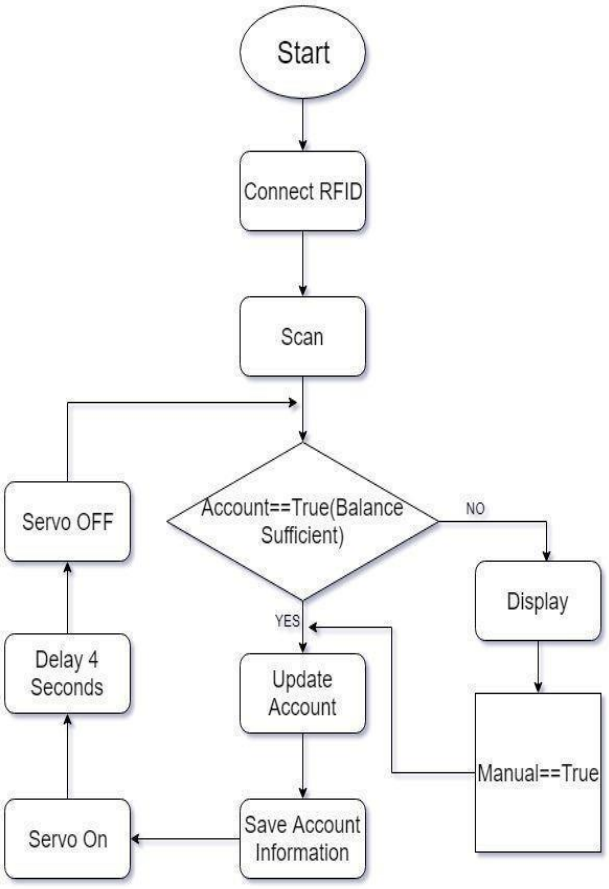

Fig. 5 Block Diagram of the System

We manually implanted the RFID tag in the demo car for vehicle information. We had scanned each RFID tag before implemented the project to know about the unique ID and stored it into the database of our system. In our prototype, we only included the RFID number and balance information in database. When the project will be implemented, there will be detailed information about the vehicle like weight, Model and tracking system of the vehicle. In the proposed model, the vehicle passes through the toll plaza and RFID reader reads theinformation about the balance of the vehicle with the help of RFID tag. If the vehicle has sufficient balance in its account, the toll money has been deducted and balance has been updated in database. After scanning, LCD Display shows the RFID number and the text "Go forward". Then, with the help of servo motor the toll gate opens for 4 seconds and it closes after that limited time.

If an unfortunate occurrence happens that the vehicle does not have sufficient money in its account, the toll gate will not open and display shows "Access Denied, go left". At left, there is a manual toll collection booth. The vehicle has to pay there and get updated the database with a warning to keep sufficient balance. Meanwhile, other car can pass the toll gate without making any traffic jam.

V. Conclusion and Future Direction

The proposed system can be used to develop a completely digital and smart toll collection system. In our country, manual toll plaza causes a lot of traffic. Besides, corruption in the toll plaza is an open secret. The proposed toll collection system can solve these problems efficiently. This RFID based tollcollection system mainly depends on the RFID tags and RFID sensors. As most of the number plate of vehicles in Bangladeshhas already been digitalized by government, Govt. can use the RFID tags of these number plates to detect the car and collect tolls without any need of stopping the vehicle. Information about the toll bill and account balances will be shared with the owners to ensure transparency in the toll collection. As a result,it will not only save the valuable time but also eliminate the corruption in the toll plaza.

Moreover, in future, additional features such as over speed detection and prevention, overload indication and prevention in bridge, tracking vehicle which is stolen or involved in any accident etc. can be added in the system which will make the transportation system smarter and more secured. Thus, the proposed model can contribute to build a digital and smart road transportation system.

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