Automated Toll Collection System With Advanced Security Features

An UndergraduateCAPSTONE Project
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Automated Toll Collection System With Advanced Security Features

A CAPSTONE Project submitted to the Faculty of Engineering, American International University - Bangladesh (AIUB) in partial fulfillment of the requirements for the degree of Bachelor of Science in theirmentioned respective programs.

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DECLARATION

This is to certify that this project **Automated Toll Collection System With Advanced Security Features** is our original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. Any material reproduced in this project has been properly acknowledged . AIUB reserves the right to reuse/update any proprietary material designed and developed for this work.

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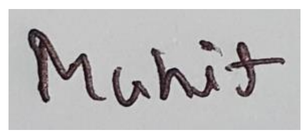

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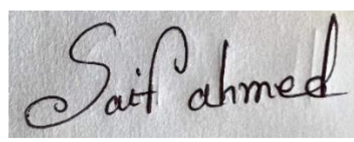

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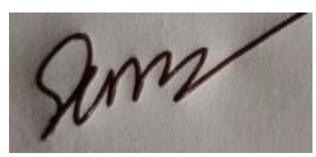

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APPROVAL

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Our daily lives are greatly impacted by automated processes, which also makes our lives easier. The number of automobiles using the road is growing daily, causing traffic congestion and a waste of human energy. Furthermore, Bangladesh's current manual toll collection system is unable to do this in a short amount of time. Therefore, we suggest an experimental strategy of operating a system concerned with a completely automated toll collection system employing radio Frequency identification (RFID) tags that is able to reduce human effort and time, and most crucially traffic jams, 24 hours a day, without interruption. The digital conversion of conventional collection practices into automated collection systems is the process of automating collections. Automating collections boosts earnings while also accelerating cash reserves, increasing productivity and customer happiness. Automating the gathering process entails putting the approach into practice. A new RFID-based automated toll collection system has been implemented in an effort to ease traffic and maintain process transparency. In order to collect tolls electronically, this article focuses on a system that uses RFID technology to identify a car. As a final flourish, weigh-in-motion is being added to the project. Total vehicle weights can be calculated using a weight sensor system as vehicles pass over a measurement site. This project uses an Arduino Uno, a circuit board, an RFID sensor, a servo motor, and other components to do it. Here, we'll collect tolls using two sensors set up in two distinct ways. The radio frequency identification reader is the first, and the weigh-in-motion is the second. It starts with developing an RF tag and code to specifically identify the vehicle, and then uses a weight sensor to determine the mass of the vehicle while it is moving. RFID tags use radio frequency technology to collect data and link identities with databases. After gathering the information, it will check to see if it has been put into its database. The trucks can move forward if the data matches what the server has. WIM systems use dynamic measurements of vehicle axle loads to estimate the corresponding static values as precisely as possible. The weight is determined as the wheel passes over the flexure of the bending plates, which span a void carved out of the pavement. These systems include weight sensors that are installed in the pavement perpendicular to the flow of traffic. They can each support a range of load sensors, including capacitive, fiber-optic, polymer, quartz, bending plate, and load sensors built from polymer. The standard systems, High Speed WIM and Low Speed WIM, builda load sensor. The three most common materials used to make load sensors are polymer, quartz, and bending plate. In each case, the sensors are hidden under the road's surface. The pavement helps to transmit the wheel force from the car to the sensor. An Arduino will then carry out a command depending on the sensor's output after the sensor has transmitted data to a database. Compared to the older mechanical ones, the electronic toll collection system has many advantages. This technique has numerous advantages for both individuals and the environment. Reduced toll booth wait times enhance traffic flow, lower noise levels around the booths, lower emissions of toxic gases, and contribute to a reduction in global warming. The toll cost were reduced, inspection control was strengthened thanks to centralized user accounts, capacity was raised without the need for new frameworks, and carrying cash was no longer necessary.

Chapter 1

INTRODUCTION

Access to reliable modes of transportation ranks high among the demands of modern society. Because our bodies are static from cradle to grave, it's impossible for us to access all of the basic goods and services without some form of transportation. By facilitating greater flexibility, facilitating greater commerce in processed goods and services, boosting employment opportunities, and facilitating greater social maneuvers ability, improved transportation systems contribute to a higher standard of living. Reliable ways to get around have always had a big effect on a country's economic success. As the population in Bangladesh and elsewhere has grown, so too has the demand for transportation. Traffic delays and accident rates are just two of the many issues caused by the proliferation of vehicles on the roads. People need a reliable traffic control system on the road, bridge, or tunnel for this. The proliferation of roadway networks has coincided with a corresponding rise in the number of toll roads built. When it comes to keeping traffic moving quickly and smoothly on the roads, toll booths are an absolute must.

Typically, tolls are collected at designated toll booths, where drivers must stop to manually accept cash or credit cards from drivers. Nevertheless, due to the need for extensive manual interference, processing times at such hubs are notoriously long. A large number of vehicles congregating in one area can be frustrating for drivers. Because drivers must stop to pay the toll, gather the change, and wait for the passageway to access, processing times cannot be significantly reduced. Traffic jams at toll plazas during rush hours causes drivers to sit in their cars for longer than necessary, waste gas, and potentially become violent.

The most common solution put forward so far to avoid these traffic jams has been the Automatic Toll Collection System. Thanks to automatic toll collection, a system of electronically collecting toll fees at regular intervals is now possible. This type of automatic toll collection system is necessary for all expressways, bridges, and tunnels, which is why it is the subject of extensive academic study. In order to avoid traffic congestion and keep the toll collection process open and honest, a new automated toll collection system has been implemented. The proposed system is meant to create a cashless and non-stop digital toll collection system for use on all types of toll roads, bridges, and tunnels. In order to collect tolls electronically, this article concentrates on a system that uses radio frequency identification (RFID) technology to uniquely identify a vehicle [1]. To top it all off, Weigh-In-Motion is being incorporated into the project. Total vehicle weights can be measured with a help of load cell system as vehicles drive over a specific place. Wheel weights and total vehicle weights are captured and recorded using weigh-in-motion (WIM) devices as vehicles pass over a weight sensor. Vehicle axle loads are measured dynamically by WIM systems, which then attempt to estimate the associated static values as accurately as feasible. The weight is determined as the tire passes across the tension or compression of the straining plates, which cross a space formed into the ground. Such systems incorporate wheel or axle load sensors perpendicular to the direction of traffic in the pavement, [2]. This category includes Constant Speed WIM, Mega WIM, and various-Sensor WIM systems. Any of these can hold various load sensors, such as fiber-optic, polymeric, quartz, flexing plate, capacitive, and resin load sensors[3]. Two load sensors make up the typical systems, which are known as fast speed WIM. The three most popular types of load sensors are constructed of polymer, quartz, and bending plate [4]. The sensors are buried in the road pavement in each instance. The pavement contributes to the transmission of the vehicle's wheel force to the sensor. The sensor will then transmit data to a database, and an Arduino will execute a command based on the sensor's output.

An Arduino Uno, a load cell amplifier, a circuit board, an RFID sensor, a servo motor and a Weigh-In-Motion sensor are all part of this project. The procedure involves generating a radio frequency (RF) tag and code to identify the vehicle, and then using a weigh-in-motion sensor to determine the vehicle's mass as it moves. Only drivers with sufficient funds in their accounts and vehicles that do not exceed weight limits set by authorities will be allowed to proceed.

The electronic toll collection system has numerous benefits over the previous analog ones. There are many ways in which this system benefits both people and the environment. It reduces wait times at toll booths, which in turn improves traffic flow, decreases noise levels in the vicinity of the booths, reduces emissions of harmful gases, and helps reduce global warming. Reduced toll payment costs, improved inspection control through centralized user accounts, increased capacity without adding new frameworks, and the elimination of the requirement to bring cash when paying tolls are all benefits of this system. It also aids law enforcement and security personnel in locating and apprehending evading vehicles.

1.1.Overture

The process of automating collections is the digital transition of traditional collections procedures into automated collections systems. Automating collections increases revenue, accelerates cash reserves, improves efficiency, and improves the customer satisfaction. To implement the strategy, collections automation involves digitizing the right procedure. In an effort to reduce gridlock and maintain transparency in the toll collection process, a new RFID-based automated toll collection system has been put in place. All forms of toll roads, bridges, and tunnels could benefit from the planned system, which aims to replace cash with a digital system that can operates whole day. This article focuses on a system that uses RFID technology to identify a vehicle as a means of electronic toll collection. Weigh-In-Motion is also being added into the project as a cherry on top [5]. With a weigh-in-motion system, total vehicle weights can be determined as cars pass over a measurement location. To do that an Arduino Uno, a load cell amplifier, a circuit board, an RFID sensor, and a servo motor are all part of this project. Here, we'll use two sensors in two different configurations to collect tolls. The first is the radio frequency identification reader, and the second is the Weigh-in-Motion. It begins with creating an RF tag and code to uniquely identify the vehicle, and continues with the use of a weigh-in-motion sensor to acquire the vehicle's mass in motion. The authorities will only allow drivers to go who have enough money in their accounts and whose cars do not exceed weight restrictions. Electronic toll collecting provides numerous benefits than mechanical. Both people and the environment gain from this arrangement. It minimizes wait times at toll booths, which improves traffic flow, reduces noise levels, and reduces greenhouse gas emissions. This system reduces toll payment expenses, improves inspection control through centralized user accounts, increases capacity without adding new frameworks, and eliminates cash toll payments. It also helps law enforcement and security find evasive automobiles.

1.2.Significance of the Project / Research Work

Modern world necessitates reliable transportation. Because our bodies are immobile from conception to death, we need transportation to get around. Improved transportation systems raise living standards by increasing flexibility, trade in processed goods and services, employment opportunities, and social maneuverability. Reliable transportation has traditionally boosted a country's economy. Population growth in Bangladesh and abroad has increased transportation needs. Vehicle proliferation causes traffic delays and accident rates. Roads, bridges, and tunnels need a reliable traffic control system. Increased road networks have led to more toll roads being created. Toll booths are essential for keeping traffic flowing smoothly. Tolls are usually collected at toll booths, where drivers must physically receive either money or credit cards. Due to manual intervention, hub processing times are infamously long. Congestion can be stressful for drivers. Because automobiles must stop to pay the toll, gather the change, and wait for passage, processing times cannot be decreased. Traffic bottlenecks at toll plazas during rush hours force vehicles to waste gas and grow aggressive [7]. To solve above problem we must need an efficient solution which is automatic toll collection system. It lessens the amount of time people have to wait in line at toll booths, which benefits traffic flow, decreases traffic noise, and cuts down on carbon dioxide emissions. This system removes cash toll payments, boosts capacity without adding additional frameworks, and decreases toll payment expenditures by centralizing user accounts for inspection control. It's also useful for security and law enforcement in tracking down fleeing vehicles.

1.3.Engineering Problem Statement

When you have a problem that can be solved by applying engineering principles and techniques, then got itself an engineering problem. There are a number of tricky problems that need fixing before this project can be completed successfully. An Arduino Uno, a load cell amplifier, a circuit board, an RFID sensor, a servo motor and a Weigh-In-Motion sensor are all part of this project. The project's fundamental methodology is shaped in such a way that the system can be deployed wherever and by everyone who requires it. The project's central idea is to employ Radio Frequency Identification tags to track down which cars have arrived at the toll, and then use that data to decide whether to let them through or not. The ATmega328 microprocessor on the Arduino board is crucial to the operation of the system. An RFID reader scans a tag worn by the car's owner. The microcontroller receives the tag ID upon scanning the tag, compares the identification to the identifier stored in the database, and then acts accordingly depending on the tag's condition. Here, writing Arduino code to manage the entire operation is the primary goal.

Which, with the aid of programming, can convert sensor data into an actionable command. To put it another way, this comprehensive effort represents the successful resolution of the Complex Engineering Problem.

1.4.Objective of this Work

This project's main purpose is to construct an automatic toll collection system. Modest design changes with optimal efficiency are suitable. By putting RFID tags on cars, the RFID-based toll system automates toll collection and reduces manual labor and long lines at toll plazas. The main purpose of this system are to do away with cash tolls, boost capacity without having extra infrastructure, and integrate user accounts for better inspection control. The project's other objectives are listed below:

1.4.1. Primary objectives

- RFID-based an automatic toll collection system has to be used to improve the efficiency.
- Develop the project with low of cost.
- Use a Weigh-In-Motion sensor to reduce road damage.
- Increasing vehicular traffic reduces congestion and reduces carbon dioxide emissions.
- Creating eco-friendly facilities.

1.4.2. Secondary Objectives

- It has froude controlling system.
- If any unauthorizeor over weight vehicle try to cross the toll plaza then it has spike to prevent it.
- Implementing a real-time tracking system would improve traffic management and monitoring for the toll authorities.
- It would be possible for toll authorities to collect tolls from buses and trucks without the requirement of manual labor by developing an automated toll collection system.

1.5.Comparison with Traditional Method

The traditional technique for collecting tolls involves stationary booths at which drivers must stop to manually accept cash or mobile banking from passing motorists. However, processing times at such hubs are notoriously long because of the need for extensive manual interference. A traffic jam occurs when a significant number of vehicles congregate in one location. Drivers cannot move quickly through the processing lanes because they must pause to pay the toll, collect the change, and wait for the gate to open. When rush hour traffic accumulates at toll booths, drivers waste gas, sit in their cars for longer than necessary, and may even resort to violence. Automatic toll collection is being implemented to counteract these issues. Automating collections boosts income, cash reserves, efficiency, and customer happiness. Automating collecting requires digitizing the correct technique. RFID-based automated toll collecting has been implemented to alleviate bottlenecks and ensure transparency. The projected system attempts to replace cash with a 24/7 digital toll collection system. This project is done by describes a toll collection system that employs RFID to identify vehicles. Weigh-In-Motion will complete the project. A weigh-in-motion system determines vehicle weights as cars pass a measurement site. This project includes an Arduino Uno, load cell amplifier, circuit board, RFID sensor, and servo motor. We'll collect tolls with two sensors in two combinations. First is the RFID reader, then Weigh-in-Motion. It starts with an RF tag and code to identify the vehicle, then uses a weigh-in-motion sensor to measure its mass in motion.

1.6. Organization of Book Chapters

Chapter-2: Literature Review with in-depth investigation

Chapter-3: Project Management

Chapter-4: Methodology and Modeling

Chapter-5: Implementation of Project

Chapter-6: Results Analysis & Critical Design Review

Chapter-7: Conclusion

Chapter 2

LITERATURE REVIEW WITH IN-DEPTH INVESTIGATION

2.1.Introduction

From a solitary barrier and a little entrance booth, the toll collecting system has evolved into the major investment it is today, playing an important part in the income generation and the smooth operation of the traffic of either a metropolis or a country. Traffic control has become an absolute necessity and a legal tool in a world where most people are always moving around.

Sachin Bhosale et al. explore RFID for automation toll roads. Radio Frequency Identification (RFID) RFID transmitter, RFID detector, and processing equipment make the whole system. The report examines RFID tags. Active and passive RFID tags exist. Battery-powered RFID tags are active. It powers the tag's electronics. Better detection and capacity. Battery-powered active tag sends a strong signal to the reader. Active RFID tags have a read range of 100 feet and a high sensing range. It enables electric-powered sensors.

The project's central idea is to employ Radio Frequency Identification tags to track down which cars have arrived at the toll, and then use that data to decide whether to let them through or not. Radio-frequency identification is also known as RFID. In its most basic form, an RFID system consists of a transmitter, a reader, and a device for processing the data. A Weigh-In-Motion is being incorporated into the project. It begins with creating an RF tag and code to uniquely identify the vehicle, and continues with the use of a weigh-in-motion sensor to acquire the vehicle's mass in motion. The authorities will only allow drivers to proceed who have enough money in their accounts and whose vehicles do not exceed weight restrictions.

The use of active RFID tag introduces some problems into the system. A major drawback of active RFID tags is that they require constant battery power to function, which drastically cuts into the tags' lifespans. To using a passive tag it would be solved.

The project's core concept is to use RFID tags to monitor which vehicles arrive at the toll and then use that information to determine whether or not to open the gates. Critical to the proper functioning of the system is the ATmega328 microprocessor found on the Arduino board. The owner of the car wears a tag that is read by an RFID reader. After scanning a tag, the microcontroller receives its unique identifier, which it then uses to cross-reference with its database entry and take appropriate action. The focus here is on using Arduino code to control the entire process. Which, with the help of code, can translate sensor readings into an actual directive. The Complex Engineering Problem has been effectively solved to this extensive work.

2.2.Related Research Works

There has already been far too much research done on the subject of automated toll collection systems. Today, the ETC system has been adopted on a global scale.It was in 1992 that studies on ETC first got underway, right around the time that RFID tags were being installed in cars all over the world in an effort to streamline the tolling process.

2.2.1. Earlier Research

ETC Pass is an electronic toll collection system that has been adopted by multiple states within the United States. Canada, Poland, the Philippines, Japan, and Singapore are just some of the several nations that have implemented the ETC system. In what follows, we'll talk about some of the real-world uses for ETC systems.

The Motor Transport Institute, along with Warsaw and Dublin universities, proposed Poland's ETC system. NATCS includes NATCC, control gates, and on-vehicle units (OBU). NATCS combines GPS and GSM (GPS). OBUs track a vehicle's location using GPS to identify how much more it's gone and how much it's paid on tolls, then transmit that data to the NATCS server farm[9]. Your car will be toll-charged from the highway's entrance to its exit. The system uses control gates with DSRC detectors and high-resolution cameras to read truck license plates. The above system's strong technical specifications make it expensive.

Since August 2000, the Philippines' ETC system has been operational on the South Luzon Expressway. The ETC is known as the E-PASS system, and it is powered by Transcore technology. In this setup, electronic transceivers are mounted in the back window[10]. When a car passes through a toll booth, the tag is scanned by a sensor, which then automatically determines the owner of the vehicle and deducts the appropriate toll money. The control gate will open and the car will be permitted to enter once the payment has been deducted.

A comparison of the above toll collection method with the proposed technology shows that the latter is more efficient.RFID tags will track which vehicles arrive at the toll and be used to open the gates. Arduino's ATmega328 microcontroller is crucial to system functionality. RFID reader reads the car owner's tag. The microcontroller utilizes the tag's unique identifier to cross-reference with its database and take action.

2.2.2. Recent Research

The Department of Computer Science & Engineering at BRAC University conducted a study in 2019[11]. The method used in that research to collect tolls electronically relies on radio-frequency identification (RFID) tags placed on each vehicle. Tags are attached to the digital license plates of automobiles, and the planned RFID system uses scanners to decipher the data contained within the tags. With this method, it is possible to reduce the requirement for toll collecting officials to hand out permits and collect tolls by hand. Documentation on toll payment may also be quickly transferred between vehicle owners and toll authorities. As a result, toll payment transparency may be ensured with less effort and fewer mistakes. This makes it less difficult to create intelligent transport networks.

Automated toll collection using an RFID sensor is another topic of study set in the year 2020. The RFID tags and RFID readers are the backbone of this toll collection system. To ensure honesty and openness in the toll collection process, information regarding the toll bill and account balances will be made available to the owners.This system also uses an optical camera equipped with Optical Character Recognition (OCR) to automatically read license plates from captured images[12].

Combining those above system, we will build a more efficient system by using RFID & Weighing in Motion sensors. We'll collect tolls with two sensors in two combinations. First is the RFID reader, then Weigh-in-Motion. It starts with an RF tag and code to identify the vehicle, then uses a weigh-in-motion sensor to measure its mass in motion. Then the pathway will open to proceed.

2.3. Validity and Accuracy of Existing Solution

In the previous method, there were some problems. In some systems, they use card punch systems. The vehicle has to be stopped to punch the card. It also wastes time and limits their ability to become more efficient. There are also some systems that provide a payment slip. To take this slip, the vehicle has to be stopped. This can also cause traffic jams during rush hour. So, to solve this problem, we designed a solution that can be more efficient without stopping the car and without taking any payment slip. To achieve this goal, we use RFID sensor antena, which is attached to the vehicle and has a range of 30 meters, so that without stopping the car, the toll taxes have been collected and given a passway. Moreover, this won't give any payment slip to prevent the wastes of time. It would collect the payment by using digital payment system. The idea behind this project is to use radio frequency identification tags to track which vehicles arrive at the toll and then use that data to determine whether or not to open the gates. The ATmega328 microprocessor housed in the Arduino board is essential to the system's operation. The car's owner wears a tag that can be read by an RFID reader. Following a tag scan, the microcontroller receives the tag's unique identifier, which it uses to look up the corresponding record in a database and take the necessary action. Here, we'll be looking at how to program an Arduino to handle the process from start to finish. Which, when programmed properly, can turn sensor data into an actual order.

2.4.Wide Range or Conflicting Research Works

There are many ways to collect toll taxes, but we have to choose the most efficient one. There are some ways to collect the toll, which will be discussed below.

Manned Tollbooth Systems**:** Toll booths on highways will have open/closed signs. Plan ahead for toll plaza congestion. Tollbooth attendants accept cash. After collecting payment, the operator presses a touch-screen button to raise a barrier and let drivers pass. When the operator clicks a button on the TPD-280 touch screen PLC, a relay from the M-7060 raises the barrier. Cash registers total toll booth cash. tDS-715 converts RS-485/serial data to Ethernet for Indusoft SCADA-running PCs.

Automated toll collection without a human attendant: Unattended, self-service automatic toll booths collect tolls on highway lanes. Pre-programmed VPD-143N Touch Screen Controllers display time-of-day. The VPD-143N delivers a signal to the M-7060 when a driver pays, opening the barrier via relay. Cash registers total toll booth cash. The tDS-715 serial to Ethernet device server converts RS-485/serial data to Ethernet for control and monitoring on a PC using Indusoft SCADA software.

Automated wireless toll booths:ZT-2052 ZigBee wireless Modbus data acquisition modules can be utilized in wireless tollbooth systems with motion detectors, cameras, a ZT-2570, and Indusoft SCADA operating on a PC. ZT-2052 zigbee wireless digital input data acquisition modules picture passing vehicles. Vision analysis software extracts license plate information and stores it with the vehicle's position, time, and a photo. Thanks to the ZT-2570 ZigBee host, the ZT-2052 can talk to a computer running Indusoft SCADA over Ethernet. The NS-205 Industrial Ethernet switch is needed to connect the computer to the ZT-2570 zigbee wireless host. Highway lanes are demarcated for automobiles with wireless transponders and credit card or debit payment accounts. So we are combining above all solution and prepare an efficient automated toll collection system with the help of RFID sensor and weigh-in-motion sensor.

2.5.Critical Engineering Specialist Knowledge

This project has many issues that must be resolved. This project includes an Arduino Uno, load cell amplifier, circuit board, RFID sensor, servo motor, and Weigh-In-Motion sensor. The project's underlying methodology makes the system deployable by anyone, anywhere. The project's main idea is to utilize RFID tags to track which automobiles arrive at the toll and decide whether to let them through. Arduino's ATmega328 microcontroller is essential to system operation. The car's owner's RFID tag is scanned. The microcontroller scans the tag, compares the ID to the database, and then acts based on the tag's status. To do Arduino work, we have to solve some programming languages in C. Data transmission and storage knowledge is also required. The main engineering problem that has been focused on in the project is to perform all operations within the least amount of time. To do that, we have to use a faster data transmission method to perform several micro-operations.

2.6.Stakeholders from Research Literatures

For facilities that are tolled under any of the tolling programs contained in the Safety, Accountable, Flexible, and Efficient Transportation Equity Act: An Impact for Users, the FHWA is creating a new part to the Code of Federal Regulations, contributing rules and regs indicating the interoperability requirements for automated toll collection systems. To be more specific, this rule says that authorized facilities must use ETC systems and try to work with other toll facilities as much as possible. Some stakeholders have also asked for an automated toll collecting system to do things like "speed up" the process of implementing an ETC system across the country.

Reduce increased costs and improve convenience for both toll customer perspective and toll facility owners or operators by taking into account the use of depreciation and amortization electronic technology that is connected to the same network in a reasonable physical region of road transport and the contingent liabilities electronic technology that is likely to be utilized in the next few years. We are trying to solve their existing requirement in this project by doing various type of steps.

2.7.Summary

With the proposed approach, an entirely digital and smart toll payment system is achievable. In our country, traffic is a major problem due to the prevalence of manual toll plazas. The toll plaza is also a hotbed of graft. These problems can be solved by the toll collection system that is being developed. Through the process of implementing "Automatic Toll Collection using RFID," the embedded console was used. This research used a novel microcontroller-based RFID & weigh-in-motion technology to accomplish this. When compared to computer and other electronic toll collection systems, automatic toll collection systems are both efficient and economical. This eliminates the need for manual work and speeds up travel on roadways. It also reduces the toll paying corruption.

Chapter 3

PROJECT MANAGEMENT

3.1.Introduction

Having access to dependable transportation is one of the main necessities of modern society. Because our bodies are stationary from birth to death, we need some form of transportation in order to access all of the necessities. Increased flexibility, increased commerce in processed goods and services, more job opportunities, and improved social maneuverability are all made possible by improved transportation infrastructure. The toll collection system has grown from a single barrier and a modest entrance booth to the substantial investment it is today, playing an important part in the revenue generation and the effective operation of traffic of either a city or a country. Traffic control is now both a required requirement and a legal tool in a culture where the majority of people are always on the go.An RFID transmitter, an RFID detector, and processing gear make up the overall system. The report examines RFID tags. Active or passive RFID tags are available. Batteries-powered RFID tags are in use. It powers the tag's electronics. enhanced detection and capacity. A strong signal is sent to the reader by active tags that are powered by batteries. Active RFID tags have a 100-foot read range and a high detection range. Electric-powered sensors are allowed.The main concept behind the initiative is to track which automobiles have arrived at the toll using Radio Frequency Identification tags, and then use that information to determine whether or not to let them through. RFID stands for radio-frequency identification. An RFID system's core components are a transmitter, a reader, and a device for data processing. The project involves including a Weigh-In-Motion. It starts with developing an RF tag and code to specifically identify the vehicle, and then uses a weigh-in-motion sensor to determine the mass of the vehicle while it is moving. Drivers who have enough money in their accounts and whose cars don't exceed weight limits will only be permitted to continue by the authorities.Initial project outcome analysis is crucial for making assumptions regarding the precise nature of future implementation and its impact. In this chapter, the project's effects will be briefly discussed.

3.2.S.W.O.T. Analysis of the Project

We require planning strategies for a project. One of the greatest strategic planning tools for a project to address weaknesses, lessen risks, and better utilize opportunities is the SWOT analysis. With the help of this study, we can assess the opportunities, dangers, andhow a job is finished. Setting the course for the project's future development in this way.

3.2.1. Strengths

In current history, Bangladesh has undertaken a number of efforts that support digitalization in an effort to keep up with current technology. Considering all current projects, the title project's greatest asset is that it can be made available to the majority of Bangladeshis. Being in a developing nation, the aforementioned initiative is not very well-liked by the general populace. The project's cost and efficacy have been given top consideration.With the suggested method, a fully computerized and intelligent toll collection system is feasible. Due to the ubiquity of manual toll booths, traffic is a significant issue in our nation. Graft is also rife at the toll booth. The toll collection system that is being designed can address these issues. The integrated console was utilized during the implementation of "Automatic Toll Collection utilizing RFID." To do this, this research employed cutting-edge microcontroller-based RFID & weigh-in-motion technologies. Automatic toll collecting systems are more efficient and affordable than computer and other electronic toll collection systems. This reduces the need for physical labor and expedites traffic on the roads. It also lessens corruption in toll collection.

3.2.2. Weaknesses

Despite its many advantages, this initiative also has significant drawbacks. Due to the fact that this project's primary functionalities depend on the sensors, it is occasionally possible that the sensors will have some issue. That is, an unanticipated delay in the sensors' responses may constitute a problem that may be seen. Again, as there are numerous sensors connected to one another, the wiring of the sensors will be a major consideration.

3.2.3. Opportunities

By designing the PCB unit with VLSI technology, the research can be improved even more. The system becomes even more compact as a result. By utilizing location-based payment systems, the payment system can be enhanced in the future. That indicates that a vehicle owner can pay the toll before showing up at the toll both. This largely cuts down on time.

3.2.4. Threats

Any breakdown of a segment, module, or internal link has the potential to be detrimental. If even one sensor in this entire system failed, the toll collection system would be rendered ineffectual. It takes awhile to repair the complete system. Furthermore, if any vehicles collide with the toll system, the entire system will fail and must be rebuilt.

Schedule Management

This part the Implemented business tools to take the management decisions to solve the complex problem.

Table 3.1: Schedule Management

Tasks															Status
Orientation	16th April 2022														Completed
Topic searching and selection		1st may													Completed
Draft Project Proposal submission to Supervisor															Completed
Online Proposal Submission				9th may											Completed
Background Research of Proposal Topic															**Completed**
Progress report writing															**Completed**
Draft Progress report and Chapter 1 & 2 Submission to Supervisor															**Completed**
Online Progress Report and Chapter 1 & 2 Submission							11th aug 2022								**Completed**
Progress Defense								8th sep 2022							**Completed**
Final model implementation															**Completed**
Project book writing															**Completed**
Draft Project Book Submission															**Completed**
Draft Project Book Submission to External															Pending
Modifications															Pending
Submission of Final Book , Plagiarism Report & Summery to Supervisor														13th dec'22		Pending
Final defense															5th January 2023	Pending

3.3.Cost Analysis

Depending on our projected estimates of the project's overall costs and the final implementation costs, which are shown in the table. The following is an approximate list of the materials needed to finish this project.

Table 3.2: Cost analysis

Sl No	Equipment name	Quantity	Estimated cost per unit	Final cost per unit (BDT)	Total Final cost (BDT)
01	Arduino Uno	01	1200	1150	1150
02	9v Battery	02	45	45	90
03	LCD Display	01	400	500	500
04	RFID Sensor	02	260	250	500
05	Weigh in motion sensor	01	600	600	600
06	IR Obstacle Avoidance Module	01	100	100	100
07	Servo motor	02	300	350	700
08	PCB board	01	400	350	350
09	Resistor	10	1	1.5	15
10	Connecting cable	35	4	3	105
11	prototype	2	200	200	400
12	Other				300
	Total cost		3,510/-	3,549.5/-	4,810/-

3.4.P.E.S.T. Analysis

PEST Analysis is a tool for appraising global market for a certain company or industry over a particular amount of time. PEST stands for Democratic, Financial, Ethical, and Innovation elements. It's indeed similar to a SWOT (Strengths, Weaknesses, Opportunities, and Threats) study.

3.4.1. Political Analysis

In recent years, the Bangladeshi government has raised its allowances in an effort to improve digitalization. In order to reduce traffic congestion in the city, government authorities emphasized the urgent necessity for the installation of integrated electronic toll collecting systems on the Mayor Hanif Flyover, the Dhaka-Mawa-Bhanga highway, and the Padma Bridge. According to officials, drivers using the electronic toll collecting system will have to use toll cards and active RFIDs on their vehicles in order to pay tolls without stopping. On July 17, 2022, the PMO established a committee to make recommendations for reducing traffic congestion at the toll booths for the Mayor Mohammad Hanif flyover, the Dhaka-Mawa-Bhanga Expressway, and the Padma Multipurpose Bridge[13].

3.4.2. Economic Analysis

This concept is one that is financially sound. The cost of the sensors and other electronic components is reasonable. The local markets have them readily available as well. Once more, the technology we use is not all that pricey. Therefore, it is a technology that is affordable and accessible to the general public.

3.4.3. Social Analysis

There were several issues with the old approach. They employ card punch technologies in various systems. Punching the card requires stopping the car. Additionally, it consumes time and prevents them from being more productive. Additionally, some systems include a payment slip. The car needs to be stopped in order to take this slip. Additionally, this may result in gridlock during rush hour. So, in order to address this issue, we created a system that can be more effective without requiring the driver to stop the vehicle or provide a receipt. To accomplish this, we use an RFID sensor antena that is mounted to the vehicle and has a range of 30 meters. This allows us to collect and grant a passway without having to stop the vehicle. To avoid time wastage, this won't even provide a payment slip. It would use a digital payment method to collect the money. The purpose of this project is to track which vehicles arrive at the toll using radio frequency identification tags, and then utilize that information to decide whether or not to open the gates. The Arduino board's ATmega328 microcontroller is crucial to the system's functionality. An RFID reader can read the tag that the car's owner is wearing.

3.4.4. Technological Analysis

The purpose of the project activity is to provide solutions to the fundamental issues that people encounter on a daily basis. The addition of several cutting-edge sensors that will increase its effectiveness and efficiency is one of the work's most notable technical aspects. However, the proposed project can be employed in more areas if more advanced sensors are used, as they will have a shorter delay time and greater accuracy.

3.5.Professional Responsibilities

A valuable and knowledgeable profession, engineering. As people on this forum, engineers are expected to maintain the highest level of trustworthiness. Technology has a visible and major impact on everyone's level of well-being. As both a conclusion, engineers need to provide the solutions with transparency, impartiality, justice, and inequality, and they must be committed to bringing the general welfare, security, and prosperity. Engineers are obliged to an ethical code that requires them to adhere to the highest ethical norms. Only as consequence, the major topics we discussed above are persons' entitlements, safety, and ethics. All of these goods were created as part of our project. It might save time, curb corruption, and increase public safety by using an autonomous toll payment system.

3.5.1. Norms of Engineering Practice

The engineers adhered strictly to the IEEE Code of Ethics. The initial one of the ten codes of ethics was mainly adhered to while collaborating on the project. "Must consider preeminent the safety, health, and wellbeing of the society, to seek to abide by ethical design and environmentally-friendly approaches, to respect the privacy of others, and to expose rapidly circumstances that might jeopardize the citizens or the climate," the first code of ethics reads. Following the law it shortens the lines at toll booths, enhancing traffic flow, lowering noise levels near the booths, and reducing carbon dioxide emissions. This is the safety & health issue has been followed. Benefits of this system include decreased toll payment costs, enhanced inspection control through centralized user accounts, expanded capacity without introducing additional frameworks, and the removal of the need for carrying currency when paying tolls. It also helps security and law enforcement agents find and capture escaping automobiles. As public wellbeing followed.

3.5.2. Individual Responsibilities

Each effort can yield positive results unless the team effort is appropriately handled. As accomplish the objectives in a collaboration, each member must understand their share of the burden. There have 4 teammates in our research team, and each one contributed their distinctive leadership style to a particular section of the work because the project needs to be broken down into numerous components to be successful. To ensure that the work rise apart, adequate preparation had to be done right away, including coming up with project ideas, discussing them in meetings, preparing and studying books, looking out information for essential book templates, organizing books correctly, verifying for copyright, and fixing mistakes. The following is a list of each mentor's unique duties, along with their leadership and equally significant performance duties:

I am Md. Muhit Alam Khan, order to develop the project proposal, I had to evaluate how we would carry out the project and create an appropriate schedule and strategy. I worked with the other teammates to create a block diagram and system flow chart about the progress report. The chapters in this research book were authored by me. I had to do a lot of research in order to get ready to write those chapters. The literature review was completed by me. I had to study roughly 12–18 academic papers and five or more articles in order to complete the works for the chronological context and scholarly evaluation. I had to research earlier writings associated with our project work and extract the relevant data and concepts to improve the writing. The hardest and toughest element of reading and comprehending the entire concept was the fact required so much effort. Just ought to research and envision this research project for approximately seven days. I spent hours reading through various articles and papers. The process of studying, gathering material, adding it to my writing area, and repeating the procedure was then ongoing.

I am Saif Ahmed, I have been deeply engaged in the project's many activities, beginning with the hunt for capstone project research. Our inspiring leader assigned each of us a portion of the research project. I developed the power point slide for the project's progress defense. Additionally, I contributed to this project's fourth chapter and some of chapters Five and six. I also assisted my group mates in preparing the project's chapter two critical analysis and previous research. Along with completing the project software and hardware task for this project, I also assisted my group members in delivering good presentation. Overall, I worked together with my group members on various tasks and voiced my viewpoint when important project decisions were being made.

I am Mahbub Morshed Sumon**,**I participated in a variety of our project's responsibilities. Certain project proposal aspects were written by me. I also contributed to the project's creation and idea. I spent time developing special features that may be incorporated to our project. I contributed a few chapters to the thesis book as well. Particularly the beginning of chapters one & two. I had to commit a lot of reading and comprehension time to those chapters' first and second preparation sections. I also wrote the entirety of chapter seven, where the difficult part was analyzing the potential future directions and project constraints. Along with the aforementioned activities, I also helped with survey question preparation and survey administration among the general public. Last but not least, I provided my team members with various solutions at various trying times so that we could effectively complete this research.

I am Rahmatul Sakib Dion**,** I assisted my group colleagues in creating the project's block diagram and flow chart. During a team meeting, our group as a whole was instructed to carry out several work activities. The project's modeling and simulation work was mine to complete. I created the project's progress report. Throughout the proposal report, I included the project's objective. I finished the result analysis and conclusion section. I also assisted our group member with the creation of the last defense presentation slide. I greatly assist them on the hardware implementation.

I truly assist with the setting up and controlling of RFID. Along with them, I helped them make improvements in the project book.

3.6.Management principles and economic models

All through the task, all managerial and economic principles are observed. Various management principles were applied while working on the project. Several of the project management techniques based on a conceptual system was S.W.O.T analysis. The project also uses a Chart calculator to determine the project's proper timeline, and prophase is another project management principle. Since this is a collective project, everyone in the participants have contributed to it, and the personal obligations part of this chapter details each member's effort.

The research also incorporates economic systems like P.E.S.T analysis, that concentrates on the effects of politics, economics, social issues, and technology on the work to assess its viability when established. This chapter's cost analysis section, which goes through the costing of the system's components and uses standard deviation calculations, is the other aspect of economic framework which was used in the above book.

3.7.Summary

In a nutshell, this chapter focused on the project's management and some of the elements that made it a workable endeavor. The two main analyses performed on the project work to ensure that it has a purpose are S.W.O.T. and P.E.S.T. Still, not many of these turn from computer simulation to reality. Cost comparison, scheduling management, and individual group member contributions are all covered in this chapter. This chapter focuses primarily on systemic design. The book's next section will offer a detailed explanation of project work.

Chapter 4

METHODOLOGY AND MODELING

4.1.Introduction

Introduce the basic engineering theories and methods that were used or implemented in the project.Finding fresh perspectives, original ideas, and improved solutions to the difficulties we face every day are all examples of new creation. The toll collection system has developed from a single barrier and a small entrance booth into the significant investment it is today, playing a significant role in the income creation and the efficient management of traffic of either a city or a country. In a society where most people are constantly on the go, traffic control has become both a necessary requirement and a legal tool. The main concept behind the initiative is to track which automobiles have arrived at the toll using Radio Frequency Identification tags, and then use that information to determine whether or not to let them through. RFID stands for radio-frequency identification. An RFID system's core components are a transmitter, a reader, and a device for data processing. The project involves including a Weigh-In-Motion. It starts with developing an RF tag and code to specifically identify the vehicle, and then uses a weigh-in-motion sensor to determine the mass of the vehicle while it is moving.There, we'll talk briefly about the project's schematic and flowchart. This section will also cover the simulation process and the software that is used to do simulations. The results of the simulation are going to be shown in this chapter.

4.2.Block Diagram and Working Principle

System Block Diagram

This block diagram contains Backup Controller and database, Account of all the users, An LED display for information showing, servo motor which is connected with the system to control the gate of the toll plaza, Potential influence on traffic condition. There is a weight measurement system to measure the weight of the vehicle. Also including test and check specification system for Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor. All those systems are including together of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor system.The weight of the vehicle in motion at the time of toll collection is determined using a weigh-in-motion sensor. As shown in Fig. 3, this sensor is included into the pavement or road at the toll plaza entry.

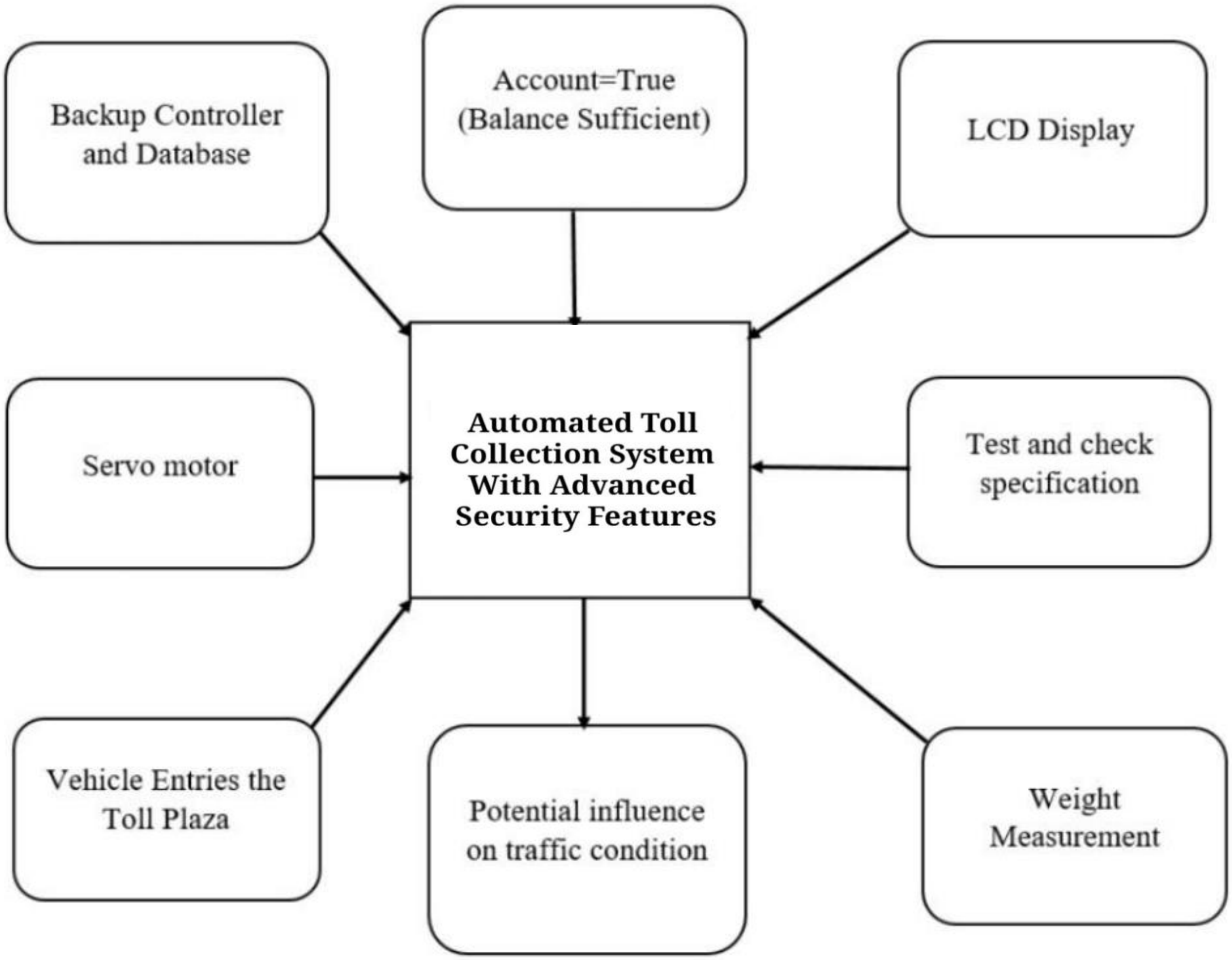


Figure 4.1: Block Diagram of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor

Wheel loads, axle loads, and gross vehicle weights are among the traffic loading data that WIM collects (GVW). Every time a vehicle crosses in front of a WIM sensor, these data might be reported. Systems for vehicle verification and toll pricing-

After acquiring the vehicle database, it is searched for the information regarding the car's registration information. The following activities are completed using the current weight(obtained from the WIM sensor system) and the vehicle registration information (retrieved from the cars database):

- A vehicle is overloaded if its present weight exceeds its GVWR (gross vehicle weight rating). These cars shouldn't be used for daily transportation.
- Verification of car registration and insurance: Only vehicles with current registration and insurance documents should be permitted to travel on public highways.

- Vehicle Toll Pricing: The weight of the vehicle is used to determine the vehicle's toll price.

Price Reduction and Toll Decision

The After the car's information has been properly confirmed, the computed toll fee is transferred to the systems for deduction from the process transactions accounts linked to the active RFID of the automobile. Usually toll barrier is not opened until a human check by a toll assessor has been performed, unless the vehicle is overloaded or the verification process was failed and authorities even at toll plaza have been alerted about the flaws in the vessel's certification.

System Flow Chart

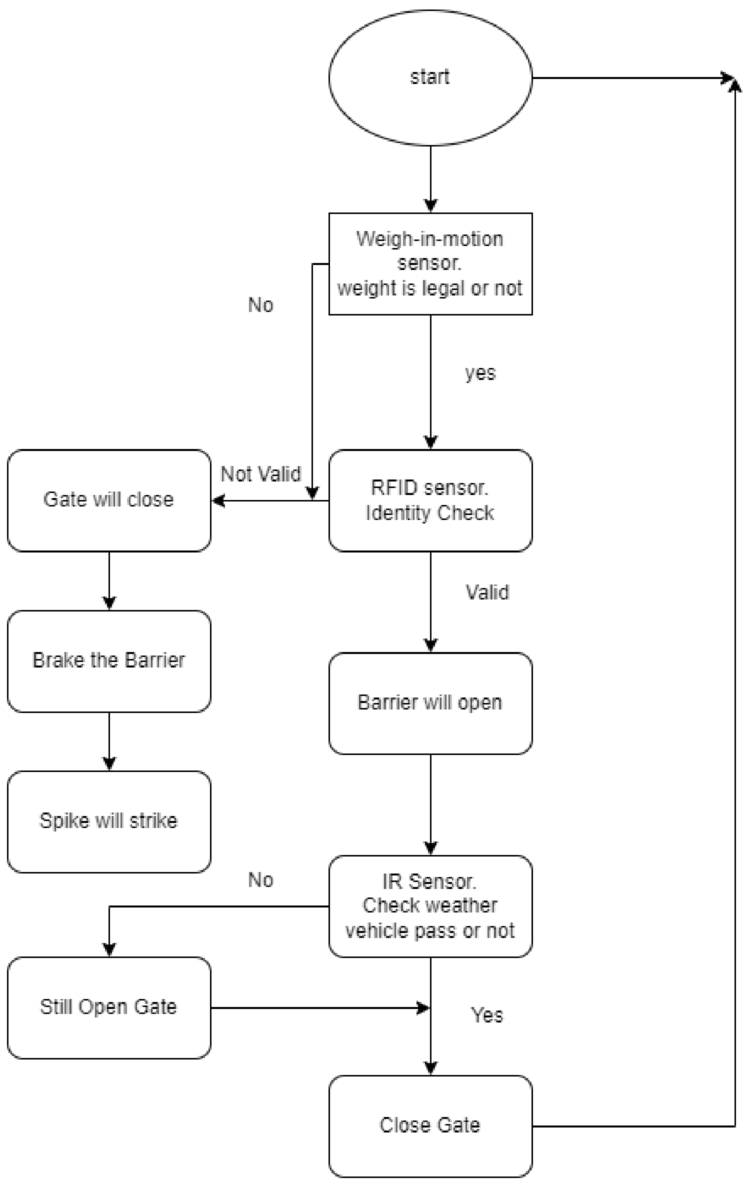


Figure 4.2: System Flow Chart

Arduino Code

```
#include <HX711_ADC.h>
#include <Wire.h>
 #include <LiquidCrystal_I2C.h>
#include <Servo.h>
#include <SPI.h>
#include <MFRC522.h>
#define RST_PIN 9
#define SS_PIN 10
#define SERVO_PIN 6
#define SERVO_PIN1 5
#define IR_PIN 4
#define CLOSE_DOOR 0
#define OPEN_DOOR 90
long sample = 0;
float val = 0;
long count = 0;
String uidString, name, ps; HX711_ADC LoadCell(2, 3);
LiquidCrystal_I2C lcd(0x27, 20, 4);
MFRC522 mfrc522(SS_PIN, RST_PIN);
Servo myServo; Servo myServo1;
void setup()
{ Serial.begin(9600);
pinMode(IR_PIN, INPUT_PULLUP);
lcd.init();
lcd.backlight();
```

```
lcd.print(" Weight ");
lcd.setCursor(0, 1);
lcd.print(" Measurement ");
LoadCell.begin();
oadCell.start(1000);
SPI.begin();
mfrc522.PCD_Init();
mfrc522.PCD_DumpVersionToSerial();
myServo1.attach(SERVO_PIN1);
myServo1.write(90);
myServo.attach(SERVO_PIN);
myServo.write(CLOSE_DOOR);
lcd.clear();
lcd.setCursor(5, 1);
lcd.print("TOLL PLAZA");
lcd.setCursor(2, 2);
lcd.print("Waiting For Car");
}
void loop()
{
LoadCell.update();
// retrieves data from the load cell if ( ! mfrc522.PICC_IsNewCardPresent())
{
LoadCell.update();// retrieves data from the load cell return;
 }
// Select one of the cards if ( ! mfrc522.PICC_ReadCardSerial())
{ LoadCell.update(); // retrieves data from the load cell return;
}
```

```
String content = "";
byte letter;
for (byte i = 0; i< mfrc522.uid.size; i++)
{
content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? "-0" : "-"));
content.concat(String(mfrc522.uid.uidByte[i], HEX)); }
}
// Serial.println();
content.toUpperCase();
uidString = content.substring(1);
Serial.print("Tag UID: ");
Serial.println(uidString);
count = LoadCell.getData();
float weight = LoadCell.getData();
weight = (weight / 1000);
if (weight < 0) { weight = weight * -1; } float tk;
if (uidString == "43-85-3E-0F") { if (weight <= 0.2) { lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Access Ganted..");
lcd.setCursor(0, 1);
lcd.print("ID : ");
lcd.print(uidString);
lcd.setCursor(0, 2);
lcd.print("Weight: ");
lcd.print(weight);
lcd.print("KG");
myServo.write(OPEN_DOOR);
while (1) { if (digitalRead(IR_PIN) == 0) { myServo.write(CLOSE_DOOR);
```

```
lcd.clear();
lcd.setCursor(5, 1);
lcd.print("TOLL PLAZA");
lcd.setCursor(2, 2);
lcd.print("Waiting For Car");
break;
} } }
else {
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Access Denied");
lcd.setCursor(0, 1);
lcd.print("Over Weight");
for (int pp = 0; pp < 4000; pp++)
{ if (digitalRead(IR_PIN) == 0) {
myServo1.write(0);
}
delay(1);
}
lcd.clear();
lcd.setCursor(5, 1);
lcd.print("TOLL PLAZA");
lcd.setCursor(2, 2);
lcd.print("Waiting For Car");
} }
else { Serial.println("Access Denied");
lcd.clear();
lcd.setCursor(0, 0);
```

```
lcd.print("Access Denied");
for (int pp = 0; pp < 4000; pp++) {
if (digitalRead(IR_PIN) == 0) {
myServo1.write(0);
}
delay(1);
}
cd.clear();
lcd.setCursor(5, 1);
lcd.print("TOLL PLAZA");
lcd.setCursor(2, 2);
lcd.print("Waiting For Car");
 }
}
```

4.3.Modeling

3D Modeling Design:

Figure 4.3: Automated toll collection system

Figure 4.4: RFID Reader scanning the RFID Tag

Figure 4.5: Weight measuring using Weigh-in-motion Sensor.

4.4.Summary

Throughout summary, the above chapter has covered the system modeling methodology. In other words, the simulation and hardware model both started with a schemes diagram that included all the parts and functionalities. This chapter primarily focuses on the gap structure technique together with the block diagram, flowchart, and simulation component. The above chapter's objective was to demonstrate the project's operating analytical approach. Further through examination of the system block diagram and flow chart, researchers have demonstrated that. Towards the following chapter, both the hardware model and the simulation are displayed and discussed.

Chapter 5

PROJECT IMPLEMENTATION

5.1. Introduction

RFID (radio-frequency identification) and Weigh-In-Motion (WIM) sensors are the foundation of the Electronic Toll Collection (ETC) system. The vehicle's license plate number and other information are recorded using the RFID sensor. The weight of the vehicle is determined using the WIM sensor. The RFID reader records the license plate number and other information from the car as it passes through the toll booth. A central server then receives this data, verifies the information, and determines the toll fees. The toll fees are automatically taken out of the driver's account if it is active. If not, the driver must manually pay the toll fees. The WIM sensor determines the vehicle's weight after it has been recognized. The necessary toll costs are subsequently calculated using this information and submitted to the central server. Once the calculations are complete, the fees are either taken out of the driver's account or they must be paid directly by the driver. The ETC system's employment of both RFID and WIM sensors provides precision and effectiveness in toll collecting. It also lessens the requirement for manual.

5.2. Required Tools and Components

The Electronic Toll Collection (ETC) system is an automated system that collects tolls from moving cars through toll plazas using RFID and Weigh-In-Motion (WIM) sensors. Drivers won't have to stop or pay the toll thanks to this system. The system's various hardware and software components enable it to collect tolls precisely and safely. The appropriate hardware and software tools are necessary to guarantee that the system operates correctly and dependably. This part will talk about the various hardware and software requirements for an RFID and WIM sensor-based electronic toll collection system in this project.

Software Tools:

1. Database Management System (DBMS): A database management system is used to store and manage the data generated from the RFID and weigh in motion sensors. The DBMS can store data related to vehicle identification, toll payment amount, time and date of passage, etc.
2. Application Software: An application software is used to process the data collected from the sensors. This software is responsible for the calculations, such as calculating the toll fee, etc.
3. Web interface: A web interface is used to provide a user-friendly interface to the system. Through this interface, users can access the system, view their toll payment history, etc.
4. Operating System: An operating system is used to provide an environment in which the software components can run.

Hardware Components:

1. RFID Sensor: An RFID sensor is used to read the RFID tags attached to vehicles. This sensor is used to identify the vehicle and collect information such as the vehicle type, etc.
2. Weigh-in-Motion Sensor: A weigh-in-motion sensor is used to measure the weight of the vehicle while it is in motion. This sensor is used to calculate the toll fees based on the weight. Using a load cell for Weigh-in-Motion Sensor is a transducer that changes force into an electrical output that can be measured. This strain gauge-style straight bar load cell may translate force (pressure) into an electrical signal. The electrical resistance that varies in reaction to and proportional to the strain (such as pressure or force) applied to the bar can be measured by each load cell. Strain gauges have typically been mounted on a spring element that makes up load cells. Typically, the spring component is constructed of steel or aluminum. As a result, it is both incredibly strong and very slightly elastic. The steel deforms somewhat under load, as suggested by the term "spring element," before returning to its initial position and responding elastically to each load.
3. Micro - controller board: The Arduino Uno microcontroller module is based on either the ATmega328P. It features a 16 MHz ceramic resonator, six analog inputs, fourteen digital input/output pins (six of which can be used as PWM outputs), a Power adapter, a power jack, an Invention relates, and a backspace button [1]. It includes with everything necessary to run the microprocessor; to get initiated, simply plug it to a cable that connects, or power it using an Inverter conversion or battery [1]. Anyone can innovate with the Uno sans fear of making a mistake; in the worst-case scenario, users can bypass the microchip for several bucks and continue again [1].
4. Lcd Screen: LCD stands for display technology [2]. It is a form of technology digital display that is used in a variety of interconnects and consumer electronic devices, calculators, computer systems, televisions, and other gadgets [2]. Such devices are typically used with seven-segment and tri light-emitting transistors [2]. Among key benefits of using this controller are its least expensive, flexibility of coding, movements, and limitless potential to display customisable symbols, creative sequences, and so much more [2]. Detector for Rfid chips: A tracking system is used to read the tracking number on the Rfid readers [2].
5. A servo motor is a type of electric motor that operates as a mechanical system and provides for exact control of angular velocity, orientation, and momentum [3]. This high current (DC) motor, as the title implies, is a form of electrochemical motor that transfers electrical energy in the form of dc current (DC) into rotary motion [3].

5.3.Implemented Models

Electronic Toll Collection (ETC) systems detect automobiles as they pass through toll plazas using RFID (Radio Frequency Identification) sensors. These sensors locate and save the vehicle's unique identifying number, which is then used to deduct the appropriate sum of money from the account or credit card of the vehicle owner. ETC systems also include weigh-in-motion (WIM) sensors to determine the vehicle weight as it passes through toll booths. This aids in determining the proper toll charges for bigger vehicles like trucks. A secure and effective method of collecting tolls is provided by RFID and WIM sensors working together.

5.3.1. Simulation Model

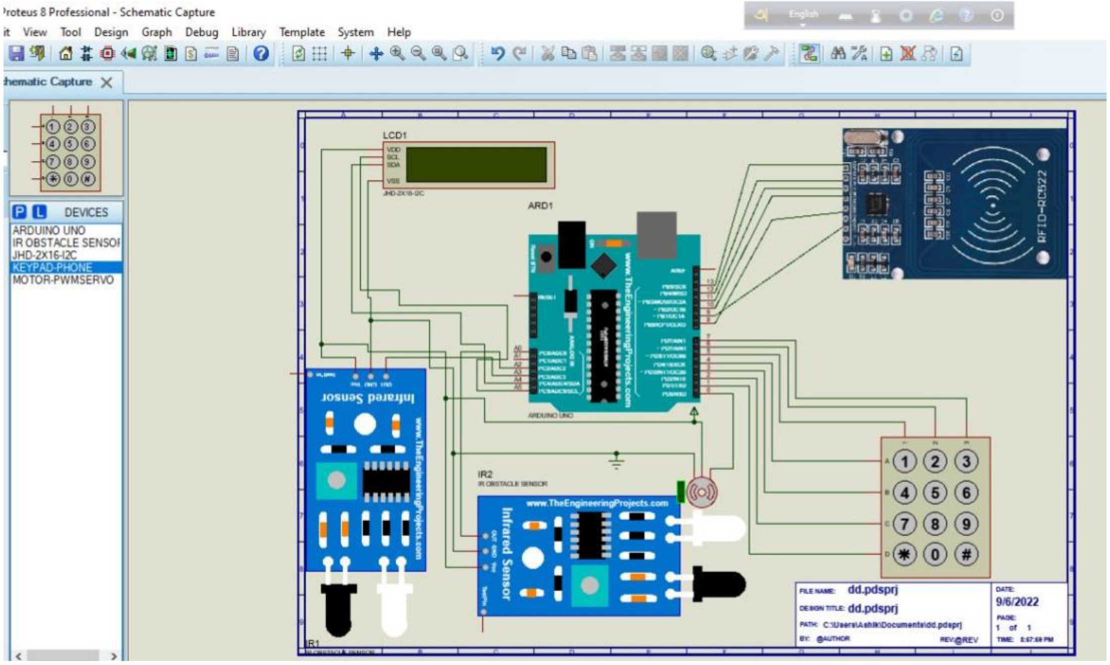


Figure 5.1: Simulation Circuit of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor

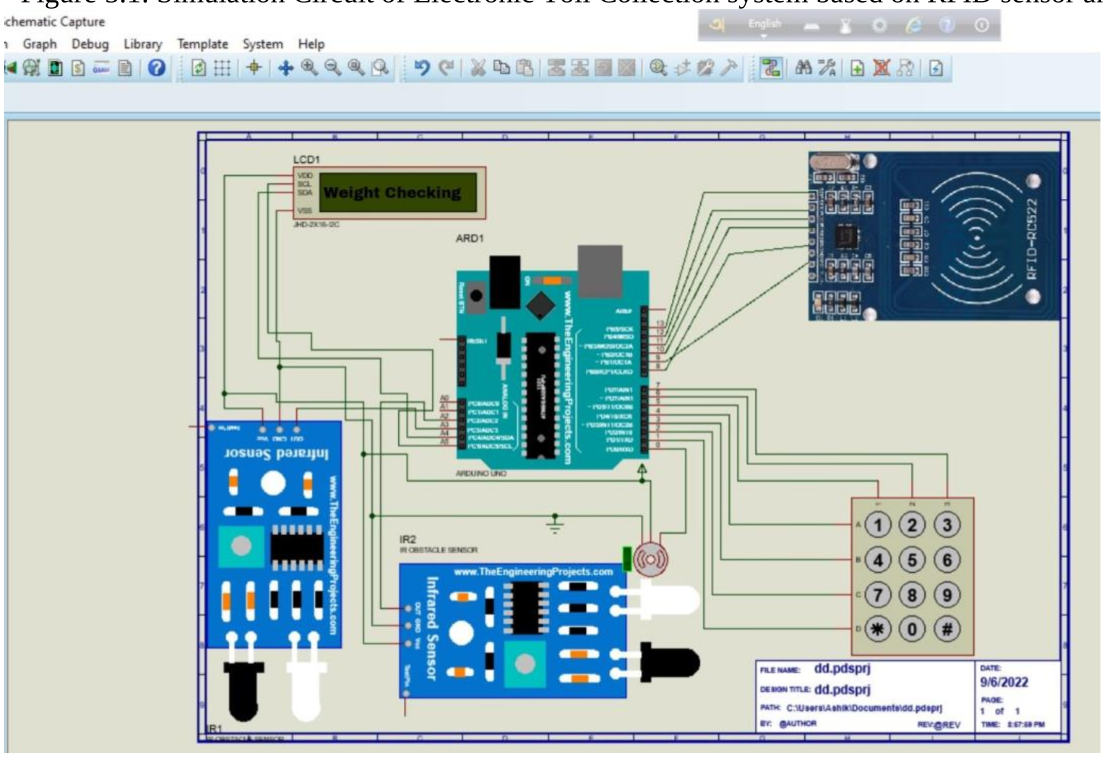


Figure 5.2: Weight Check of Electronic Toll Collection system based on RFID sensor andWeigh-In-Motion sensor

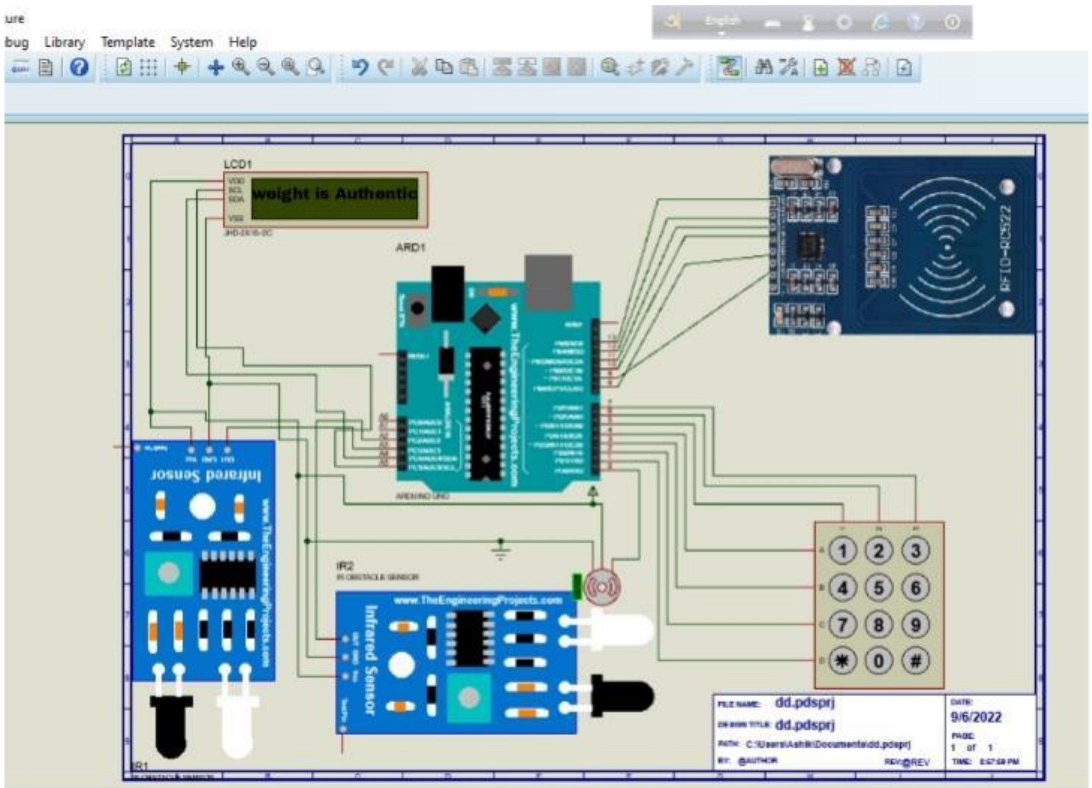


Figure 5.3: Weight Authentication of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor

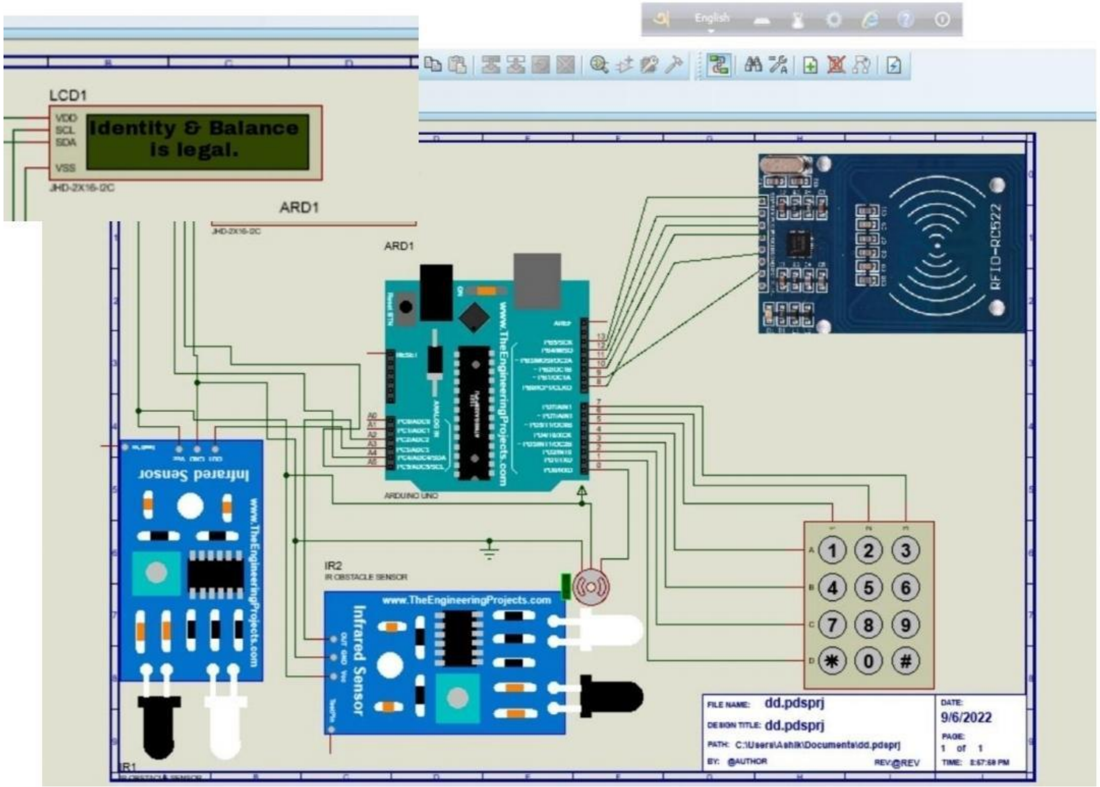


Figure 5.4: Identity Verification of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor

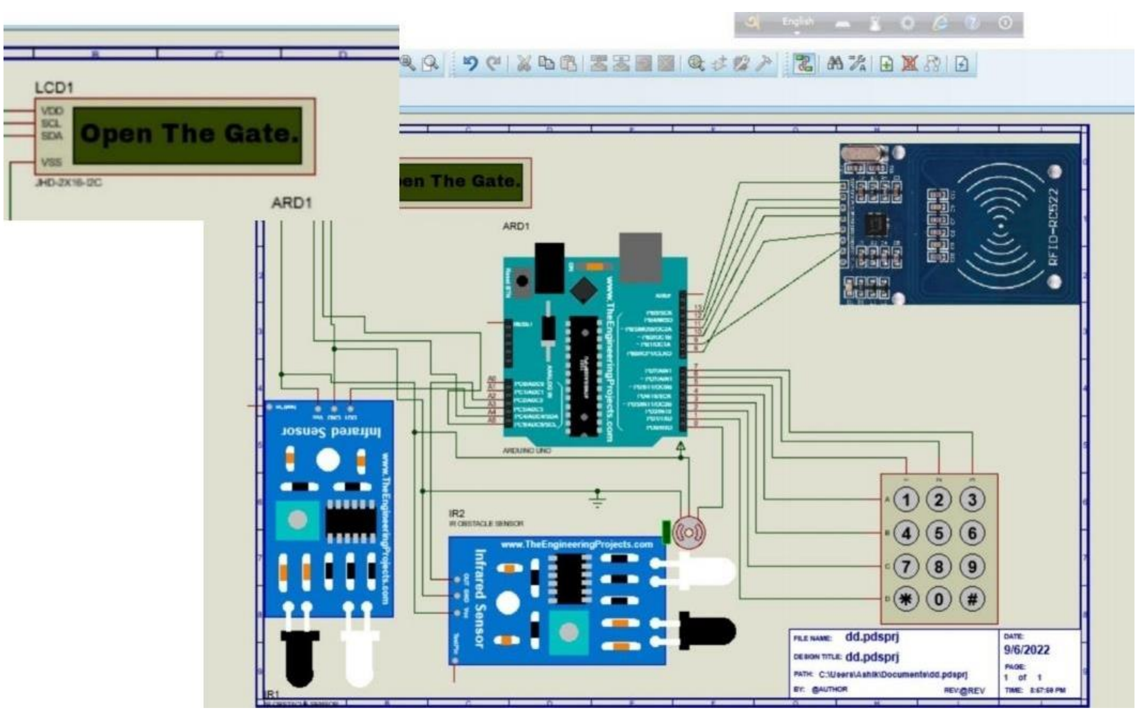


Figure5.5: Opening the get of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor

This simulation modal contains different components like a microprocessor, LED display, RFID sensor, Weight Authentication sensor, different motors for get control.

In figure 5.1 it shows the Simulation Circuit of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor.

First The Weigh-In-Motion (WIM) sensor is used to measure the weight of the vehicles as they pass over it. It consists of a load cell, an amplifier and an analog-to-digital converter (ADC). Then The data processing unit is used to process the data collected from the RFID reader and the WIM sensor. It consists of a microcontroller, a memory, and a communication interface. To figure out the weight by using weight sensor which has been shown in figure 5.2. If the weight is authenticated than the next step will be provided.

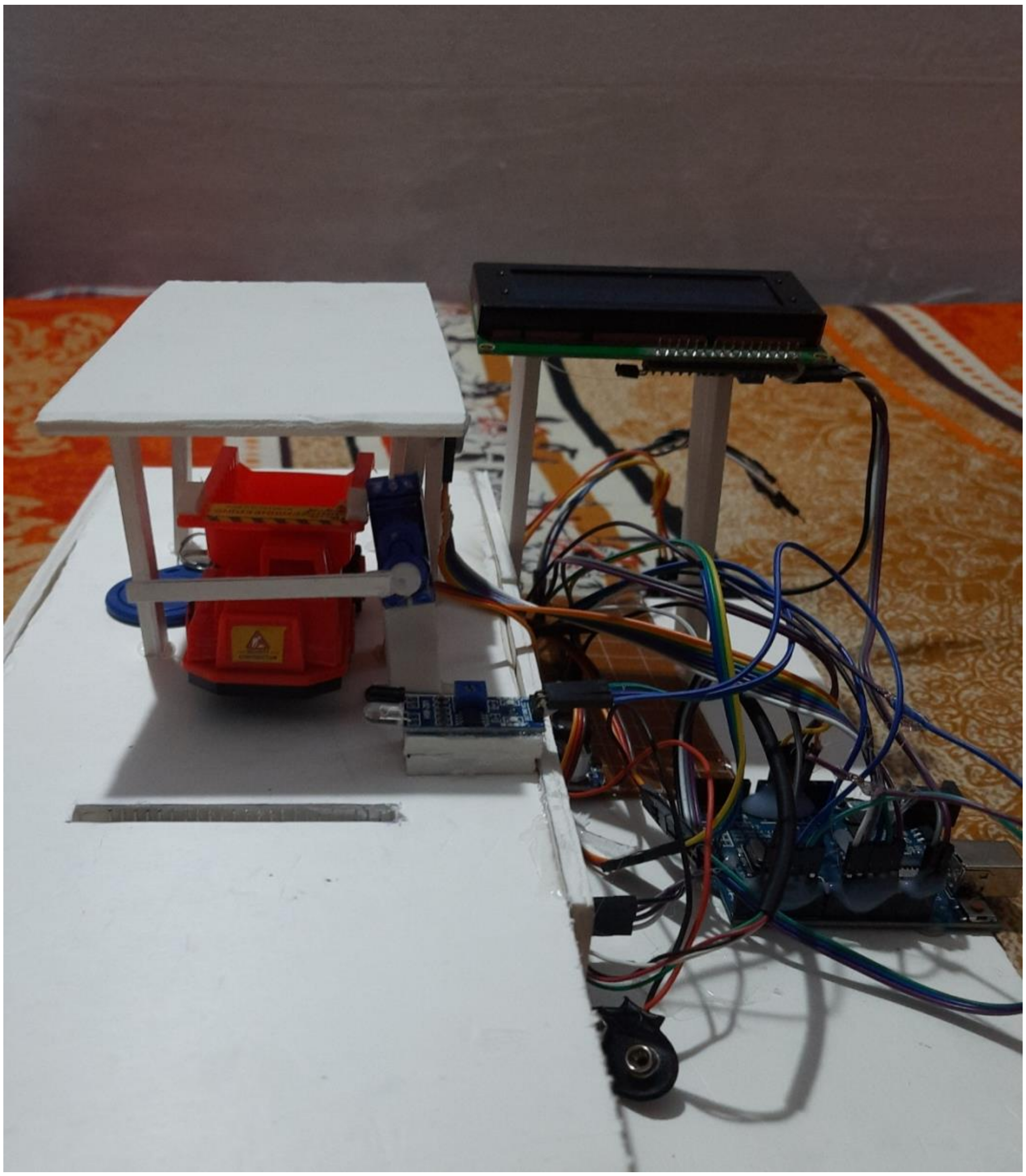
Then in figure5.3 the weight has been checked to determination for toll price. Then figure 5.4 is verifying the identity of the vehicle of the Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor.

It will check the weight is on point and the identity is legal than it will show in figure 5.5. If everything is ok than the weight and the identity, after that the gate will be opens that has been showed in figure 8.

- The RFID tags affixed to the automobiles are read by the RFID reader. It comprises of a control unit and a transceiver that are connected via an antenna.
- Weigh-In-Motion Sensor: The Weigh-In-Motion (WIM) sensor estimates the weight of the moving vehicles. A load cell, an amplifier, and an analog-to-digital converter make up the device (ADC).
- Data Processing Unit: The WIM sensor and the RFID reader both need the data processing unit to process the data. It is made up of a memory, a microcontroller, and a communication interface.
- Communication Interface: The central system receives data from the WIM sensor and the RFID reader via the communication interface. It is made up of a network card, a modem, and a router.
- Central System: The data gathered from the RFID reader and the WIM sensor is stored in the central system. It is made up of a web server and a database.
- User Interface: The data are shown using the user interface.

5.3.2 Hardware Model

The RFID reader checks to see whether users are valid or not. The LCD Screen will display inadequate balance if invalid and low. Using the Keypad System, the RFID Card can be loaded with balance information. The user can pay the toll and pass through the toll gate after the Card is recharged. The Servo Motor, whose spindle rotates at a fixed angle step, is attached to the toll gate. The controller verifies that the user is legitimate once the controller receives a signal from the reader when the user pass through the reader. If the card is legitimate, the controller instructs the servo motor to turn counterclockwise so the gate can open. The controller sends the signal to turn the servo motor in a clockwise direction to close the gate after passing it for a period of time, so that the gate remains open until the vehicle



moves.

Figure 5.6: Hardware model of Automated Toll Collection System with advanced Security Features

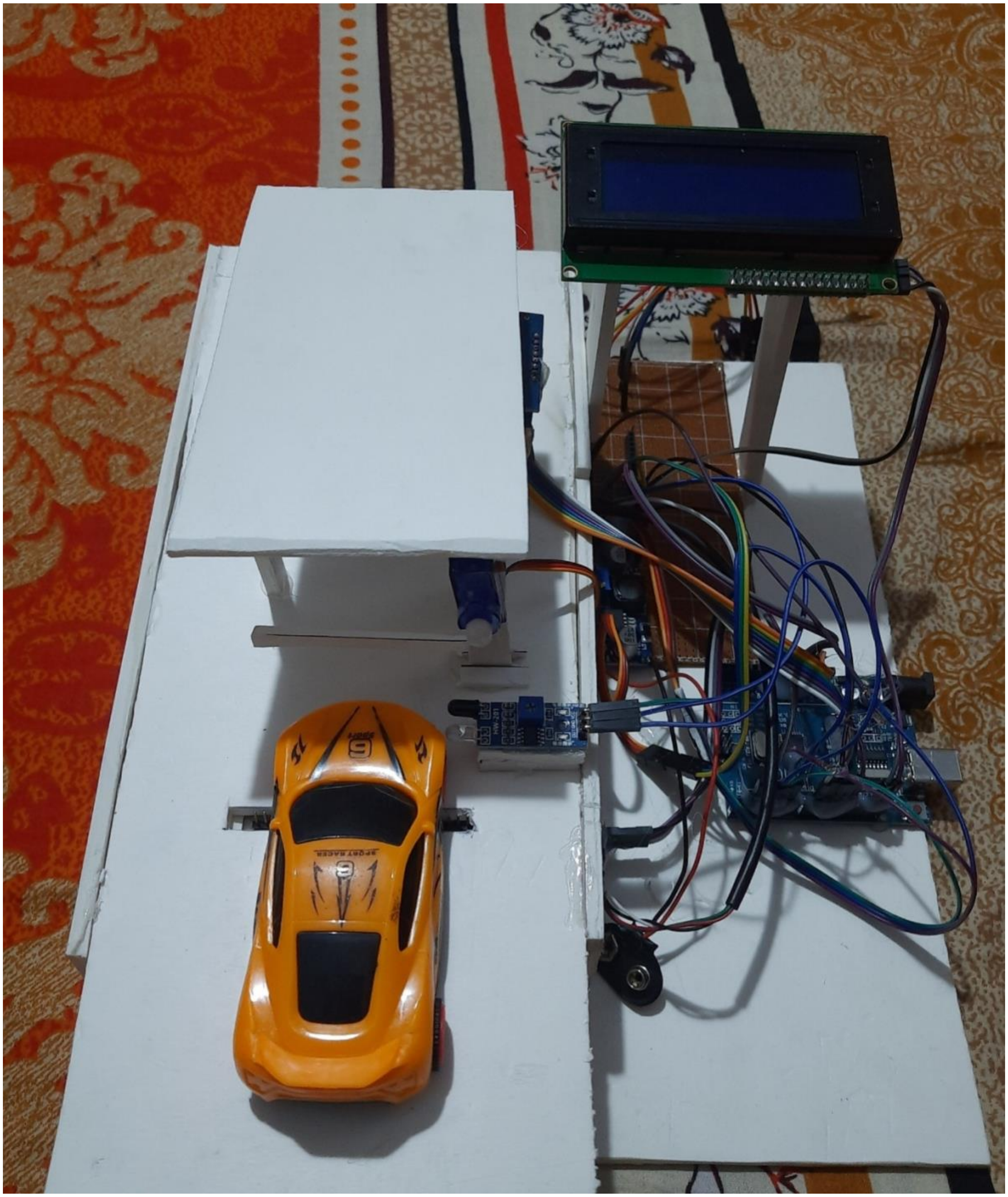


Figure 5.7: Figure 5.6: Hardware model of Automated Toll Collection System with advanced Security Features

5.4.Summary

Radio Frequency Identification (RFID) and Weigh-In-Motion (WIM) sensors are the foundation of the Electronic Toll Collection (ETC) system. RFID sensors are used to recognize a vehicle and the information it carries, such as the registration number and the toll amount. The weight of the vehicle is determined by the WIM sensors since it has an impact on the toll that will be assessed. The ETC system is a contactless payment system that does not require manual payments because the toll is automatically credited to the vehicle's account. The user has access to the toll information, which is kept in a centralized database and used for payments and records.Given that technology speeds up transactions and does not allow for human error, the ETC system is a safe and practical method of collecting tolls.

Chapter 6

RESULTS ANALYSIS & CRITICAL DESIGN REVIEW

6.1.Introduction

Under this article, a thorough analysis of the results derived from both the hardware and the simulation model is described. Its preceding chapter displayed both the detailed working prototype and the simulation model. Specific simulation models of the sensors, including RFID, IR, weigh-in-motion, and others, have been displayed. This chapter will first go over the simulation and its findings before moving on to the hardware model and its findings. The results will be evaluated by comparing to ensure that the system is operating as intended, and the framework will also be evaluated against other options to determine its relevancy.

6.2.Results Analysis

6.2.1. Simulated Results

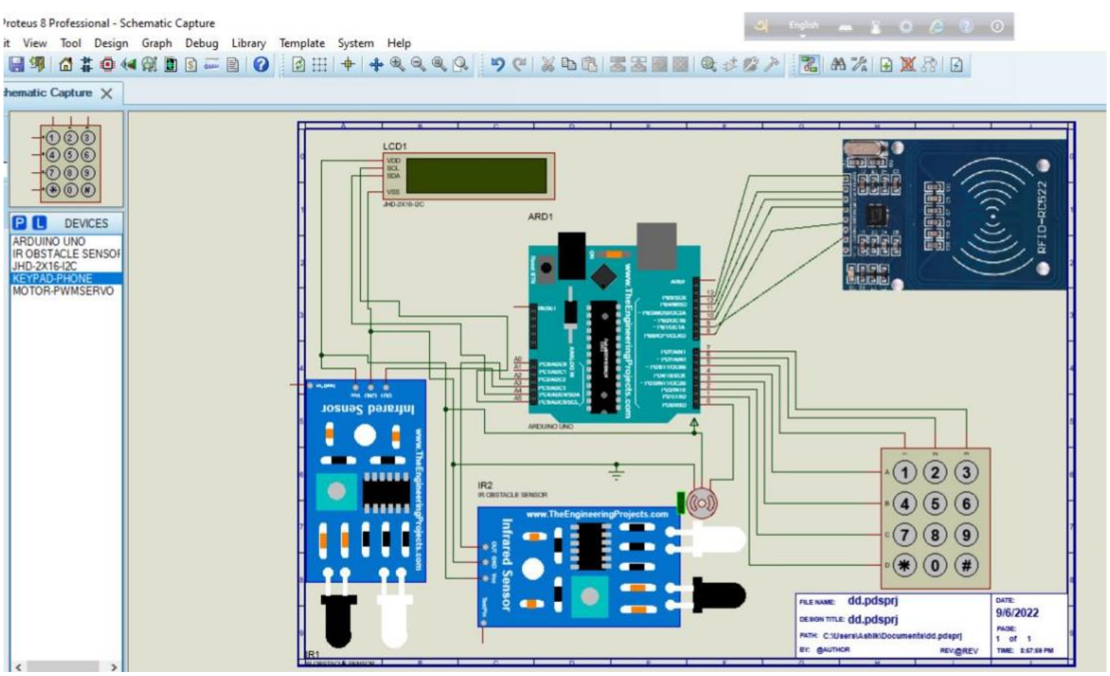


Figure 6.1: Simulation Circuit of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor.

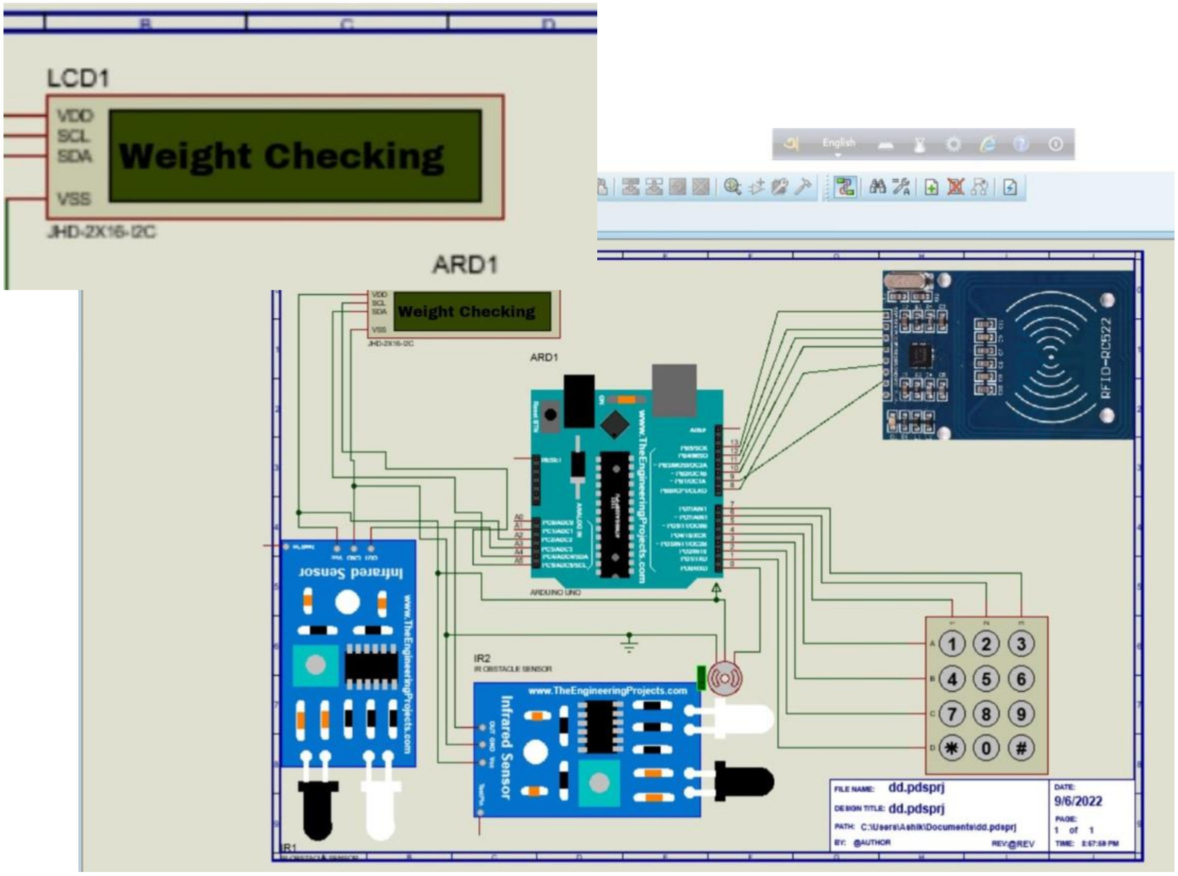


Figure 6.2: Weight Check of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor

A microprocessor, LED display, RFID sensor, weight authentication sensor, and various control motors are among the various parts of this simulation model.Figure 6.1depicts the electronic toll collection system's simulation circuit, which is based on RFID and weigh-in-motion sensors.

First The weight of the vehicles is justified as they pass over the Weigh-In-Motion (WIM) sensor. A load cell, an amplifier, and an analog-to-digital converter make up the device. Then The data gathered from the RFID reader and the WIM sensor is processed by the data processing unit. It is made up of a memory, a microcontroller, and a communication interface. Utilizing the weight sensor depicted in figure 6.2to determine weight.

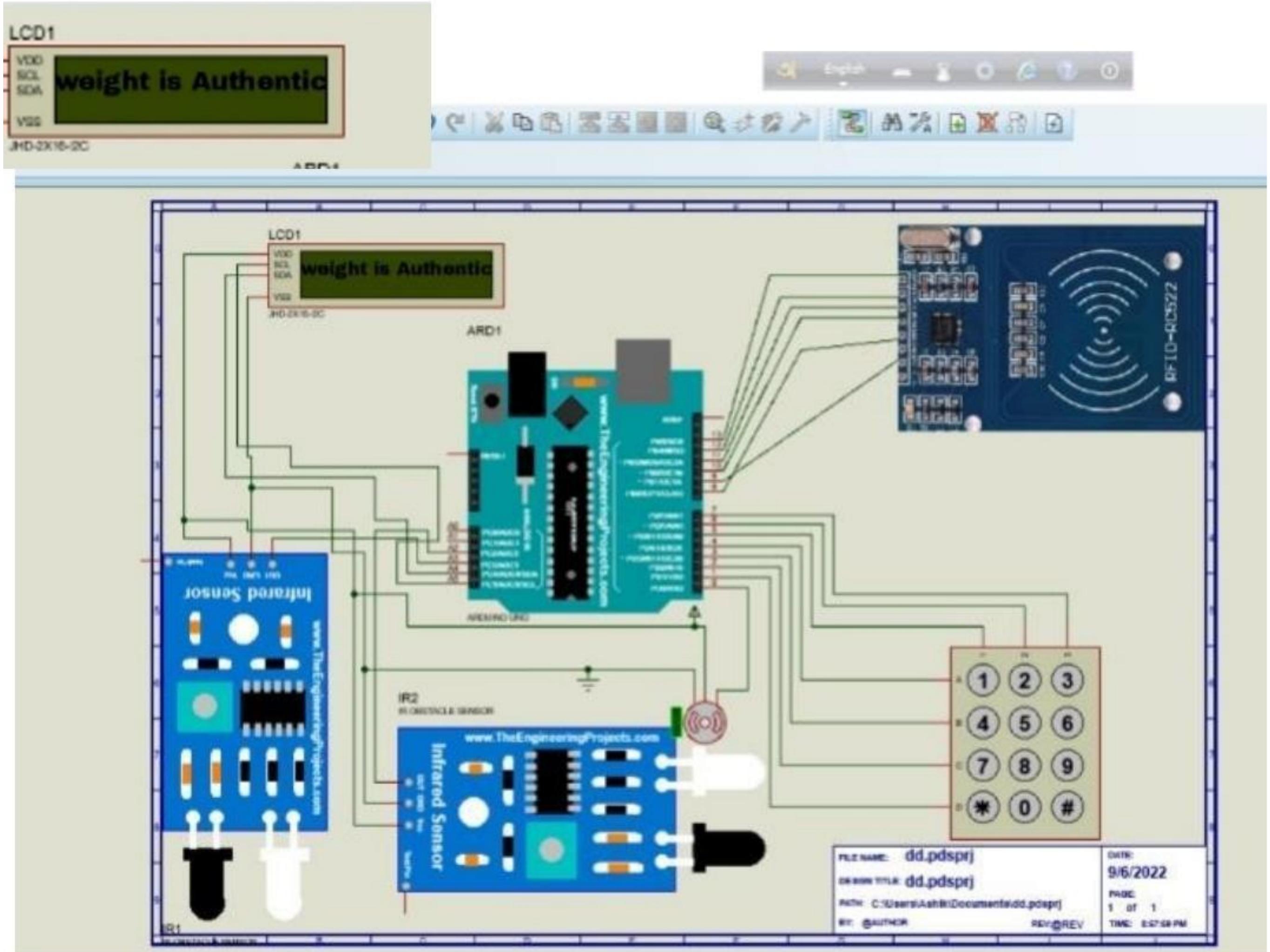


Figure 6.3: Weight Authentication of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor

If the weight can be verified, the next step will be given. The weight was then examined in the figure to determine the toll price. Then, figure 6.3 uses an RFID sensor as well as a weigh-in-motion sensor to confirm the identity of the vehicle in the Electronic Toll Collection system.

Figure 6.4 will be displayed after the weight and identity have been verified as being accurate. If everything is in order, the gate shown in figure 6.5 will open after the identity and weight checks.

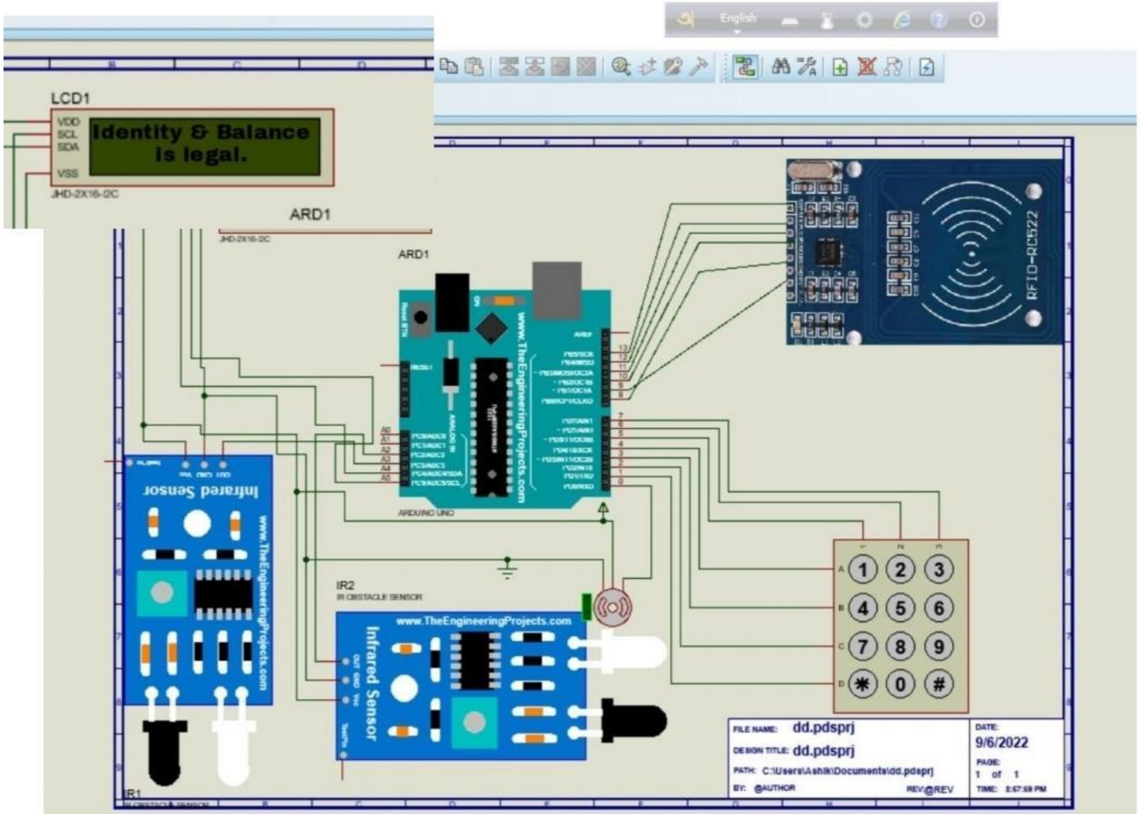


Figure 6.4: Identity Verification of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor.

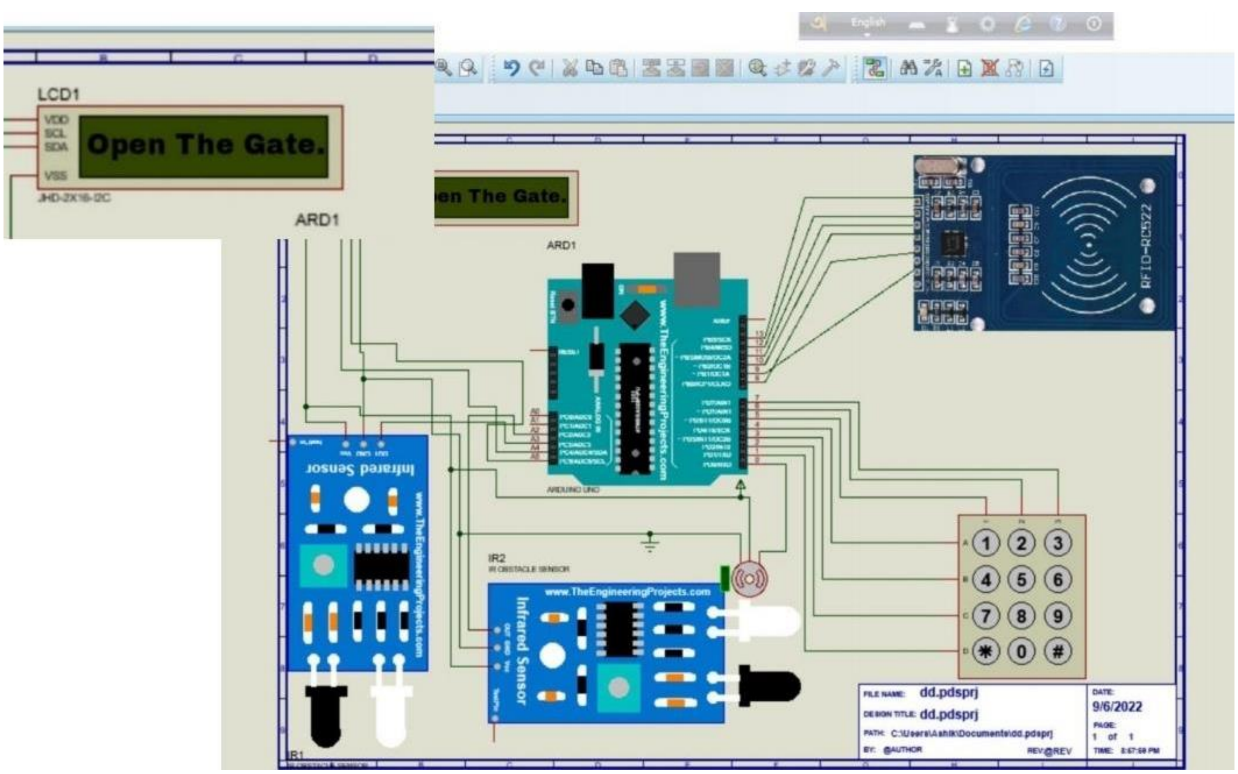


Figure6.5: Opening the get of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor

The RFID reader reads the RFID tags that are attached to the vehicles. It consists of a transceiver and a control unit that are linked by an antenna.

The Weigh-In-Motion (WIM) sensor makes an estimation of the weight of moving vehicles. The instrument consists of a load cell, an amplifier, and an analog-to-digital converter (ADC).

Data Processing Unit: In order to process the data, both the WIM sensor and the RFID reader require a data processing unit. A memory, a microcontroller, and a communication interface make up the device.

Communication Interface: Through the communication interface, the central system receives data from the WIM sensor and the RFID reader. It is made up of a router, a modem, and a network card.

Central System: The central system stores the information gathered from the RFID reader and the WIM sensor. A database and a web server make up the system.

User interface: The user experience is used to display the data.

6.2.2. HardwareResults

The validity of the RFID tags is verified by the reader. If the balance is invalid or low, the LCD screen will show an inadequate balance. After the Card has been recharged, the user can pay the toll and proceed through the toll gate. The toll gate is connected to the servo motor, whose spindle rotates at a fixed angle step. Once the controller receives a signal from the reader as the user passes through the reader, the controller confirms that the user is legitimate. If the card is valid, the controller tells the servo motor to rotate in the opposite direction so the gate can open.After passing the gate for a while, the controller sends the signal to turn the servo motor clockwise to close it, leaving the gate open until the vehicle moves.

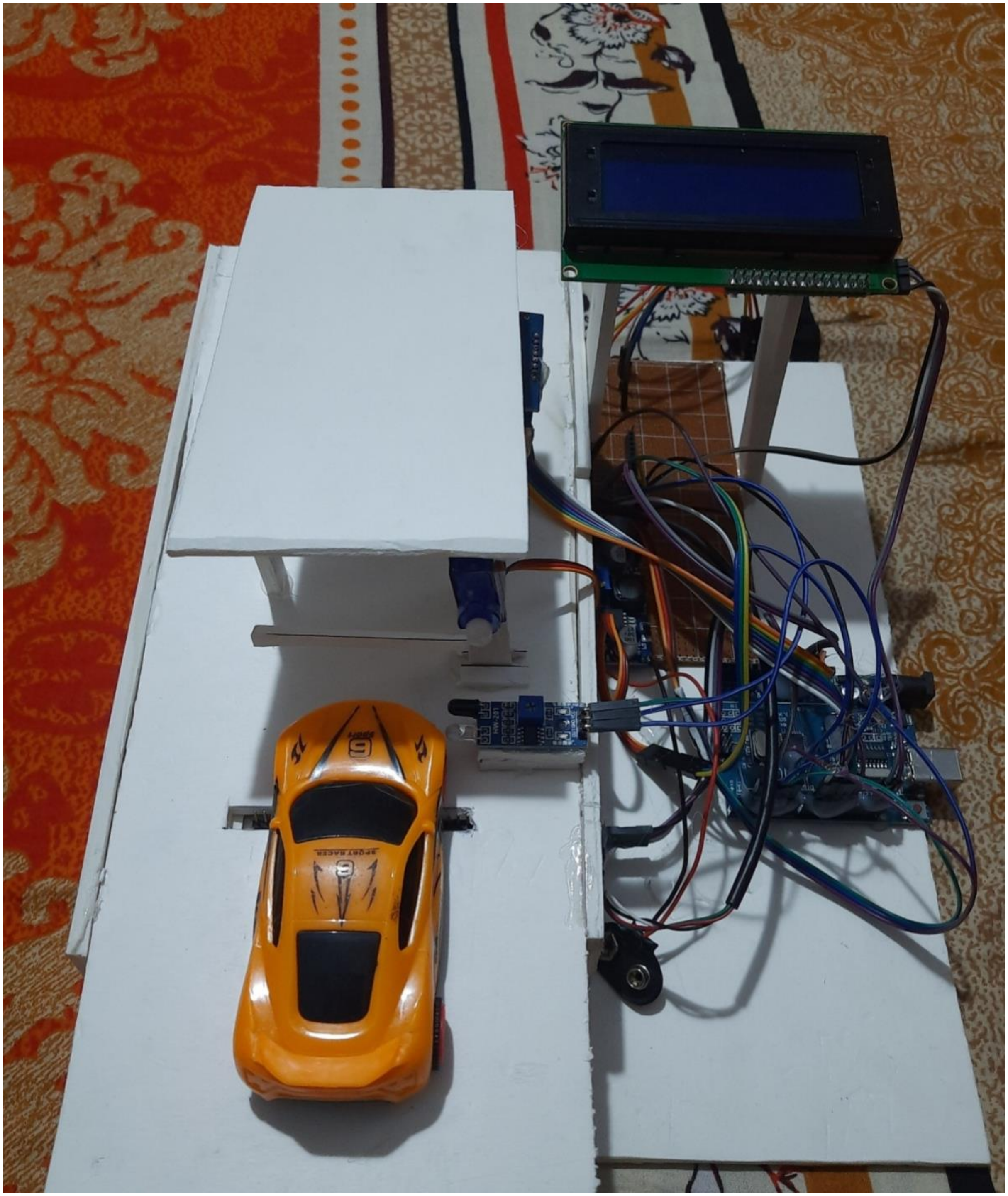


Figure 6.6:Vehicle entering in a Automated Toll Collection System with advanced Security Features

Comparison of Results

Before creating the actual working model, a simulation model was created to ensure its functionality. When the results from the operating system and simulation were combined, they were compared, and the results were as expected.

We have seen that it functions properly in the simulation portion. However, implementing hardware is difficult and fraught with error. We ultimately resolve every issue, making it worthwhile. The hardware and simulation components operate as shown below.

First The weight of the vehicles is justified as they pass over the Weigh-In-Motion (WIM) sensor. A load cell, an amplifier, and an analog-to-digital converter make up the device. Then The data gathered from the RFID reader and the WIM sensor is processed by the data processing unit. It is made up of a memory, a microcontroller, and a communication interface.If the weight can be verified, the next step will be given. The weight was then examined in the figure to determine the toll price. Then, use an RFID sensor as well as a weigh-in-motion sensor to confirm the identity of the vehicle in the Electronic Toll Collection system. Then the weight and identity have been verified as being accurate. If everything is in order, the gate shown in figure 8 will open after the identity and weight checks. As demonstrated by simulation, the hardware component is implemented to complete the processes mentioned above.

6.3.Summary

Outcomes from hardware and simulation were also featured in this chapter. The system's effectiveness is determined by analyzing and comparing all the results, and the framework as a whole is also evaluated for legitimacy by comparing it to already-proven solutions. The outcomes presented in this chapter demonstrate the design's success. The system is finished and functioning properly, but there are some shortcomings and opportunities for enhancement that will be covered in the following chapter.

Chapter 7

CONCLUSION

7.1.Summary of Findings

The digital conversion of conventional collection practices into automated collection systems is the process of automating collections. Automating collections boosts earnings while also accelerating cash reserves, increasing productivity and customer happiness. A new RFID-based automated toll collection system has been implemented in an effort to ease congestion and maintain process transparency.

Findings:

- The Weigh-In-Motion (WIM) sensor and RFID sensor-based Electronic Toll Collection (ETC) system can successfully collect tolls from moving vehicles without the need for human interaction.
- The WIM sensor can precisely determine the weight of the cars.
- The RFID sensor can swiftly and precisely acquire the car registration information.

Results:

- With minimum manual involvement, the ETC system is able to collect tolls more effectively; it also uses RFID and WIM sensors to conduct transactions swiftly and securely.
- The system can enhance traffic flow and relieve congestion at toll plazas.
- The system can lower labor expenses and increase the effectiveness of the toll collection process overall.

7.2.Novelty of the work

In the past, staff members and technicians scaled the line to determine the source of the problem for tool collection system. If this project wants to be utilized in field a vehicle's toll is electronically collected when it passes through a specified toll booth or lane under an Electronic Toll Collection (ETC) system. It primarily consists of three parts: RFID sensors, Weigh-In-Motion (WIM) sensors, and a payment system, and is frequently used on highways, bridges, and tunnels. A toll lane's entry and exit frequently have RFID sensors there. Using radiofrequency identification (RFID) tags, these sensors can identify the type, size, and presence of a vehicle. The tags are normally fastened to the windshield of the car, and the RFID sensors can scan the tags to identify the car. There are Weigh-In-Motion (WIM) sensors at the toll lane's entry. These sensors can distinguish between empty and loaded vehicles by weighing the vehicle as it travels through the toll lane. Then the online payment system is used to collect payment using the payment system. Typically, this system consists of a toll payment booth where motorists can pay their tolls with cash, credit/debit cards, or an automated toll collection system.The design was a part of utilizing the altered model set which utilizing the altered model set to it has been implemented in the model.

7.3.Cultural and Societal Factors and Impacts

7.3.1. Cultural and Societal Factors Considered in Design

Cultural and societal factors are important considerations when designing an Electronic Toll Collection (ETC) system. This system considered the values, beliefs, and norms of the culture they are designing for. Also considering the target audience and their needs, as well as the context in which the product or service will be used. Additionally, there is no potential ethical issues that could arise from the design. Lastly, this system had considered the impact of the design on the environment and society.

7.3.2. Cultural and Societal Impacts of the Proposed Design

It is evident that the social benefits are substantial. Due to improved road safety, this initiative is able to build automated systems that are environmentally sustainable. As a result, it can conclude that this method does not result in the release of environmentally damaging substances because it aids in the production of good monitoring system and prevents human labor, no air pollutants in the form of gases or compounds. It might therefore conclude that this project effort had a very favorable societal influence.

7.4.Proposed Professional Engineering Solution

The goal of this project is to create a qualified engineering solution for the implementation of an RFID sensor- and weigh-in-motion (WIM) sensor-based Electronic Toll Collection (ETC) system. By offering clients a comfortable payment option, this project aims to provide an effective, dependable, and cost-effective solution for the toll collection.

The toll collection system in place is ineffective, unreliable, and expensive. With the manual system, the toll collectors must spend time collecting cash from the drivers, which increases the risk of fraud. Additionally, the manual approach is inefficient at controlling the dense traffic and protracted lines that frequently form at toll booths.

The suggested remedy must be reliable, economical, and effective. Installing RFID and WIM sensors at toll booths is the suggested fix. The identification of vehicles and toll collection will be done using RFID sensors. The WIM sensors will be employed to weigh the vehicles and determine the toll fee based on their weight. The customer will be charged for the toll price.

7.5.Limitations of the Work

These systems can detect, identify, and collect tolls from vehicles using RFID sensors and Weigh-In-Motion (WIM) sensors. These systems have a lot of advantages, but they also have some drawbacks that need to be taken into account. The limitations of RFID- and weigh-in-motion-based electronic toll collection systems will be covered in this project.

- Vehicle identification: The sensors may miss some vehicles, and vehicle identification is not always 100% accurate. This may result in incorrect toll billing and collection.
- Maintenance Problems: The system's sensors need to be regularly maintained and repaired. It can take a lot of money and time to do this.
- Privacy Issues: The sensor-collected data may be misused and subject to privacy violations.
- Price: Setting up and maintaining the equipment required for an electronic toll collection system can be expensive.
- Reliability: The system's dependability is based on the effectiveness of the sensors and the network connection. System faults may be caused by subpar sensors and unstable network connections.
- Security: The system is susceptible to hacking and other threats because it relies on wireless connection.

7.6.Future Scopes

Using facial recognition technology in conjunction with the Electronic Toll Collection system would allow toll authorities to identify drivers. Implementing a real-time tracking system would improve traffic management and monitoring for the toll authorities. Putting in place an automatic payment system would enable drivers to pay using their credit cards or mobile phones and eliminate the need for manual payment. Introducing dynamic pricing would allow toll authorities to change the toll costs in accordance with the volume of traffic. It would be possible for toll authorities to collect tolls from buses and trucks without the requirement of manual labor by developing an automated toll collection system. By implementing a real-time data analytics system, toll authorities would be able to learn more about traffic patterns and pinpoint areas for improvement.

7.7.Standard Requirements and Ethical Concerns

Standard Requirements and Ethical Concerns of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor could be the system should have an efficient and reliable RFID sensor and Weigh-In-Motion sensor to accurately detect vehicles and calculate toll charges. Between the toll sites and the collection center, there should also be a secure and trustworthy communication network. Also heaving the capacity to automatically gather information from the RFID and Weigh-In-Motion sensors and store it in a secure database. This system can generate billing reports and generate invoices for the customers. Allow users to access their account information and make payments online. System should have a backup system in case of power failures. Generating real-time alerts for any suspicious activities.

Ethical Concerns: The system should adhere to the privacy and security of customers' data. Also, system should not be used to discriminate against any person or group of people. This project has designed in a way that it does not interfere with the privacy rights of individuals.

7.7.1. Related Code of Ethics and Standard Requirements

Data Privacy: The use of RFID and Weigh-In-Motion sensors can record and store data of the users, such as license plate numbers, vehicle weights, and payment methods. This data can be used to track individuals and their movements. To protect users' privacy, the system must have robust measures in place to ensure that this data is kept secure and is only used for the purpose of managing tolling transactions.

Security: Electronic toll collection systems rely on the use of RFID and Weigh-In-Motion sensors to accurately charge users for their tolls. If these sensors are not properly secured, they can be vulnerable to malicious actors who could tamper with the system and cause inaccurate billing.

Accuracy: The accuracy of the system's readings must be ensured to avoid overcharging or undercharging users. This can be done through the use of calibration checks and regular maintenance of the sensors.

Cost: Electronic toll collection systems can be expensive to install and maintain. This cost must be weighed against the benefits that the system provides in terms of increased efficiency and accuracy.

7.7.2. Health and Safety

The most critical factor in this project is safety. This project's design took human health into consideration. The human body is not involved in any way. The program of Electronic Toll Collection system based on RFID sensor and Weigh-In-Motion sensor maintained all the safety measures.

7.7.3. Economy, Environment and Sustainability

These systems offer practical, affordable, and long-lasting ways to manage tolls on highways, relieve traffic congestion, and improve highway traffic flow.

Fuel efficiency can be increased and air pollution can be decreased with the use of RFID sensors and weigh-in-motion sensors. These systems can decrease the amount of time vehicles spend idling, resulting in fewer pollutants and better air quality. They do this by properly detecting vehicular traffic and removing the need for manual toll collecting. Additionally, since vehicles no longer need to stop and restart in order to pay the toll, these systems can aid in lowering the amount of gasoline they use. Reduced operational costs can also be achieved through the use of RFID sensors and weigh-in-motion sensors. These systems can greatly reduce the requirement for staff, which lowers operational expenses by doing away with the necessity for human toll collecting. The adoption of these systems can also assist in lowering administrative costs because the data acquired by the sensors can be used to provide precise billing data and invoices.

Lastly, RFID-based and weigh-in-motion-based electronic toll collection systems can enhance.

7.8. Conclusion

The Electronic Toll Collection (ETC) system is a method of collecting toll payments from moving cars as they pass through tollbooths using RFID sensors and Weigh-In-Motion (WIM) sensors. Vehicles are equipped with RFID tags, which are read by RFID readers at the toll booth. The car is subsequently identified using this information, and the proper toll fee is then assessed. Additionally, weigh-in-motion sensors are used to identify the weight of cars and calculate the appropriate price. The toll fee is then determined using this information. The centralized system receives the toll fees after user data have been collected and processes the data. ETC systems are an economical method of collecting toll payments and easing traffic at tollbooths.

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