Smart Car Parking System using Arduino UNO



A thesis

by

Md. Rashidul Islam; ID: BME1501005383

S.M. Naimur Rahman; ID: ME2101023022

Md. Amir Hamza; ID: BME1901017095

Department of Mechanical Engineering

SONARGAON UNIVERSITY (SU)

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Md. Rashidul Islam; ID: BME1501005383

S.M. Naimur Rahman; ID: ME2101023022

Md. Amir Hamza; ID: BME1901017095

Supervisor:

Md. Mahafujul Islam

Lecturer

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Abstract

The Automatic Car Parking System using Arduino is an innovative solution designed to optimize parking spaces, reduce time, and enhance convenience in urban areas where efficient vehicle management is critical. This project is to set up a smart parking system. According to primary investigation, nowadays maximum people want a smart parking system for hassle free parking with digital assistant. The Ultrasonic Range Detection Sensor is utilized with Arduino to indicate the empty slot. By measuring the distance using ultrasonic sensor drivers are able to find the empty slot in parking to park the car and help the driver to find the slot easily and reduce the searching time. As the parking place is found to be empty it is detected using ultrasonic sensors. We achieved this by programming the sensors and Arduino. This sensor and Arduino Microcontroller based technological solution can prevent inadequate parking, take payment digitally and save time and manpower. This can be a sustainable solution in a cheaper cost. The discussed systems will be able to reduce the problems which are arising due to unavailability of a reliable, efficient and modern parking system, while the economic analysis technique will help in analyzing the projects' feasibility.

Smart car parking project aims at providing a confusion free and easy parking. This project helps the drivers of the cars to park their vehicles with minimum wastage of time with accurate information of the availability of the space to park It includes an Arduino Uno as the microcontroller unit to which the servo motors, LCD display ultrasonic sensors (HC-05) are interfaced. The LCD displays the availability of the space, the ultrasonic sensors keep the check of the number of cars entering and exiting the parking space. The ultrasonic sensors detect the availability of the parking space.

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Chapter-1
INTRODUCTION

1.1 Background of study and motivation:

Parking is a major problem in our country. Drivers in our country cannot properly park their vehicle in the parking slot because of improper parking system. Sometimes when they do not find any parking space, they park their vehicle in the roadside and as a result roads become so narrow and occurs traffic jam.[1] Also, sometimes it seems that people start fighting for parking slot in the parking lot. Because from outside people cannot understand weather there is any parking slot is available or not. It also wastes our lot of time. Till now no smart technology exists to solve this problem. This project will change and standardize the parking system for a parking lot. [3]

An automated car parking system is a process through which car parking can be done more efficiently and easily than manual method. The system will provide the user better services.

The system counts the number of cars in the garage and checks if there's any vacancy. There's an entry and exit path. When vehicle enters, the display shows the number of cars inside. When any vehicle leaves, the count decreases and shown on display.[2] If the garage is full. The display will show a message regarding that. This whole process includes the use of Arduino, Display and sensor. The sensor detects whether the vehicle is entering or leaving. The report then showed on display. [5]

1.2 Project Objectives:

The objectives to be achieved are:

- ➢ Providing safe and secure parking spots within a limited space.
- ➢ Developing a sophisticated automated parking system that lowers workforce, and traffic congestion and save time.
- ➢ Automatically keeping count and monitoring total entered and exited vehicle and calculate free available slots.
- ➢ Implementing a digital payment method for parking system.

1.3 Report outlines:

In this report, the background of study and motivation of Smart parking system were described. under introduction section 1. The project objectives were briefly discussed.

To complete this report, 7 different literatures were reviewed to gather the knowledge of the ongoing development of Smart parking system.

In the methodology and modeling section 3, the working principle of the proposed report of Smart parking system was described. The process of work was explained. The important components of the model were described. Then the implementation of the theory and components were explained. After that, the test/experimental setup was performed and noted. The total estimated cost of the project was explained including the individual component's costs.

In section 4 results and discussion, the simulation / numerical analysis was described. Measured responses and experimental results were analyzed and discussed. The comparison between numerical and experimental data was not discussed as Due to the pandemic, the current mode of education is completely online based.

In the section 5 conclusion, the impact and benefit of the project in real life was explained. It was also described how this smart system will be beneficial over the existing parking system.

The project's introduction, operating principle, operation, specific components, circuit setup and simulation, discussion of simulated data, budgeting, conclusion, and documentation are all included in this report.

Chapter-2
LITERATURE REVIEW

In 2012, research was conducted on Automatic Parking Management System and Parking Fee Collection Based on Number Plate Recognition by M. M. Rashid and at all. The research objective was electronic fee collection by detecting car numberplates. For the functioning of the parking and paying system, the system employed image processing to recognize number plates. The algorithm-based approach for extracting license plates from automobile photos, followed by character segmentation and rearrangement.[16]

Ultrasonic sensor is an electronic component which can detect presence of any obstacle with the help of ultrasound wave. Taiwan researcher Ter-Feng Wu and at all in 2016 published a paper named Research and implementation of auto parking system based on ultrasonic sensors. The researchers were able to detect the parking place surroundings, duplicate the driver's parking method, and perform roadside and reverse parking using a smart wheeled mobile robot (SWMR). The SWMR can autonomously regulate the servomotors of two wheels to turn around, travel straight, go backward, and stop once the ultrasonic sensors detect enough parking space. [17]

In 2020, a group of researchers from Indonesia developed a parking system based on Radio Frequency Identification (RFID) which was based on microcontroller AT89C51 control system. This was an automatically and flexibly served a parking lot as a subscription parking system. RFID contains data that may be used to verify a user's identification while entering a parking lot. Simulating a small portal door system to enter and leave automobiles on campus utilizing RFID cards/tags as subscriber IDs was used to design and construct a parking system in that study. [18]

In 2020, research on Ultrasonic based easy parking system based on Microcontroller was published by Mohapatra and at all. The research was focused to avoid collision and reliable

vehicle parking system. Slot Fill level is computed by measuring distance information, an ultrasonic sensor is critical in grain level filling in a slot. While parking, parking sensor systems employ either electromagnetic or ultrasonic sensors to inform the driver of any obstructions in the route. In a nutshell, the sensor identifies adjacent things. It will be beneficial in terms of unanticipated parking, as well as one type of time and fuel waste. As a result, in a short period of time, a parking spot with minimal fuel use might be easily found. Drivers become irritated when they have to wait for a long period for a parking spot. As a result, the ultrasonic sensor was used to complete the task. [19]

Not so before, A research named Design and Development of a Smart Parking System was conducted by Saudi Arabian researchers Mohammed Omar Ba Sabean and at all. The management of car parking is one of the primary difficulties in cities. In the past, research on how to structure parking systems were done. Smart parking systems, on the other hand, are still in demand and are attracting researcher's interest as a potential upgrade to meet current needs and requirements. It is critical to monitor and manage vehicle access in government and private sector parking lots in order to improve the world's security system. As a result, the goal of this study is to create and construct a smart parking system employing mobile application technology. The created system can control allowed vehicle admission into parking areas while blocking illegal cars. In addition, a parking charge payment system was built. This project was also talked about SMS confirmation to the user. [20]

Indian researcher D.J. Bonde and at all published research titled Automated car parking system commanded by Android application in 2018. The goal of this article was to automate both the automobile and parking. It featured a project that features a small model of an automated automobile parking system that can control and manage the number of cars that may be parked in a particular location at any given moment based on parking space availability. Automated parking is a technique for parking and exiting vehicles that makes use of sensors. An Android based application controls the entrance and exit from the parking lot. Their goal was to make their system as human-independent as possible by automating both the automobiles and the

parking lot; most existing systems, on the other hand, need human staff (or the car owner) to park the car manually. [21]

In 2019, D. Yashwant, and at all published research named "Automated car parking system". The goal of this article was to automate both the automobile and parking. It featured a project that features a small model of an automated automobile parking system that can control and manage the number of cars that may be parked in a particular location at any given moment based on parking space availability. Automated parking is a technique for parking and exiting vehicles that makes use of sensors. An Android-based application controls the entrance and exit from the parking lot. Their goal was to make their system as human-independent as possible by automating both the automobiles and the parking lot; most existing systems, on the other hand, need human staff (or the car owner) to park the car manually.[22]

Mr. Basavaraj S R-2015 has proposed A carmates Smart Parking System using Internet of Things (IOT)-------Internet of Things (IOT) plays a vital role in connecting the surrounding environmental things to the network and made easy to access those un-internet things from any remote location. It's inevitable for the people to update with the growing technology. And generally, people are facing problems on parking vehicles in parking slots in a city. In this study we design a Smart Parking System (SPS) which enables the user to find the nearest parking area and gives availability of parking slots in that respective parking area. And it mainly focus on reducing the time in finding the parking lots and also it avoids the unnecessary travelling through filled parking lots in a parking area. Thus, it reduces the fuel consumption which in turn reduces carbon footprints in an atmosphere. [1]

Deepthi. S, Anil A R has proposed A Survey on Smart Parking System Based on Internet of Things------ In today life people don't depend on public vehicles. They use their own vehicles to travel. So, traffic increases. When people travel through a city the most difficult problem is to park the vehicle. It causes not only a waste of time and fuel for drivers looking for parking but it also leads to additional waste of time and fuel for other drivers as a result of traffic congestion. At first, we use PGI (Parking Guidance Information) for better parking management. Parking

information may be displayed on VMS (Variable Message Sign) at major roads or streets or it may be disseminated through the internet. In PGI systems e-parking is an innovative platform which allows drivers to obtain parking information before or during a trip and reserve a parking spot. [2]

Abhirup Khanna-2016 has worked on IOT based smart parking system-----Recent times the concept of smart cities has gained grate popularity. Thanks to the evolution of Internet of things the idea of smart city now seems to be achievable. Consistent efforts are being made in the field of IoT in order to maximize the productivity and reliability of urban infrastructure. Problems such as, traffic congestion, limited car parking facilities and road safety are being addressed by IoT. In this paper, we present an IoT based cloud integrated smart parking system. The proposed Smart Parking system consists of an on-site deployment of an IoT module that is used to monitor and signalize the state of availability of each single parking space. **[3]**

R. Yusnita, Fariza Nirbhaya and at all has proposed "Intelligent Parking Space Detection System Based on Image Processing" **------**This paper aims to present an intelligent system for parking space detection based on image processing technique that capture and process the brown rounded image drawn at parking lot and produce the information of the empty car parking spaces. It will be display at the display unit that consists of seven segments in real time. The seven segments display shows the number of current available parking lots in the parking area. This proposed system, has been developed in software and hardware platform. [4]

D.B.L. Bong, K.C. Ting and K.C. Lai- 2007 has worked on Integrated approach in the design of car park occupancy information system (coins)----- In large parking areas such as those at mega shopping malls or stadiums, drivers always have difficulty to find vacant car park lots especially during peak periods or when the parking lots are almost full. A solution to reduce the drivers' searching time for vacant car-park lots will greatly save time, reduce cost and improve the traffic flow in the car park areas. In this paper, a research project which was developed to acquire car-park occupancy information using integrated approach of image processing algorithms is

presented. Security surveillance cameras which are readily available in most car parks can be used to acquire the images of the car park. This project is called as Car-Park Occupancy Information System (COINS), and it was tested using simulation model and also in real-case scenarios. [7]

Ivan Guanche and Mairtin O' Dorma has proposed et.at [6] "A cloud based intelligent car parking services for smart cities" ------ In this the IOT sub system includes sensor layer, communication layer and application layer. The primary goal of the intelligent car parking system is to find, allocate and reserve the best available car parking lot for a user who is driving a car in a particular area and to provide instructions for reaching this lot. Sensor layer detecting the car lot occupancy. A car parking lot detection method is proposed based on carmates threshold algorithm. An infestation based multi-agent system facilitating a car parking locator service is proposed. An access control system for reducing the waiting time proposed. At the application layer, an information center provides cloud-based service. An IOT management center administrates the smart city via an IOT integrated service portal. A number of business services explore interfaces to the sensor layer. These includes a car parking locator service, car parking supervision service, car parking information service, GIS and GPS services, vehicle license patrolling, vehicle tracking service. [6]

A Cloud-Based Smart-Parking System Based on Internet-of-Things Technologies--- This paper provides a unique algorithm which increases the capability of the current cloud based smart parking system [5] and it also develops a network architecture based on the Internet of Things technology. This system helps the users to find a free parking space with minimal cost based on new performance metrics which is carmates. This metrics will calculate the user spaces in each car park. To enhance the parking management, an intelligent parking system was developed which reduced the purpose of hiring people to maintain the parking system [1]. In this paper it proposes an effective cloud-based Smart parking system based on the Internet of Things. The data that includes the vehicle GPS location and distance between car parks and number of free parking space in car parks will be sent to the data center. Here the data center is presented as a cloud server which calculates the costs of a user parking request and this information is regularly updated and is made available to the vehicles in the network at any time. In this proposed system,

each car park is an IoT network and it operates independently as a regular car park. This paper implements a system model with wireless access in an open-source physical computing platform based on Arduino with RFID technology. It uses smartphone that acts as a user interface between the cloud and the vehicles to check the feasibility of the proposed system [4].

A New “Smart Parking” System Based on Optimal Resource Allocation and Reservations----- In this system a new smart parking system is implemented for cities. This system assigns and reserves a parking space for a user (driver) based on the user’s distance from the parking area and parking cost and also ensures that the overall parking capacity is effectively utilized. Their approach solves a Mixed Integer Linear Program (MILP) problem at each decision point in a time-driven sequence [3]. For each MILP there is a solution which gives an optimal allocation based on user’s current state information and also supports random events such as new user requests and parking space availability. The allocation is updated at the next decision point which ensures that there is no parking slot reservation conflict and that no user is ever assigned a parking slot with higher than the current cost function value. This mechanism ensures a better response from the system along with assured reservations. [3]

Faiz Shaikh1 and at all 2015 has proposed A Survey on “Smart Parking” System-----People owning vehicles face parking problems in most metropolitan area, especially during peak hours. The difficulty roots from not knowing where the parking spaces are available at the given time, even if this is known; many vehicles may pursue a small number of parking spaces which in turn leads to serious traffic congestion. This paper focuses on different smart parking techniques developed to overcome said problem using various wireless sensor network and providing real-time data analysis from the sensors, some papers include system based on resource allocation and reservation of parking lot which have various problems in efficiently achieving the goals. The given paper would be useful for new researchers for study of various guided parking and information techniques and algorithms which are covered in this paper. [10]

Prof. Yashomati R and at all 2016 has proposed Android Based Smart Car Parking System----- The purpose of this system is to computerize the parking space reservation. Its talk about undertaking which introduces a miniature model of car parking that can direct and manage the

number of cars that can be parked in given space at any given time based on availability of parking space after doing the registration by user using android application on his smart phone. car mated parking is a strategy for parking and leaving cars utilizing detecting device i.e., sensors. The entering to or leaving from parking lot is also commanded by an android-based application. This provides users to book parking spaces online in advance for given location and then park the vehicle with minimal fees. We have concentrated on some current systems and it shows that the current systems are not totally car mated and require a certain level of human interference and communication with the system. [12]

Vishwanath Y1 and at all -2016 has proposed **A** survey paper on smart parking system based on internet of things a Smart Parking system**----** It provides an optimal solution for parking problem in metropolitan cities. Due to rapid increase in vehicle density especially during the peak hours of the day, it is a difficult task for the drivers to find a parking space to park their vehicles. The aim of the paper is to resolve the above-mentioned issue which provides the Smart Parking system. This system uses cloud computing and Internet of Things (IOT) technology. A suitable shortest path algorithm is used to find the minimum distance between the user and each car park in the system. Thus, the waiting time of the user is minimized. The paper also introduces the usage of android application using smart phone for the interaction between the Smart Parking system and the user. RFID technology is used in this system to avoid the human intervention which minimizes the cost. [11]

Chapter-3

Methodology and Modeling

3.1 Introduction:

This chapter will cover the details explanation of methodology that is being used to make this project complete and working well. Many methodologies or findings from this field mainly generated into journal for others to take advantages and improve as upcoming research on projects. The methodology refers to the overall approach that our project requires. We need to explain our project briefly, demonstrating that we comprehend the meaning of our approaches. The methods are the tools of data collection, the procedure of our project. The procedures or strategies used to find, select, process, and analyze information about a topic are referred to as methodology. [14]

Shrewd Car Parking System Using Arduino UNO Designing, creating and delivering a main edge stopping innovation is called as Smart stopping.[12] It is a vehicle stopping framework that helps drivers locate an empty spot. Utilizing the Ultrasonic sensors in each stopping space, it identifies the nearness or nonattendance of a vehicle. Brilliant Parking framework is demonstrated as a correct, strong and cost-effective approach to guarantee that street clients know precisely where empty car parking spots are.

A particular procedure or set of procedures demonstrating the issue is massive revision of teaching methodology. In a report or article, the methodology section allows the reader to critically evaluate a study's overall validity and reliability. So, this methodology chapter explains what we did and how we did it.

3.2 Block Diagram of the proposed project

Block Diagram of our proposed system is given below:

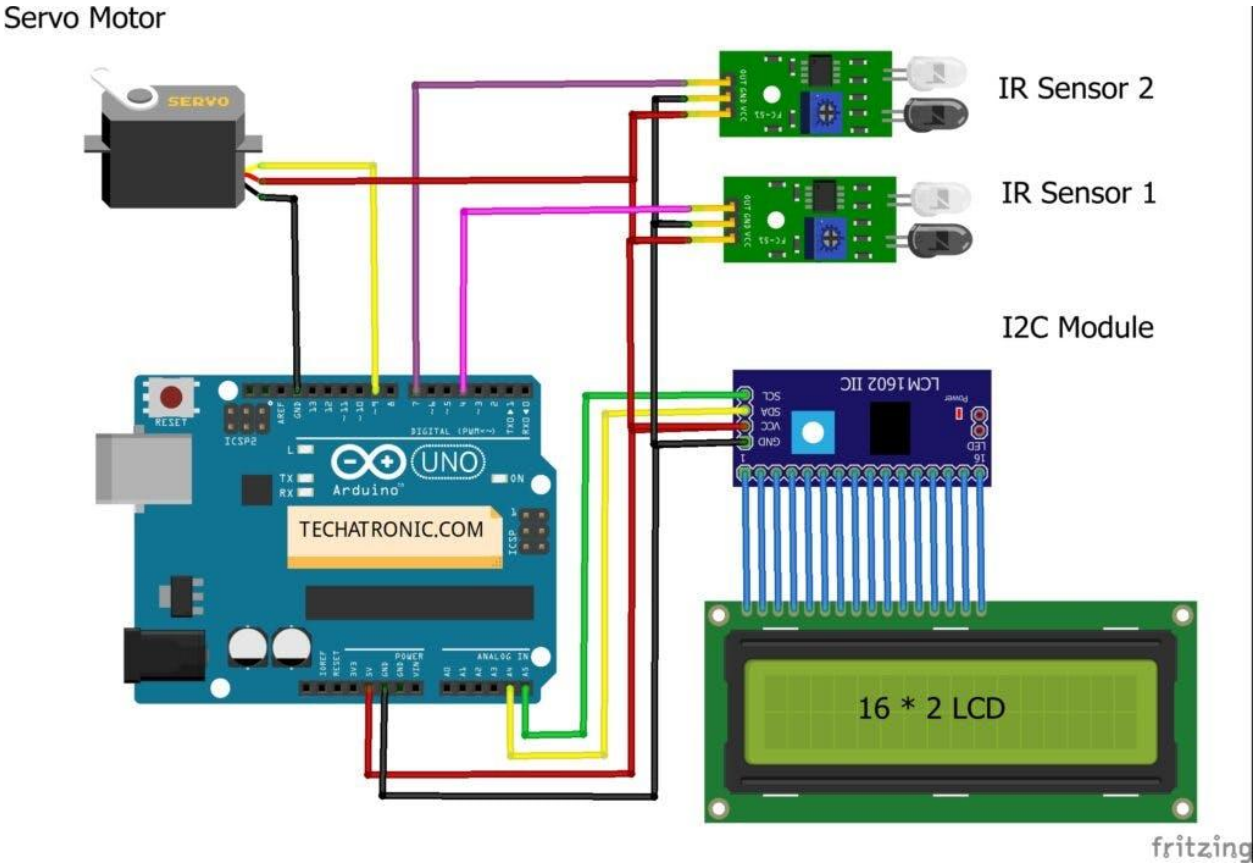


Figure-1: Block diagram of car parking system

The circuit shown in Fig. 1 an Arduino microcontroller (MCU) requires only 5V. As Arduino Uno has an inbuilt 5V voltage regulator, a common 5V supply can be used for the whole system.

The brain of the circuit is Arduino Uno MCU board (BOARD1). It is based on Arduino UNO R3 V1.0 and has 14 digital input/output (I/O) pins, six analogue inputs, servo motor, a USB connection, IR sensor with 12 C module among others. It can be programmed using Arduino IDE software IR sensor are connected to Arduino digital pins 2 and 3 and servo motor are connected to Arduino pins 13, which are used for serial communication.

The LCD display (LCD1) is used to display messages during action. Here, a 16×2 display is used; each character is made of 5×7 dot-matrix. Pins 3, 4, 5 and 6 of the LCD are the control lines connected to preset (PR1) output, pin 12 (Arduino), GND and pin 11 (Arduino). Pins 11, 12, 13 and 14 are data pins of the LCD that are connected to pins 7, 6, 5 and 4 of Arduino, respectively. Preset PR1 is used to adjust the contrast of the LCD display.

3.3 Construction and working principle:

The construction and working of the project are divided into two parts: -

1) Entry Part:

The project is a sensor based automatic system. The Entry Part of the project consists of Arduino Mega microcontroller to which a servo motor, IR sensor, LCD and ultrasonic sensor are interfaced. The servo motor acts as a gate at the entrance and it opens and closes when the IR sensor detects presence of car. The input IR sensors reads presence of any car and sends to the controller Arduino UNO board. While entry IR sensor detect car, it opens the door in condition of having available slot. After entering the car, the gate gets closed with the help of servo motor. The motor gets instruction from the board. The LCD displays the parking slots which are empty for the car drivers. While A car gets into a slot, the corresponding slot status in the LCD display shows "Have space". At the time of exiting a slot, the status of the slot changed to "Vacant". When all the slots are booked, the system doesn't allow the fourth car to enter, and shows "Sorry parking full". The ultrasonic sensors detect the presence and absence of car in each parking slot.

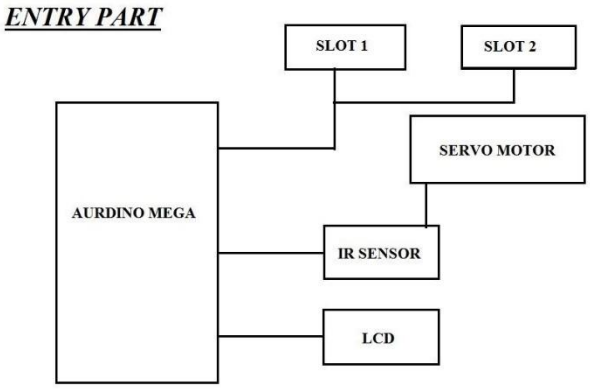


Figure-2: Entry part of car parking system

2) Exit Part

The Exit Part of the project consists of Arduino Uno to which a servo motor, IR sensor and the object counter are interfaced. The servo motor acts as a gate at the entrance and it opens and closes when the IR sensor detects presence of car. When a car exits from a slot, the exit IR sensor detects the car and opens the gate with the servo motor. Then total available free slot count increase by 1 in the screen.

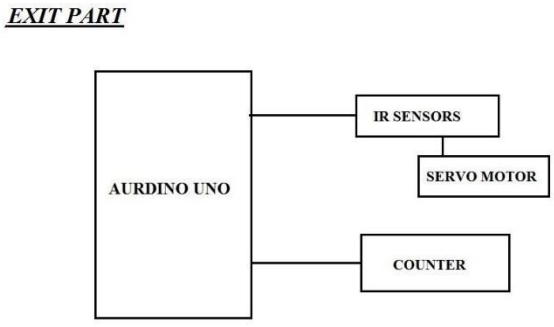


Figure-3: Exit part of car parking system

The system will be very reliable and understandable to the users.

3.3.1 Process of Work:

The project is a difficult technological problem that requires a certain method or working procedure to obtain the required outcomes. Users' cultural, religious, language, morality, and socioeconomic characteristics, such as education level, money, and gender, have no influence on how the process is developed, as explained in this research.

As a result, there is no such conflict in our system. Our technology is cost-effective and simple to deploy, and it will not cause any linguistic difficulties. The religious beliefs of people will be unaffected by this method. In addition, our method will not obstruct gender equity.

Our method will not affect other department without parking. It hasn't any issue with public security and people will be benefitted. Traffic Jam, a major problem of the country will be solved. That is to say, this approach will have a favorable influence on smart parking and may also be useful to all drivers. As a result, our system will not have any religious, economic, or moral disagreements because it is clarified that the device will save time and labor cost.

We prepared a poll based on our working method to learn about people's perceptions of whether our project would truly cause conflict due to language, religion, or culture. The following are excerpts from the survey:

Does the system have any impact on Religion?

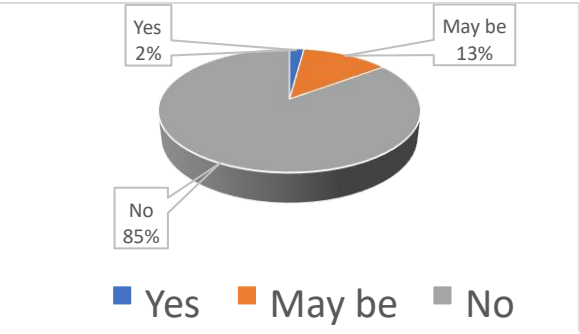
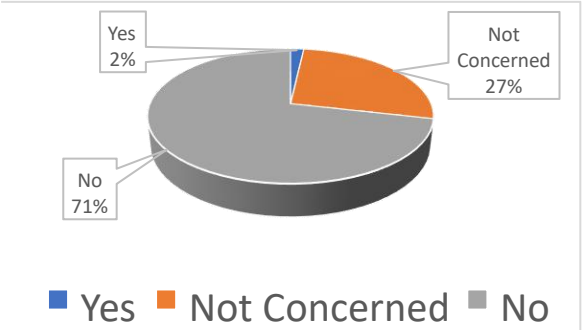


Figure-4:(a)

Can the project create any cultural conflict?



(b)

Figure-5: Graphical Representation of car parking system

3.4 Hardware Design

Hardware equipment that we need in order to build the project are given below:

1. Arduino UNO
2. Ultrasonic Sensor
3. LCD Screen
4. Bread Board
5. Power Supply
6. Connecting Wires
7. 12 C module

3.5 Description of the important component:

First of all, we use Proteus software to complete the simulation. in this simulation, we've used some important components to build the whole parking system, which are Arduino UNO R3 V1.0, LEDGREEN, LM044L 20x4 Alphanumeric Display, MOTOR-PWMSERVO, POT variable resistor, IR sensor with module.

3.5.1 Arduino Board:

Arduino is a project made by the largest technical community of engineers, developers and hobbyists whose goal is to develop ideas and interactive control projects around the world, based on different types of electronic panels but programmed in a language Single programming and free.

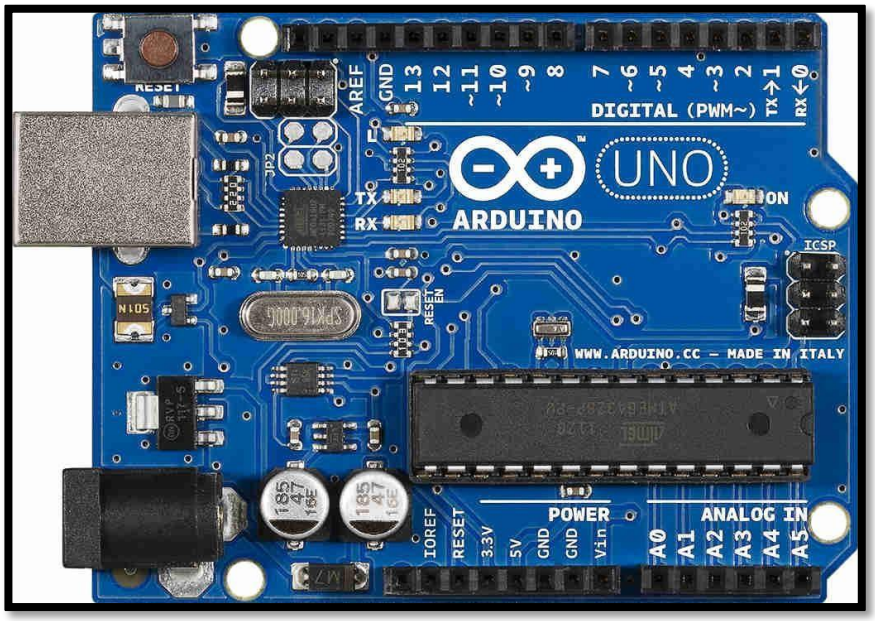


Figure 6: Arduino UNO Board.

Sure, Arduino is not the only electronic controller in the market, but there are many micro-controllers available in the market such as Parallax, Basic Stamp and the most powerful competitor, Raspberry Pi, all with powerful capabilities and the ability to work. Full projects, of course depending on the needs of your project, but what distinguishes the following Arduino Open-source platform Open-Source Hardware and Software.[23]

Arduino is made primarily of ATMEGA8 and ATMEGA168 controllers, and all its designs are licensed under the Creative Commons license. This is the most important feature for electronic circuit designers because it makes it easier for them to design anything they want. The software is written in C ++, and is available to everyone to download and programmers can modify it according to their needs.

It is the most widely used and widely used one of the many Arduinos. It is the first choice for beginners. It is easy to learn. It operates with an ATmega328 controller. This type has 14 digital ports (I / O), 6 of which can be used as ports to control the " PWM Outputs ", the most important feature of this type is that the control chip" ATmega328 "is not fixed in the board, but installed on the holder of the integrated circuit" IC ". This feature makes it the best option for beginners so that if burned the slide while working on your project by mistake, you can Restore your work on the board as soon as you change the slide The ATmega328 controller is similar to the same model.

The first-ever type of Arduino's motherboard is the ATmega32u4 controller, which has a unique feature that contains a built-in USB connection, eliminating the need to use a secondary processor. The feature allows the panel as soon as it is connected to your device to appear as a keyboard and mouse, which makes it ideally suited to build various applications that enable you to control your PC. [23]

Advantages of Arduino:

Simplicity

Arduino's paintings are designed to suit the needs of all engineers, designers, professors, students, and interactive electronics enthusiasts around the world.

Self-Assembly

Easy to deal with and easy to connect circuits, as we mentioned in our first article that it was an easy solution to the problem of microcontrollers and complex connections.

Multi-platform

The Arduino program has the ability to work with all the different operating systems of Windows, Mac and Linux, while most other boards running on Windows only

Easy and simple software environment

The "Environment" programming environment is designed to be easy for beginners and powerful professionals and its programming language "Arduino C" is easy to learn.[23]

3.5.2 LED-GREEN:

Proteus contains LEDs of different colors and types that are being used in real

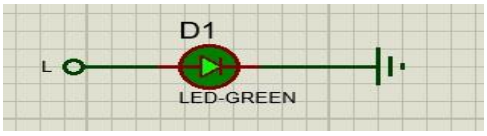


Figure 7: LED-GREEN

time applications. LEDs are found in Proteus software under Library Category Optoelectronics.

At LED **Green** Light International, we understand that LED lighting is the foundation of energy efficient, environmentally responsible and sustainable lighting technology.

That's why we design and market the most innovative and advanced LED lighting solutions for our customers – encouraging them to "**go green**" using advanced LED and Controls Products for every possible lighting application. [28]

3.5.3 16x2 Alphanumeric Display

16x2 Alphanumeric Display means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

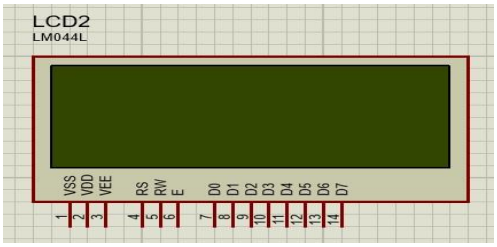


Figure 8: 16x2 Alphanumeric Display

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations etc.[24]

LCD 16×2 Pin Diagram

The 16×2 LCD pinout is shown below.

- Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.

- Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.
- Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.
- Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).
- Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).
- Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.
- Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.
- Pin15 (+ve pin of the LED): This pin is connected to +5V
- Pin 16 (-ve pin of the LED): This pin is connected to GND.

Features of LCD 16x2

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8-pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters [24]

3.5.4 SERVO MOTOR:

A Servo Motor is a small device that has an output shaft. This shaft can be positioned to specific angular positions by sending the servo a coded signal. As long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft.



Figure 9: SERVO MOTOR

The servo engine is a motor that comes with a Gear gearbox and a Shaft transmission that gives motion greater torque and greater precision. This engine can rotate 180 degrees and in some types 360 degrees. The servomotor is internally made up of a "mostly microcontroller" control circuit. When the engine gives pulses at a certain time constant, the engine rotates to the angle according to that time constant. Edited with the trial version of To remove this notice, visit www.pdfpro.co 14 In each type, the time constant varies from one engine to another according to the manufacturer and the technical bullet in that comes with the servo engine. In the Arduino, programming environment there is a library called Servo Library installed in the program. This library gives us the ability to control most of the 180-degree

Cervo drives. At the end of this post, you will have the ability to use the library's commands through practical examples.[25]

3.5.4.1 Servo Motor Working Mechanism

It consists of three parts:

1. Controlled device
2. Output sensor
3. Feedback system

It is a closed-loop system where it uses a positive feedback system to control motion and the final position of the shaft. Here the device is controlled by a feedback signal generated by comparing output signal and reference input signal.

Here reference input signal is compared to the reference output signal and the third signal is produced by the feedback system. And this third signal acts as an input signal to the control the device. This signal is present as long as the feedback signal is generated or there is a difference between the reference input signal and reference output signal. So, the main task of servomechanism is to maintain the output of a system at the desired value at presence of noises.[25]

3.5.5 POT variable resistor:

The potentiometer (POT) is the most common variable resistor. It functions as a resistive divider and is typically used to generate a voltage signal depending on the position of the potentiometer.

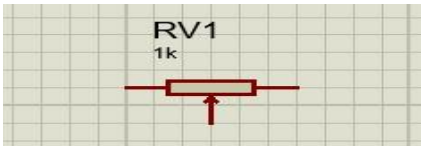


Figure 10: POT variable resistor

A potentiometer is a manually adjustable variable resistor with 3 terminals. Two of the terminals are connected to the opposite ends of a resistive element, and the third terminal connects to a sliding contact, called a wiper, moving over the resistive element. The potentiometer essentially functions as a variable resistance divider. The resistive element can be seen as two resistors in series (the total potentiometer resistance), where the wiper position determines the resistance ratio of the first resistor to the second resistor. If a reference voltage is applied across the end terminals, the position of the wiper determines the output voltage of the potentiometer.[26]

3.5.6 IR Sensor:

An infrared (IR) sensor is a type of electrical gadget that detects and measures infrared radiation in its surroundings. In the year 1800, an astronomer named William Herchel made an unintentional discovery of infrared radiation. He found that the temperature just beyond the red light was the highest when measuring the temperature of each hue of light (separated by a prism). Because the wavelength of IR is longer than that of visible light, it is invisible to the human eye (though it is still on the same electromagnetic spectrum). Infrared radiation is emitted by everything that emits heat (anything with a temperature over roughly five degrees Kelvin).[27]



Figure 11: Obstacle Infrared Sensor module MOD56

The IR sensor module includes five essential parts like IR Tx, Rx, Operational amplifier, trimmer pot (variable resistor) & output LED. The pin configuration of the IR sensor module is discussed below.

- VCC Pin is power supply input
- GND Pin is power supply ground
- OUT is an active-high o/p

The main specifications and features of the IR sensor module include the following.

- The operating voltage is 5VDC
- I/O pins – 3.3V & 5V
- Mounting hole
- The range is up to 20 centimeters
- The supply current is 20mA
- The range of sensing is adjustable
- Fixed ambient light sensor

Types of IR Sensor

The classification of IR sensors can be done based on the application which includes the following.

- Active Infrared Sensors
- Passive Infrared Sensors

Active IR Sensor

This type of sensor includes both the emitter & the receiver which are also known as transmitter & receiver. In most situations, a laser diode or LED is used as a source. For non-imaging infrared sensors, LED is used whereas laser diode is used for imaging infrared sensors.

The working of an infrared sensor can be done through radiating energy, detected and received through the detector. Further, it is processed through a signal processor to fetch the required data. The best examples of active infrared sensors are reflectance & break beam sensors.[27]

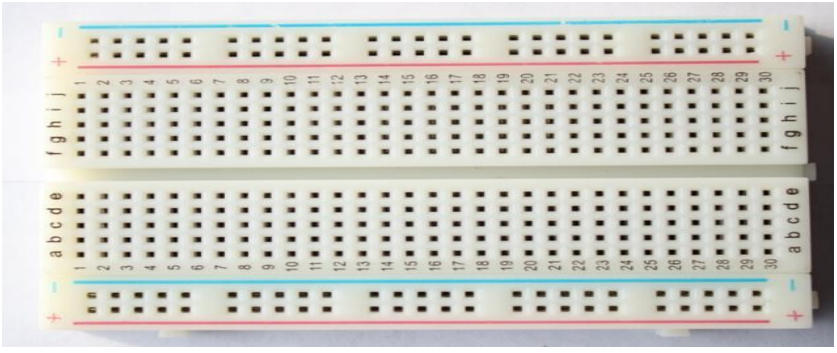
Passive Infrared Sensor

Passive Infrared Sensor (PIR) includes detectors only and this kind of sensor uses targets like infrared transmitters or sources. Here, the object will radiate the energy & detects it through infrared receivers. After that, a signal processor is used to understand the signal to obtain the required data. The best examples of PIR sensors are bolometer, Pyro-Electric Detector, Thermocouple-Thermopile, etc. PIR sensors are available in two types like thermal IR sensor and quantum IR sensor.[27]

3.5.7 Other Components:

The project uses some other electronic components like:

- Board:



- Connecting wires:



(b)

Figure -12: Other Components.

3.6 Flow Chart

The flow chart includes how the system works. The program flow chart is given below:

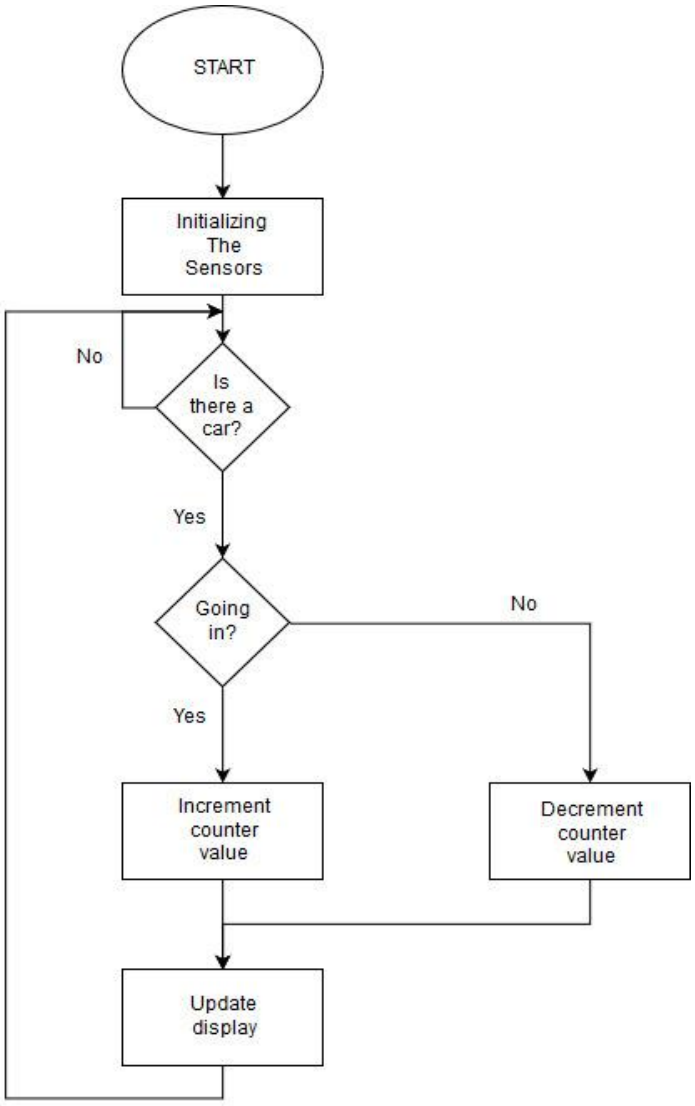


Figure-13: Flow chart of Smart Car Parking System

3.7 Implementation:

To implement the Smart Parking System, we have used Proteus professional 8.12 simulating software and Arduino IDE. Figure 9 shows the simulation implementation of the project.

Firstly, A new project created without any firmware in proteus. After creating the blank new project, there will be a schematic diagram window. In this schematic window, the simulation circuit is constructed. All of the devices used here, were found under pick device option. Arduino UNO R3 V1.0 was chosen as microcontroller board for Smart Parking System. This system works on the basis of some major components such as Arduino UNO R3, POT variable resistor, LED-GREEN, IR-SENSOR, MOTOR-PWMSERVO, LM044L 16x2 Alphanumeric Display

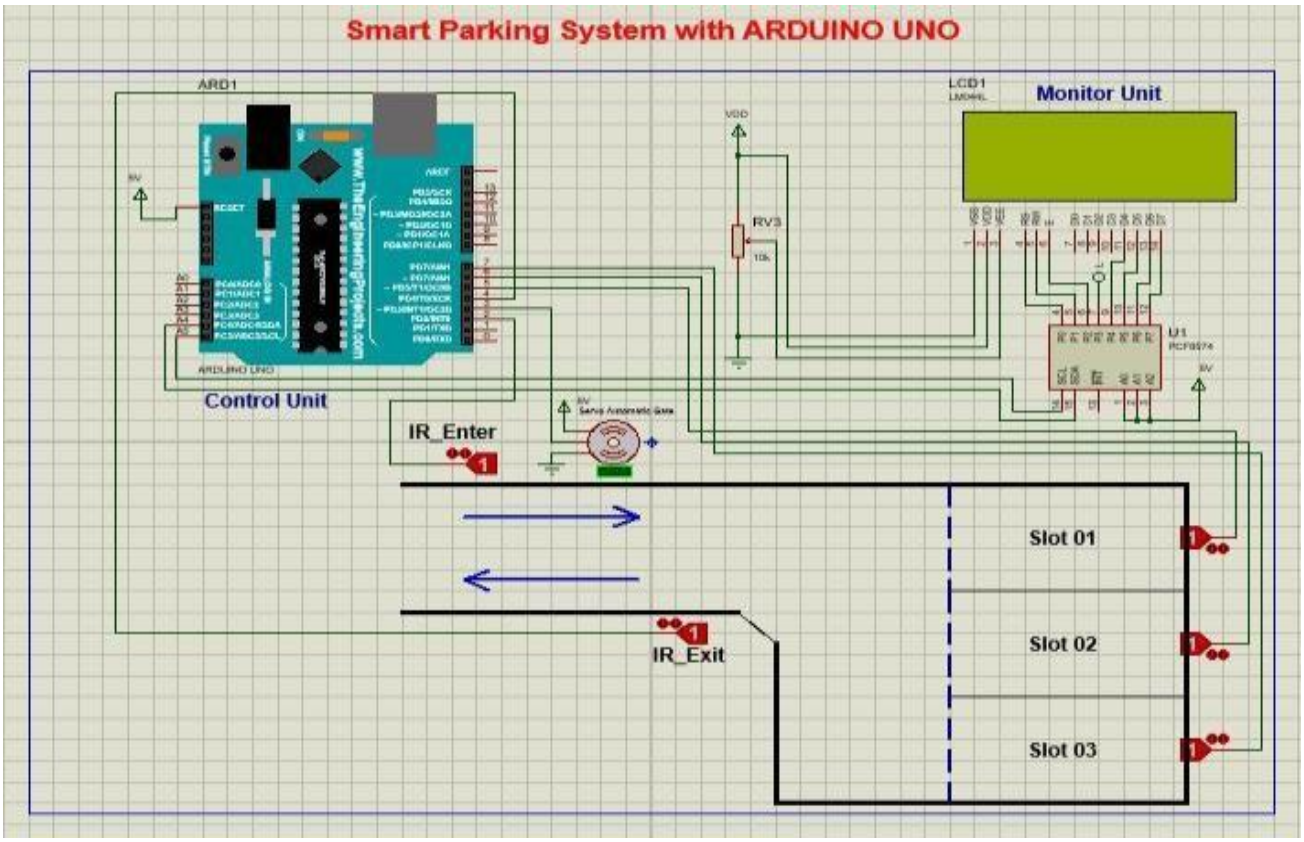
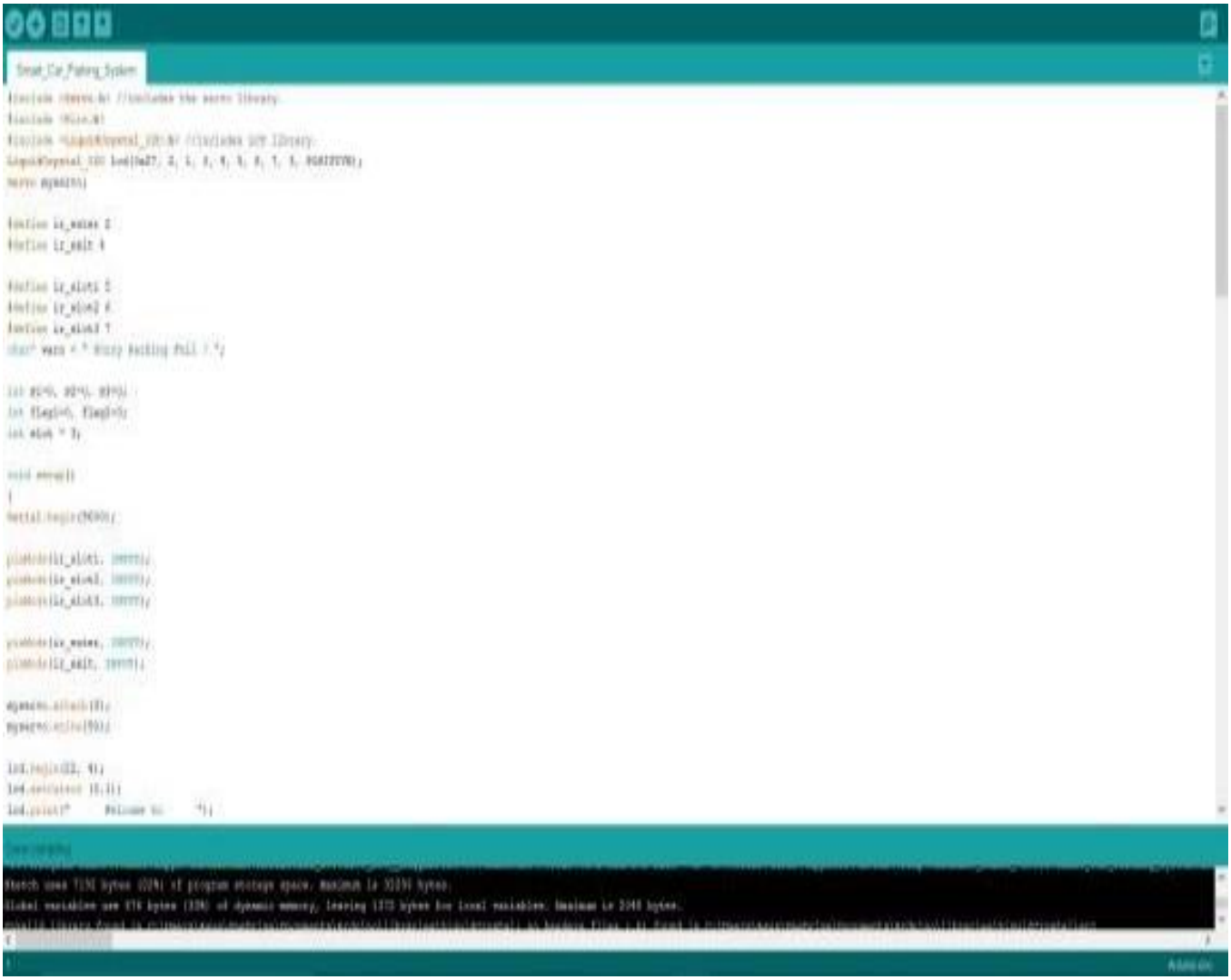


Figure 14: The design of Smart Parking System using Arduino UNO

had used in this project. The display was connected to the board through the expander. So basically, we have used the LM044L 16x2 Alphanumeric Display to print the slot list, each slot payment status of the parking lot. For the connection of the Display, we used Remote 8-bit I/O expander to reduce the connection with the Arduino pin. As it is a simulation-based project, here IR sensor use was not too easy. The logic states used to show the functionalities of the IR sensors. Every logic states connected to individual digital I/O pin of the Arduino UNO. The servo motor



was.

Figure15: The code window on Arduino IDE

also connected with a digital pin for get instruction and it get external power to run. Two IR sensor set at the gate of the parking spot for detect entry and exit of car. Each slot also has IR sensor to identify slot is empty or not. The servo motor rotates 180 degrees to open the gate and 90 degrees to close the gate. The green LED lights while the whole system is turned on. Pot variable resistor ensures different power supply to the LCD display. After setting up the components as figure 9, we went to Arduino IDE and installed all the necessary libraries to run the project successfully. Then the codes/commands were written and uploaded to the Arduino Board. After upload finely, the code worked without any errors.

3.8 Test/Experimental setup:

While doing the setup, the project was evaluated that every functionality is accomplished or not. The code was edited as proposed requirements.

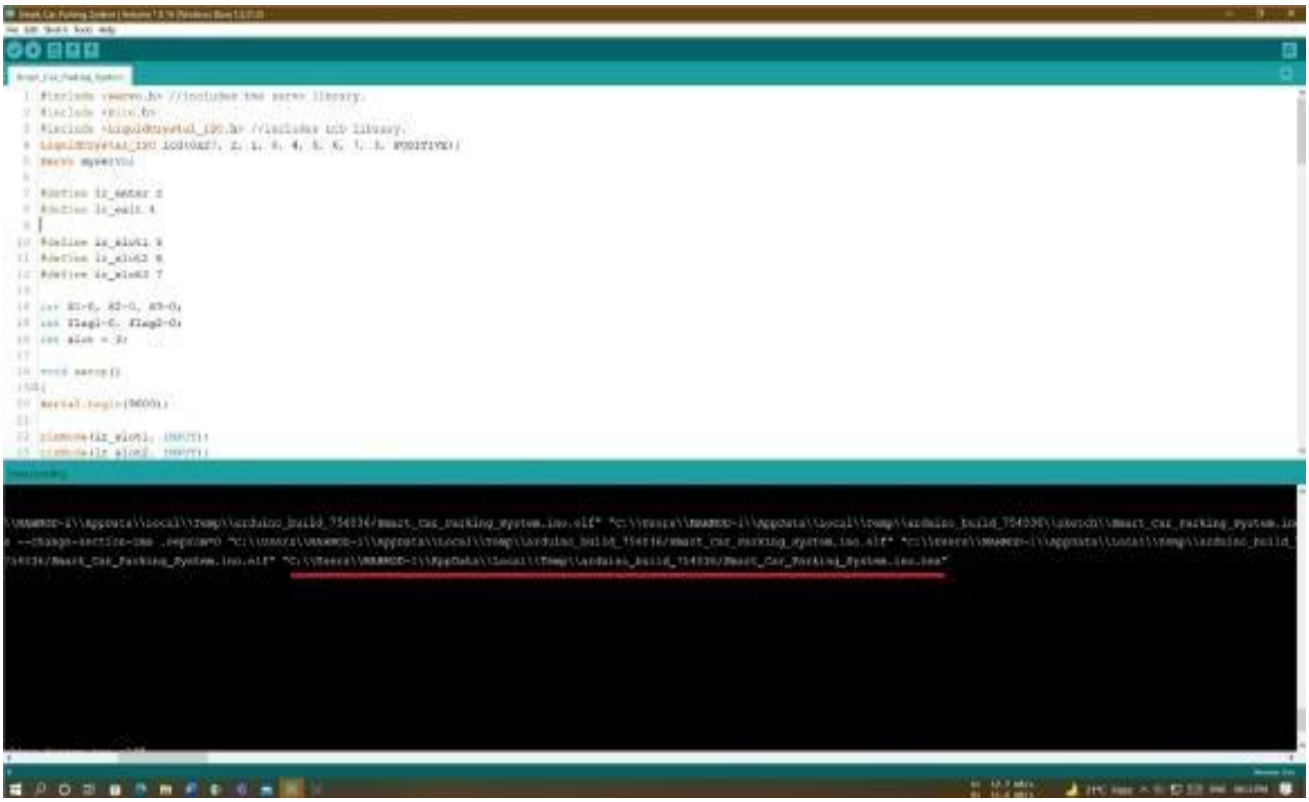


Figure-16: Hex File in Arduino IDE

After running the instruction code finely, there will be a .HEX file found under IDE's compiler console and this file location should be copied. In proteus, double click in the Arduino board and in the program file section, paste the link without any change. Click ok and run the simulation. The system will run expectedly. All the output was observed while running the simulation as like following.

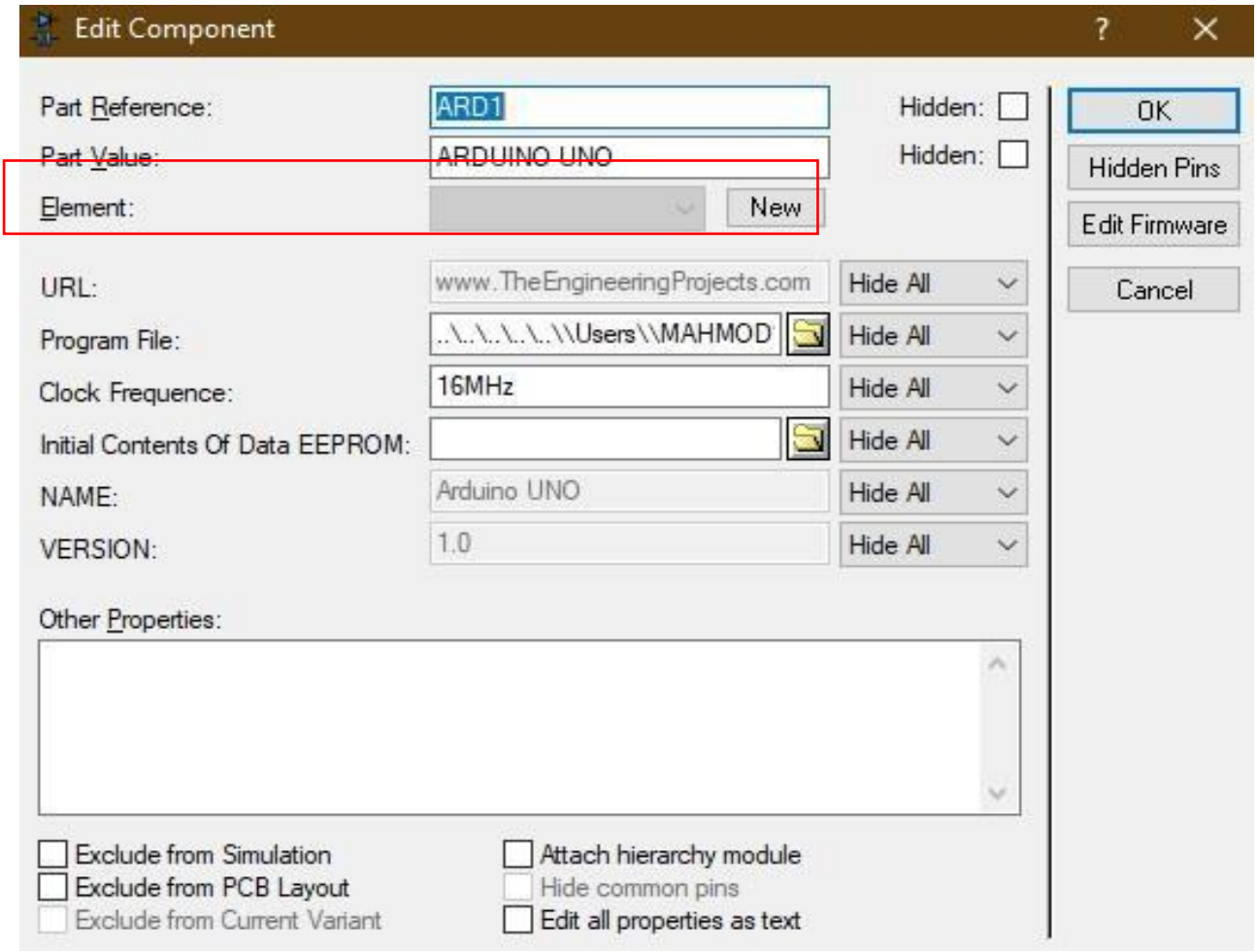


Figure-17: The program file location for Arduino

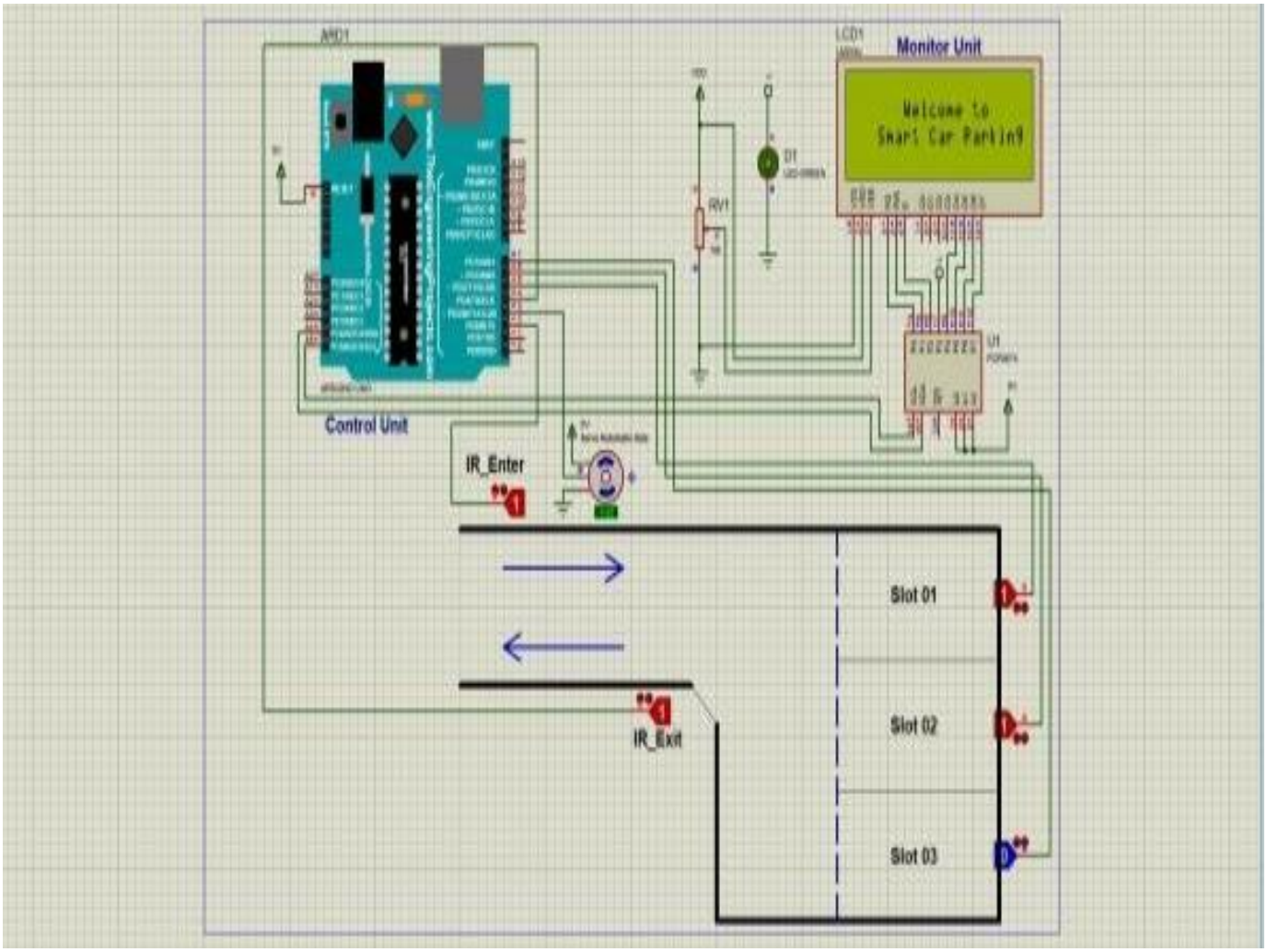


Figure-18: After Simulation Run Successfully

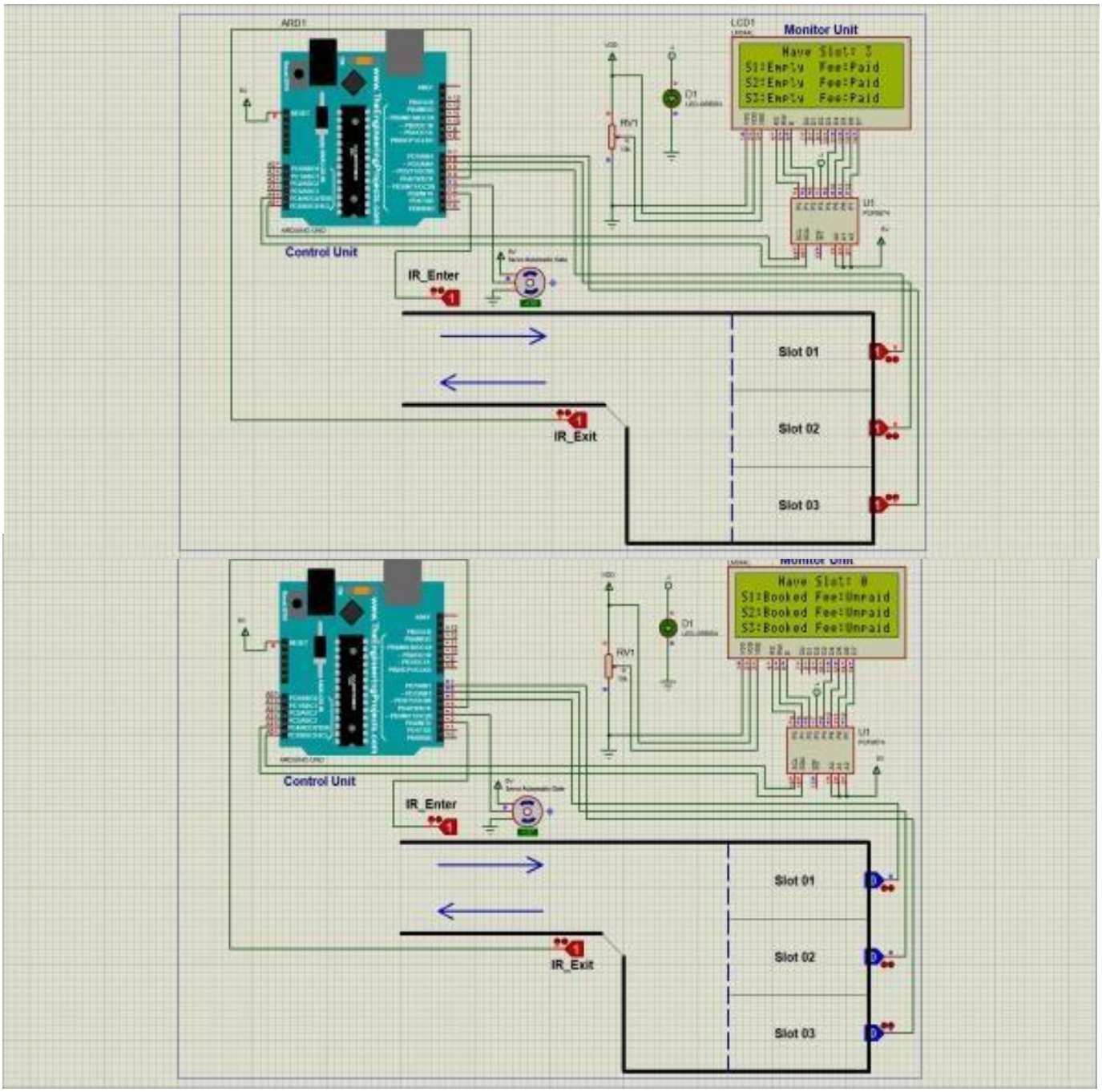


Figure-19: Running Simulation

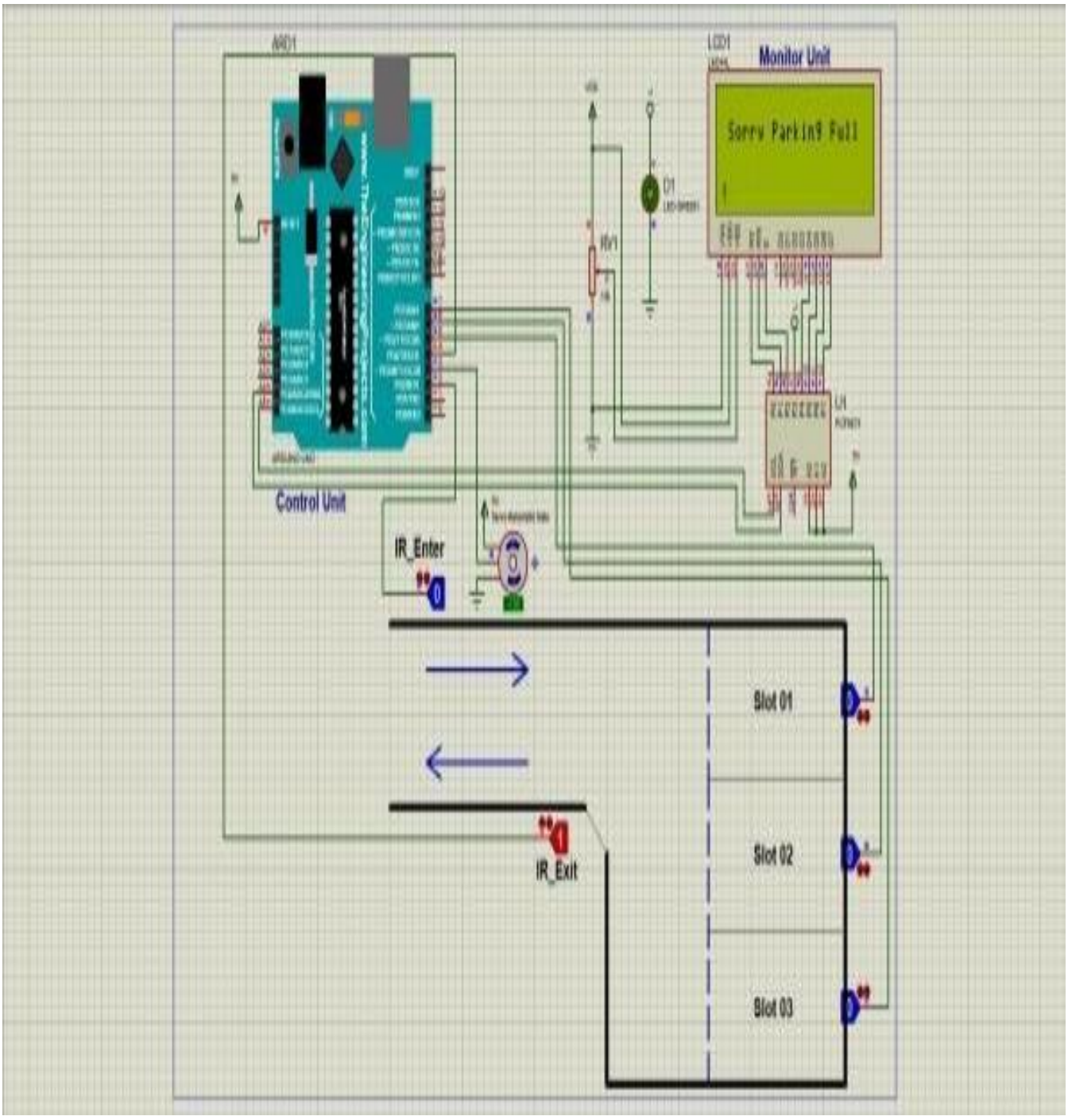


Figure-20: Running Simulation

3.9 Cost analysis:

The costs of each individual components are listed here.

Item	Quantity	Price (Taka)
Arduino UNO Board	1	600/=
16x2 LCD	1	300/=
LED Indicator	3	10/=
Servo Motor (PWM)	1	350/=
PCF8574 Remote 8bit I/O Expander	1	250/=
IR Sensor	5	450/=
Variable Resistor	1	30/=
Connection Wire	4 yards	40/=
Total		2030/=

Here, the total cost is BDT 2030/=. Here we tried to keep the cost minimal and used better components to implement the circuit. This budget will not so over for such a sustainable system with good components. We used less wire and other unnecessary components to complete the project.

3.10 Problem Statement:

Parking Lot Problems

Difficulty in Finding Vacant Spaces Quickly finding a vacant space in a multilevel parking lot is difficult if not impossible, especially on weekends or public holidays. Finding spaces during weekends or public holidays can take more than 10 minutes for about 66% of visitors. Stadiums or shopping malls are crowded at peak periods, and difficulty in finding vacant slots at these places is a major problem for customers. Insufficient car park spaces \ lead to traffic congestion and driver frustration.

Improper Parking

If a car is parked in such a way that it occupies two parking slots rather than one, this is called improper parking. Improper parking can happen when a driver is not careful about another driver's rights. This is tackled by the development of automated smart car parking system.

Chapter-4

RESULTS AND DISCUSSION

1. It guarantees snappy and computerized parking and simple recovery of vehicles.
2. Up to 3 cars can be effectively and securely parked in the outlined model.
3. The surface space required is identical to the parking spot of two cars as it were.
4. Most reasonable for parking in workplaces, shopping centers and comparable spots.
5. Low support levels are required by the framework.
6. Sensors utilized have high affectability and are anything but difficult to deal with.
7. Minimal effort framework, giving most extreme computerization.
8. It doesn't require observable pathway operation.
9. Cordial reorientation of cars for driving in and out.
10. Security of vehicle.

4.1 Hardware Connections:

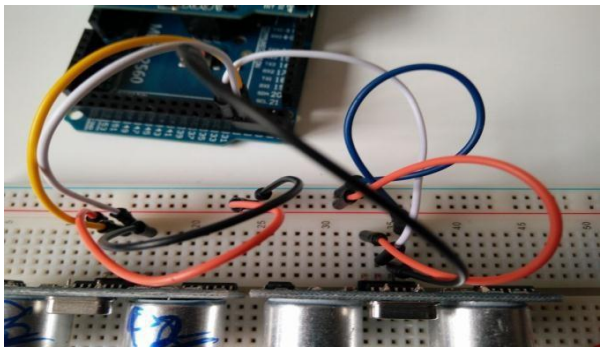


Figure 21: Working model of Smart Car Parking System

- Connect the Vcc stick to the positive rail on your breadboard.

- Connect the Gnd stick to the negative rail on your breadboard.
- Connect the Trig stick to any advanced stick on the Arduino.
- Connect the Echo stick to any computerized stick on the Arduino.
- Finally, interface the positive rail of the breadboard to 5V stick on the Arduino and the negative rail of the breadboard to the Gnd stick on the Arduino.

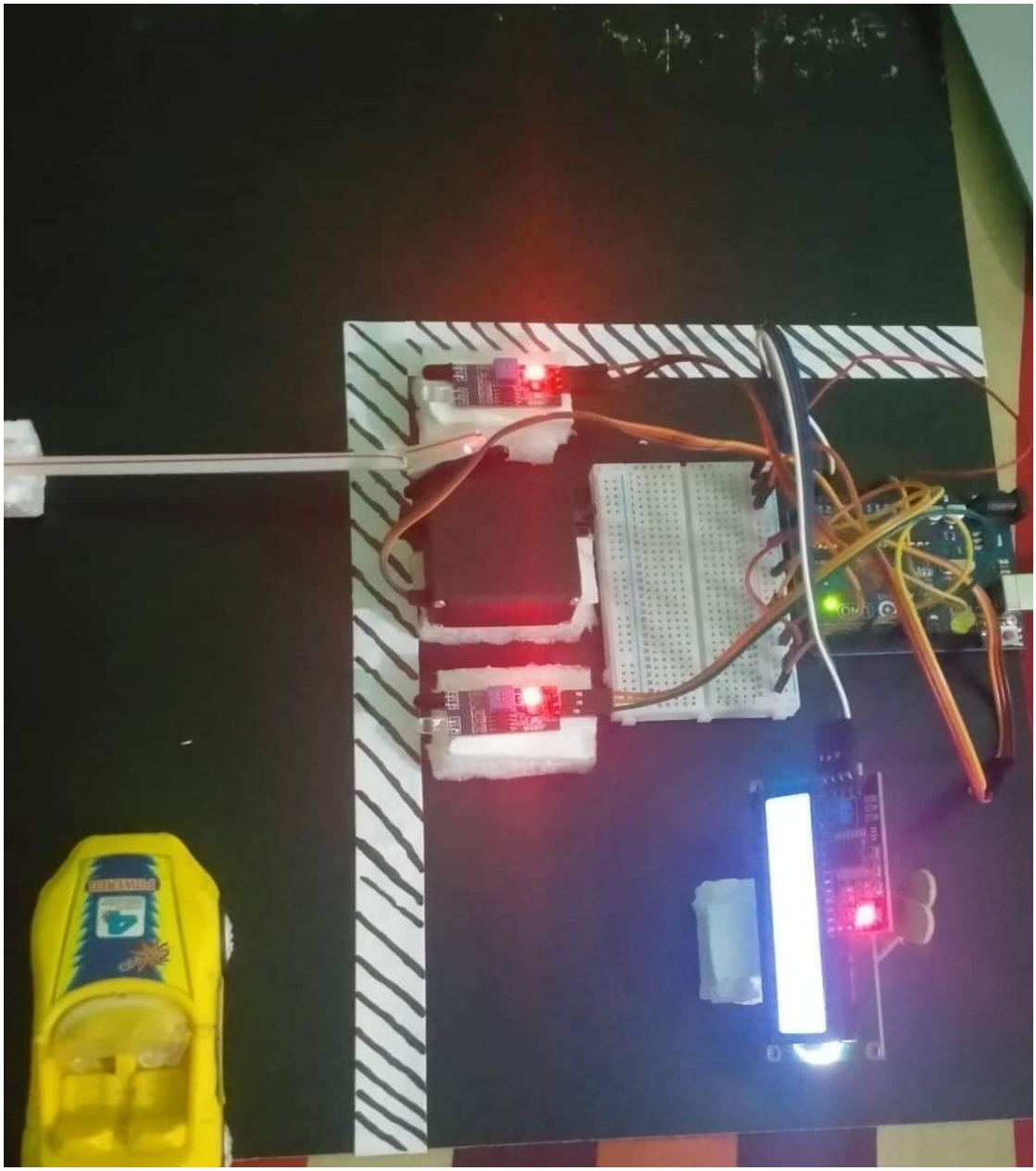


Figure-22: Actual Working Model

4.2 Simulation/Numerical analysis:

During test run, all the simulation data were stored. At the initial point of running the circuit, a welcome message is seen in the LCD screen for 1500 milliseconds. After that, the display shows total available free slots at the 1st line. Then all the slot status are updated consecutively as well as the payment status of each slot. There were not so unexpected occurrences but the operation was performing a little bit slower and the servo motor movement was delayed a little though it was not so longer. Sometimes, LCD texts was fluctuating and rendering with delay. But each operation was running finely.

4.3 Measured response/Experimental results:

Though it is a simulation-based project, physical observation was not possible to perform. Thats why here we are not adding any data now. The experiment will be implemented in lab and this section will be updated then.

4.4 Comparison between numerical and experimental results:

The thing observed from the experiment are as follows:

Total Parking Slot = 03			
Car at Entry-IR	1	1	0
Car at Exit-IR	1	0	1
Servo_Motor	90	180	180
Free Slot	X	X+1	X-1

All the simulated data combination are noted here. While any car wants to enter, the IR-Entry is turned to 0 and the servo opens the gate. When a car exits, IR-Exit turned into 0 and the gate

opens. The slot number increases and decreases respectively. The system did not malfunction at any test condition.

4.5 Advantage of smart car parking system

1. Reduced traffic
2. Reduced pollution
3. Enhanced User Experience
4. Integrated Payments and POS
5. Increased Safety
6. Real-Time Data and Trend Insight
7. Decreased Management Costs
8. Increased Service and Brand Image
9. Secutiry from theft and car damages
10. Simple structure, simple operation

4.6 Disadvantage of smart car parking system

1. It achieves wireless technology with limited options of connecting to particular device only
2. It does not know who the driver in the car is, checks only the key placed
3. Node-to-node implementation requires more time.

4.7 Benefit analysis of smart car parking system

1. Reduced traffic

2.Reduced pollution

3. Enhanced User Experience

4. Integrated Payments and POS

5.Increased Safety

6. Real-Time Data and Trend Insight

7. Decreased Management Costs

8. Increased Service and Brand Image

Chapter-5
CONCLUSIONS AND FUTURE WORK

5.1 Conclusion

Our project detects the empty slots and helps the drivers to find parking space in unfamiliar city. The average waiting time of users for parking their vehicles is effectively reduced in this system. The optimal solution is provided by the proposed system, where most of the vehicles find a free parking space successfully.[22] Our preliminary test results show that the performance of the Arduino UNO based system can effectively satisfy the needs and requirements of existing car parking hassles thereby minimizing the time consumed to find vacant parking lot and real time information rendering. This smart parking system provides better performance, low cost and efficient large scale parking system. When car enters the parking area, the driver will park the car in the nearest empty slot when slot is occupied the LED light glows and when slot is empty LED lights are turned off chromatically indicating that the parking slot is empty to be occupied. [21]It also eliminates unnecessary travelling of vehicles across the filled parking slots in a city. Smart Parking solutions are designed to provide drivers an ultimate solution on their journey from the beginning to end without searching for parking, cost, travel time etc. This advantage comes by paying marginal fees to the smart parking service providers. To change a culture which has been existing for several centuries is a humongous task. Parking has always been an at the moment affair with direct cash exchange. The inclusion of technology in this method is a change in culture which will take the time to establish. Smart Parking is one of the most adopted and fastest growing smart city solutions across the world. Airports, universities, shopping centers and city garages are just a few entities that have begun to realize the significant benefits of automated parking technology.[28]

In this study, the various types of smart parking system and has been presented. From the various examples of the implementation of the smart parking system being presented, its efficiency in alleviating the traffic problem that arises especially in the city area where traffic congestion and the insufficient parking spaces are undeniable. It does so by directing patrons and optimizing the use of parking spaces. With the study on all the sensor technologies used in detecting vehicles, which are one of the most crucial parts of the smart parking system, the pros and cons of each

sensor technologies can be analyzed.[16] Although, there are certain disadvantages in the implementation of visual based system in vehicle detection as described earlier, the advantages far outweigh its disadvantages.

5.2 Future Work

In some of the parking areas are lacking such facilities and hence fail all the security norms necessary to park a vehicle. By looking such a huge concern, it is highly required that each and every parking area should be well equipped with high tech parking control systems, that nevertheless lasts the best. These innovative parking control systems not only make a bright choice but also allow you to pay the right price without getting any worry.[12] Parking control system has been generated in such a way that it is filled with many secure devices such as barricades, swing gates, slide gates, parking control gates, toll gates, time and attendance machine, car counting system etc. These features are hereby very necessary nowadays to secure your car and also to evaluate the fee structure for every vehicle's entry and exit. Nowadays parking is very important and hence it is necessary for every vehicle owner to park his or her car in a secure designated parking slot available. To escalate this particular system various parking owners have integrated themselves with sophisticated parking control systems, which are high tech and offers full-fledged parking services.[6]

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Appendix A:

1. **Arduino IDE:** The Arduino IDE is an opensource program for writing and uploading code to Arduino boards. The IDE program is compatible with a variety of operating systems, including Windows, Mac OS X, and Linux. C and C++ are supported programming languages. IDE stands for Integrated Development Environment in this case. Sketching refers to the process of writing a program or code in the Arduino IDE. To upload the sketch written in the Arduino IDE software, we must connect the Genuine and Arduino boards to the IDE. The '.ino' extension is used to save the sketches.

2. **Proteus Professional 8.12:** Proteus Professional 8.12 is the simplest and most advanced software for designing circuits. In which you will have to search for components, place them in the workspace and connect these with wires. It is mostly used for designing and testing circuits. It has different measuring devices like oscilloscope, voltmeter. Ammeter etc. Also using this software, you can also model micro-controllers, microprocessors, and different sensors for circuit designing. This is the complete package in which you can design any circuit of your choice for free.

3. **Servo-Motor:** A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

4. **Arduino Library:** The Library is considered as the advanced feature, which extends the capabilities of the Arduino IDE. It means that the libraries provide extra functionality to the programming platform of Arduino. The libraries in Arduino are written in C or C++ (.cpp). These libraries allow us to manipulate data and work with the hardware. To implement any Library in the Arduino IDE, go to the Sketch -> Import Library. There are several libraries available for download. We can also create our own library.

5. **Schematic Capture:** Schematic capture or schematic entry is a step in the design cycle of electronic design automation (EDA) at which the electronic diagram, or electronic schematic

of the designed electronic circuit is created by a designer. This is done interactively with the help of a schematic capture tool also known as schematic capture.

APPENDIX B

Arduino Part (Coding Summary)

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
#include<Servo.h>
Servo s;
int ir1 = 7;
int ir2 = 9;
int light = 13;
int total = 2;
void setup()
{
  s.attach(3);

  pinMode(ir1, INPUT);

  pinMode(ir2, INPUT);
```

```
  pinMode(light, OUTPUT);
  lcd.init();
  // Print a message to the LCD.
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("Total Space: ");  lcd.print(total);
}
void loop() {
  lcd.setCursor(0, 1);
  lcd.print("Space Left: ");  lcd.print(total);
  s.write(0);
  if (digitalRead(ir1) == LOW)
  {
    if (total > 0)
    {
      for (int i = 0; i <= 90; i++)
      {
        s.write(i);
        delay(20);
        if (i == 90)
        {
          while (digitalRead(ir2) != LOW);
        }
      }
      for (int i = 90; i >= 0; i--)
      {
        s.write(i);
        delay(20);
      }
      total = total - 1;
    }
```

```
  }
  if (digitalRead(ir2) == LOW)
  {
   if (total < 2) {
     for (int i = 0; i <= 90; i++)
     {
      s.write(i);
      delay(20);
      if (i == 90)
      {
        while (digitalRead(ir1) != LOW);
      }
     }
     for (int i = 90; i >= 0; i--)
     {
      s.write(i);
      delay(20);
     }
     total = total + 1;
   }
  }
}
```