

# **Automated Car Parking System**

**A Thesis Submitted in Partial Fulfillment of the  
Requirement for the  
Degree of Bachelor of Science in Electrical and Electronic Engineering**

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### **DECLARATION**

We hereby declare that, the thesis titled “Automated Car Parking System” is our work. The work has not been presented elsewhere for assessment. Where materials has been used from other sources, it has been properly acknowledged.

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## **Abstract**

Now a day's vehicle parking is an important issue and day by day its necessity is increasing. In Bangladesh we are still using the manual vehicle parking system and that is why we are facing problems like wastage of time and fuel finding free space around the parking ground when we need to park our car which requires a good amount of lighting. Another issue is chaos that happens while parking because there is no particular system anyone can park anywhere that sometime causes damage to the vehicles while moving out or in the parking lot. Security is also an issue there.

To solve these problems we are introducing new car parking system. The system works as follows: The driver will place the vehicle in front of the garage door and there will be a monitor available where the number of available parking slots will be displayed. The user will have to provide his mobile phone number and car's registration number and the operator will give command to open the gate, a car parking tray will come & will park the car in the garage. The user will receive a SMS which will contain a code. After the car is parked a time counter will count the amount of money to be deducted till the car is parked out. While parking out the driver will have to provide the code to the operator at the exit gate. The user will receive a SMS stating the amount to be paid. After paying the amount the car parking tray will park out the car using the same process it was parked out.

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## ***ABBREVIATION:***

**APS:** Automated Car Parking system

**AGV:** Automated Guided Vehicle

**RGC:** Rail Guided Cart

**LCD:** Liquid Crystal Display

**GSM:** Global System for Mobile Communication

**SIM:** Subscriber Identification Module

**HTTP:** Hyper Text Type Protocol

**GHG:** Green House Gas

## ***Chapter 1***

### **Introduction**

#### ***1.1 Introduction to Automated car parking System:***

Over the decades our country has been developed drastically, now we are in this state that we have a lot of well contacted roads, commercial building and increasing number of automobiles. While parking these automobiles in parking space we use the manual procedure of parking. Which most of the cases is unplanned and lack of discipline due to this, people can park their cars anywhere they want to, which creates a mess as people do not follow the particular cue most of the time. As a result of this, a huge traffic jam takes place in that place. While parking in and retrieving car due mismanagement cars can get dent by bumping with each other as there is lack of sufficient space. This leads to arguments, fights among people which sometimes makes huge traffic jam. This is also an economical loss as we need to repair our damaged car and also cars consumes extra fuel while parking in or out. Traffic jam is an issue here as it kills our precious time. Due to this chaos in parking our valuable time gets wasted. It harms the students, office going staffs and emergency patients to a great extent.



Figure 1.1.1: Existing Car Parking

It also causes economical loss to commercial places like shopping malls, amusement parks as people are more likely not to visit these places due to this parking hazard. As we are advancing with time, the manual car parking system in commercial spaces is creating hurdle which is causing wastage of time and some economic losses as well. Therefore we need a solution which can overcome these problems. Here we are introducing Automated Parking Systems as a solution of these problems as well as a car parking system in commercial spaces is creating hurdle which is causing wastage of time and some economical losses as well. Therefore we need a solution which can overcome these problems. Here we are introducing Automated Car Parking Systems as a solution of these problems as well as a replacement to the manual car parking systems at commercial spaces. This system not only saves time and money, it can also earn money by charging for parking spaces.

**AUTOMATED PARKING SYSTEM**

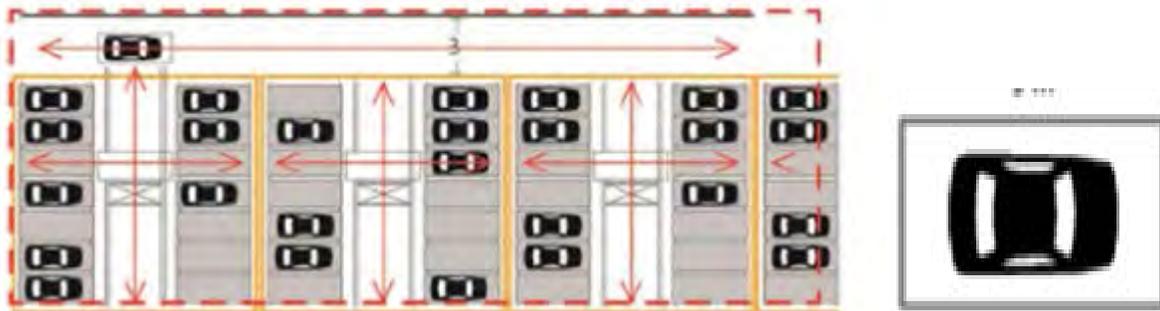


Figure 1.1.2: Proposed Automated Car Parking System

## ***1.2. Problems with the Traditional car parking system:***

Traditional or manual car parking system is everywhere in our country but this system is full of problems. They are:

1. We can see in many shopping malls, hospitals huge traffic jam in front of the parking. The parking guard stops the entire vehicle and gives a payment slip, this creates traffic jam.
2. It is difficult and time consuming to find out the parking slot which costs extra fuel and wastes time.
3. Security problem is one another problem in manual car parking, people can enter in parking slot and there snatching, robbery can happen.
4. In manual parking system some guard needs to be appointed for the whole job, it is costly enough.

## ***1.3 Advantages of automated vehicle system:***

The advantages of automated car parking systems are:

### ***1. Reducing traffic jam:***

Automated vehicle system reduce the traffic jam because here we are using a card system for paying the money, punching the card in the payment booth and one tray will place the vehicle in required place

### ***2. Time saving:***

It is a time saving system. In manual parking system it is too hard to find out the empty space for parking, it is very much time consuming. Sometimes it causes late in meeting or other important works.

### ***3. Safety in the parking:***

Here no people can enter in the parking so that there is no chance of snatching, robbery, stealing, sometimes in silent parking space peoples are being harassed. This system prevents these problems.

### ***4. Fuel saving:***

In this system we are using an automatic tray which will take the vehicle into the parking space and place it in required slot. This will reduce the fuel cost. Here we do not need to lighting all over the parking space. It will on the light when it moves and where is the path and it is very much electricity saving also.

## **5. Operating cost saving:**

Over a period of time, the parking charge collecting cost is reduced. There is reduction in the man-hour required as the system does not require any human interaction for the money transaction.

### ***1.4 Motivation and Objectives:***

#### ***1.4.1. Motivation:***

The motivation of the project is, we want to digitalize our daily life as well as our country. In many countries this automated vehicle system is available and popular.

#### ***1.4.2 Objectives:***

The objectives are:

1. Introducing automatic vehicle parking system in Bangladesh and get benefited by it.
2. To compare various aspects of this manual parking system with the automated parking system.
3. To find out the economic benefits of introducing automated vehicle system.

### ***1.5 Background of our project:***

Over the decades our country has been developed drastically, now we are in this state that we have a lot of well contacted roads, commercial building and increasing number of automobiles. With the increasing amount of roads and highways transportation has become the backbone of our day to day life.

Transportation has also become the backbone of our economy for its wide usage in trade and business. So parking of these transportation or vehicles has become a matter of consideration. While parking these vehicles in parking space we still use the very old fashioned manual procedure of parking. Which are maintained in unplanned manner, without any discipline. Due to this people can park their cars anywhere they want to, which creates a mess as people don't follow any discipline most of the time. While parking in and retrieving car due mismanagement cars can get dent by bumping with each other as there is lack of sufficient space. This leads to arguments, fights among people which sometimes create traffic jam. This is also an economical lose as we need to repair our damaged car. Cars consume extra fuel while parking in or out. Due to this chaos in parking our valuable time gets wasted. It harms the students, office going staffs and emergency patients to a great extent. It also causes economical loss to commercial places like shopping malls, amusement parks as people are more likely not to visit these places due to this parking hazard. Automated car parking systems will provide several benefits. It will save time and fuel cost. In manual parking system it is too hard to find out the empty space for parking, it is very much time consuming. Sometimes it causes late in meeting or other important works. It will save fuel as in this system an automatic tray will take the vehicle into the required slot. This will reduce the fuel cost of searching for parking space, parking in and out. Here we do not need to lighting all over the parking space all the time. It will only have the lights on when it moves and where is the path and it is very much electricity saving also. It provides security from theft of vehicle and it can earn revenue. It can introduce us to advanced digitalized systems which show us the Engineering excellence in our country.

### ***1.6 Different Type of Automated Car parking Systems:***

There are mainly seven different types of automated car parking system:

- AGV systems
- Crane systems
- Puzzle systems
- RGC systems
- Shuttle systems
- Silo systems
- Tower systems

#### ***1.6.1 AVG Systems:***

Automated Guided Vehicle known as AGV technology has been introduced in automated parking system most recently though AGVs has been used in automated warehousing for decades. The vehicles are parked on pallets in the parking space which are collected from the parking entrance by the AGVs driving beneath the vehicle pallet, lifting it and then parking it in the parking space. The number of AVGs in the system is flexible and can be based around the client's requirements. Generally AVG systems operate on solid finished concrete floors that can move in both lengthways and sideways directions along fixed paths and are able to rotate on the spot. This allows the vehicle pallets to be collected by an AGV from any direction and with several AGVs operating on a floor. It also allows for multiple, simultaneous parking and retrieval movements along multiple paths. To move the vehicle pallets with or without an AGV, vehicle elevators are used within the system.



Figure 1.6.1: AVG Systems

### ***1.6.2 Crane Systems:***

This system is used utilizing a single mechanism that is to simultaneously perform the horizontal and vertical movements of the vehicle to be parked or retrieved in the parking system. This mechanism allows the vehicle platform to move to and from one parking spot to another very quickly. The crane mechanism has a vertical elevator platform fitted and it moves horizontally on rails, typically located on the floor and ceiling of the parking system, where vehicles to be parked and retrieved are placed, which means that a floor-to-ceiling opening in the center of the system is required for the crane for the crane(s) to operate.



Figure 1.6.2: Crane Systems

This mechanism can move in line with the normal direction of a vehicle or orthogonal to it depending on the site constraints. The crane system also has two cranes running parallel to one another should the site constraints allow it, if higher throughput or redundancy is required. The system redundancy is potentially low but back-up motors; switches, etc. can be installed to increase the system's redundancy as there is typically only one mechanism for the parking and retrieval of vehicles and turning devices can be fitted under the vertical elevator platform.

### ***1.6.3 Puzzle Systems:***

Puzzle systems offer the densest form of automated parking as it utilizes around 95% of the floor area and often used in smaller systems. A grid of pallets covers a solid floor or steel frame, and each pallet is supported by a set of rollers and belts that are driven by motors fitted to the support frames underneath each pallet location in a horizontal puzzle system. Until the pallet with the required vehicle on is maneuvered to the desired location, the rollers and belts maneuver the pallets. The frames, supported by the pallets are installed in all possible parking positions. Typically there are two fewer pallets than support frames per floor that provides the necessary free spaces to maneuver the pallets.



Figure 1.6.3: Puzzle System

Puzzle systems provide flexible layout options as the system configuration is highly adaptable because a pallet can be moved in any directions. The system shape can vary greatly, such as: rectangular or square, “T” shaped, “U” shaped, “H” shaped, etc. in puzzle systems scissor lifts are typically used as they allow the pallets to move on and off the lift platforms in all directions. We can also use electrical cantilevered lifts but the pallet movements on and off the lift platform are more restricted, turning the vehicles can be done in the parking module, on an elevator or within the parking system.

#### ***1.6.4 RGC Systems:***

Rail Guided Cart known as RGC technology operate in a similar ways to AGVs except the RGCs are less complex and more robust than AGVs and therefore more cost effective and more reliable. The RGCs park the vehicles on pallets in the parking modules which are collected from the parking modules by driving beneath the vehicle pallet, lifting it then moving it out of the parking module into the system. The number of RGCs in the system is flexible and can be based around the client’s requirements.



Figure 1.6.4: RGC System

Generally RGC systems operate on solid concrete floors and can move in both lengthways and sideways directions along small guided rails fitted to the floor. Elevators are used within the system to move the vehicle pallets with or without an RGC.

### ***1.6.5 Shuttle Systems:***

The shuttle systems utilize autonomous shuttles and elevators to park and retrieve vehicles. The number of shuttles in the system is flexible and is based around the client's requirements. The shuttle moves horizontally to a designated location in a shuttle lane, which is either a set of rails in a steel or concrete structure or recess in a solid floor. A vehicle is parked or retrieved at the designated location by a robot, or parallel exchanger or conveyor belts, located on the shuttle by moving the vehicle from or to the shuttle and the parking space. Generally there is a single row vehicle either side of the shuttle lane but if needed more rows of vehicles can be added. The retrieval process of vehicle for the second row and onwards is slower than for the first row of the robot has longer distance to travel to retrieve the vehicle and there may be a vehicle parked in the front of the vehicle to be retrieved, which has to be removed before the vehicle in the second row can be retrieved. When a vehicle is required to be moved from one level of the system to another there are two options for achieving this, one option is with vehicle elevators and the other one is with shuttle elevators.



Figure 1.6.5: Shuttle Systems

A shuttle moves adjacent to a vehicle elevator and deposits the vehicle on the vehicle elevator platform when vehicle elevators are used. A shuttle collects the vehicle from the vehicle elevator when the vehicle elevator then moves the vehicle to the designated parking space. In this option shuttles remain on their assigned levels, therefore at least one shuttle is required per parking level which can make redundancy an issue if only one shuttle is used per level, so this can be costly. When shuttle elevators are used the shuttle moves with the vehicle on to a shuttle elevator located at either end of the shuttle lane. The shuttles are free to go to and from any level in the system allowing for fewer shuttles than parking levels and greater redundancy, in this option. We can say that the shuttle elevators are often the system bottlenecks and throughput is much lower than with vehicle elevators.

### ***1.6.6 Silo Systems:***

The silo systems are cylindrical systems with a single, centrally positioned mechanism used to park and retrieve vehicles. The central mechanism allows the vehicle platform to move to and from one parking spot to another very quickly by moving vertically and rotating simultaneously. Typically they are installed underground and are most suitable where soil conditions are particularly unfavorable.



Figure 1.6.6: Silo Systems

It can also be installed above ground. In silo systems typically only one vehicle can be parked or retrieved at one time. System redundancy can be issue as there is only one mechanism for parking and retrieving vehicles.

### ***1.6.7 Tower Systems:***



Figure 1.6.7: Tower Systems

This system is typically consists of a vehicle elevator with a parking space either side of the elevator shaft. To complete a parking tower, this configuration is repeated over a number of levels. The vehicle elevator simply rises to one of the parking levels of the tower and deposits the vehicles sideways into a parking space. A vehicle is retrieved in a same way. System redundancy is an issue with tower system as there is single mechanism to park and retrieve vehicles.

### ***1.7 Summarization of our project:***

Here we are trying to build a suitable computerized Automated Car Parking System with manual payment system. An assessment of the existing system would be made including the operating system being made as a prototype, the efficiency of car parking system, problem faced during operating the prototype etc. An in depth analysis of the Automated Car Parking System would then be made. Various aspects of these two systems would then be compared and the benefit of introducing the AUTOMATED CAR PARKING System would be found out in terms of saving in time, fuel and emission reduction.

## *Chapter 2*

### *Overview of project*

#### *2.1 Applicability of our project:*

Over the decades with the development of our country we've reached in a situation where the manual car parking system in commercial spaces needs to be replaced. The manual car parking system is causing hurdle and chaos in parking space, therefore resulting in wastage of time and some economic losses as well. Therefore introducing Automated Car Parking Systems in commercial spaces can be replacement to the manual car parking systems at commercial spaces. We can install this system in the places like:

➤ **Office buildings:**

It will help the staff to park their car without any hurdle and wastage of time. It will also relieve their mind from the unnecessary parking hurdle. Also if someone is already late he wouldn't be late any further by having to search for the parking space and park his car. It will also provide security to their cars from stealing.

➤ **Shopping Malls:**

It will help the customers to park their car without any hurdle, which will give them time to browse for more products. It'll benefit both the customers and the sellers as the customer will have more time to explore their options and the sellers have more product options to sell. It will increase the number of customers coming in the malls. It will increase revenue as the customer has to pay for the parking space. It will also help removing the cars which are kept all day long without shopping purposes as they need to pay for parking their cars. As there is a time limit for the parking space the customers will keep that in mind and they will remove their cars on time. This will help more customers to come to these malls each day. It will also provide security to their cars from stealing.

➤ ***Hospitals:***

In hospital when there are a lot of emergency cases there are a lot of a cars and ambulances coming in the parking space. This creates jam which cause delay for the patients to receive the medical services, which often can be fatal to them. If we install the automated system, it will take less time to park car and the patients to reach the medical services. Also they can earn revenue for cars other than the ambulances. It will also provide security to their cars from stealing.

➤ ***Amusement Parks:***

If we install automated car parking systems in amusement parks it will attract more people to come to these places. The more the people will come the more revenue will be earned. Moreover these amusement parks relieve us from our dull and monotonous lives, refreshes our mind. The more people can enjoy these places due to the advanced parking facility. It again increases the revenue as people need to pay for parking their cars. It will also provide security to their cars from stealing.

Along with these places we can use this system in educational institutes and mosques where car parking area is available. It will help people to park their car easily without making any hurdle. It will also provide security to their cars from stealing.

***2.2 Comparison between the existing system and proposed system:***

In present days we are facing many problems with the existing car parking system. As we need to park our car manually and there is no discipline in this process it creates a huge hurdle. People can park their cars anywhere they want to, which creates a mess as people don't follow a particular cue most of the time. As a result of this a huge traffic jam takes place in that place. While parking in and retrieving car due mismanagement cars can get dent by bumping with each other as there is lack of sufficient space. This

leads to arguments, fights among people which sometimes create traffic jam. This is also an economical lose as we need to repair our damaged car. This chaos also leads to cars consuming extra fuel.



Figure: Existing car parking systems in our country

Traffic jam is an issue here as it kills our precious time. Due to this chaos in parking our valuable time gets wasted. For places like shopping malls or amusement parks it causes economical loss, as due to this chaos a lot of people are unwilling to visit these places which decrease the number of the customers in these places. Again the customers get less time to browse for options through these places which can again lessens the opportunity to selling the products. Sometimes the customers cannot enter in these places due to this parking chaos. This car parking hazard causes problem for the student and office staff as they cannot reach their destination on time which sometimes causes huge loss in their respective career. It can cause fatal damage to the patients as it can cause delay for them to reach the medical services may be just a few floor away in the hospital building. Moreover there is no payment system for car parking in most of the parking spaces in our country. So by introducing the automated car parking systems we can handle the mismanagement of parking space save time and recover losses caused by the existing system and also earn money by charging money for car parking.

### ***2.3 Working principle of our project:***

Our project will work as follows:

The LCD display will display the number of available slots and price. When a car will come the operator will send instruction through arduino to open the gate. DC motor helps the gate to open up when it gets the signal from arduino, arduino will only get the signal to DC motor using RF module. The operator will

send a SMS containing the code to the user's mobile phone using arduino& GSM module. This code will be saved in the system against a slot which will be sent to the car parking tray using RF Module. The user will have to provide the registration number of the car and mobile number. The car parking tray will also be called by using RF module and arduino. The car parking tray will park the car and will come out to park the next car. The wheels of the car parking tray will be controlled by arduino so that it reaches the particular slot. For parking out the user will have to give the provided code to the operator at the exit gate. The user will receive a SMS stating the amount to pay for the parking again by using arduino and GSM Module. After the user makes payment the operator will give command to park out the car. The car will be parked out the way as it was parked in.

#### ***2.4 Pricing principle and time limit:***

The pricing principle and time limit for automated car parking system is in the table given below:

<b><i>Name of place</i></b>	<b><i>Price per hour (tk)</i></b>	<b><i>Time limit (hours)</i></b>
Shopping Mall	40	3
Amusement Park	30	5
Hospitals	15	2
Office space	10	office hours

## ***Chapter 3***

### ***Hardware and Software Components***

#### ***3.1 Introduction:***

To have a proper knowledge about the hardware components as well as the software components of the project is a must. Arduino Uno played a vital part in our project as it contains all the software data in it. To send the confirmation message to the user we've used GSM module. We used DC motor to open gate and move the tray wheel.

#### ***3.2 Hardware Components:***

We've used the following hardware components for our project:

- Arduino Uno
- RF Module
- L293D
- LCD Display

- GSM Module
- SIM900A Kit
- DC Motor

- **3.2.1 Arduino Uno R3 Board:**

Arduino/Genuino Uno is a microcontroller board, which is based on the ATmega328P microcontroller. This board has 14 digital input/output pins of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button in short it contains everything needed to support the microcontroller. We can connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. It is named as Arduino Uno as “Uno” means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0, the Uno board and version of Arduino. The Uno board is the first in a series of USB Arduino boards, reference model for the Arduino platform.



Figure 3.1: Arduino R3 Board

- **3.2.2 RF Module:**

A radio frequency module known as RF module is usually a small electronic device used to transmit and/or receive radio signals between two electronic devices. It is often used in an embedded system to communicate with another device wirelessly. This wireless communication may be accomplished through radio frequency (RF) communication or through optical communication. RF as it does not require line of sight. RF communications incorporate a transmitter or receiver for many applications is the medium of choice.

RF modules are widely used in electronic design as it is difficult to designing radio circuitry. Because of the sensitivity of radio circuits and the accuracy of components and layouts required to achieve operation on a specific frequency, electronic radio design is notoriously complex. To ensure that the RF performance is not adversely affected, a reliable RF communication circuit requires careful monitoring of the manufacturing process. Radio circuits are usually subject to limits on radiated emissions, and require conformance testing and certification by a standardization due to these reasons, design engineers will often chose to design a circuit for an application which requires radio communication and then “drop in” a pre-made radio module than attempt a discrete design, saving time and money on development. Medium and low volume products for customer applications such as garage door openers, wireless alarm system, industrial remote controls, smart sensor applications, and wireless home automation systems and sometimes used to replace older infrared communication designs as they has advantage of not requiring line-of-sight operation RF modules are most commonly used. Several carrier frequencies are commonly used in commercially available RF modules such as 433.92 MHz, 915 MHz, and 2400 MHz and short range devices may also use frequencies available for unlicensed such as 315 MHz and 868 MHz RF modules may implemented a proprietary protocol or they may comply with a defined protocol for RF communications such as Zigbee, Bluetooth low energy, or Wi-Fi. RF modules typically incorporate in a printed circuit board, transmit or receive circuit, antenna, and serial interface for communication to the host processor.

Most well-known types are:

- Transmitter module
- Receiver module
- Transceiver module
- System on a chip module



Figure 3.2: RF Tranceiver Module

**Transmitter module:**

This module is a small PCB sub-assembly, which is capable of transmitting a radio wave and modulating that wave to carry data. Transmitter modules are usually implemented alongside a micro controller which will provide data to the module which can be transmitted. They are usually subjected to regulatory requirements, which dictate the maximum allowable band edge requirements, transmitter power output and harmonics.

**Receiver module:**

This module is used to receive the modulated RF signal, and demodulates it. There are two types of RF receiver modules, such as: super-regenerative receivers and super-heterodyne receivers.

**Transceiver modules:**

This module incorporates both a transmitter and receiver. This transmitter and receiver circuit is typically designed for half-duplex operation.

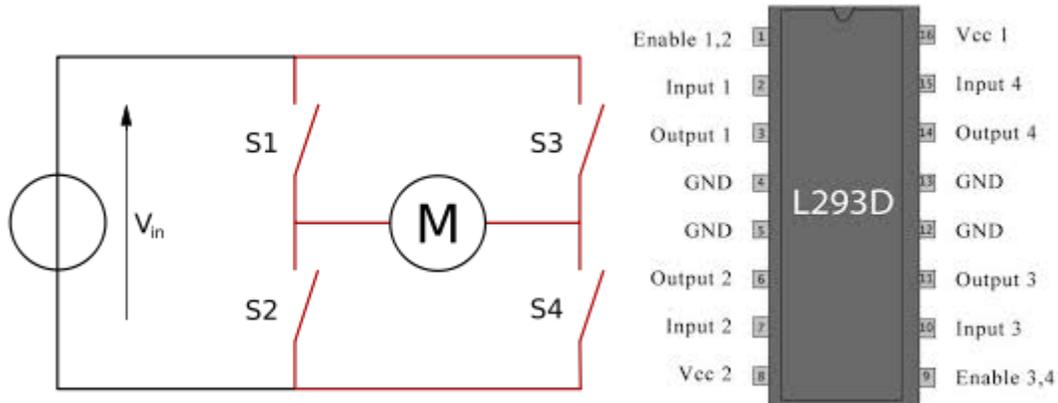
**System on a chip (SoC) module:**

This module is generally same as a transceiver module, but it is often made with an onboard microcontroller. To handle radio data packaging or managing a protocol such as an IEEE 802.15.4 compliant module and for designs that require additional processing for compliance with a protocol when the designer does not wish to incorporate this processing into the host microcontroller, this microcontroller is typically used.

- **3.2.3 L293d motor driver:**

An L293d motor driver H bridge is an electronic circuit that enables a voltage to be applied across a load in either direction. These circuits are often used to allow DC motors to run forwards or backwards in robotics and other applications. Most AC/DC converters, DC-to-AC converts (power converts), most the DC-to-AC push-pull converter, most motor controllers and many other kinds of power electronics use H

bridges. They are available as integrated circuits, or can be built from discrete-components. This is built with four switches (solid-state or mechanical). When the switches S1 and S4 are closed and S2 and S3 are open a positive voltage will be applied across the motor. When S1 and S4 switches are opened and S2 and S3 switches are closed, this voltage is reversed, allowing reverse operation of the motor. The switches S1 and S2 should never be closed at the same time, as this would cause a short circuit on the input voltage source and same applies to the switches S3 and S4, this condition is known as shoot-through.



Figur 3.3: L293D

The H-bridge arrangement is generally used to reverse the polarity/direction of the motor, it also can be used to 'brake' the motor, when the motor comes to a sudden stop, as the motor's terminals are shorted, or to let the motor 'free run' to stop, as the motor is effectively disconnected from the circuit. The following table summarizes operations.

The following table summarizes operation.

S1	S2	S3	S4	Result
1	0	0	1	Motor moves right
0	1	1	0	Motor moves left
0	0	0	0	Motor coasts
1	0	0	0	Motor coasts
1	1	0	0	Motor coasts
0	0	1	0	Motor coasts
0	0	0	1	Motor coasts
0	1	0	1	Motor brakes

1	0	1	0	Motor brakes
1	1	0	0	Short circuit
0	0	1	1	Short circuit
0	1	1	1	Short circuit
1	0	1	1	Short circuit
1	1	0	1	Short circuit
1	1	1	0	Short circuit
1	1	1	1	Short circuit

- **3.2.4 LCD Display:**

Liquid -crystal display known as LCD is a flat-panel display or electronically modulated optical device that uses the light modulating properties of liquid crystals, liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary or fixed images with low information content, which can be displayed or hidden, such as preset words, digits and 7-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images and made up of a large number of small pixels. LCDs are used in wide range of applications such as: computer monitors, televisions. Instruments panels, aircraft cockpit displays indoor and outdoor signage, digital cameras and mobile telephones, including smart phones.



Figure 3.4: LCD Display

LCD Pin Description

<i>Pin no</i>	<i>Function</i>	<i>Name</i>

1	Ground(0V)	Ground
2	Power Supply(4.7-5V)	V <sub>CC</sub>
3	Contrast Adjustment (through a variable register)	V <sub>EE</sub>
4	Selects data register when high; Selects command register when low	Register Select
5	Writes to register when low; Reads from register when high	Read/Write
6	Sends data to data pins when a high to low pulse is given	Enable
7	Data Pin	DB0
8	Data Pin	DB1
9	Data Pin	DB2
10	Data Pin	DB3
11	Data Pin	DB4
12	Data Pin	DB5
13	Data Pin	DB6
14	Data Pin	DB7
15	BackLight V <sub>CC</sub> (5V)	Led+
16	BackLight Ground(0V)	Led-

- **3.2.5 GSM Module:**

Global system for Mobile communication known as GSM is an architecture used for mobile communication in most of the countries. This module is used to establish communication between a computer and a GSM-GPRS system, it consists of a GSM/Gprs modem assembled together with power supply circuit and communication interfaces (like RS-232, USB, etc.) for computer. Global Packet Radio Service (GPRS) is an extension of GSM that enables higher data transmission rate. The operation can be performed by GSM module is as follows:

1. Receiver, reject and make a voice call.
2. Receive, send and delete messages in aSIM.
3. Add, search and receive phonebook entries of the SIM.



Figure 3.5: GSM Module

- **3.2.6 SIM900 Kit:**

The SIM900A is an ultra-compact and reliable wireless module which is complete Dual-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. The SIM900A delivers GSM/GPRS 900/1800MHz performance for voice, SMS, data and Fax in a small form factor and with low power consumption. It has a tiny configuration of 24mmx24mmx3mm, through which SIM900A can fit in almost all the space requirements in user applications, especially for slim and compact demand of design.



Figure 2.6: SIM900A Kit

- **3.2.7 DC Motor:**

A DC motor is a rotary electrical machine that converts direct current electrical energy into mechanical energy. DC motors are widely used in tools, toys and propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills.



Figure 3.7: DC motor

### ***3.3 Software Components:***

The Arduino IDE software is known that Arduino IDE is open source software. This software is used to compile the program into the microcontroller. It uses C-programming language for coding. There is two parts in this code mainly, one is Void setup () which is known as preparation for the program and it runs only once and another one is void loop () which is known as execution for the program. In this software we have used some function from the Arduino library to get the authentication of SIM, GPS data, send the data to the script with HTTP, to send and receive data via RF Module. We used AT command for SIM900A kit to connect with the Arduino for sending message to the user's mobile phone.

## ***Chapter 4***

### ***Prototype Mechanism, Algorithm and Flowchart***

#### ***4.1 Design and Working principle of our project:***

Our project will work as follows:

The Automated Car Parking System is made up with 3 major components: Arduino Uno R3, GSM Module and RF Module. The core part of this system is the microcontroller in Arduino R3. The coding of this system has been done using ArduinoIDE programming language. The LCD display will display the number of available slots and price it will have a RF Receiver Module to get updates about the parking

slot. When a car will come, the operator will send instruction through arduino to open the gate using RF Transmitter Module and update the LCD display at the entrance. DC motor helps the gate to open up when it gets the signal from arduino, arduino will only get the signal to DC motor using RF Receiver Module. The operator will send a SMS containing a code to the user's mobile phone using arduino& GSM Module. The stopwatch will be started as soon as the gate opened. This code will be saved in the system against a slot which will be sent to the car parking tray using RF Transmitter Module. The car parking tray will also be called by using RF Receiver Module & arduino. The car parking tray will park the car & will come out to park the next car. The wheels of the car parking tray will be controlled by arduino so that it reaches the particular slot. For parking out the user will have to give the provided code to the operator at the exit gate. The user will receive a SMS stating the amount to pay for the parking again by using arduino& GSM Module. After the user makes payment the operator will give command to park out the car. The operator will update the slot information to the LCD display at the entrance using RF Transmitter Module. The car will be parked out the same way it was parked in.

#### 4.2 Block Diagram of our project:

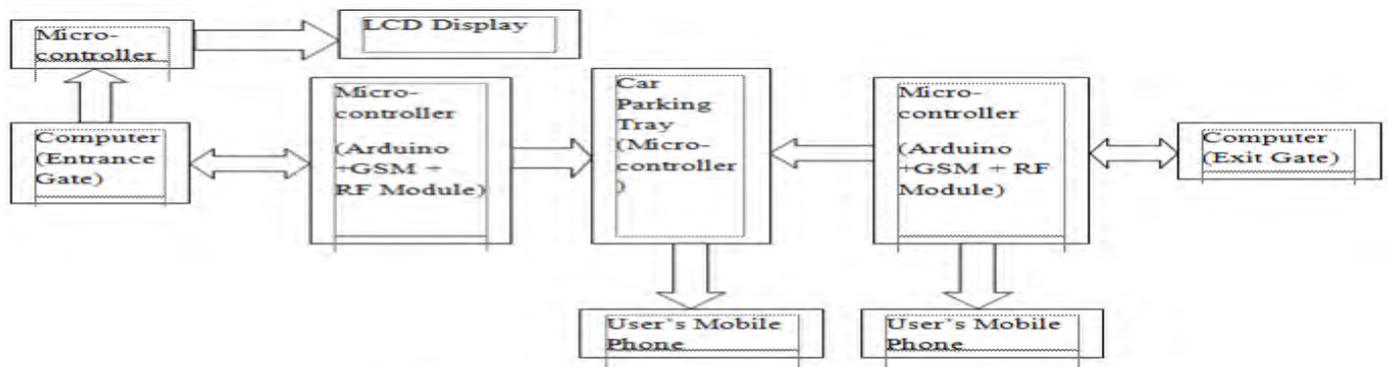


Figure: Block diagram for automated car parking system

#### 4.3 Working Procedure of prototype:

##### 4.3.1 The Display:

The display will show the total number of total slots, available slots and price.

❖ Calculation:

Total slot= $n$ ; Busy Slot= $a$ ;

After every entry:

$a=a+1$ ; Free Slot= $n-a$ ;

❖ Flowchart:

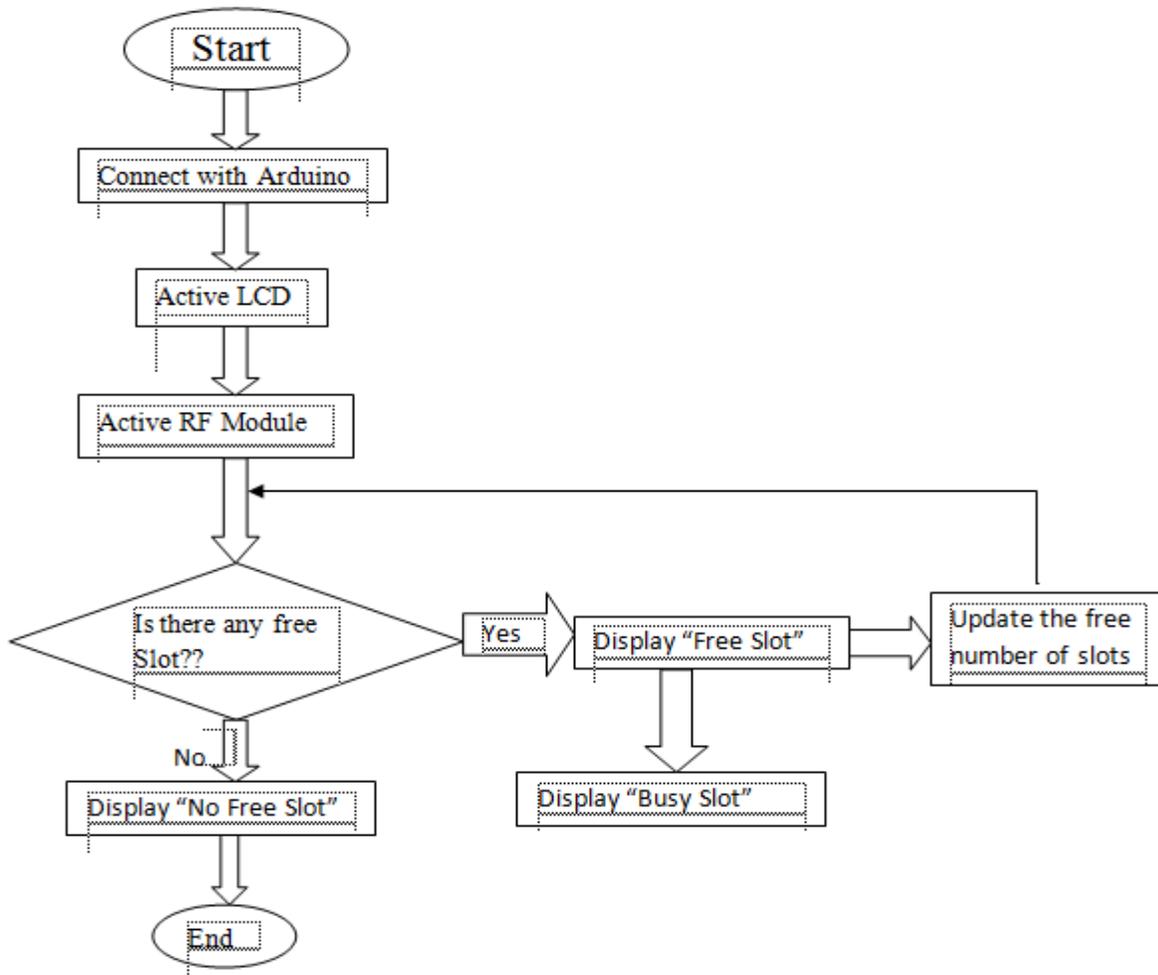


Figure: Flowchart for the display

#### 4.3.2 The Gate:

The operator will open the gate by giving command to arduino.

❖ Flowchart

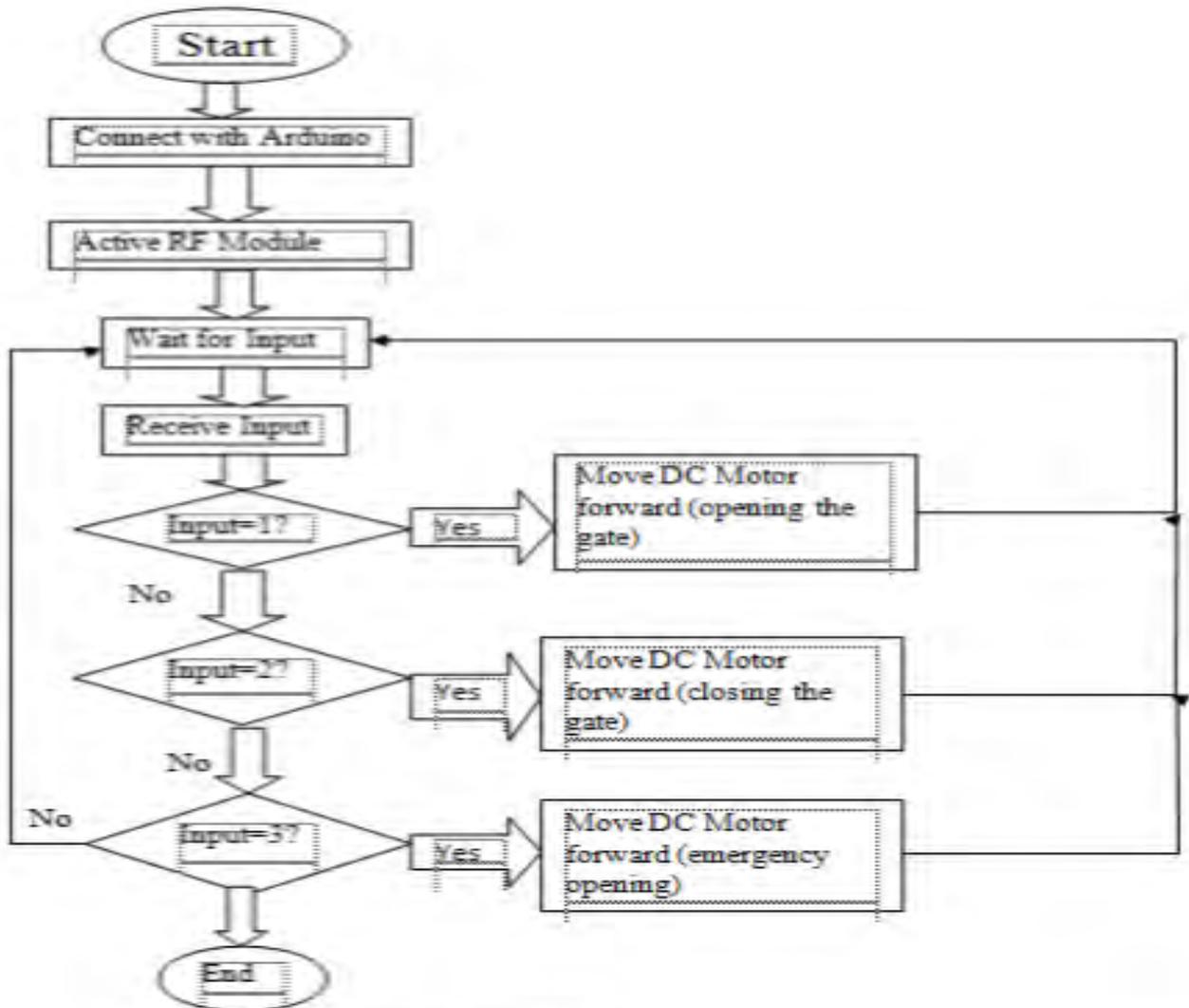


Figure: Flowchart for Gate

#### 4.3.3 The central command:

- ❖ Calculation

Initially:

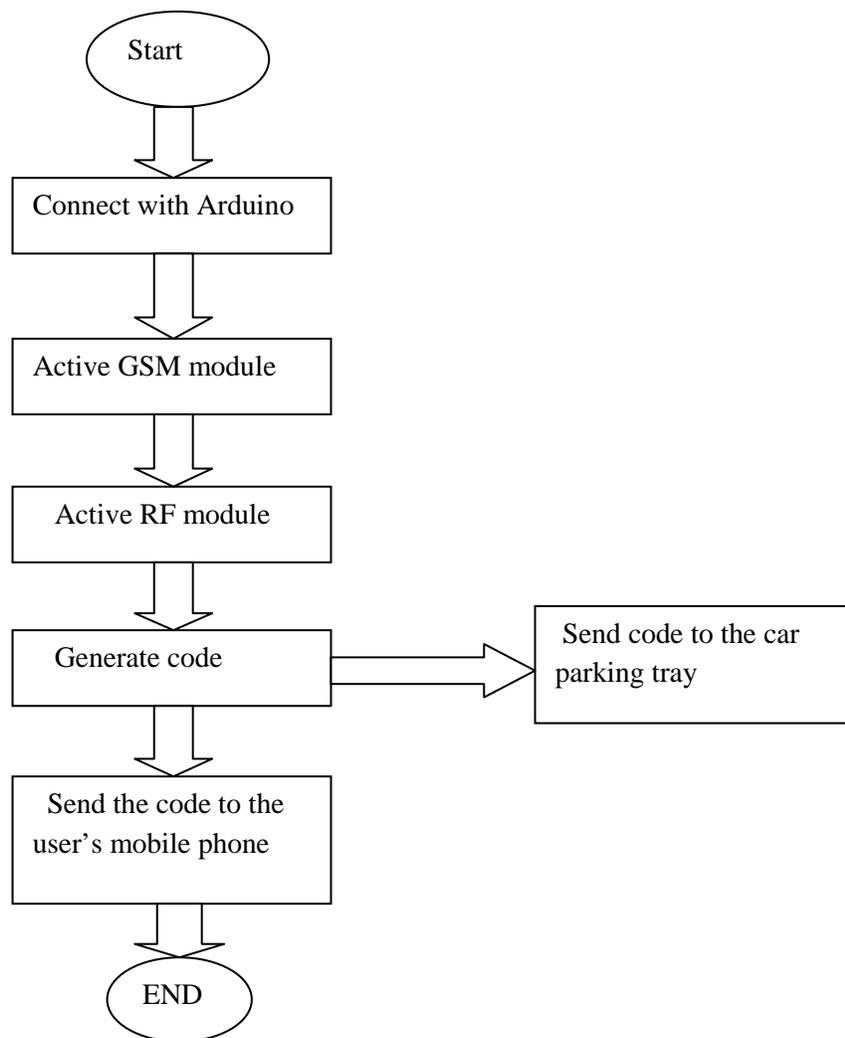
Count = n; allocated slot = 0; Number of slot = a;

After every input:

$n = n + 1$ ; allocated slot = allocated slot + 1;

Code =  $(3399 - (\text{allocated slot} * 7)) + (n - 1200) + (a * 3)$

❖ Flowchart:



#### 4.3.4 The car parking tray:

❖ Calculation

Initially:

Count = n; allocated slot = 0; Number of slot = a; Stopwatch no = allocated slot;

Stopwatch value (n) = elapsed time; price of slot (n) = Stopwatch value\*price per unit;

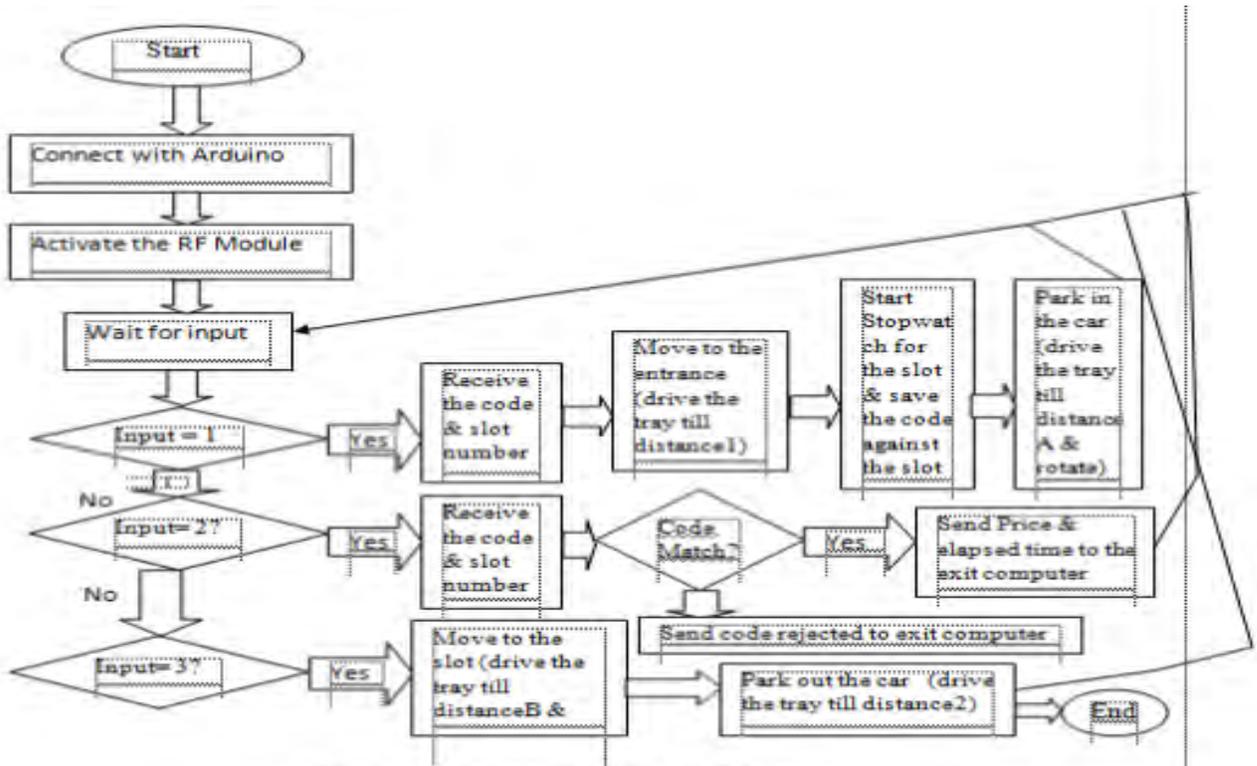
Time to reach the 1<sup>st</sup> slot from entrance = m; distanceA = n\*m; distanceB = o\*n;

Time to reach the last slot from exit = o; distance1= n+ distanceA; distance2 = n+ distanceB;

After every input:

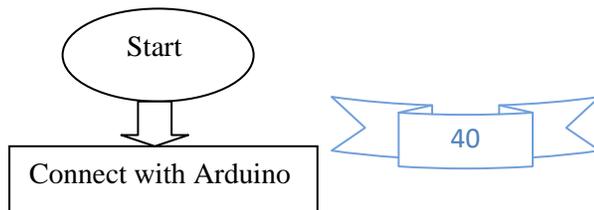
allocated slot = allocated slot + 1; n = n+1;

❖ Flowchart:



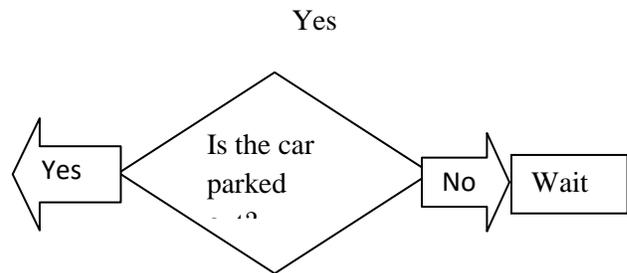
#### 4.3.5 The Exit:

❖ Flowchart:



Yes No

Yes



***Chapter 5***  
***Economic Overview***

***5.1 Economical Benefits of Automated Car Parking System***

***5.1.1 More Profitable Land Use:***

APS (automated parking systems) require significantly less area and volume for a given number of parking spaces than other parking options. APS enables the more profitable use of valuable land for tenants, green space etc. and provide property developers various options such as: minimizing the area needed for parking to maximizing the number of parking spaces or some optimum point in between the two.

#### ***5.1.2 Parking Optimized for Profitability:***

Conventional parking solutions are too large or unfeasible whereas the design flexibility of APS allows them to fit in locations or areas. APS can be installed inside, under or between existing structures, very narrow and deep areas and even irregularly shaped spaces: horizontally, vertically or both. APS help increase profitability by using unusable or lower value space for car parking.

#### ***5.1.3 Capital Cost:***

The common idea that the APS always cost more than multi-story parking garages is overly simplistic and frequently incorrect. APS can be replacements for conventional car parks APS's substantially smaller size and design flexibility can significantly shift capital cost and project profitability for if the developers incorporate them into preliminary designs.

#### ***5.1.4 Reduced Fuel & Maintaining Costs:***

Operation and maintenance costs are highly specific to each application. APS have the advantage of requiring no or minimal lighting, ventilation, fire suppression, monitoring, clean up, staff and security measures in the unoccupied parking area unlike the conventional car park.

#### ***5.1.5 Sustainable Building:***

APS offer numerous advantages over conventional parking when it comes to green space, emissions and carbon footprint reduction, solar access, storm water runoff and more:

- Greenhouse gases (VOCs, CO, NO, etc.) can be reduced 60 to 85% since no driving is required to find spaces and park cars.
- Permit more green space by reducing land requirements
- APS can be substantially more energy efficient than conventional parking solutions, especially in underground or enclosed parking applications.

- Less excavation depth of APS minimizes the potential groundwater impact
- Unlike the conventional car parking APS require much less building material.
- APS can minimize the obstruction of views and sunlight
- Recycling of high value building materials such as steel.

#### ***5.1.6 Inherent Securities:***

The APS concept inherently provides much higher levels of protection and security for cars, their contents and their drivers. Vandalism and theft are virtually impossible in an APS. Personal security is much higher than in car parks since drivers and passengers are always in well-lighted, highly visible/public entry and exit areas at street level. APS are also an ideal solution for the handicapped since entry and exit bays can readily accommodate specific requirements and building codes.

#### ***5.1.7 Lower Risk & Liability:***

Insurance premiums are often heavily influenced by the probability of accidents or other events occurring, here APS may help as APS minimize the potential for property damage, theft, personal injury or death. The possibility of dents, scratches, other damage and vandalism to cars, theft of property from cars, car theft, robbery, arson, fire, assault, rape, falls and suicide can be reduced greatly by using the inherent safety and security of APS.

#### ***5.1.8 Tax Advantages:***

The property developers may have significant tax advantages in the form of accelerated depreciation compared to car parks or parking garages by using APS. Several countries permit faster, or accelerated, depreciation rates for equipment based on its useful life as equipment value declines at a faster rate in the earlier years. APS may be eligible for much higher depreciation rates increasing profitability compared to the 25 to 50 year depreciation of buildings such as car parks.

#### ***5.1.9 Faster Constructions:***

APS are typically faster and easier to install because of much smaller and highly pre-fabricated structures, than larger monolithic concrete car parks. There is much less volume to excavate and transport, this leads to reduced construction costs, less interest during construction and a faster start of revenue generation.

#### ***5.1.10 Improved Profitability and Other Factors:***

Less quantifiable benefits of APS that can improve profitability for developers include:

- Location: - APS can add to the value of the location as it can gain people's attention.
- Reduced visual impact:By using APS we can reduce the space parking slot that can reduce lease/rental rates the lower heights and smaller volumes of APS minimize obstruction of views and sunshine.
- Aesthetics: APS to blend in to the surroundings as it has customizable external treatments.

APS (automated parking systems) provide property developers a numerous benefits and opportunities for car parking, so a change in thinking is needed to take advantage of APS.

### ***5.2 Losses due to manual car parking:***

#### ***5.2.1 Improper usage of lands:***

As the manual car parking systems are unplanned they lack the proper usage of lands, which is unprofitable for property developers. It is unable to use unused property without proper shape which is again wastage of land.

#### ***5.2.2 Added capital cost:***

Manual car parking system adds extra expenditure to capital cost as it is comparatively costlier than the automated car parking system.

#### ***5.2.3 Extra fuel and maintenance cost:***

Manual car parking system there is huge maintenance cost. Also there is added fuel expenditure while parking in or out the cars.

#### ***5.2.4 Risk and liability:***

Insurance premium often heavily influenced by the probability of accidents or other events occurring, using manual car parking system may maximize the potential for property damage, theft, personal injury or death. The possibility of dents, scratches, other damage and vandalism to cars, theft of property from cars, car theft, robbery, arson fire, assault, rape, falls and suicide can take place as safety and security of manual car parking systems are that much reliable.

### ***5.2.5 Wastage of time:***

As manual car parking systems are not planned properly it takes a lot of time for finding parking space, parking in and retrieving the vehicles.

### ***5.2.6 Other disadvantages:***

There are a several other disadvantages of manual car parking systems. Such as:

- Manual car parking systems are not eco-friendly they cause noise, GHG emission and sometimes make the parking ground dirty due to disposal of litters by people.
- Manual car parking systems are not sustainable.
- Manual car parking systems sometimes block air and sunlight.
- Manual car parking systems can hardly be recycled.

## ***5.3. Equation for data analysis:***

In this study we've considered on the analysis of fuel consumption, time saving and GHG emission reduction. This analysis has been done considering the data from the prototype:

### ***Fuel consumption:***

The fuel consumption per day for an automated car parking system calculated using the following equation:

$$FC = N S A_D f t$$

Where, FC = fuel cost;

N = Total number of car parked and retrieved in one day;

S = Speed of car parking tray;

A<sub>D</sub> = Average distance traveled;

f = Fuel used per unit distance;

t = Average time to park and retrieve a car (in seconds)

***Time saving:***

Time consumed in to park and retrieve a car is calculated by:

$$T_S = T_M - T \dots (1)$$

$$T = (D_p * t) + (D_R * t) + t_e \dots (2)$$

Where, T<sub>S</sub> = Time saved by automated car parking system;

T = time consumed for automated parking system;

T<sub>M</sub> = Time consumed for manual car parking;

D<sub>p</sub> = Distance of slot from entrance;

D<sub>R</sub> = Distance of slot from exit;

t = time to travel per unit distance;

t<sub>e</sub> = Average time elapsed at exit gate;

***GHG Emission:***

The reduction of GHG emission rate is calculated by the following formula:

$$G_{RE} = T_S * G_R$$

Where,

$G_{RE}$  = Reduced emission of GHG;

T = Time saved;

$G_R$  = Rate of GHG emission per unit time;

#### ***5.4. Data analysis and result:***

Having the equations it is easy to calculate savings and fuel consumption. Here only the prototype has been considered, it is an approximate calculation:

<b><i>Item</i></b>	<b><i>Manual Car Parking System</i></b>	<b><i>Automated Car Parking System</i></b>
Cost per sq.ft (tk)	1800	2000
Space needed per slot (ft)	15/8	15/8
Maintenance cost per month (tk)	80000	35000
Staff needed at the parking	8	5
Fuel consumed per hour per 100 km (liter)	2	1.9
Average distance traveled by a car to park in or park out (km)	48.06	45.19
Fuel consumed per car to park in or park out a car (liter)	0.267	0.047
Total fuel consumption per day		
Average time needed to park in or park out a car (minutes)	8	1.5
Average time to wait in a queue (minutes)	1.5	5-10
Time saved (minutes)	6.5	0
Total GHG emission per km (ppm)	60	150
Total GHG emission per hour (ppm)	35.15	56.25

## ***Chapter 6***

### ***Planning and Budget***

#### ***6.1 Planning for prototype project:***

##### ***6.1.1 Timeline for Prototype:***

Calendar 2016												Calendar 2017			
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR
<ul style="list-style-type: none"> <li>✓ Identifying the objective of the project</li> <li>✓ Read and search for information related to project</li> <li>✓ Gathering ideas for designing</li> </ul>															
				<ul style="list-style-type: none"> <li>✓ Budget planning</li> <li>✓ Searching for materials</li> <li>✓ Full design of the project</li> </ul>											
								<ul style="list-style-type: none"> <li>✓ Working on Arduino</li> <li>✓ Writing codes</li> <li>✓ Components gathering for prototype</li> </ul>							
												<ul style="list-style-type: none"> <li>✓ Completing the full prototype</li> <li>✓ Simulating all codes and merging with hardware</li> <li>✓ Writing the book</li> <li>✓ Presentation</li> </ul>			

### 6.1.2 Budget for Prototype:

Number	Component	Price(tk)
1	Arduino Uno R3	(600.01*6) = 3600.06
2	GSM Module	966.67
3	Sim900A Kit	2176.7

4	Jumper Wires	350.15
5	RF Module(Transmitter-Receiver pair)	$(239.36*6) = 1436.16$
6	LCD Display (20*4)	335.84
7	Robotic Chassis (2Wheels)	720.01
8	DC Motor(9V)	$(80*3) = 240$
9	4 Cars	1000
10	Base + Road Construction	2500
11	Project Book	1000
Total:		14325.59

## ***6.2 Planning for original project:***

### ***6.2.1 Budget for original project:***

The estimated budget for the original model of our project:

<b><i>Number</i></b>	<b><i>Component</i></b>	<b><i>Price(tk)</i></b>
1	Arduino Uno R3	$(600.01*6) = 3600.06$
2	GSM Module	4500
3	Wires	11000
4	RF Module(Transmitter and Receiver pair)	3468.6
5	LCD Display (21 inch)	120000
6	Car Parking tray	25000
7	DC Motor	60000
8	Base + Road Construction	240000
9	Taxes due to purchase	50000
10	Personal computer	$(30000*2) = 60000$
11	Gate	30000
Total:		607568.66

## ***Chapter 7***

### ***Conclusion and future ideas***

## ***7.1 Conclusion:***

After doing study on ACP project it is found that ACP systems can be introduced in our country and it will be beneficiary in the context of our country. The main benefits are time and fuel saving. It can also provide sustainable parking management in an eco-friendly manner. As the GHG emission will be less in amount and the surroundings will be clean. There is less maintenance cost for this system so it helps the property developer in cost saving. It provides security to the parking ground. ACP systems reduce the hassle in parking grounds and traffic jam. It will benefit the property developer to increase their revenue which will add to the government tax revenue. So in a way it is also helping the government by increasing tax revenue. It will also encourage Automation Engineering in our country which will make advancement in increasing usage of technology. Therefore we should introduce ACP systems and enjoy the benefits.

## ***7.2 Future Ideas:***

### ***7.2.1 Smart recognition of cars:***

We can recognize the cars by their number plates with the help of image processing in ACP system. By using this type of technology users can directly pay for their car parking using mobile phone's prepaid balance or car parking account balance.

### ***7.2.2 Updating Users about available slots and account balance:***

User can get updates about available slots of a particular parking space and account balance by sending a simple SMS to the data base.

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## ***Appendix***

### ***Appendix A:***

Display code:

```
#include <LiquidCrystal.h>

LiquidCrystallcd (13,12,11,10,9,8)

#include <VirtualWire.h>

constintledPin = 7;

constintdatain = 6;

int n; int Add=n; int Subtract=0;

void setup(){

vw_set_ptt_inverted(true);

vw_set_rx_pin(datain);

vw_setup(4000);

pinMode(ledPin, OUTPUT);

vw_rx_start();

lcd.begin(20, 4);

lcd.setCursor (0,0);

lcd.clear();

lcd,print("Welcome to Car Parking");

lcd.setCursor (0,1);

lcd.clear();

lcd,print("Price: 1hr:36 tk");

lcd.setCursor (0,2);

lcd.clear();

lcd,print("2hr:80tk; 3hr:120tk");
```

```

lcd.setCursor (0,3);

lcd.clear();

lcd,print("Total:n Free: Busy:");// n=number of slots

lcd.setCursor (14,3);

lcd.clear();

lcd,print(Add);

lcd.setCursor (19,3);

lcd.clear();

lcd,print(Subtract);

}

void loop() {

if (Subtract<=n){

uint8_tbuf[VW_MAX_MESSAGE_LEN];

uint8_tbuflen = VW_MAX_MESSAGE_LEN;

if (vw_get_message(buf, &buflen))

{

if(buf[0]=='8')

{

digitalWrite(ledPin,HIGH);

Add-=1;Subtract+=1;

lcd.setCursor (14,3);

lcd.clear();

```

```
lcd,print(Add);

lcd.setCursor (19,3);

lcd.clear();

lcd,print(Subtract);

}

if(buf[0]=='9')

{

digitalWrite(ledPin,HIGH);

Add+=1;Subtract-=1;

lcd.setCursor (14,3);

lcd.clear();

lcd,print(Add);

lcd.setCursor (19,3);

lcd.clear();

lcd,print(Subtract);

}

}

else if(subtract==n) {

lcd.setCursor (0,3);

lcd.clear();

lcd,print("No Free Slot");

Add==n; Subtract==0;
```

```
return Add, Subtract;
}
}
}
```

### ***Appendix B:***

Gate Code:

```
#include <VirtualWire.h>

const int ledPin = 13;

const int dataIn = 12;

#define ENABLE 3

#define DIRB 4

#define DIRA 5

void setup()

{

pinMode(ENABLE, OUTPUT);

pinMode(DIRA, OUTPUT);

pinMode(DIRB, OUTPUT);

vw_set_ptt_inverted(true);

vw_set_rx_pin(dataIn);

vw_setup(4000);

pinMode(ledPin, OUTPUT);
```

```
vw_rx_start();

Serial.begin(9600);

}

void loop()

{

uint8_tbuf[VW_MAX_MESSAGE_LEN];

uint8_tbuflen = VW_MAX_MESSAGE_LEN;

if (vw_get_message(buf, &buflen))

{

if(buf[0]=='1')// for exit gate it will be 4

{

digitalWrite(ledPin,HIGH);

Serial.println("Opening Gate");

digitalWrite(ENABLE, HIGH);

digitalWrite(DIRA, HIGH);

digitalWrite(DIRB, LOW);

delay(10000);

digitalWrite(ENABLE, HIGH);

digitalWrite(DIRA, LOW);

digitalWrite(DIRB, LOW);

delay(10000);

}

}
```

```

if(buf[0]=='0')
{
digitalWrite(ledPin,LOW);

//Serial.println("0");
}

if(buf[0]=='2')//for exit gate it will be 5
{
digitalWrite(ledPin,HIGH);

Serial.println("Closing Gate");

digitalWrite(ENABLE, HIGH);

digitalWrite(DIRA, LOW);

digitalWrite(DIRB, HIGH);

delay(10000);

digitalWrite(ENABLE, HIGH);

digitalWrite(DIRA, LOW);

digitalWrite(DIRB, LOW);

delay(10000);

}

}}

```

### ***Appendix C:***

Central command code:

```
#include <GSM.h>
```

```

#include <SPI.h>

#include <VirtualWire.h>

constintledPin = 13;

char *data;

char *data1, data2;

int code, index;

intallocatedslot = 0;

int Number of slot = a;// a=total number of slots

void setup()

{

Serial.begin(9600);

pinMode(ledPin,OUTPUT);

vw_set_ptt_inverted(true);

vw_set_tx_pin(12);

vw_setup(4000);

Serial.println("Enter 1 to open & 2 to close gate");

}

void code(){

code=(3399-(allocatedslot*7))+(n-1200)+(a*3);

data1[4];

String str;

str=String(code);

```

```
str.toCharArray(data1,4);

}

void loop()

{

void code();

while (Serial.available()>=0)

{

data1=Serial.parseInt();

if (data1==1)

{

data="1";

data2=8;

vw_send((uint8_t *)data2, strlen(data2));

vw_wait_tx();

digitalWrite(ledPin,HIGH);

vw_send((uint8_t *)data, strlen(data));

vw_wait_tx();

digitalWrite(ledPin,HIGH);

Serial.println("you've pressed 1");

data="1";

vw_send((uint8_t *)data1, strlen(data1));

vw_wait_tx();
```

```
digitalWrite(ledPin,HIGH);

n=n+1; allocatedslot=allocatedslot+1;

returnn,allocatedslot;

delay(1200);

Serial.print("AT");

delay(1200);

boolbOK = false;

while (Serial.available() > 0)

{

charinChar = (char)Serial.read();

bOK = true;

}

if(bOK)

{

index = 0;

Serial.println();

Serial.println("AT+CMGF=1"); // sets the SMS mode to text

delay(100);

delay(1200);

boolbOK = false;

while (Serial.available() > 0) {

//Serial.write(Serial.read());
```

```
charinChar = (char)Serial.read();

bOK = true;

}

if(bOK)

{

Serial.println();

Serial.print("AT+CMGS="); // send the SMS number

Serial.print("+....."); //Enter the number SMS to be sent

Serial.println();

delay(1000);

Serial.print("Welcome to automated car parking"); // SMS body

Serial.print("Your code is:"); // SMS body

Serial.println(code); // SMS body

delay(500);

Serial.write(0x1A);

Serial.write(0x0D);

Serial.write(0x0A);

}

}

}

if (data==2)

{
```

```
data="2";

vw_send((uint8_t *)data, strlen(data));

vw_wait_tx();

digitalWrite(ledPin,HIGH);

Serial.println("you've pressed 2");

}

if (data==0)

{

data="0";

vw_send((uint8_t *)data, strlen(data));

vw_wait_tx();

digitalWrite(ledPin,LOW);

}

}

while (Serial.available()<0){}

Serial.println("Enter 1 to open & 2 to close gate");

data1=Serial.parseInt();

}
```

### ***Appendix D:***

Exit code:

```
#include <GSM.h>
```

```
#include <SPI.h>

#include <VirtualWire.h>

int index;

constint ledPin = 13;

constint ledPin1 = 6;

constint datain = 12;

constint datain1 = 7;

int Data2;

char *data;

char *data1;

charSecChar[2], MinChar[2], HrChar[2], PriceChar[10];

int code;

intHr,Min,Sec,Price;

void setup()

{

Serial.begin(9600);

pinMode(ledPin,OUTPUT);

vw_set_ptt_inverted(true);

vw_set_rx_pin(datain);

vw_setup(4000);

pinMode(ledPin1, OUTPUT);

vw_rx_start();
```

```
vw_set_tx_pin(datain1);

Serial.println("Enter 7 to park out, 1 to open & 2 to close gate");

}

void Code(){

data1[4];

String str;

str=String(code);

str.toCharArray(data1,4);

}

void loop()

{

Code();

while (Serial.available()>0)

if(Data2==7)

{

Serial.println("Please Enter Code");

code=Serial.parseInt();

data=data1;

vw_send((uint8_t *)data, strlen(data));

vw_wait_tx();

digitalWrite(ledPin,HIGH);

uint8_tbuf[VW_MAX_MESSAGE_LEN];
```

```

uint8_tbuflen = VW_MAX_MESSAGE_LEN;

if (vw_get_message(buf, &buflen))

{

if(buf[0]=='1')

{

digitalWrite(ledPin1,HIGH);

Serial.println("Code accepted");

data="2";

vw_send((uint8_t *)data, strlen(data));

vw_wait_tx();

digitalWrite(ledPin,HIGH);

uint8_tbuf[VW_MAX_MESSAGE_LEN];

uint8_tbuflen = VW_MAX_MESSAGE_LEN;

if (vw_get_message(buf, &buflen))

{

inti;

// Message with a good checksum received, dump it.

for (i = 0; i<buflen; i++)

{

if(i<2){

SecChar[i] = char(buf[i]);

}

}

```

```
{ SecChar[bufLen] = '\0';  
    Sec = atoi(SecChar);  
}  
  
if(i==3 && i<4){  
    MinChar[i] = char(buf[i]);  
}  
  
{ MinChar[bufLen] = '\0';  
    Min = atoi(MinChar);  
}  
  
if(i==4 && i<6){  
    HrChar[i] = char(buf[i]);  
}  
  
{ SecChar[bufLen] = '\0';  
    Hr = atoi(HrChar);  
}  
  
if(i==6 && i<16){  
    PriceChar[i] = char(buf[i]);  
}  
  
{ PriceChar[bufLen] = '\0';  
    Price = atoi(PriceChar);  
}  
  
if(i==15)
```

```
{  
i==0; return i;  
}  
}  
}  
}  
}  
  
delay(1200);  
  
Serial.print("AT");  
  
delay(1200);  
  
boolbOK = false;  
  
while (Serial.available() > 0)  
{  
charinChar = (char)Serial.read();  
  
bOK = true;  
}  
  
if(bOK)  
{  
index = 0;  
  
Serial.println();  
  
Serial.println("AT+CMGF=1"); // sets the SMS mode to text  
  
delay(100);
```

```
delay(1200);

boolbOK = false;

while (Serial.available() > 0) {

    //Serial.write(Serial.read());

    charinChar = (char)Serial.read();

    bOK = true;

    }

if(bOK)

    {

Serial.println();

Serial.print("AT+CMGS="); // send the SMS number

Serial.print("+....."); //Enter the number SMS to be sent

Serial.println("Time elapsed:"); // SMS body

Serial.print(Hr);

Serial.print(":");

Serial.print(Min);

Serial.print(":");

Serial.println(Sec);

Serial.print("Price:");

Serial.println(Price);

delay(500);

Serial.write(0x1A);
```

```
Serial.write(0x0D);

Serial.write(0x0A);

}

if (data==0)

{

data="0";

vw_send((uint8_t *)data, strlen(data));

vw_wait_tx();

digitalWrite(ledPin,LOW);

Serial.println("Code rejected");

}

}

if (Data2==1){

{

data="4";

vw_send((uint8_t *)data, strlen(data));

vw_wait_tx();

digitalWrite(ledPin,HIGH);

}

if (Data2==2){

{
```

```

data="5";

vw_send((uint8_t *)data, strlen(data));

vw_wait_tx();

digitalWrite(ledPin,HIGH);

data2="9";// sending data to display

vw_send((uint8_t *)data2, strlen(data2));

vw_wait_tx();

digitalWrite(ledPin,LOW);

}

}

}

while (Serial.available()<0){}

Serial.println("Enter 1 to open & 2 to close gate");

data1=Serial.parseInt();

}

```

### ***Appendix E:***

```

#include <VirtualWire.h>// car parking tray wheel

constintledPin = 13;

constintdatain = 12;

#define ENABLE1 3

#define ENABLE2 6

#define DIRA1 4

```

```
#define DIRB1 5

#define DIRA2 8

#define DIRB2 7

#define ENABLE 9

#define DIRA 10

#define DIRB 11

int Delay=1000;

charSlotChar; int Slot; int n;//number of slots

void setup()

{

vw_set_ptt_inverted(true);

vw_set_rx_pin(datain);

vw_setup(4000);

pinMode(ledPin, OUTPUT);

vw_rx_start();

Serial.begin(9600);

pinMode(ENABLE1,OUTPUT);

pinMode(ENABLE2,OUTPUT);

pinMode(DIRA1,OUTPUT);

pinMode(DIRB1,OUTPUT);

pinMode(DIRA2,OUTPUT);

pinMode(DIRB2,OUTPUT);
```

```
pinMode(ENABLE,OUTPUT);

pinMode(DIRA,OUTPUT);

pinMode(DIRB,OUTPUT);

}

void Wheel()

{

//Enabling motors

digitalWrite(ENABLE1, HIGH);

digitalWrite(ENABLE2, HIGH);

digitalWrite(ENABLE, HIGH);

delay(100);

//Motion forward

digitalWrite(DIRA1,LOW);

digitalWrite(DIRB2,LOW);

digitalWrite(DIRB1,HIGH);

digitalWrite(DIRA2,HIGH);

delay(Delay);//time to reach the slot

//Stopping motors

digitalWrite(ENABLE1, LOW);

digitalWrite(ENABLE2, LOW);

//turning

digitalWrite(DIRA,LOW);
```

```
digitalWrite(DIRB,HIGH);

delay(500);

digitalWrite(ENABLE, LOW);

//getting inside the slot

digitalWrite(DIRA1,LOW);

digitalWrite(DIRB2,LOW);

digitalWrite(DIRB1,HIGH);

digitalWrite(DIRA2,HIGH);

delay(200);//time to reach the slot

//Stoping motors

digitalWrite(ENABLE1, LOW);

digitalWrite(ENABLE2, LOW);

//Getting out of the slot

digitalWrite(ENABLE, LOW);

digitalWrite(DIRA1,HIGH);

digitalWrite(DIRB2,HIGH);

digitalWrite(DIRB1,LOW);

digitalWrite(DIRA2,LOW);

delay(500);

//Stoping motors

digitalWrite(ENABLE1, LOW);

digitalWrite(ENABLE2, LOW);
```

```
//turning
digitalWrite(DIRB,LOW);
digitalWrite(DIRA,HIGH);
delay(500);
digitalWrite(ENABLE, LOW);
//going back
digitalWrite(ENABLE1, HIGH);
digitalWrite(ENABLE2, HIGH);
digitalWrite(ENABLE, HIGH);
delay(100);
//Motion forward
digitalWrite(DIRA1,LOW);
digitalWrite(DIRB2,LOW);
digitalWrite(DIRB1,HIGH);
digitalWrite(DIRA2,HIGH);
delay(Delay);//time to reach the slot
//Stoping motors
digitalWrite(ENABLE1, LOW);
digitalWrite(ENABLE2, LOW);
}
void loop(){
uint8_tbuf[VW_MAX_MESSAGE_LEN];
```

```

uint8_tbuflen = VW_MAX_MESSAGE_LEN;

if (vw_get_message(buf, &buflen))

{

if(buf[0]=='1' || (buf[0]=='1')){

inti;

for (i = 0; i<buflen; i++)

{

if(i<n){

SlotChar[i] = char(buf[i]);

}

{ SlotChar[buflen] = '\0';

Slot = atoi(SlotChar);

}

}

if(i==(n-1)){

i==0; return i;

}

}

Delay=1000*Slot;

return Delay;

Wheel();

}

```

}