University of Ghardaïa

Faculty of Sciences et Technologies
Department of Automatic et Electromechanic

Memory submitted in candidacy to fulfill the degree

MASTER

field: *Sciences and Technologies*
Stream: *Automatic*
Specialty: *Automatic and Systems*

By : ***AMIEUR Tahar***

Title:

Study and realization of automated car parking system

Defended on : October 28th,2020

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year 2019/2020

شكر

الحمد لله الذي بنعمه تتم الصالحات.

بداية وقبل كل شيء أتوجه بجزيل الشكر و الامتنان إلى الله العلي القدير الذي اعطاني الشجاعة، الارادة ، الصبر والصحة والتوفيق في دراستي.

كما أتوجه بشكري لأمي وزوجتي وأستاذتي الفاضلة الأستاذة شنيني كلثوم اللواتي كن عونا وسندا في أصعب المواقف خلال انجاز هذه المذكرة.

شكرا لأستاذي المشرف: فيها خير مهدي أمين على مساعدته في اتمام هذا المشروع.

شكرا للسيد أويابة عمر الذي ساهم بشكل كبير لانجاح هذا العمل

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شكرا لكل أساتذة و اطارات وعمال قسم العلوم والتكنولوجيا خاصة وجامعة غرداية عامة.

شكرا لكل من ساهم من قريب أ ومن بعيد في اتمام هذا العمل.

إهداء

أهدي ثمرة هذا الجهدإلى:

من كان سندا لي في حياتي منذ بدايتها عائلتي الكبيرة

سندي وأمل حياتي عائلتي الصغيرة

عائلتي الثانية شنيني وكل عائلتي عمير ولكحل

اساتذتي ومن علمني طوال فترة تعليمي

زملائي وكل من ساعدني و ساندني في جميع المواقف

كما أهدي هذا العمل إلى نفسي :

الطاهر

Abstract

Traffic jam, road congestion, time wasting and economical losses are from the most important problems caused by lack of car parking places and the absence of the management of car parking places, due to over population in cities and more number of vehicles growing day-by-day. With the new technologies of the Automated Parking Systems, scientists and experts have already find a solution for those problems, and make life easy and simple for public, biggest nations already implemented these technologies. We, as well, in this memory have explained them, and chosen one of this technologies to delve deeper by studying the silo parking systems techniques, and realized a prototype of it, using small electrical and mechanical components, such as stepper motors and Arduino Uno, and the open source Software Arduino IDE software to program the microcontroller to do the command part.

Keywords: parking, stepper motors, microcontroller, Silo Automated Parking Systems, Software Arduino IDE.

Résumé :

Les embouteillages, la congestion routière, la perte de temps et les pertes économiques sont dus aux problèmes les plus importants causés par le manque de places de parking et l'absence de gestion des places de parking, en raison de la surpopulation dans les villes et de l'augmentation du nombre de véhicules de jour après jour. Avec les nouvelles technologies des systèmes de parking automatisés, les scientifiques et les experts ont déjà trouvé une solution à ces problèmes, et rendent la vie facile et simple pour le public, les plus grandes nations mettent déjà en œuvre ces technologies. Nous les avons également expliqués dans cette memoire et choisi l'une de ces technologies pour approfondir en étudiant les techniques des systèmes de parking en silo, et en ai réalisé un prototype, en utilisant de petits composants électriques et mécaniques, tels que des moteurs pas à pas et Arduino Uno, et le logiciel open source Arduino IDE pour programmer le microcontrôleur pour faire la partie commande.

Mots clés: parking, moteurs pas à pas, microcontrôleur, systèmes de parking en silo, logiciel Arduino IDE.

ملخص :

زحمة السير، احتقان الطرقات، ضياع الوقت والخسارة الاقتصادية تعتبر من أكبر المشاكل التي تكون بسبب نقص أماكن توقف السيارات، و غياب التسيير الخاص بها، وهذا راجع إلى ارتفاع عدد السكان والمركبات الذي يتزايد يوما بعد يوم. مع التقنيات الجديدة الخاصة بأنظمة مواقف السيارات الآلية، وجد العلماء والخبراء حلا لهذه المشاكل، ما جعل حياة المواطنين سهلة وبسيطة، الدول الكبرى قد قامت فعلا باستعمال هذه التكنولوجيات، في هذه المذكرة قمنا بشرح هذه التكنولوجيات، وقمنا بالتعمق فيها عن طريق دراسة تقنيات نظام موقف السيارات الآلي من نوع Silo، وانشاء نموذج عنه باستعمال مركبات كهربائية وميكانيكية صغيرة، كالمحرك الكهربائي خطوة بخطوة، و الأردوينو إينو، ولغة البرمجة أردوينو IDE من أجل برمجة المتحكم الدقيق (microcontroller) ليقوم بعملية التحكم.

كلمات مفتاحية: موقف، محرك خطوة بخطوة، المتحكم الدقيق، أنظمة المواقف الآلية سايلو (Silo)، أردوينو IDE.

List of figures

List of Picture

List of tables:

List of Abbreviations

AGV	Automated Guided Vehicle	
RGC	Rail Guided Cart	
LCD	Liquid Crystal Display	
HPCB	High Power Carbone Brushes	
LP	Low Power	
MP	Medium Power	
HP	High Power	
DC	Direct Current	
LED	Light Emitting Diode	
IDE	Integrated Development Environment	
3D	3 Dimensions	
CNC	Numeric Calculator	
CAD	Computer Aided Design	
PCB	Printed Circuit Board	

List of Continents

General Introduction

General Introduction:

In the last two decades our country Algeria has been developed rapidly and drastically, in many field, now it has a lot of well contacted roads, commercial and office building and increasing number of automobiles and transportation vehicle. 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 and misunderstanding. Due to this, people can park their cars anywhere they want to, which creates a mess as people do not follow the particular cue and violate of traffic law most of the time. As a result of this, huge traffic jam and road congestion take places 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 (drivers) which also sometimes makes huge traffic jam. This is also an economical loss as we need to repair our damaged car and also car 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 sometimes there be life at stake by stalling 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. 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, it also affects tourism and tourist so they take bad ideas of our people. 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 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 in this memory and as a solution of these problems we are introducing Automated Car Parking Systems as well as a replacement to the manual car parking systems at commercial spaces and big states and towns. This system not only saves time and money, it can also earn money by charging for parking spaces, and stops looting people from the opportunist who manage surface and street parking place, and it also helps to exploit ancient parking spaces in other things.

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

The objectives are:

- To compare various aspects of this manual parking system with the automated parking system.
- Realize a prototype of a silo systems car parking systems.
- Introducing automatic vehicle parking system in Algeria, make it public and get benefited by it.

Our work will be subdivided in three chapters:

In the first chapter we will talk about Generalities about Parking Systems in purpose of enriching our theme, I want to make a general description of car parks systems, its different types, and car parks management advantages, also we are going to describe some common parking systems.

In the second chapter we will talk about Technical Study of Parking System and the design of a prototype of silo systems car parking, describe the major components and electrical parts of the prototype, and explain the working principal of the project.

The last chapter which talk about Realization and Programming of Parking Systems we are going to collect the parts and install the electrical components, to build the prototype, then we will program the Arduino's microcontroller with the open source software Arduino IDE.

Chapter I:

Generalities about Parking Systems

Chapter I: Generalities about Parking Systems

I.1- Introduction

Any journey by car is likely to end in a parking space. Lack of parking space, waste of time, pollution, and traffic jams while the driver searches for a place to park his vehicle are real problems for drivers and even for the city.

Parking management is the way to regulate the imbalance between parking supply and demand.

In this chapter, we are going to describe the parking systems and make differences between types.

I.2- Definition of parking

The car park is a place specially designed for the garage of cars which is parked for a determined time. They are located in different places (airports, hospitals, buildings, large market, etc ...) [1].

We distinguish two different type of car parks:

- Traditional car parks.
- Automated car parks (automated vehicle system).

I.3- Traditional car parking system

In this type of car parks the drivers parks their cars in by theme selves, in many ways as it possible by the location they are in, or they find.

There are many types of traditional car parks.

I.3.1- Surface parking

The surface parking is located outside, in public or private space. This type of parking includes on-street parking (spaces along a street, a quay, etc.) and in spaces between buildings, in front of shopping centers, etc [2]. it could be parallel or by angle.

Picture I.1: surface parking [3].

There are many advantages for surface parking:

• easy access and maneuvering.

• a general feeling of security linked to the absence of a pole.

• quick pedestrian access to all parking spaces.

• no risk of containment of a fire.

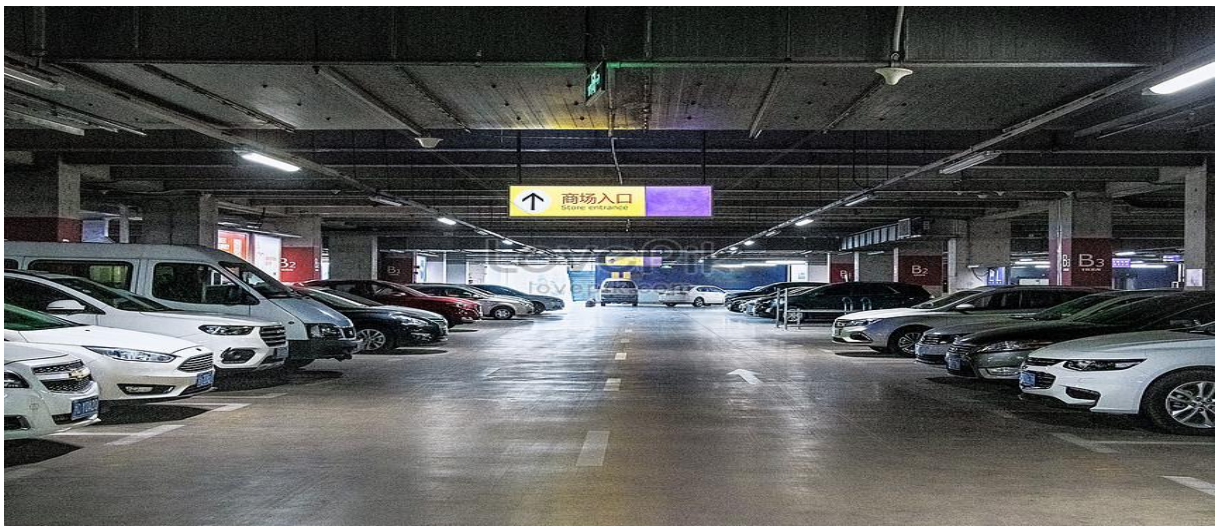
I.3.2- Overhead parking (aerial parking)

The overhead parking looks a lot like underground closed parking except that they are built outside and not in the basement. Overhead car parks also have floors and ramps that allow you to move from one level to another. Constructed of concrete or metal structure (or both).[2]

Picture I.2: overhead parking [4].

I.3.3- Underground parking (or closed)

Underground parking is a parking that is located under buildings, airports, shopping centers. It is a very secure car park. The underground car park is made up of several floors. To reach their parking spaces, drivers use ramps to move from one floor to another. They can then join an elevator or a staircase to exit the car park as pedestrians.



Picture I.3: underground parking [5].

Since it is in the basement and not on the surface, the underground car park must have an excellent ventilation system with plenty of ventilation in order to minimize pollution and improve the air quality in the car park [1].

I.3.4- 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.

I.4- Automated car parks

I.4.1- Automated parking with manual parking

In the case of automated parking with manual parking, the parking is managed automatically but for parking the driver must park his vehicle [2].

I.4.2- Automated parking with automatic parking

This type of parking consists of an automatic system that allows the vehicle to be parked and retrieved without human intervention [2].

I.4.2.1- parking in the vehicle

To park, the driver moves the vehicle into the automatic parking entrance, also called the entrance hall. He is then guided by panels and automatic signals indicating the procedure to follow. When the car enters the airlock, the system records its dimensions in order to assign it the available space best suited to its size.

The driver then stops the engine, gets out of the vehicle with his passengers, locks it, then leaves the entrance hall by collecting his ticket at the terminal provided for this purpose.

When the sensors have verified that the car is empty, the exterior doors of the airlock close automatically and those giving access to the APS (automated parking system) open. APSs work using different techniques and technologies, but all use mechanical systems to pick up the vehicle in the airlock, transport it inside the parking area and drop it in its place, all automatically, thanks to car lifts provided for this purpose. The vehicle remains parked in its place until the driver wishes to retrieve it [2].

I.4.2.2- Vehicle retrieving

Recovering a parked vehicle in an automatic parking system is also a very simple step in the process. The driver inserts the ticket into the terminal outside the APS, pays what he owes, and is then directed to the exit where his car will be waiting. Once the automatic parking system has deposited it in the exit hatch, the doors open and the driver and his

passengers can again get into the vehicle. The outer door of the airlock is then opened and the driver only has to exit [2].

Benefits for customers (user)

There are many benefits for the customer in using automated car parks, such as

• No need to search for available parking spaces.

• No need to walk through the garage.

• Time saving.

• Vehicle is parked safely (no worry about theft / damage).

Benefits for municipalities / owners

The owner as well has also benefits:

• Space efficiency.

• Respect for the environment (no driving indoors).

• Increased visual impact.

• Increases public safety (less risk of theft, accident and assault).

• Economic benefits.

• No people inside, no trash / fights / accidents / etc.

• No people inside, no need for signs / lighting / pedestrian areas / etc.

• Cars inside do not drive but are moved automatically, meaning an expensive ventilation system is not required.

• No need to employ personnel (except for occasional maintenance).

I.4.3- Parking entry / exit control

The parking control is always for one main purpose which is payment, it could be at the entrance or at the exit, typically it is at the exit so that the owner/operator can count the hours of using the parking.

I.4.3.1- Controlled entry and free exit

As soon as the visitor arrives at the entrance terminal, he must pick up a coin at the automatic cashier then the barrier opens and the driver can enter the parking lot. To leave the car park, go to the exit terminal and the barrier opens automatically. So he can go out [1].

I.4.3.2- Free entry and controlled exit

As soon as the visitor arrives at the Entrance terminal, the barrier opens. To leave the car park, the visitor must pick up a coin at the automatic cashier, then the barrier opens, and the visitor can leave the car park [1].

I.4.4- Advantages of automated vehicle system and car parks management

The advantages of automated car parking systems and the management of car parks for drivers and also for the car parks themselves are several, among these advantages we can distinguish: [6].

I.4.4.1- Reducing traffic jam

Automated vehicle systems 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 [6].

I.4.4.2- 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 [6].

I.4.4.3- 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 [6].

I.4.4.4- 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 [6].

I.4.4.5- 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 [6].

I.4.5- Different Type of Automated Car Parking Systems

Generally, the process of parking a vehicle for drivers in automated parking systems remains the same regardless of the technology used: it's just the methodology of moving the vehicles to and from the parking module that differs. The types of technology used in automated parking systems can be divided into many categories:

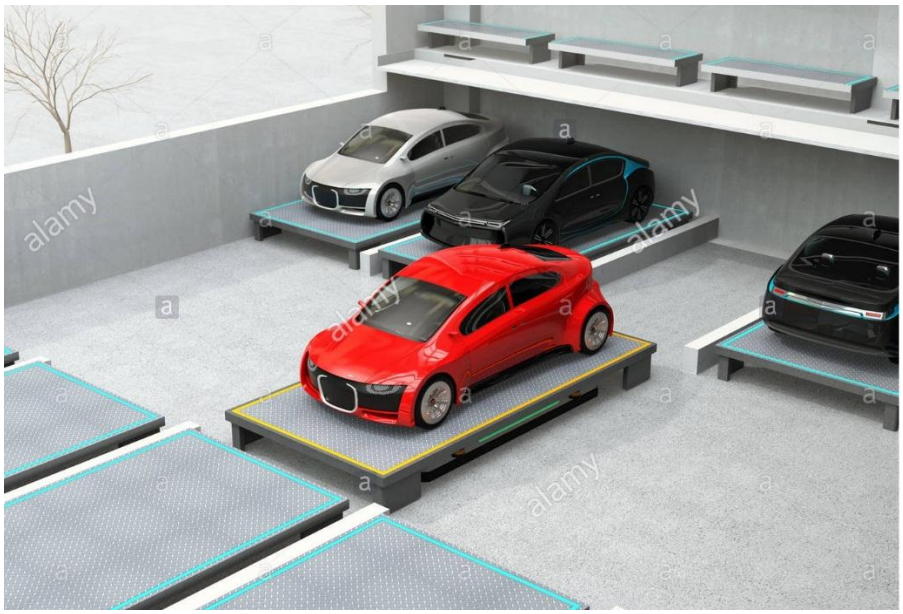
- AGV systems.
- Crane systems.
- Puzzle systems.
- RGC systems.
- Shuttle systems.
- Tower systems.
- Chess systems.

- Silo systems.

Each technology has both advantages and disadvantages over another, and the selection of one technology over another largely depends on the project site, building codes and the client's requirements in terms of budget, throughput, density and redundancy [7].

I.4.5.1- AVG Systems

More recently Automated Guided Vehicle (AGV) technology is being used in automated parking and although AGVs have been used in automated warehousing for decades, they remain unproven in automated parking systems. Vehicles are parked on pallets in the parking modules which are collected from the parking modules by the AGVs driving beneath the vehicle pallet, lifting it, then moving it out of the parking module into the system. The number of AGVs in the system is flexible and can be based around the client's throughput and budgetary requirements.



Picture I.4: Automated Guided Vehicle (AGV) parking systems [9].

Typically, AGV systems operate on solid, finished concrete floors and can move in both lengthways and sideways directions (X and Y planes) along fixed paths and are also able to rotate on the spot. This potentially allows for 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.

Vehicle elevators are used within the system to move the vehicle pallets with or without an AGV [8].

I.4.5.2- Crane Systems

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

Picture I.5: crane parking systems [11].

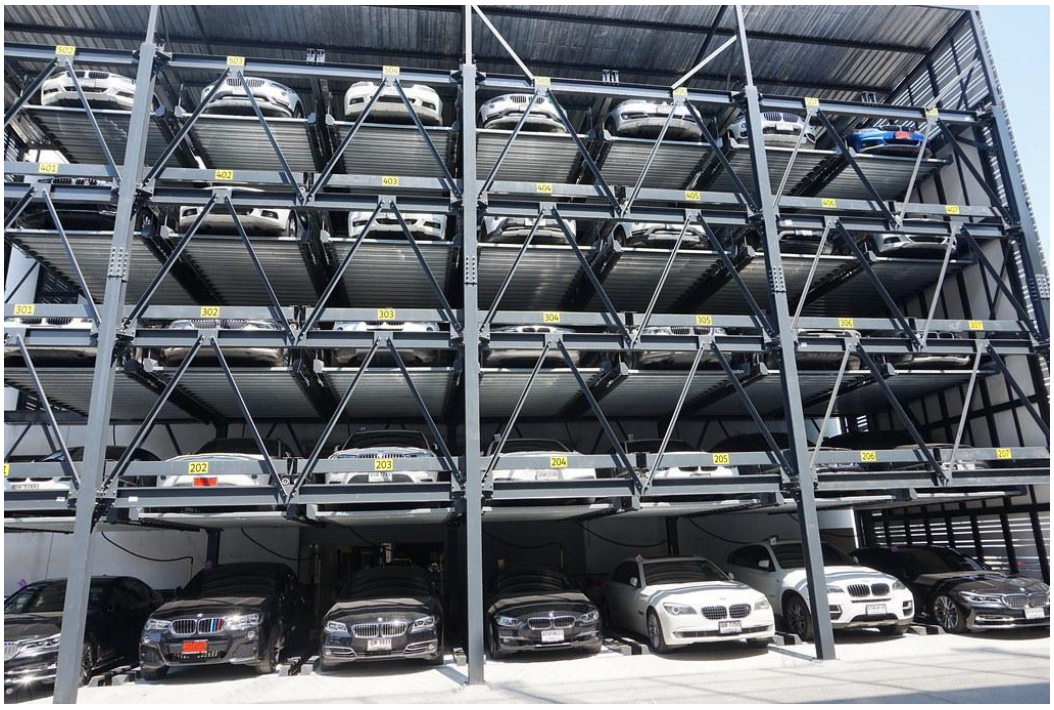
The crane mechanism can move in line with the normal direction of a vehicle (a longitudinal system) or orthogonal to it, i.e. sideways (a transverse system) depending on the site constraints. If higher throughput or redundancy is required, crane systems can also have two cranes running parallel to one another should the site constraints allow it. As there is typically only one mechanism for the parking and retrieval of vehicles the system redundancy

is potentially low but back-up motors, switches, etc. can be installed to increase the system's redundancy. Turning devices can be fitted under the vertical elevator platform should this be required [10].

I.4.5.3- Puzzle Systems

Puzzle systems offer the densest form of automated parking, typically utilizing around 95% of the floor area, and are often used in smaller systems. In a horizontal puzzle system, 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.

The rollers and belts maneuver the pallets until the pallet with the required vehicle on is maneuvered to the desired location, e.g. parking module, elevator, etc. The pallet support frames are installed in all possible parking positions and typically there are two fewer pallets than support frames per floor which provides the necessary free spaces to maneuver the pallets.



Picture I.6: puzzle parking systems [13].

Puzzle systems also provide flexible layout options as the system configuration is highly adaptable as a pallet can be maneuvered from one support frame to an adjacent on in

any direction. This means the system shape can vary greatly, instead of being rectangular or square, puzzle systems can also be “T” shaped, “U” shaped, “L” shaped, “H” shaped, etc. as long as there is a route for pallets to get from their current location to their destination location via an adjacent support frame. This also makes maneuvering around structural members possible that may not otherwise be possible with other system types.

Scissor lifts are typically used in puzzle systems as they allow the pallets to move on and off the lift platforms in all directions. Electrical cantilevered lifts can also be used 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 [12].

I.4.5.4- RGC Systems

Nowadays Rail Guided Cart (RGC) technology is being used in automated parking. The RGCs operate in a similar way to Automated Guided Vehicles (AGVs) except the RGCs are less complex and more robust than AGVs and therefore more cost effective and more reliable.

Vehicles are parked on pallets in the parking modules which are collected from the parking modules by the RGCs 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 throughput and budgetary requirements.

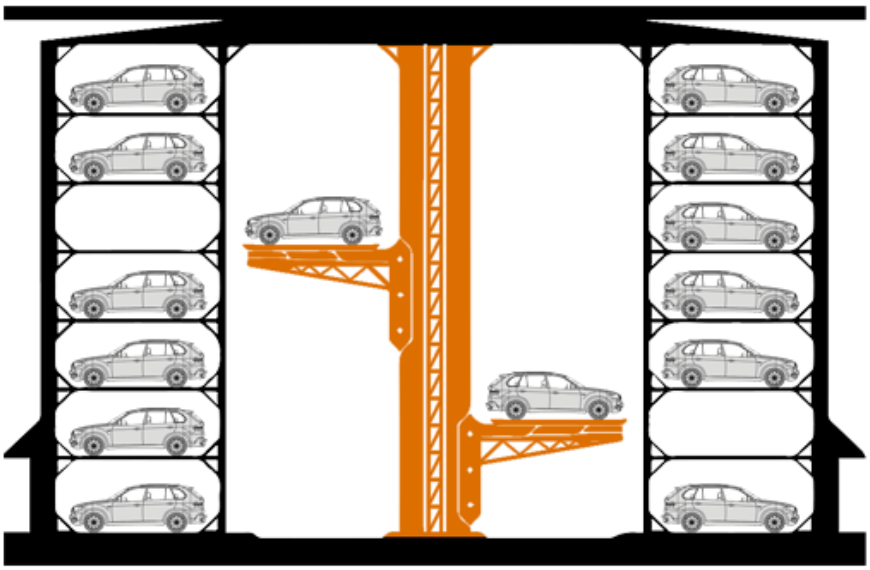
Picture I.7: Rail Guided Cart (RGC) parking systems [15].

Typically, RGC systems operate on solid concrete floors and can move in both lengthways and sideways directions (X and Y planes) along small guide rails fitted to the floor.

Vehicle elevators are used within the system to move the vehicle pallets with or without an RGC [14].

I.4.5.5- Shuttle Systems

Shuttle systems utilize autonomous shuttles and elevators to park and retrieve vehicles. The number of shuttles in the system is typically flexible and is based around the client's throughput and budgetary requirements. The shuttles move horizontally in a shuttle lane, which is either a recess in a solid floor or a set of rails in a steel or concrete structure, to a designated location. A robot, or pallet exchanger, or conveyor belts, located on the shuttle then park or retrieve a vehicle at the designated location by moving the vehicle from or to the shuttle and the parking space.



Picture I.8: Shuttle parking systems [17].

Typically, there is a single row of vehicles either side of the shuttle lane but for increased parking density a second row of vehicles can be added. The retrieval process for the second row of vehicles is slower than for the first row as the robot has a 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. A third row of cars can be added but the retrieval process is very slow.

When a vehicle is required to be moved from one level of the system to another there are two options for achieving this, one with vehicle elevators and the other with shuttle elevators [16].

When vehicle elevators are used a shuttle moves adjacent to a vehicle elevator and deposits the vehicle on the vehicle elevator platform. The vehicle elevator then moves the vehicle to the designated parking level and another shuttle collects the vehicle from the vehicle elevator. 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. The system throughput can be very high when vehicle elevators are used in this configuration.

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 shuttle elevator moves to the designated level whereupon the shuttle with the vehicle moves off the shuttle elevator to a designated location. In this option the shuttles are free to go to and from any level in the system allowing for fewer shuttles than parking levels and greater redundancy. However, the shuttle elevators are often the system bottlenecks and throughput is much lower than with vehicle elevators.

I.4.5.6- Tower Systems

Tower systems typically consist of a vehicle elevator with a parking space either side of the elevator shaft. This configuration is repeated over a number of levels to complete the parking tower. Typically, there is a parking module located on the ground floor, where the vehicle is turned, and the vehicle elevator simple raises to one of the parking levels of the tower and deposits the vehicle sideways into a parking space. This process is reversed to retrieve a vehicle.

Picture I.9: tower parking systems [19].

As there is a single mechanism to park and retrieve vehicles system redundancy is an issue with tower systems [18].

I.4.5.7- Chess systems

This system is a revolutionary type of system in the parking systems. With this system maximum utilization of the floor space is possible. NO drive way, no space for movement of mechanisms. This has floor mounted roller bed system which can allow the crisscross movement of the pallet and the car. This system preferably installed on RCC floors. System can be designed for from 800 to 1000 cars or even more also. It has separate lifts which acts as ENTRY & EXIT points. These systems can be used in longitudinal & square of parking areas also [20].

Picture I.10: Chess parking systems [21].

I.4.5.8- Silo Systems

Silo systems are cylindrical systems typically with a single, centrally positioned mechanism used to park and retrieve vehicles. The central mechanism moves vertically and rotates simultaneously allowing the vehicle platform to move to and from one parking spot to another very quickly. Typically silo systems are installed underground, and are most suitable where soil conditions are particularly unfavorable, but can also be installed above ground.

Picture I.11: Silo parking systems [23].

Single or multiple parking modules are possible with silo systems but typically only one vehicle can be parked or retrieved at one time. As there is only one mechanism for

parking and retrieving vehicles, and little possibility of adding another, system redundancy can be an issue [22].

I.5- Conclusion

In this chapter, we tried to touch the typically known parking systems, make differences between traditional and automatic systems, and the need of the technology of automated vehicle systems.

In the next chapter we are going to do the study and the conception of a prototype of a silo system.

Chapter II:

Technical Study of Parking System

Chapter II: Technical Study of Parking System

II.1- Introduction

To make any idea reel, and takes its place in reality, there are steps to take, in this chapter we are going to try to concept a silo parking system, starting with the design, explain the working principle of the project, then choosing the right components.

II.2- Design and Working principle of project:

II.2.1- Working principal of the project:

Our project will work as follows:

The Automated Car Parking System type Silo systems we are going to study will be made up with 3 major components: Arduino Uno, motors and software. The core part of this system is the microcontroller in Arduino. The coding of this system will be done using Arduino IDE programming language.

The LCD display will display the number of available slots and the ability of parking in, it gets updates about the parking slot.

When a car will come, the user/operator will send instruction through Arduino to open the gate and update the LCD display at the entrance.

DC motor helps the gate to open up when it gets the signal from Arduino.

The car parking tray will park the car as follow:

Micro DC motor 1 helps to put breaks in the car's wheel on the tray by closing on wheels with metal bars.

Stepper motor 1 helps to choose the level of the parking slot. It works as an elevator.

Stepper motor 2 helps to rotate the tray on same level to choose the appropriate position of the right slot.

Generally, at this point the two stepper motor 1 and 2, works simultaneously.

Micro DC motor 2 helps to park the car in the slot, by moving it from the elevator into the slot.

Stepper motor 1 at this point helps to put down the car in floor of the slot.

Micro DC motor 1 turns backward to loose breaks from the car's wheel.

Micro DC motor 2 turns backward to return the tray to its initial position on the elevator.

Stepper motor 1 and stepper motor 2 now also turn backward to return to their initial position making the tray coming out to park the next car.

These operations will be controlled by Arduino, so that it reaches the particular slot.

For parking out the user will have to type slot number and the retrieval code of confidentiality at the gate using the keyboard below the LCD display to give command to park out the car.

That operation will update the slot information to the LCD display at the entrance. The car will be parked out the same way it was parked in.

II.2.2- Block Diagram of the project

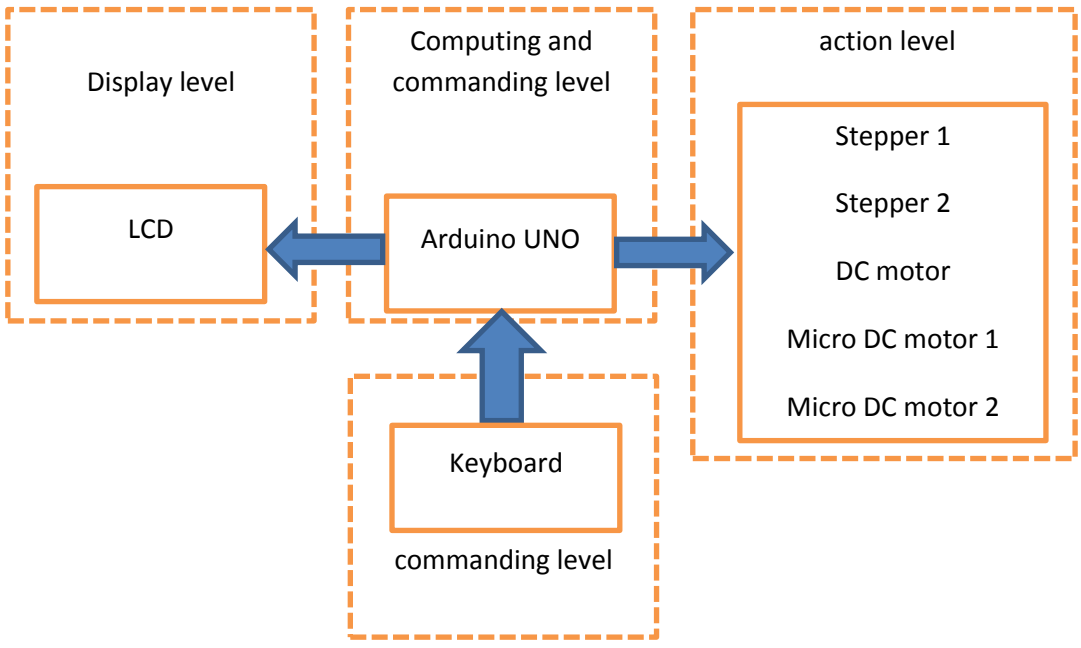


Figure II.1: Block Diagram of the system.

II.2.3- The Display

The display will show the total number of total slots, available slots and the retrieval code of confidentiality generated by the Arduino.

If there is no available slot the LCD display will show the next message “no parking place available”, and the process will end.

If there is/are available slot/slots, the LCD will show the number of the free slot at first.

The user/operator will choose the operation he wants to, parking in or retrieving a car.

After the parking in is done, the LCD will show the number of slot, and the retrieval code of confidentiality generated by the Arduino.

If the operation is parking out, the shown message will be “enter slot number and your code”.

If the code is correct the LCD will show “please wait for your car”

If the code is incorrect the LCD will display “incorrect code, please try again"

Initially

Total number of slot is tn=a

Number of occupied slot= n

Number of free slot=tn- Number of occupied slot

Calculation

After every parking in

Number of occupied slot= n+1

Number of free slot= tn- Number of occupied slot =a-(n+1)

After every parking out

Number of occupied slot= n-1

Number of free slot= tn- Number of occupied slot =a-(n-1)

Flowchart

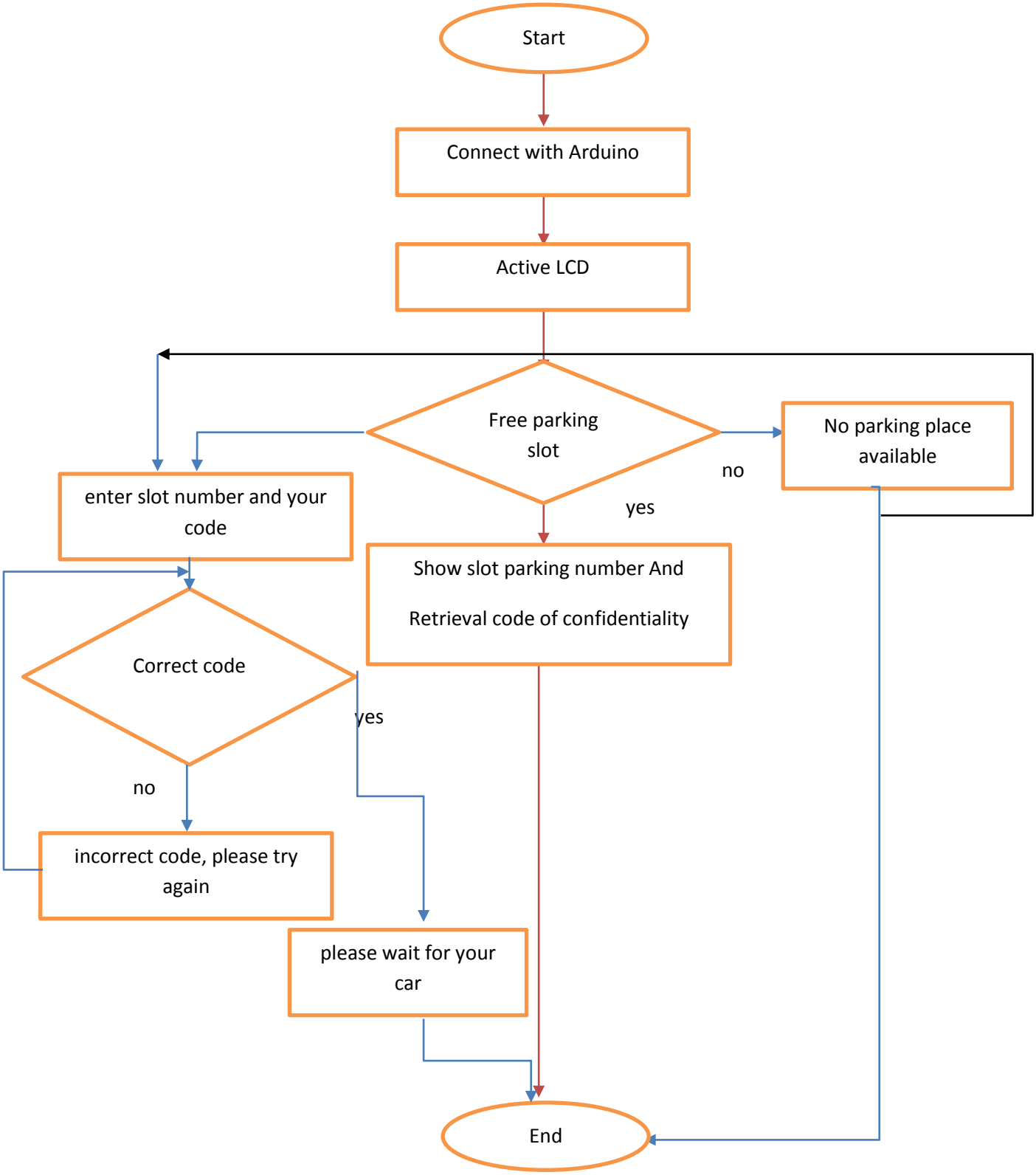


Figure II.2: Flowchart of display procedure**.**

II.2.4- The Gate

The operator will open/close the gate by giving command to Arduino, then the Arduino will give the signal to the DC motor to move Forward/backward.

Flowchart

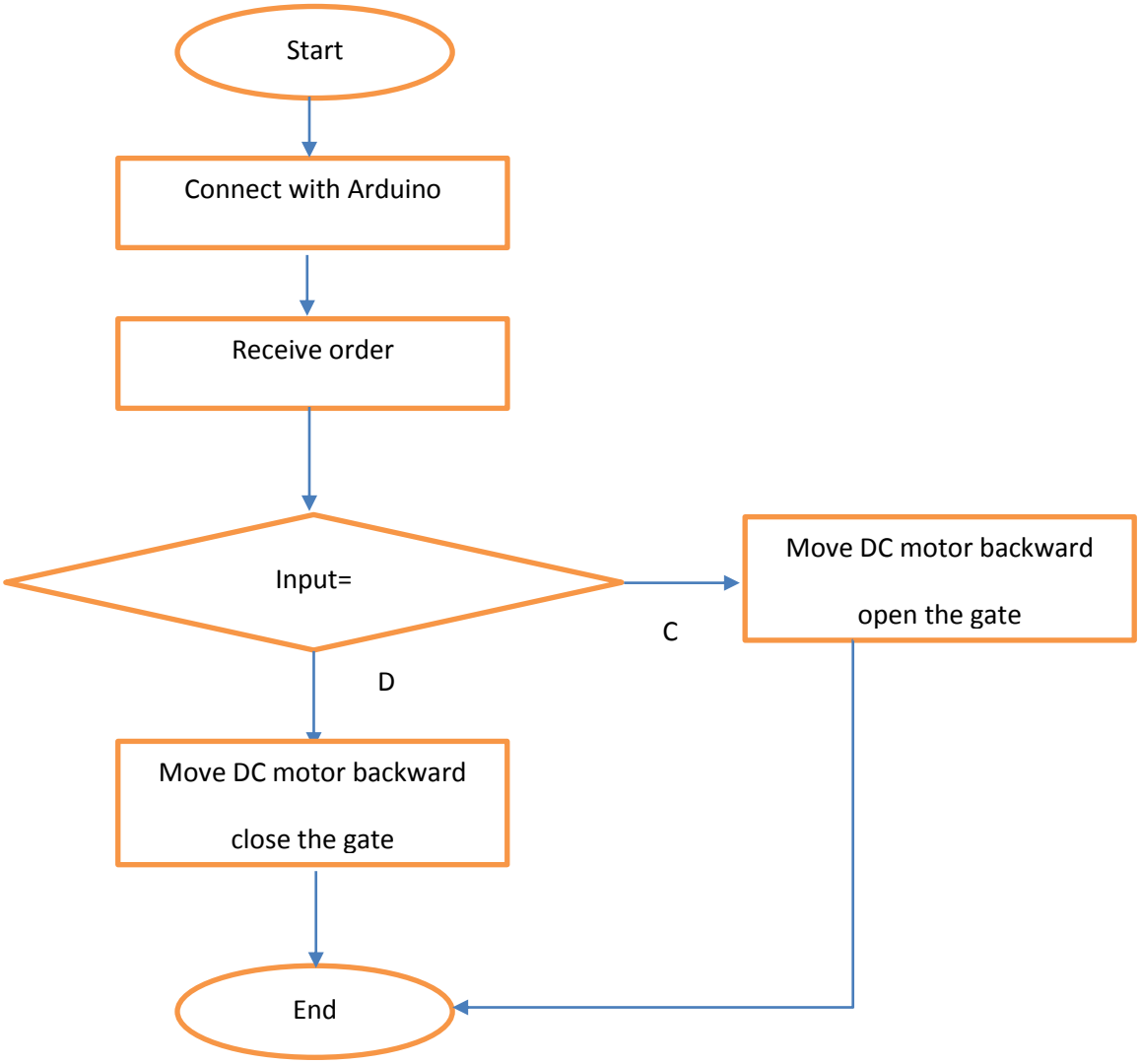


Figure II.3: Flowchart of opening/closing the gate procedure**.**

II.2.5- The central command (generating the code):

For security reasons, the retrieval code of confidentiality must not be a standard code, and it has no relation with slot number, it should be changed after every using of the slot, for that the regeneration of the code will be done after parking in the car by microcontroller in the Arduino UNO. After generation the code will be sent to the LCD to display it.

The calculation would be as follow:

Initially:

Count = m

Total number of slot is tn=a

Number of occupied slot= n

Calculation:

After every input

m=m+1

Code = (9999-m*5)+(a-n)*3

Flowchart:

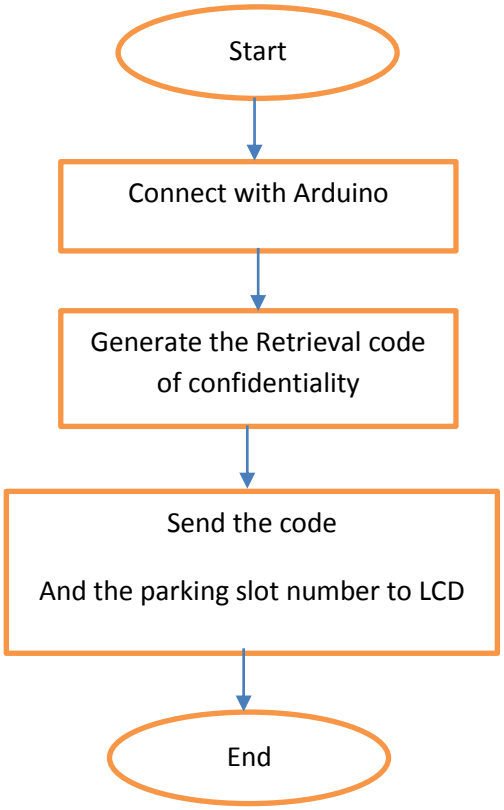


Figure II.4: Flowchart of generating/regenerating the code procedure**.**

II.2.6- The keyboard

The keyboard is used to the command and choose the operation of parking in or retrieving a car.

It also be used to enter the slot number and the code as shown in the display.

If the code or the slot number don't match, a message will be shown as mentioned earlier to try again and enter the correct code and the slot number.

Flowchart

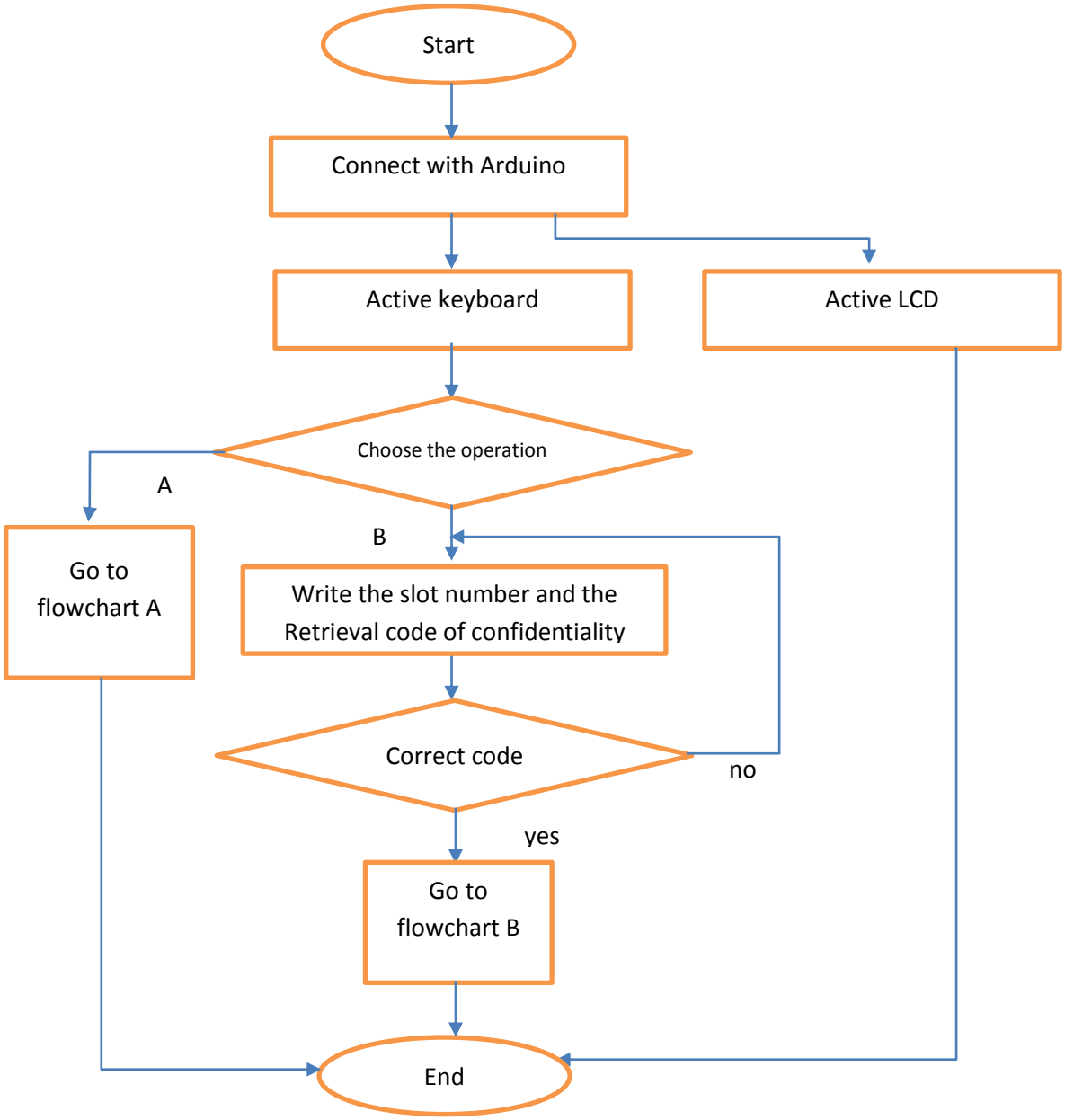


Figure II.5: Flowchart of keyboard using procedure**.**

II.2.7- The car parking in procedure

Initially

Slot number =ls

Level number=l

Slot position =s

Number of spinning of stepper motor 1 to move one level=n1

Number of spinning of stepper motor 2 to move one slot position =n2

Move stepper motor 1 forward turning once= to

Move stepper motor 2 forward turning once= to

calculation

Move micro DC motor 1 forward all the way out.

Move stepper motor 1 forward one level = to*n1

Move stepper motor 1 forward to the slot level= to*n1*l.

Move stepper motor 2 forward one level = to*n2

Move stepper motor 2 forward to the slot position= to*n2*s.

Move micro DC motor 2 forward all the way out.

Move stepper motor 1 forward turning once= to

Move micro DC motor 1 backward all the way in.

Move micro DC motor 2 backward all the way in.

Move stepper motor 1 backward to zero level= to*(n1*l+1).

Move stepper motor 2 backward facing the tray to the gate= to*n2*s.

Flowchart A

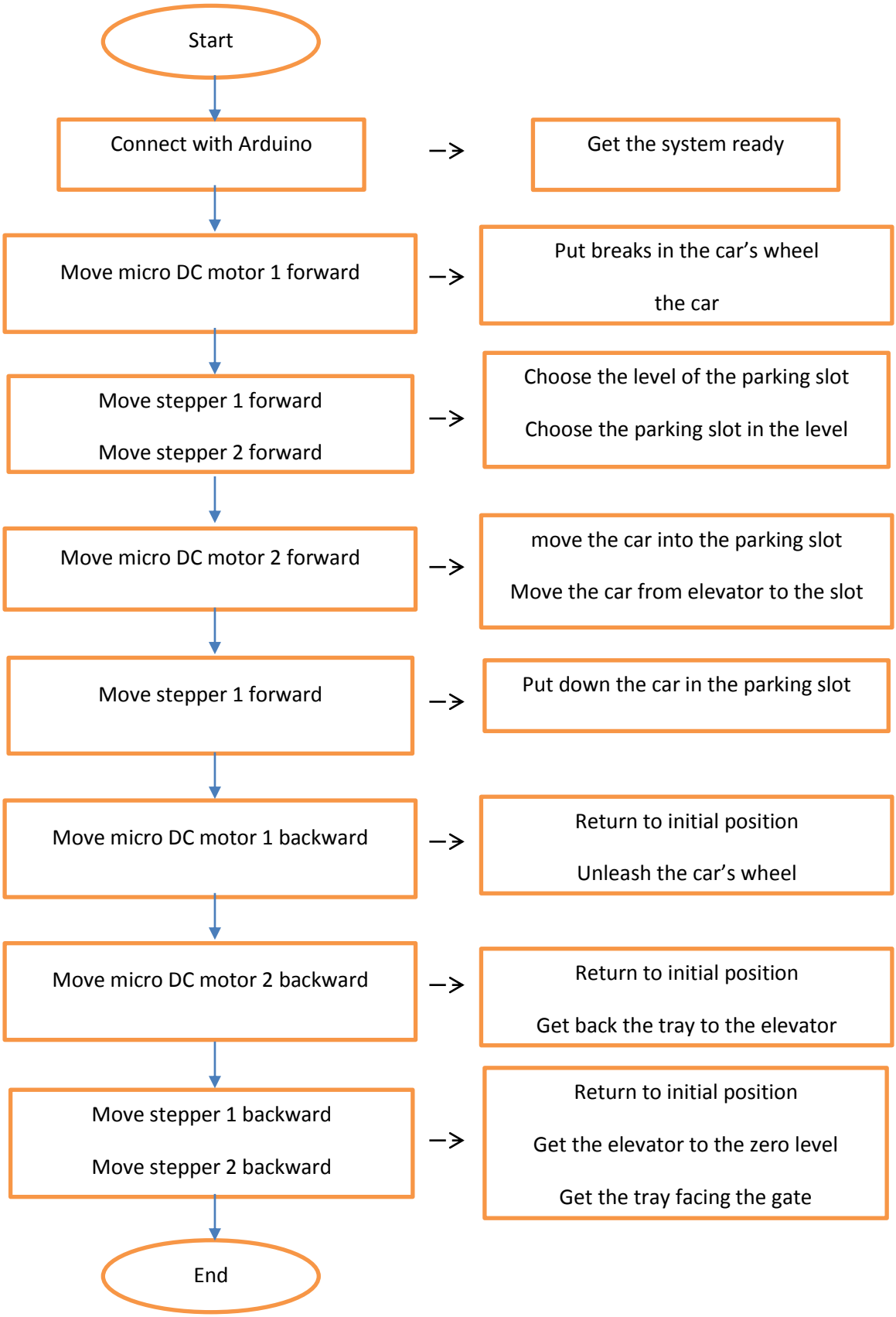


Figure II.6: Flowchart A of parking in procedure.

II.2.8- The car parking out (retrieving) procedure

Initially

Slot number =ls

Level number=l

Slot position =s

Number of spinning of stepper motor 1 to move one level=n1

Number of spinning of stepper motor 2 to move one slot position =n2

Move stepper motor 1 forward turning once= to

Move stepper motor 2 forward turning once= to

Calculation

Move stepper motor 1 forward one level = to*n1

Move stepper motor 1 forward to the slot level= to*n1*l.

Move stepper motor 2 forward one level = to*n2

Move stepper motor 2 forward to the slot position= to*n2*s.

Move micro DC motor 2 forward all the way out.

Move micro DC motor 1 forward all the way out.

Move stepper motor 1 backward turning once= to

Move micro DC motor 2 backward all the way in.

Move stepper motor 1 backward to zero level= to*(n1*l-1).

Move stepper motor 2 backward facing the tray to the gate= to*n2*s.

Move micro DC motor 1 backward all the way in.

Flowchart B

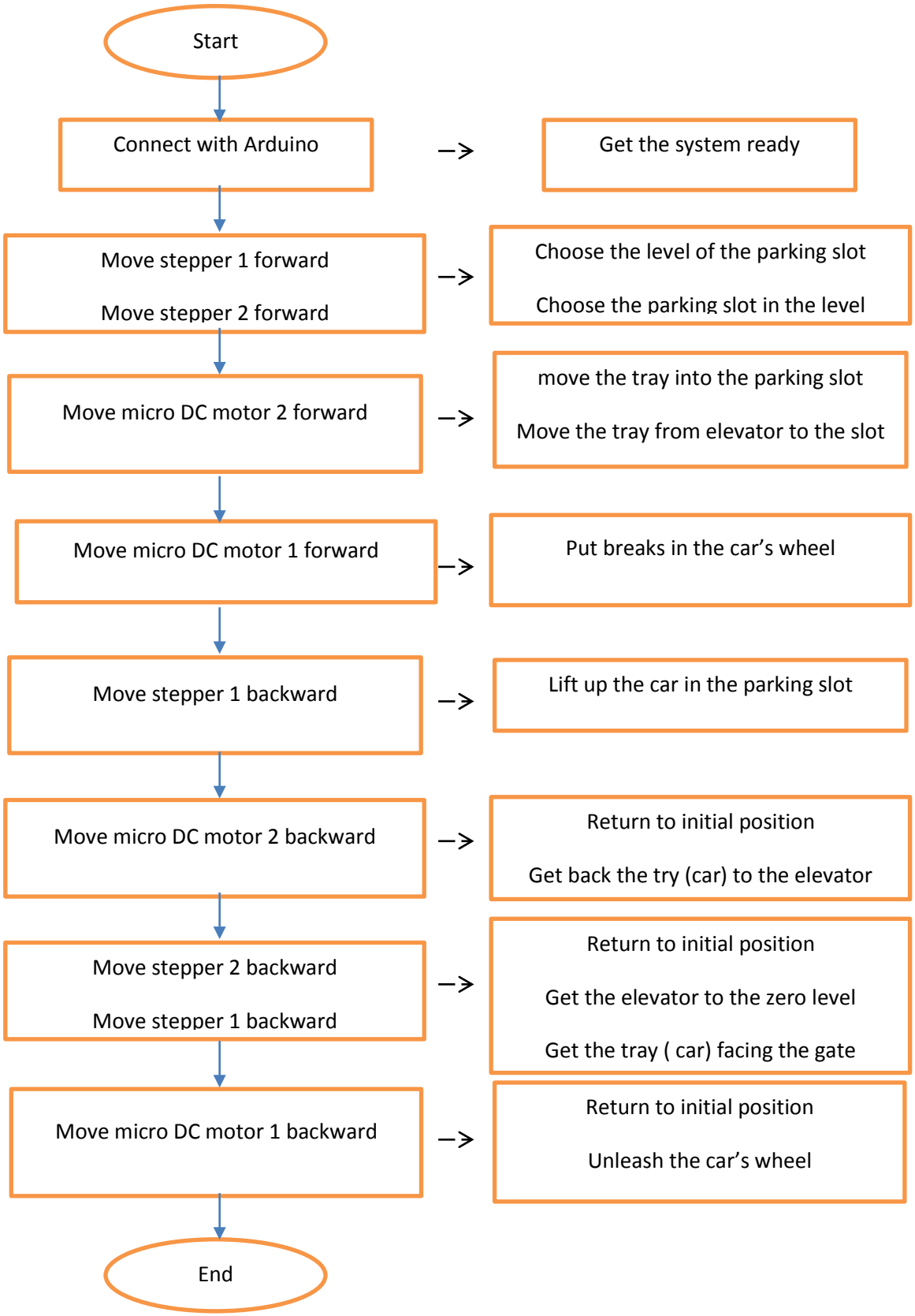


Figure II.7: Flowchart B of parking out procedure**.**

II.3- Choosing the prototype components

In order to build our project, first we are going to choose all the components to make the prototype functional.

There are mainly two types of components:

- Hardware components to construct the corps of the prototype.
- Software components to command the hardware and make the systems go.

II.3.1- Hardware components

The hardware components are also two types:

- Mechanical components.
- Electrical components.

II.3.1.1-Mechanical components choosing

There are many necessary components to build the corps of the prototype, some of these components, we are going to make, and the other components I can find the in shops.

a- Gears

The gears will be used for rotary motions. Here in the project we are going to print them using 3D printer machine, the size of the gear will be chosen corresponding to the prototype, and we will use them to get the car in the right slot.

b- Threaded shafts

The threaded shafts will be used as poles to support and carry the different levels of the project. In this project we are going to use 8mm diameter threaded shafts.

Picture II.1: threaded shafts from different sizes [24].

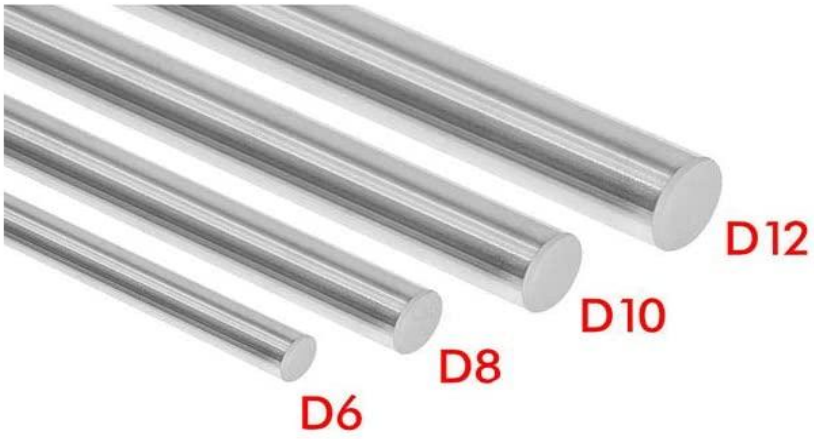
c- Nuts

The nuts will be used to fix some components in the prototype on the threaded shafts. In this project the will be used nuts are 13 mm size.

Picture II.2: Nuts from different sizes [25].

d- Metallic smooth shaft

Those shaft will be used to helps the elevator move between levels, they are necessary to finish the elevator, in this project we are going to use 8mm diameter ones.



Picture II.3: Smooth shafts from different sizes [26].

e- Bearings

We will need the two types of bearings:

- **Radial ball bearing**

They will be used to help the stirring gear rotate smoothly; in mean time they fix it to stay stable during the movement of the elevator.

Picture II.4: different types of Radial ball bearing [27].

- **Linear motion ball bearing**

As the name employ, this type of bearing generally used to help the metallic smooth shaft to slip linearly. In this project we are going to use lm8uu.

Picture II.5: Linear motion ball bearing [28].

f- Lead screw with brass nut

Lead screw drives are machine elements that convert rotary movement into linear motion, in this project the lead screw will be used to move up/down the elevator, We are going to use 8mm diameter leadscrew.

Picture II.6: Lead screw with brass nut [29].

g- Belt

The belt will be used to rotate the stirring gear to get the car in the right position.

II.3.1.2- Electrical components choosing

In order to realize our project, we are going to choose the electrical and electronic components; those components must have some special features to make the system easy to be used, and smoothly working.

a- 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.

Picture II.7: LCD Display [30].

LCD Pin Description

Table II.1: LCD pin description [30].

Pin no	Function	Name
1	Ground(0V)	Ground
2	Power Supply(4.7-5V)	V_{CC}
3	Contrast Adjustment (through a variable register)	V_{EE}
4	Selects data register when high; Selects command register when low	Register Select
5	Register Select	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	Back Light V_{CC}(5V)	Led+
16	Back Light Ground (0V)	Led-

b-DCMotor

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 [6].

Picture II.8: DC motor [6].

c- Micro Metal Gearmotors (micro DC motor)

With a cross section measuring only 10 × 12 mm (0.39″ × 0.47″), these small brushed DC gearmotors are available in a wide range of gear ratios—from 5:1 up to 1000:1—and with five different motors: high-power (HP), medium power (MP), and low power (LP) 6 V motors with precious metal brushes, and high-power 6 V and 12 V motors with longer-life carbon brushes (HPCB).

Picture II.9: Micro Metal Gearmotors [31].

features of Micro Metal Gearmotors

Table II.2: features of Micro Metal Gearmotors [31]

Items		unit	specifications
Motor type		/	1100
Rated voltage		/	4.995
pololu item		/	2500
Gear ratio	:1	/	0.02
No load	speed	RMP	2500
	Current	A	0.02
Stall extra polation	Torque	Kg.mm	0.1
	Current	A	0.36

d- Stepper motor

A stepper motor, also known as step motor or stepping motor is a brushless DC special electric motor that divides a full rotation into a number of equal steps (move in discrete steps).

With a computer controlled stepping you can attain very precise positioning and speed regulator. [32]

Stepper motors are DC motors that move in discrete steps. They have multiple coils that are organized in groups called "phases". By energizing each phase in sequence, the motor will rotate, one step at a time.

With a computer controlled stepping you can achieve very precise positioning and/or speed control. For this reason, stepper motors are the motor of choice for many precision motion control applications.

Stepper motors come in many different sizes and styles and electrical characteristics. This guide details what you need to know to pick the right motor for the job. [33]

Types of Steppers

There are a wide variety of stepper types, some of which require very specialized drivers. For our purposes, we will focus on stepper motors that can be driven with commonly available drivers.

NEMA 17 is a common size used in 3D printers and smaller CNC mills. Smaller motors find applications in many robotic and animatronic applications. The larger NEMA frames are common in CNC machines and industrial applications.

The NEMA numbers define standard faceplate dimensions for mounting the motor. They do not define the other characteristics of a motor. Two different NEMA 17 motors may have entirely different electrical or mechanical specifications and are not necessarily interchangeable. [33]

In our project we are going to use two stepper motors, one for the elevator and the other for positioning:

The type of stepper motor I used for the elevator is Stepper motor NEMA 17HS8401.

The type of stepper motor I used for the stirring is Stepper motor NEMA 17 type 42SHD0001-24B.

Picture II.10: stepper motor 17HS8401 and steeper motor 42SHD0001-24B.

Feature of the used stepper motors

Table II.3: feature of Stepper motor NEMA 17HS8401 and 42SHD0001-24B [34][40].

Items	Unit	Specifications	
Series Model		17HS8401	42SHD0001-24B
Step Angle	(deg)	1.8	1.8
Motor Length	(mm)	48	34
Rated Current	(A)	1.7	0.4
Phase Resistance	(ohm)	1.8	30
Phase Inductance	(mH)	3.2	37
Holding Torque	(N.cm Min)	52	260
Detent Torque	(N.cm Max)	2.6	12
Rotor Inertia	($g.cm^2$)	68	38
Lead Wire	(No.)	4	4
Motor Weight	(g)	350	200

e- Motor driver

Motor driver is a little current amplifier1 the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor [6].

The A4988 Motor driver

The A4988 is a complete micro stepping motor driver with built-in translator for easy operation. It is designed to operate bipolar stepper motors in full-, half-, quarter-, eighth-, and sixteenth-step modes, with an output drive capacity of up to 35 V and ±2 A. The A4988 includes a fixed off-time current regulator which has the ability to operate in Slow or Mixed decay modes. The translator is the key to the easy implementation of the A4988. Simply inputting one pulse on the STEP input drives the motor one micro step. There are no phase

sequence tables, high frequency control lines, or complex interfaces to program. The A4988 interface is an ideal fit for applications where a complex microprocessor is unavailable or is overburdened. During stepping operation, the chopping control in the A4988 automatically selects the current decay mode, Slow or Mixed. In Mixed decay mode, the device is set initially to a fast decay for a proportion of the fixed off-time, then to a slow decay for the remainder of the off-time. Mixed decay current control results in reduced audible motor noise, increased step accuracy, and reduced power dissipation [35].

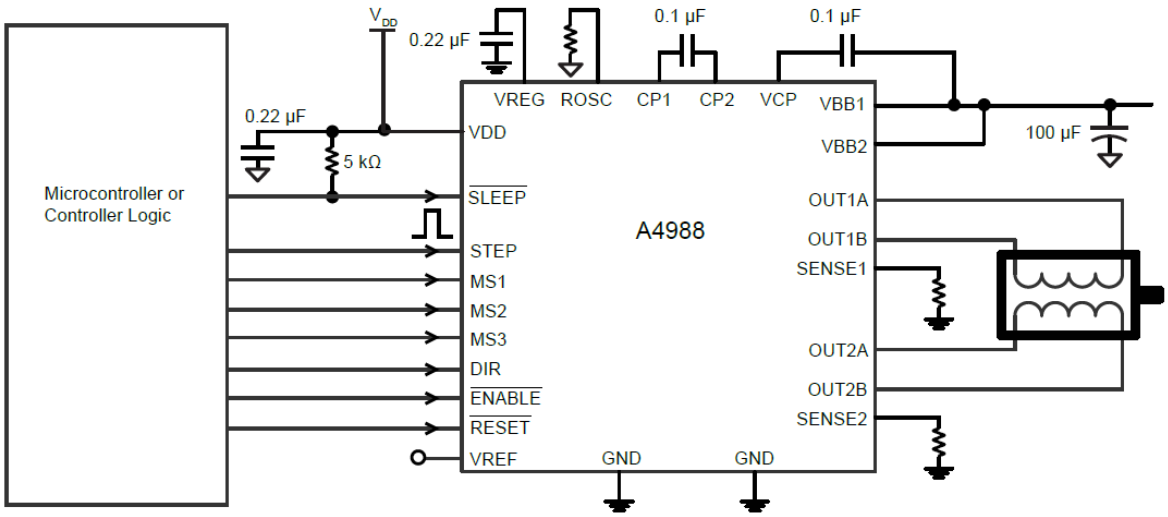


Figure II.8: Typical Application Diagram [35].

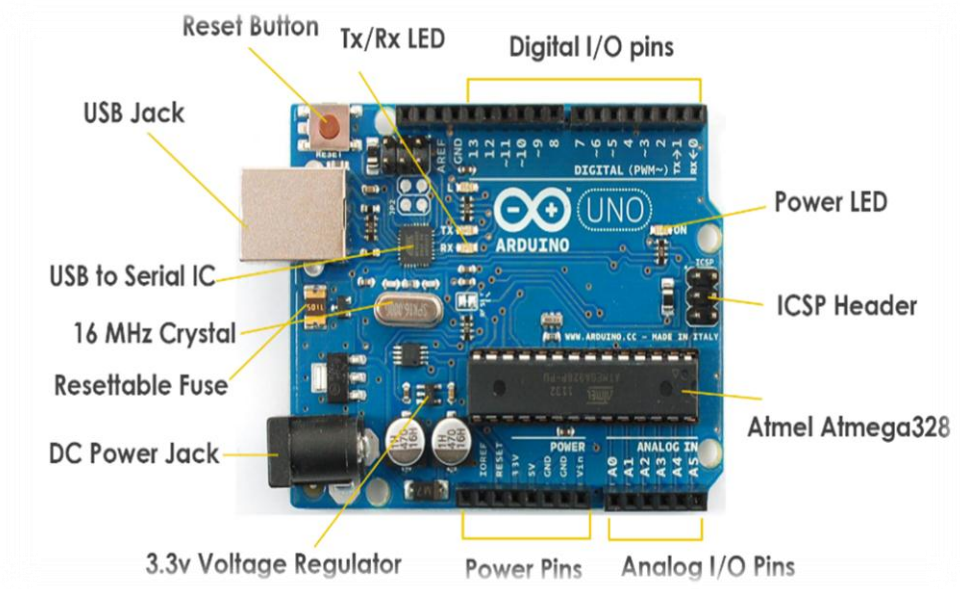
f- Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards can read inputs - light on a sensor, a finger on a button - and turn it into an output - activate a motor, light an LED. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do this, you use the Arduino programming language (wiring-based) and Arduino software (IDE), which is processing-based.

With its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. Arduino software is easy to use, yet flexible enough for advanced users [36]. In our work we used the Arduino UNO which has the following technical specifications:

Table II.4: Technical specifications of the ARDUINO UNO [37].

Microcontroller	ATmega328P
Working voltage	5V
Input voltage (recommended)	7-12V
Input voltage (limit)	6-20V
Digital I / O pins	14 (of which 6 provide PWM output)
Analog input pins	6
Direct current per I / O pin	20 mA
Direct current for 3.3V pin	50 mA
Flash memory	32 KB (ATmega328P) Dont 0,5 Ko utilisé par boot loader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock speed	16 MHz



Picture II.11: the ARDUINO UNO [38]

g- DuPont Cable Wires

These are wires with pin at each end. They are used to interconnect different components on the breadboard without needing to solder them. For this project, they will be used to transfer data from one parking component to the other [39].

Picture II.12: DuPont Cable Wires [39].

II.3.2- 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 [38].

II.4- Conclusion

After studying the whole process and choosing the electrical components, and realizing the electronic circuit, I explained the working principal of the process, using diagram blocks and flowcharts for most important operations, now I can design the prototype's final form and build it and install, then program the Arduino to control it.

These steps are to be done in the next chapter.

Chapter III:

Realization and Programing of Parking System

Chapter III: Realization and Programming of Parking System

III.1- Introduction

To make this project reel, in this chapter we are going to build the silo parking system prototype, starting with the design and realizing of the mechanical support and the electronic circuit, and installing the whole prototype.

Than at last programing the Arduino's microcontroller to control the parking system.

III.2- Realizing the prototype

To finish the project there are two main steps to be done:

- Realizing (building) the hardware.
- Programming the software.

III.2.1- Hardware of the project

The hardware of the project is composed of two parts:

- Mechanical part that support prototype.
- The electrical part that command and move the mechanical parts.

III.2.1.1- Mechanical parts

Some of the mechanical parts used in this project we will make, taking as example: gears are to be printed using a 3D printer. And some other parts as parking's level are to be cut using CNC laser cutting machine, the other parts are available in shops.

Both of parts we are going to make will be designed, to do that we will use the software Fusion 360.

a- Fusion 360

Fusion 360 is a cloud-based CAD/CAM tool for collaborative product development.

Fusion 360 enables exploration and iteration on product ideas and collaboration within distributed product development team.

Fusion 360 combines organic shapes modelling, mechanical design and manufacturing in one comprehensive package [41].

The whole prototype will be designed with Fusion 360, as follow:

Figure III.1: the design the prototype with the software Fusion 360.

b-The mechanical parts we will make

- **The stirring gear**

It will be turned by the stepper motor 2 to choose the slot in the level.

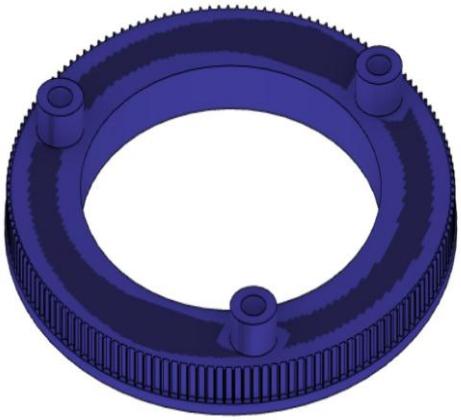


Figure III.2: the design of stirring gear.

Picture III.1: the reel stirring gear.

- **The tray**

It will be moved into/out from the slot, to put the car into the slot, or get it from the slot.

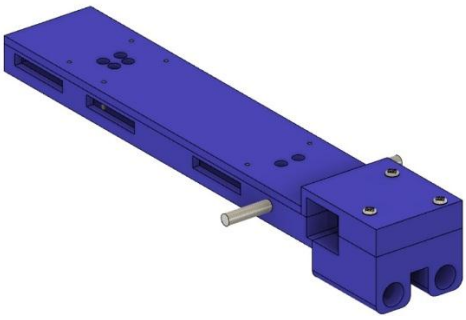
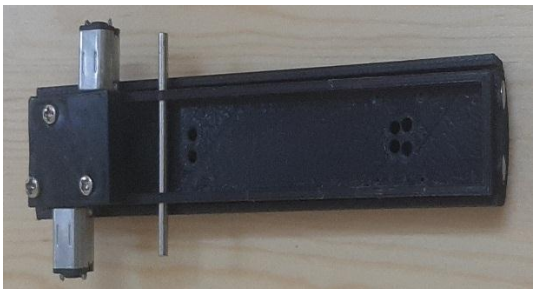


Figure III.3: the design of tray.



Picture III.2: the reel tray.

- **The elevator**

the elevator will carry the tray with/without the car and lift them up/down between the parking level. It will be moved up/down by moving stepper motor 1 forward/backward.

It can also be turned by the stirring gear used the choose the slot.

Figure III.4: the design the elevator.

Picture III.3: the reel elevator.

- **Levels**

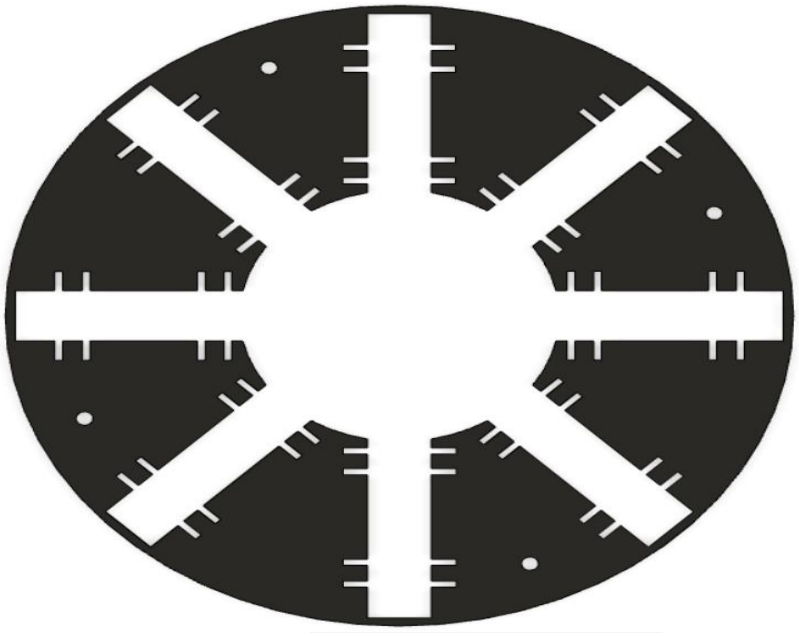
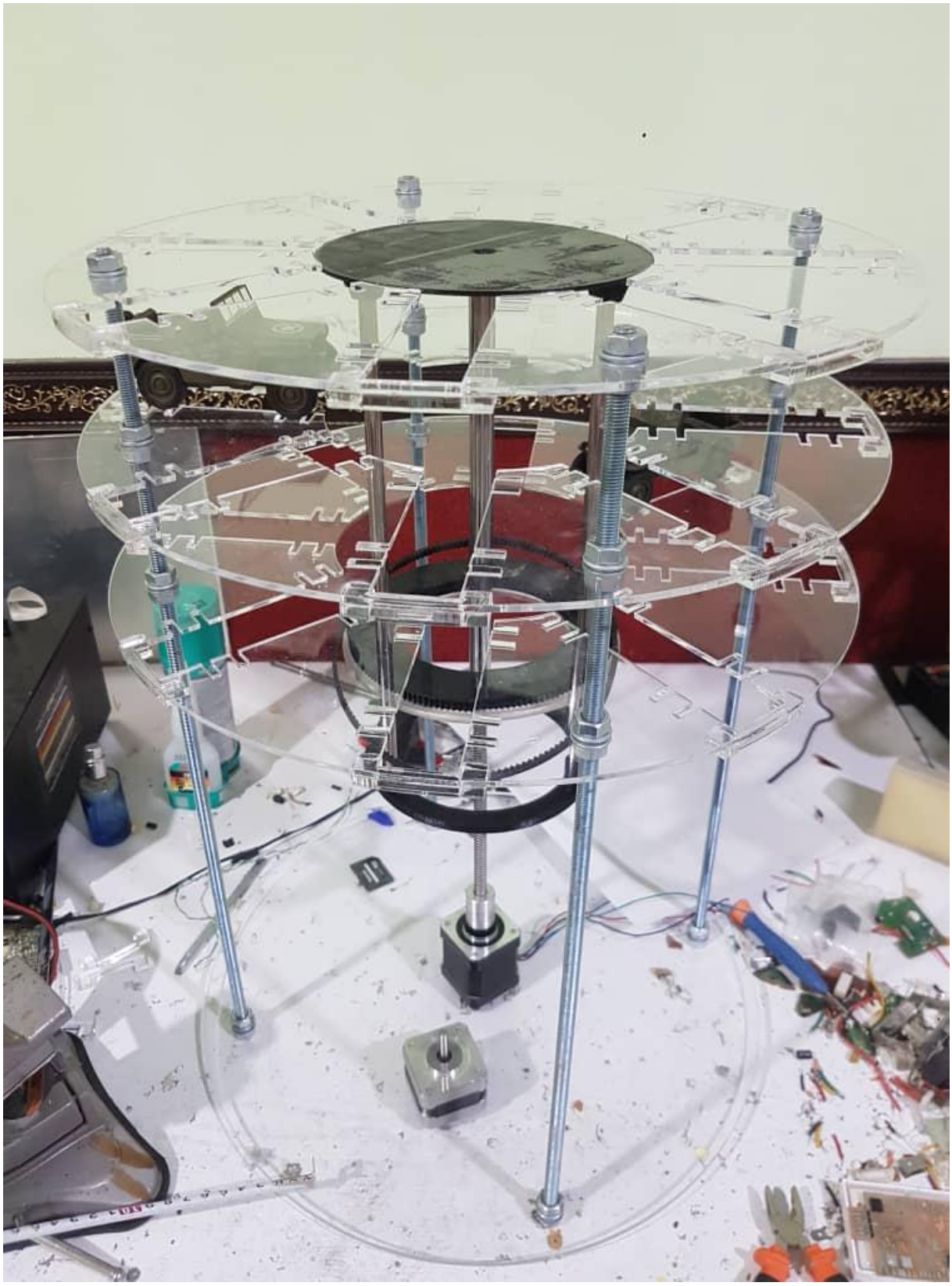


Figure III.5: the design the elevator.

After combining all mechanical parts, the real project will be as follow:



Picture III.4: the mechanical support of the project.

III.2.1.2- Electrical part

a- Design of the electronic circuit

To realize the electronic circuit, we are going to use the software Proteus, first to make the draw the circuit than simulate the process.

- **Proteus**

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto router and basic mixed mode simulation capabilities [42].

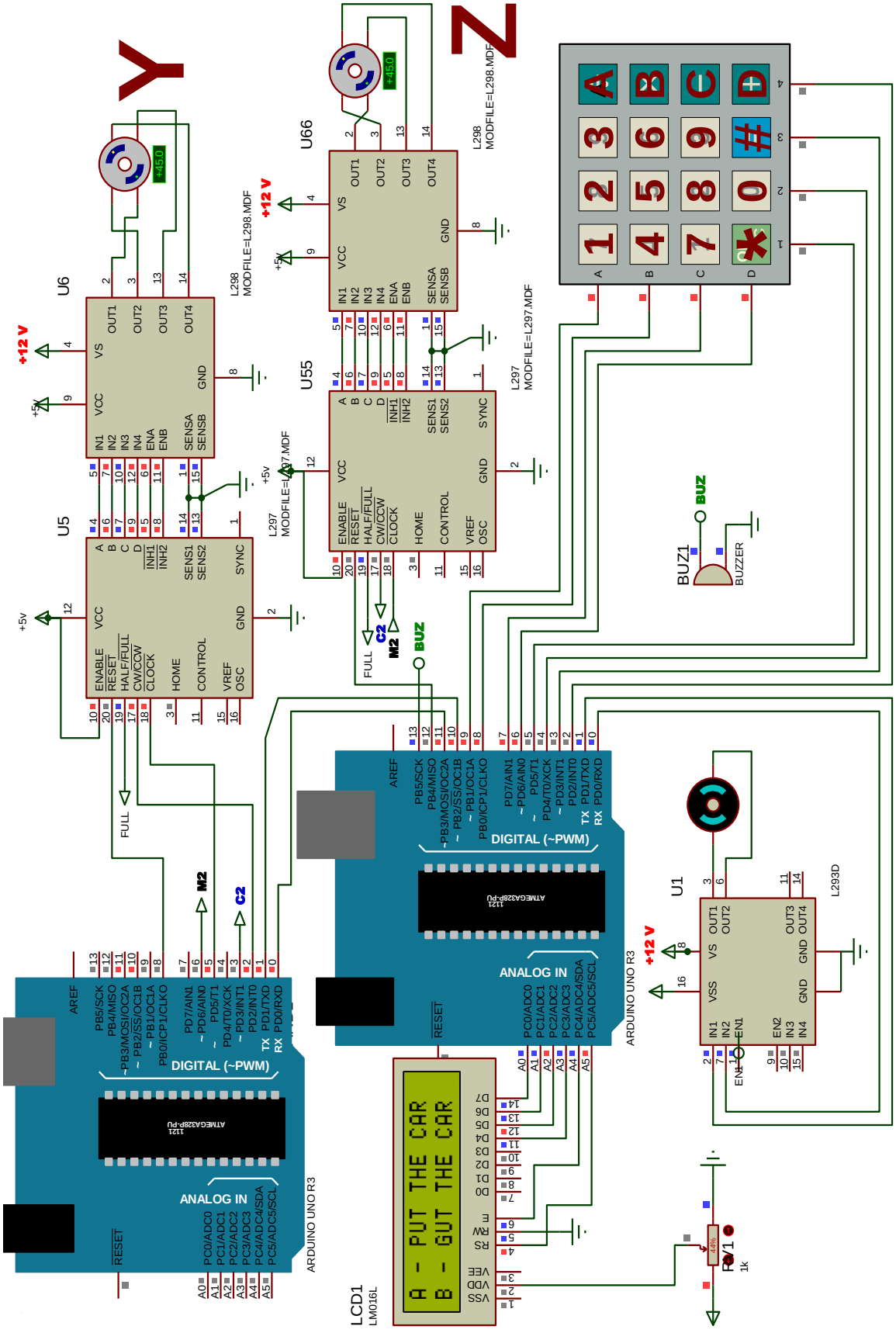


Figure III.6: the electronic circuit.

- **Fritzing**

Fritzing is an open-source initiative to develop amateur or hobby CAD software for the design of electronics hardware, to support designers and artists ready to move from experimenting with a prototype to building a more permanent circuit. It was developed at the University of Applied Sciences Potsdam [43].

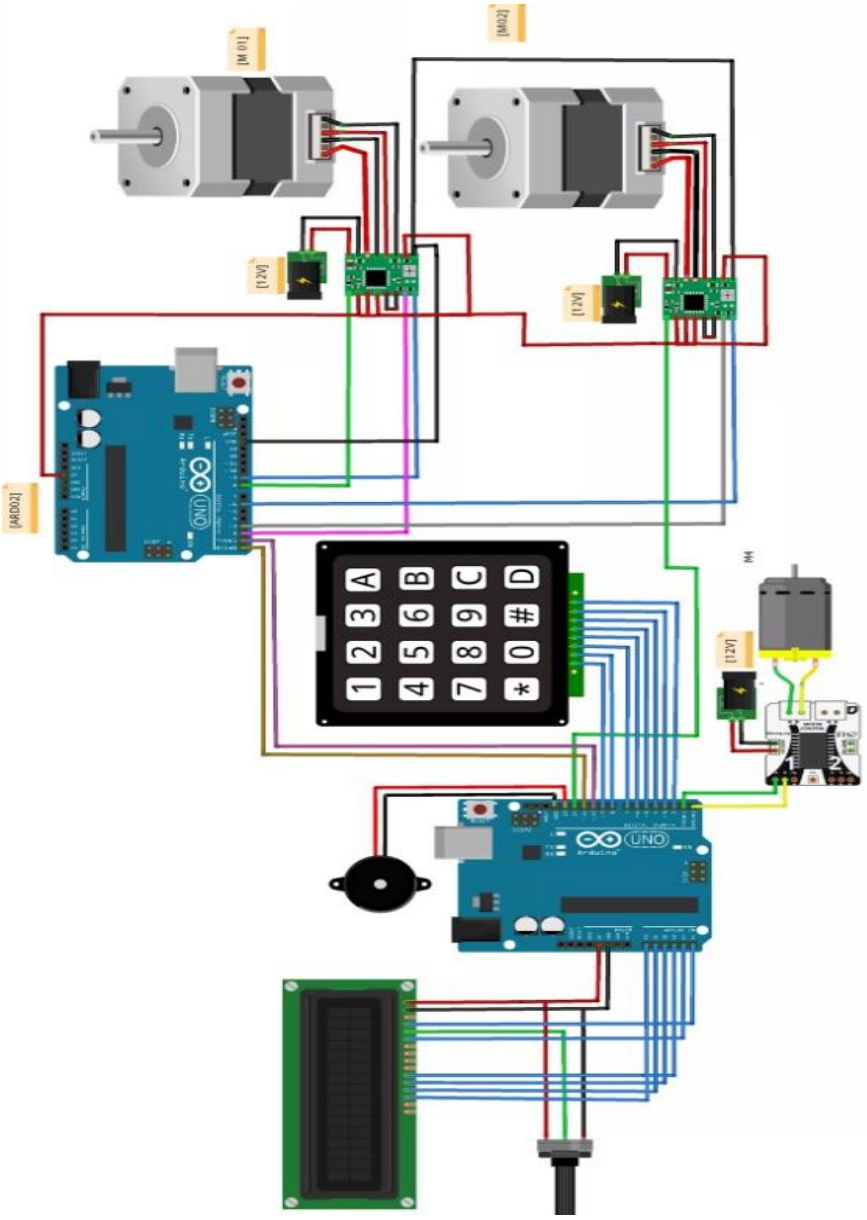
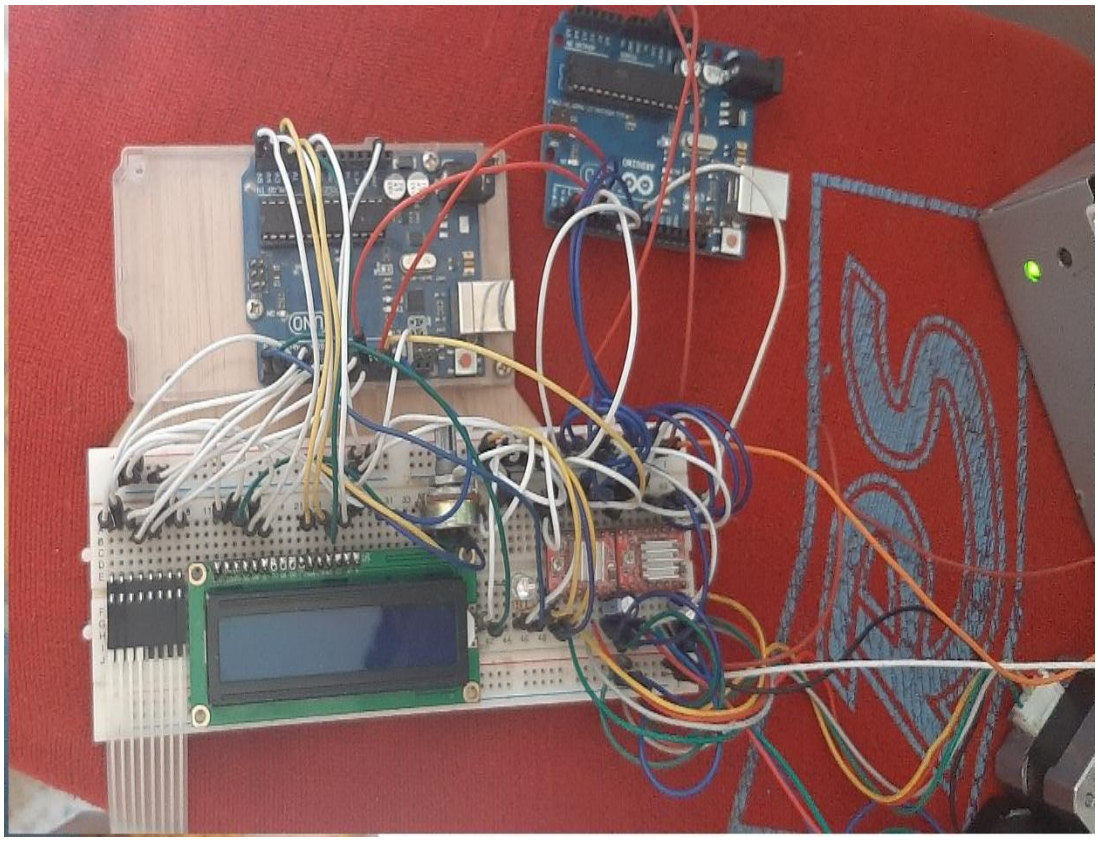


figure III.7: the electronic circuit designed using Fritzing.

b- Realization of the electronic circuit

Before making and printing the circuit, we must test it using a breadboard and wire the components without needing to solder them.



Picture III.5: the electronic circuit using a breadboard

III.2.2- Programming the software

To program the Arduino Uno, we are going to use the software Arduino IDE.

The open source software (Windows, linux or mac) supplied with the Arduino is a text editor which allows you to program the card using a simple language close to C [36].

On opening, the visual interface of the software shown in the following figure (II. 8):

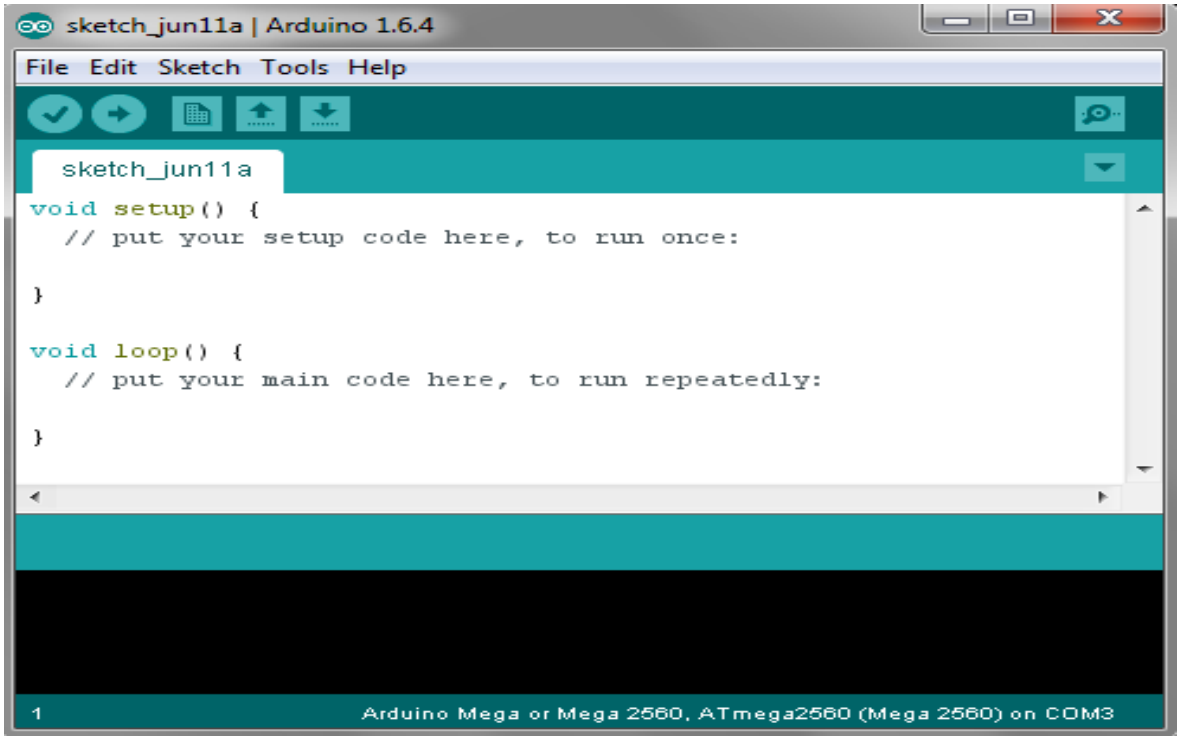


Figure III. 2 : software Arduino (IDE)

III.3- Conclusion

At the end of this chapter, I have finished the realization of the whole prototype of the silo parking car systems, this prototype is now functional and can automatically park in/out twenty-four cars, looking at the surface occupied by the prototype, twenty-four is an important number.

General Conclusion

General Conclusion

The parking system we realized in a small surface place has a lot number of parking slots, these number could be an important value if there are more levels, and it could be enormous with high level technology, in this project, at first we started the design with five levels, but according to the building stability, we stopped at three levels so the prototype corps stays stable.

As seen from the results, we can reduce random car parking places and traffic problems. due to automation of the parking system, entry and exit of vehicles control is based on the status of the slots. This will over all save the parking time and space.

Due to over population in cities and more number of vehicles growing day-by-day, implementation of this system is very much needed. even in the existing multi-stored buildings this can be implemented with some additional features.

All of the above factors together combine to make parking garages the future of parking. Experts have already predicted that implementing these automated systems parking will reduce the demand for the increasingly rare parking spot.

In other countries its already being implemented. bigger cities in Europe and Asia started this system. As this system is the one of the solution for all the parking and traffic problems, this APS has better future scope.

For next studies:

The payment operation, which we did not mention in our study, could be an important subject to be studied; therefore we propose the next title “study and realizing of a payment process for car parking lot management”.

Also reservation problem, users sometimes come at the automated parking systems, but they will not find free places to park in their cars, reservation by phone could be a solution for this problem, therefor we propose the next title: “study and realizing of a car parking lot management based on GSM”.

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