

الجمهورية الجزائرية الديمقراطية الشعبية

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

وزارة التعليم العالي والبحث العلمي

Ministry of Higher Education and Scientific Research

جامعة أبي بكر بلقايد - تلمسان

Aboubakr Belkaïd University - Tlemcen-
Faculty of TECHNOLOGY



MEMORY

Presented for obtaining the **diploma** of **MASTER**

In: Electronic

Specialty: Instrumentation

By: TABET FAICAL & HADADI ABDELOUAHAB

Subject

Design and realization of a robot control using a G sensor from a smartphone

Publicly defended, on 08/ 05/2023, before the jury composed of:

Mr B.Benadda	Professor	University of Tlemcen	President
Mr A.N Moulai Khatir	MCB	University of Tlemcen	Examiner
Mr N.Massoum	MCB	University of Tlemcen	Framer

Academic year :2022/2023

GRATITUDE

We thank God for the courage, patience and health that have been useful throughout our journey.

We would like to thank our promoter Mr Massoum Nouredine who directed this project and for his availability, help and valuable advice.

Our sincere gratitude also goes to the members of the jury Mr B.Benadda and Mr A.N Moulai Khatir who have agreed to judge this work.

It is particularly pleasant to express our gratitude to our parents, brothers and sisters, all our families and friends who have made this work possible.

May all those who have contributed in any way to our training find here our sincere thanks.

Table of contents

<i>GRATITUDE</i>	I
<i>Table of contents</i>	II
<i>List of figures</i>	III
<i>List of tables</i>	IV
<i>Abstract</i>	V

General Introduction.....	1
Chapitre I : Generalities in robots.....	2
I. Introduction.....	3
I.1 History.....	3
I.2 The general structure of the system.....	4
I.2.1 Type of robots	4
I.2.1.1 Industrial robots:	4
I.2.1.2 Service robots:	4
I.2.1.3 Military robots:	4
I.2.1.4 Medical robots:.....	4
I.2.1.5 Educational robots:.....	5
I.2.1.6 Entertainment robots:	5
I.2.1.8 Mobile robots:	5
I.2.1.8 Autonomous robots:.....	5
I.2.1.9 Humanoid robots:	5
I.2.1.10 Social robots:	5

I.3	The field of application.....	6
I.3.1	Manufacturing:	6
I.3.2	Healthcare:	6
I.3.3	Exploration:.....	6
I.3.4	Agriculture:	6
I.3.5	Education:.....	6
I.3.6	Transportation:	6
I.3.7	Construction:.....	6
I.3.8	Personal Assistance:.....	7
I.3.9	Energy:.....	7
I.4	Manipulator robots.....	7
I.4.1	Definition:.....	7
I.4.2	Different Types of Robot Manipulators	8
I.5	Mobile Robots:	9
I.5.1	Definition.....	9
I.5.2	Advantages of mobile robots	9
I.5.2.1	Flexibility:	9
I.5.2.2	Efficiency:	9
I.5.2.3	Safety:.....	10
I.5.2.4	Cost Savings:	10
I.5.2.6	Data Collection:.....	10
I.5.2.7	Accuracy:	10

	I.5.2.8 Scalability:	10
I.6	Classification of mobile robots.....	10
I.7	Architecture of mobile robots:.....	11
I.8	DC motor:	11
	I.8.1 Type of Dc motor:.....	11
	I.8.1.1 Permanent magnet motors:.....	11
	I.8.1.2 Series DC motor:	12
	I.8.1.3 Shunt motor:.....	13
	I.8.1.4 Compound motors:	13
	I.8.2 Operation of a DC motor	14
I.9	The servomotor	15
	I.9.1 Composition of a servo motor	16
	I.9.2 Operation of the Servomotor:	16
I.10	Sensors	17
	I.10.1 Dification of sensors.....	17
	I.10.2 Classification of Sensors.....	17
	I.10.3 How do Sensors work?	18
	I.10.4 Different Types of Sensors.....	18
I.11	G sensor	19
	I.11.1Definition of G sensor.....	19
I.12	Conclusion.....	20

Chapter II : The Arduino programmable device.....	21
II. Introduction.....	22
II.1 The arduino	24
II.1.1 Architactuer of Arduino	24
II.2 Type of Arduin broad :.....	23
II.2.1 Arduino UNO:.....	23
II.2.1.1 Technical Specifications of Arduino UNO:	25
II.2.2 Arduino Nano:.....	26
II.2.2.1 Technical Specifications of Arduino Nano:	27
II.2.3 Arduino Mega:	27
II.2.3.1 Technical Specifications of Arduino Mega:.....	28
II.3 Bluetooth :	28
II.3.1 Bluetooth Technology:.....	29
II.3.2 Bluetooth Architecture :.....	29
II.3.2.1 Piconet Network.	29
II.3.2.2 Scatternet Network:.....	30
II.4 Connections:.....	31
II.4.1 Bluetooth HC-05:	31
II.4.1.1 Specification :	31
II.4.1.2 HC-05 Pinout Configuration:	32
II.5 Driver motor L298N:.....	33
II.5.1 Power supply :.....	34
II.5.2 Principale of operation :.....	37
II.6 Conclusion :	37

chapter 3 : Practical realization of the Robot.....	36
III Introduction.....	37
III.1 Project desgin	37
III.1.2 Hardware used :	37
III.1.3 Software Used:.....	39
III.1.4 Flow chart for working of module	38
III.2 Programming environement for Arduino broade (Arduino IDE).....	39
III.2.1 Injection of program in the Arduino board:.....	39
III.2.2 Structure of a Arduino program :.....	40
III.2.3 Instructure de base de programmation:	40
III.2.4 Arduino code:	40
III.3 The Simulation part:	43
III.3.1 Proteus Software:.....	43
III.3.2 Using the Proteus Software:.....	43
III.4 The simulation of the circuit	44
III.4.1 The simulation of Arduino Uno broad and Bluetooth.....	44
III.4.2 The simulation of Arduino Uno broad and l298n motor driver.....	44
III.4.3 The simulation of Arduino with G sensor.....	45
III.4.4 The simulation of the project.....	45
III.5 Control system via bleutoothe:	45
III.5.1 RemoteXY:	45
III.6 Implementation part:.....	46
III.7 Conclusion.....	47
General Conclusion.....	49
Bibliographic references.....	50

List of figures

Figure I.1: Robot manipulation	7
Figure I.2: mobile robot	9
Figure I.3: Architecture of a mobile robot	11
Figure I.4: DC motor	11
Figure I.5: Moteur à aimant permanent.....	12
Figure I.6: DC motor series.....	12
Figure I.7: Compound motors	13
Figure I.8: Compound motor.....	13
Figure I.9: component of DC motor	14
Figure I.10: servomoteur	15
Figure I.11: Power supply wires	15
Figure I.12: Sensors	16
Figure I.13: G sensor	19
Figure II.1: Arduino Architecture.....	23
Figure II.2: The Arduino Uno board	24
Figure II.3: The components of Arduino UNO	24
Figure II.4: The Arduino Nano.....	26
Figure II.5: The Arduino Mega	28
Figure II.6: Piconet Network	30
Figure II.7: Scatternet Network	30
Figure II.8: The Bluetooth HC-05 module	31
Figure II.9: Driver motor L298N	33
Figure II.10: The connection between driver motor and DC motor	33
Figure II.11: Work principal of L298n	34
Figure III.1 : Overview of the main software parts (Arduino IDE).....	39
Figure III.1 : Select card type and USB port.....	39
Figure III.3 : the Proteus Software	43
Figure III.4 :Connecting Motor Driver with Arduino UNO using Proteuse.....	44
Figure III.5 : Connecting HC-05 with Arduino UNO using Proteus.	44
Figure III.6 : Simulation of Arduino with G sensor in Proteus	45
Figure III.7 : Assembly of the prototype under ISIS.....	46
Figure III.8 : RemoteXY web site.....	47
Figure III.9 : The four wheels and motors on the chassis.	47
Figure III.10 : The Arduino board with the motor driver and Bluetooth.....	47
Figure III.11 : Installing project components	48

List of tables

Tabla1: Pinout Configuration of HC-05.

Tabel2: Connecting electronic components to the Arduino board.

Abstract:

Robots have undergone significant advancements in recent years, leading to the development of innovative techniques and modern methods for controlling them. Among these methods is control by motion , and thus, in this paper, we will discuss the mechanism of controlling a robot through the G sensor, which is one of the remote motion control methods for robots.

We used the Arduino board as a means of receiving, processing and sending commands.

We have also added Bluetooth technology as a means of wirelessly transmitting commands from the sensor to the Arduino panel.

Keywords:

Arduino, Robot, G Sensor, Bluetooth, L298n, Mobile Phone

الملخص :

شهدت الروبوتات تطورات كبيرة في السنوات الأخيرة ، مما أدى إلى تطوير تقنيات مبتكرة وأساليب حديثة للتحكم فيها. ومن بين هذه الطرق التحكم بالحركة، وبالتالي سنناقش في هذه الورقة آلية التحكم في الروبوت من خلال مستشعر G وهو أحد طرق التحكم في الحركة عن بعد للروبوتات.

استخدمنا لوحة الاردوينو كوسيلة استقبال ومعالجة وارسال الاوامر.

قد أضفنا أيضا تقنية البلوتوث كوسيلة نقل الاوامر لاسلكيا من المستشعر الى لوحة الاردوينو.

كلمات مفتاحية:

هاتف محمول, l298n, البلوتوث , المستشعر G, روبوت, الاردوينو

Résumé :

Les robots ont connu des avancées significatives ces dernières années, ce qui a conduit au développement de techniques innovantes et de méthodes modernes pour les contrôler. Parmi ces méthodes figure le contrôle par le mouvement, et donc, dans cet article, nous discuterons du mécanisme de contrôle d'un robot par le biais du capteur G, qui est l'une des méthodes de contrôle du mouvement à distance pour les robots.

Nous avons utilisé la carte Arduino comme moyen de recevoir, de traiter et d'envoyer des commandes.

Nous avons également ajouté la technologie Bluetooth comme moyen de transmettre sans fil des commandes du capteur au panneau Arduino.

Mots-clés:

Arduino, robot, capteur G, Bluetooth, L298n, téléphone portable

General Introduction

People have always wanted to free themselves from hard work.

Technological progress, as we have known it over the past half-century, has also fulfilled these desires with two general tools: computers for intellectual work and robots for manual labor the former easily surpassed the latter with the discovery of semiconductors, solid materials capable of organizing information without mechanical mobility the latter still relies on ancient mechanisms with precise, moving, and expensive parts. Despite its modern appearance, robotics has its roots in the oldest civilizations.

Mobile robots have made amazing strides and are delivering greater efficiency in terms of cognition, autonomy, and decision-making. This progress is an inevitable result of the development of mechanics, microelectronics, and information technology. This progress is the inevitable result of the development of mechanics, microelectronics, and computing. That is why the success of robotics in a very short time, generation after generation, has seen the birth of a branch of robotics aimed at a broader field of vision: it is the era of mobile robots.

The main goal of our work is to make a small autonomous car based on Arduino UNO, which is controlled remotely.

This work was then organized into three chapters:

- The first chapter presents background information on real autonomous cars.
- The second chapter presents some of the components of our project, such as the Arduino board, and the definition of sensors and motors.
- The third and final chapter describes the steps involved in building our autonomous car, with a presentation of the programs and programming language used.

Chapter I:

Generalities about robots

I. Introduction

Robotics is the field of study that focuses on developing mechanical, computer, or hybrid systems that can perform human beings' motor, sensory, and cognitive activities in their place. Mobile robots and industrial robots are the two main categories. Industrial robots are typically fixed and utilized in a variety of industrial tasks, including welding, painting, and mechanical assembly. On the other hand, mobile robots are not stationary and are divided into many categories based on how they move, such as walkers, wheeled robots, or tracked robots, as well as the applications they are used for, such as industrial, service, military, and laboratory robots.

I.1 History

Mobile robots represent a particular case in robotics. Their interest lies in their mobility, which enables them to perform difficult tasks (such as transporting heavy loads) and to work in hostile environments (such as nuclear, marine, space, firefighting, surveillance, etc.). The particular aspect of mobility imposes technological complexity (sensors, mobility, and energy).

The autonomy of mobile robots is a faculty that allows them to adapt or make decisions in order to carry out a task even in an unfamiliar or totally unknown environment.

The term autonomous car is not new. Several attempts have been made since the 1970s and with the development of technologies related to sensors, telematics and the internal performance of digital processors, good results have been achieved and the sector has seen good technological development.

In 1977, the first driverless vehicle was developed in Japan at the Tsukuba Laboratory, which traveled at a speed of 30 km/h and followed signs indicating to stay on the road. Since this first vehicle was not in a condition to drive without this marking, it is not possible to classify this first vehicle according to the different levels indicated below [1].

Mercedes-Benz tested in 1984 an automatic transporter equipped with cameras whose detection software was developed by a team from the University of the Federal Armed Forces in Munich, led by Ernst Dickmanns. The vehicle reached a speed of 100 km/h on the road network without traffic.

In 1986, the Autonomous Land Vehicle (ALV) project funded by the Defense Advanced Research Projects Agency (DARPA) produced an autonomous demonstration vehicle capable of driving on the road at a speed of 30 km/h. Carnegie-Mellon University's Robotics Laboratory in Pittsburgh is beginning work on automated Navlab vehicles.

In 1985, the European Commission funded the European Prometheus program with 800 million euros, which among other things helped develop technological tools for automated

driving. In the same year, the Hughes Aircraft Research Laboratory (HRL) completed the VMA, making it all-terrain and capable of moving at 3 km/h in complex environments (vegetation, rocks, canyons). At a scientific conference on this subject in 1994, Daimler-Benz demonstrated two in real traffic situations on the A1 freeway in Paris autonomous vehicles (VaMP and Vita-2) controlled by the Dickmann team's software, capable of driving on the line, changing lanes and overtaking at a maximum speed of 130 km/h.

In August 1997, a large National Automated Highway System Consortium (NAHSC) demonstration was held in San Diego, where different autonomous vehicles could be compared. A special infrastructure was set up for the occasion by placing magnetic beacons on some sections of the highway. Companies are currently competing to find the best autonomous car. As the graph below shows, American companies are the most advanced in this respect.[2]

I.2 The general structure of the system.

I.2.1 Type of robots

Generally, robots are classified according to their type as follows:

I.2.1.1 Industrial robots:

Industrial robots are made to carry out repetitive, frequently hazardous activities in production and manufacturing settings. These robots may be trained to do out jobs like welding, painting, and assembly. They are often big and powerful. [3]

I.2.1.2 Service robots:

Service robots are made to help humans with a variety of chores, including cleaning, cooking, and caring for the elderly. These robots can be taught to carry out duties like sweeping, mopping, and helping with daily activities. They are frequently smaller and more mobile than industrial robots.

I.2.1.3 Military robots:

Robots for the military are made for tasks including bomb disposal, reconnaissance, and surveillance. These robots are capable of remote control or autonomous operation, and they can be fitted with cameras, sensors, and other cutting-edge gadgets.[4]

I.2.1.4 Medical robots:

Surgical robots and rehabilitation robots are two examples of medical robots that are made to help with medical treatments. These robots can be extremely accurate and dexterous, and surgeons or other medical specialists can operate them.[5]

I.2.1.5 Educational robots:

Robots like LEGO Mindstorms are examples of educational robots that are intended to teach or pique interest in robotics and STEM subjects. These robots can be programmed and controlled by students, and they are frequently smaller and more cheap than other kinds of robots.

I.2.1.6 Entertainment robots:

Robotic pets, toys, and amusement park attractions are examples of entertainment robot designs. These robots can be entertaining and companionship for individuals of all ages because they are frequently made to be cute, pleasant, and interactive.

II.2.1.8 Mobile robots:

Are yet another significant class of robots that can navigate their surroundings on their own or with remote control. Many different environments, including factories, warehouses, hospitals, and homes, can benefit from the deployment of mobile robots. Autonomous vehicles, delivery robots, and cleaning robots are a few examples of mobile robots. To navigate and interact with their surroundings, mobile robots can be given a variety of sensors and tools, including cameras, LIDAR, and manipulators. Because they have the potential to boost efficiency and lower labor costs, mobile robots are becoming more and more significant in a variety of industries.[6]

I.2.1.8 Autonomous robots:

Autonomous robots, like self-driving cars and drones, are robots that can function without human supervision. These robots have the potential to disrupt the delivery, transportation, and other industries by using cutting-edge sensors and algorithms to navigate and interact with their surroundings.

I.2.1.9 Humanoid robots:

Robots called "humanoids" are made to move and behave in ways that resemble and mimic human beings. These robots are capable of doing a range of jobs, including teaching, entertaining, and providing customer service.

I.2.1.10 Social robots:

Social robots are made to interact with people in a social setting, such as by being a companion for the elderly or the disabled. It is possible to teach these robots to recognize and react to human emotions and behaviors.

I.3 The field of application.

Here are a some of the various magazines and purposes that robots can serve:

I.3.1 Manufacturing:

For many years, manufacturing industries have used robots extensively to complete jobs like welding, painting, and assembly. Industrial robots can be trained to carry out particular jobs, increasing productivity and efficiency while lowering personnel expenses and mistakes.

I.3.2 Healthcare:

Robots are now used in the healthcare industry to do duties including surgery, physical therapy, and patient monitoring. Robotic surgical devices have made it possible for surgeons to carry out intricate operations with more accuracy and minimally invasive methods, speeding up patient recovery and increasing outcomes.

I.3.3 Exploration:

Robots have been utilized in deep-sea and space research to carry out duties like data collection, equipment repair, and terrain mapping. We are able to explore and learn about new facets of the universe and the earth because to the ability of these robots to function in conditions that are too harsh or hazardous for humans.

I.3.4 Agriculture:

Robots created to carry out activities like planting, harvesting, and crop monitoring are also being employed in agriculture. These robots can increase productivity, save labor expenses, and lessen the need for pesticides and chemicals.

I.3.5 Education:

Robots are being used to teach coding, programming, and other STEM-related disciplines in educational settings, where robotics is being used more frequently. Inspiring and involving pupils while teaching them important future skills is possible with the aid of educational robots.[7]

I.3.6 Transportation:

Robotics is increasingly finding use in autonomous vehicles, where self-driving cars and trucks are being developed to increase road safety and productivity. Additionally, robots are being developed for use in public transportation, including self-driving buses and trains.

I.3.7 Construction:

Robots are being employed in the construction industry to perform operations like welding, pouring concrete, and putting bricks. Construction projects can be completed faster and for less money because to these robots' increased efficiency.

I.3.8 Personal Assistance:

Robots are being employed in the construction industry to perform operations like welding, pouring concrete, and putting bricks. Construction projects can be completed faster and for less money because to these robots' increased efficiency.

I.3.9 Energy:

Robots are also being utilized in the energy industry to do duties including inspecting and maintaining infrastructure, mending pipelines, and keeping an eye on wind and solar farms.

I.4 Manipulator robots

In several industries, the manufacturing process has been revolutionized by industrial robots. Robots were first used to do activities in inaccessible locations and to handle radioactive or biohazardous items. Today, they are used in a wide range of automation operations, such as welding, assembly, robotic surgery, pick-and-place labor, plastic injection molding, and many other things.

Understanding the various parts of the machine is useful if you're looking for the best industrial robot for the plastics business. The robot manipulator is one of these that is particularly important.[8]

I.4.1 Definition:

Robot manipulators are industrial robots that resemble human arms. This part is in charge of carrying out the duties that the robot has been instructed to carry out. The manipulator, which is often referred to as a robot arm, attaches to the robot body and is made up of several linkages and joints. The robot manipulator is depicted in Figure (I.1).



Figure I.1: the robot manipulator

Links, which connect the various parts of the robot arm, are solid components. Although its rigidity offers a strong structure, flexibility requires joints. Robotic joints move in a variety of ways, enabling linear, rotary, and revolutionary motions, just like the human body does. As a result, the robot can carry out the desired motions within the limits of its work envelope.

I.4.2 Different Types of Robot Manipulators

A robot manipulator's range of motion, the contour of its work envelope, and its potential uses are all dependent on the types and number of joints it has. Here are some examples of the modern robot manipulators that are most frequently utilized. :

- **Gantry or Cartesian robot manipulators** having three prismatic joints that allow for linear sliding motions, are positioned overhead. They fall under the category of 3-axis robots and feature sizable cubical or rectangular work envelopes.
- **Cylindrical robot manipulators** are so named because of the design of the work envelope. They have rotational bases and linear joints that allow for movement along the vertical axis. With this configuration, the manipulator can extend and retract in any 360-degree circle.
- **Selective Compliant Assembly Robot Arm (SCARA) robot manipulators** possess rotating joints, X/Y axis motion, and rigidity in the Z axis. A large, semi-circular work envelope is the end outcome. 4-axis robots fall under the category of SCARA robot manipulators.
- **Polar robot manipulators** feature a base mounted revolute joint mounted to a rotary and linear joint combination. This makes it possible for the arm to move in circular motions within three axes for a spherical work envelope.
- **Articulated robot manipulators** are the industrial robotic configurations that are most flexible. A rotary joint joins the arm to the base, while revolute joints combine the links within the arm, allowing the arm to roll, pitch, and yaw. These manipulators fall under the category of 6-axis robots.

I.5 Mobile Robots:

I.5.1 Definition

A work is focused on creating a mobile robot that can be remotely controlled by a controller in line with this standard.

A vehicle with mechanisms of movement that enable it to move is referred to as a mobile robot. It can have sensory and cognitive capabilities depending on its level of autonomy. The mobile robot is shown in figure (I.2).[9]



Figure I.2: the mobile robot

I.5.2 Advantages of mobile robots

Mobile robots offer several advantages over traditional stationary robots or human labor. Here are some of the key advantages:

I.5.2.1 Flexibility:

Mobile robots are very flexible and adaptive to varied activities and workflows since they are built to move and function in a variety of situations. They can be programmed to accomplish activities that call for them to move around and engage with their surroundings, as well as to navigate through challenging terrain.[10]

I.5.2.2 Efficiency:

Without pause or rest, mobile robots can complete jobs fast and accurately. They are able to work continuously, which boosts productivity and cuts down on the amount of time needed to do tasks.

I.5.2.3 Safety:

Mobile robots can be used to perform tasks in hazardous environments, such as chemical plants or nuclear power plants, where it would be unsafe for humans to work. By using mobile robots in these settings, we can reduce the risk of injury or death to human workers.[11]

I.5.2.4 Cost Savings:

In some instances, mobile robots may be more cost-effective than human labor, especially for risky or repetitive jobs. Employing mobile robots to automate these jobs allows businesses to cut labor expenses, increase productivity, and lower the danger of accidents.

I.5.2.6 Data Collection:

Sensors and other tools for data collection can be added to mobile robots so they can learn more about their surroundings and the tasks they are carrying out. This information can be utilized to enhance workflows, increase security, and pinpoint potential areas for additional automation.

I.5.2.7 Accuracy:

Mobile robots can be programmed to perform tasks with a high degree of accuracy and precision. They can repeat tasks with the same level of precision every time, reducing errors and improving quality control.

I.5.2.8 Scalability:

To adapt to changing production demands, mobile robots can simply scaled up or down.

This enables businesses to swiftly and effectively alter their production capacity without requiring additional human labor. [12]

I.6 Classification of mobile robots

A number of factors determine how mobile robots are categorized (degree of autonomy, locomotion system, energy used, etc.). The most intriguing and popular classification is based on how autonomous they are. Teleoperated vehicle with a driver who mandates the completion of each simple task .a vehicle that is remotely operated in terms of the job to be done. The car operates under automatic control .a vehicle that operates partially autonomously and without operator input.

Semi-autonomous vehicle that completes tasks on its own. The following are the primary specific issues with the design of such robots: relating to mobility is mechanical design. Position, orientation, and the best course of action determination

I.7 Architecture of mobile robots:

- The mechanical structure and the mobility and energy system.
- Safety devices.
- Information processing and task management system.
- Localization system.

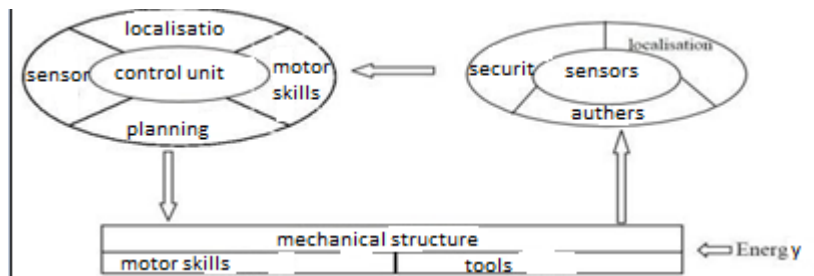


Figure I.3: Architecture of a mobile robot

I.8DC motor:

Electrical energy is converted into mechanical rotational energy by DC motors. By transforming mechanical rotational energy into electrical energy, they can also act as generators.[13]



Figure I.4: DC Motors

I.8.1Types of DC motor

I.8.1.1Permanent magnet motors:

A magnet is used to create the field flux in permanent magnet motors. Permanent magnet DC motors feature outstanding speed management and excellent starting torque capacity.

The limited amount of load that permanent magnet DC motors can drive is one of their drawbacks. These motors are suitable for low-power uses.[14]

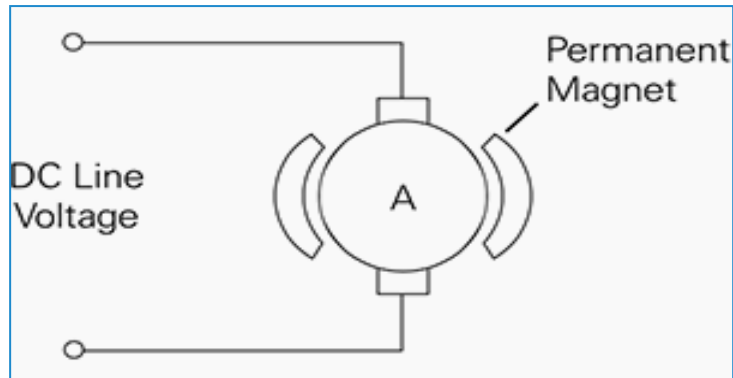


Figure I.5: Permanent magnet motor

I.8.1.2 Series DC motor:

The field and armature are connected in series in a DC motor. Because the field must sustain the maximum armature current, it is coiled with a few turns of thick wire.

The fact that series motors produce a lot of starting torque is one of their traits. However, between no load and high load, the speed significantly fluctuates. When a consistent speed is required under variable loads, series motors cannot be employed. In addition, a series motor's speed can become dangerously high when there is no load on it. A series-connected motor must always have some loads connected to it. For the majority of variable speed applications, series motors are typically not appropriate. .

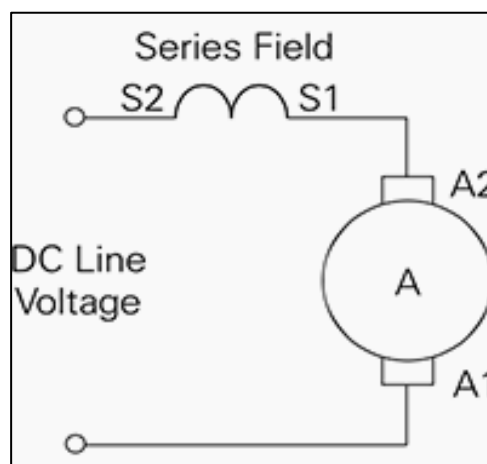


Figure I.6: DC motor series

I.8.1.3 Shunt motor:

A shunt motor has a parallel (shunt) connection between the field and the armature windings. The shunt-connected motor offers effective speed control. It is possible to separately excite the field winding or to link it to the same source as the armature. The capability of a speed controller to enable independent control of both the armature and field is a benefit for an independently stimulated shunt field.

The shunt-connected motor gives streamlined reversing control. This helps regenerative drives in particular.[15]

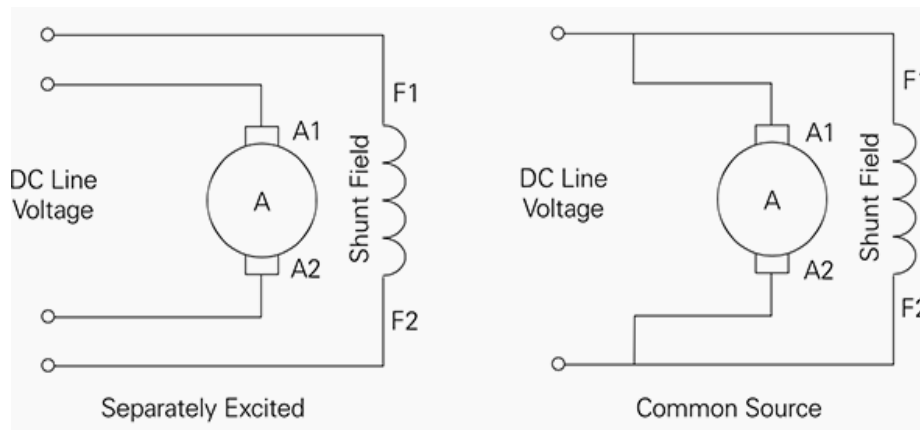


Figure I.7: Compound Motors

I.8.1.4 Compound motors:

A field coupled in series with the armature and a separately excited shunt field are both present in compound motors. Greater starting torque is offered by the series field, while better speed control is offered by the shunt field.[16]

However, the series field is typically not used in four-quadrant drives and can lead to control issues in applications requiring varied speeds.

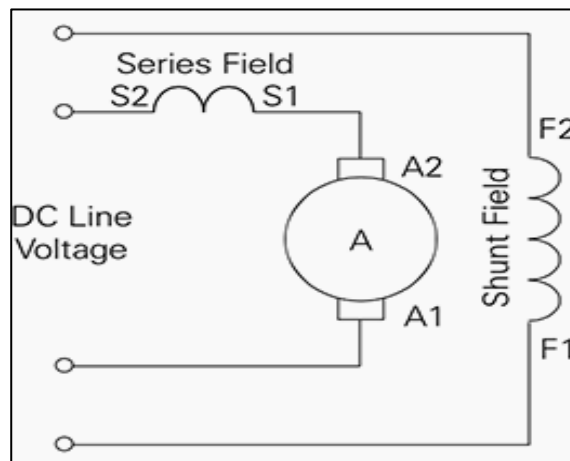


Figure I.8: Compound Motors

I.8.2 Operation of a DC motor

The stator and the rotor are the two major parts of a DC motor.

In contrast to the rotor, which rotates and houses the conductors, the stator is a stationary component of the motor that houses the magnetic field. There is a tiny air gap between the stator and the rotor.

A current passes through the armature windings of the motor when a voltage is applied, producing a magnetic field. The rotor rotates as a result of the magnetic field's interaction with the stator's magnetic field, which exerts a torque on it. In a brushed DC motor, the commutator and brushes carry the current to the rotor windings, causing it to reverse direction as it turns and maintaining rotation.

By adjusting the voltage or current fed to the motor, one can regulate the speed of a DC motor. By switching the voltage or current's polarity, the direction of rotation can be changed. Overall, because of their straightforward design, dependability, and ease of control, DC motors are widely employed in a number of applications.[17]

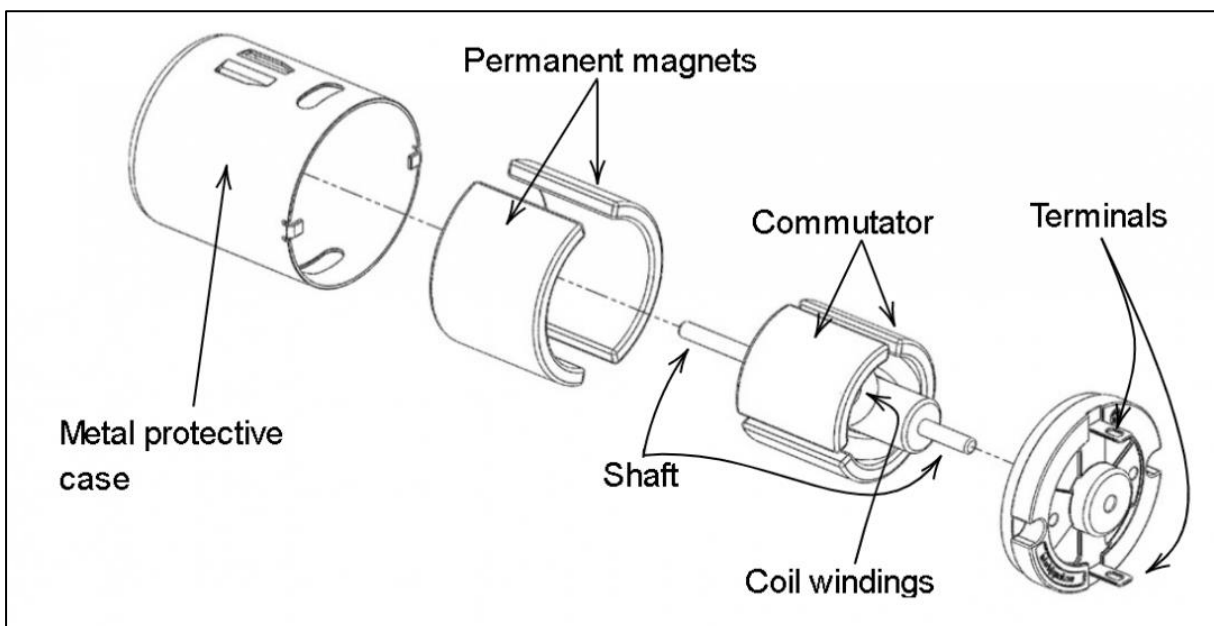


Figure I.9: component of DC Motors

I.9 The servomotor

Servomotors are used to move an arm to a certain position (or angle of rotation), and then hold that position firmly. The term servomotor itself means that it is a controlled motor, obeying an external command.

A DC motor, often of small size.

An electronic control board.

A speed reducer.

A potentiometer, to control the position of the motor axis.

An axis protruding out of the housing with different arms or fixing wheels.



Figure I.10: servomoteur

The servomotor requires three connection wires to operate. Figure 2.13 shows the arrangement of these three wires, with two wires used for its power supply, and the last one receiving the control signal.[18]



Figure I.11: Power supply wires

I.9.1 Composition of a servo motor

A servomotor, also known as a servo or a servomechanism, is a type of electric motor that is designed to provide precise control over the position, speed, and torque of the output shaft. Servomotors are commonly used in a variety of applications, including robotics, automation, and CNC machines.

The basic composition of a servomotor consists of three main components: a DC motor, a control circuit, and a feedback mechanism. The DC motor is responsible for rotating the output shaft of the motor, while the control circuit is responsible for controlling the position, speed, and torque of the motor.

The feedback mechanism in a servomotor is what makes it unique. This mechanism typically consists of an encoder or a potentiometer that provides information about the position and speed of the output shaft. This feedback information is then used by the control circuit to adjust the position, speed, and torque of the motor as needed to maintain the desired output.

I.9.2 Operation of the Servomotor:

A servomotor is controlled through a three-wire cable. This cable both powers the motor and transmits position commands through the signal wire.

Unlike a DC motor, which can be controlled by varying voltage or by turning it on and off, the servomotor responds to a variable duration pulse. It is the duration of this signal that determines the rotation of the axis and therefore the position of the object fixed onto it.[19]

I.10 Sensors

I.10.1 Definition of a sensor:

A sensor is a device that measures a physical quantity and converts it into a signal.

The quantity in question can be, for example, temperature, length, force, or of course, pressure. The transmitted signal is generally an electrical signal but can also be optical.[20]



Figure II.12: Sensors

I.10.2 Classification of Sensors

Sensors are classified on the basis of the output signal, physical parameters measured by them, and various other points. Sensors on the basis of the output signal are classified into analog and digital output sensors.

The output given by the sensors in the case of analog output sensors is an analog voltage that can be measured and used for determining the required physical parameter. This is done by making use of the sensor's transfer function. It may be resistive, capacitive, or anything which is analog. The digital data which can be read via parallel or serial communication buses is the output of digital output sensors. The format for the data, in this case, is demonstrated in the sensor's datasheet. An accelerometer sensor is an example of a digital sensor that is used for sending the output data by using the I2C two-wire bus.

The sensors are further classified on the basis of physical parameters; these types may be used for measuring anything. The most common sensors are tilt sensor, magnetic sensor, cameras, color sensor, pressure sensor, fingerprint sensor, current sensor, light sensor, etc.[21]

I.10.3 How do Sensors work?

Sensors are known to react as per the changing physical conditions by bringing a change in their electrical properties. It has been observed that artificial sensors in most cases rely on electronic systems for analyzing, capturing, and relaying environment information.

In simple words, it can be said that a sensor converts the stimuli such as sound, motion, heat, and light into electrical signals. These signals are passed through an interface that further converts these into a binary code passing them on to a computer to get processed.

Mostly, the sensors act as a switch and are used for controlling the flow of electric charges passing via the circuit. Switches form an important part of electronics as these are known for changing the state of the circuit.

The components present in sensors such as transistors, diodes, and integrated circuits or chips consist of semiconducting material. These materials are included in the sensor circuits so that they can be used as switches.

Mostly, sensors use radiation such as laser or light, infrared radio waves, or other waves such as ultrasonic ones for detecting the changes and objects present in the environment. This is possible if they have an energy source that assists them in emitting radiation in the direction of their target object.

This radiation is reflected back by the object and gets detected by the sensor; it is termed an active sensor. Passive sensors don't send radiation or waves that are their own and detect what is being emitted by the target objects such as thermal infrared radiation, heat, or radiation from external sources like Sun reflected off the objects.[22]

I.10.4 Different Types of Sensors

- IR Sensors
- Ultrasonic Sensor
- Touch Sensor
- Chemical Sensor
- Proximity Sensor
- Gas Sensor
- Humidity Sensors
- Acceleration Sensor
- Sound Sensor

I.11 G sensor

I.11 Definition of G sensor

The G-sensor, also called an accelerometer, is based on the principles of microelectromechanical systems (MEMS) or other technologies such as piezoelectric materials. Measures the acceleration, or rate of change of velocity, in an object. Here is a general overview of how the G-sensor works:

I. micro electro mechanical systems (MEMS) accelerometers:

- MEMS accelerometers consist of tiny microstructures, mostly silicon, embedded in a microchip.
- These microstructures include small proof masses or capacitive plates that can move in response to acceleration.
- When an object is accelerated, the microstructures move relative to the rest of the sensor, resulting in a change in capacitance or resistance.
- The change in capacitance or resistance is converted into an electrical signal that can be measured and processed to determine acceleration.

II. Piezoelectric Accelerometers:

- Piezoelectric accelerometers use materials that generate an electrical charge when subjected to mechanical stress or vibration.
- The sensor consists of a piezoelectric material such as quartz or ceramic sandwiched between two electrodes.
- When the sensor is accelerated, the piezoelectric material generates an electrical charge proportional to the force applied.
- This charge is collected by the electrodes and converted into an electrical signal that can be measured and processed to determine acceleration.

With both types of accelerometers, the output signal is usually an analog voltage or a digital signal. The signal is processed by electronic circuits and converted into meaningful acceleration values that can be used in a variety of applications.

Accelerometers can measure acceleration in multiple axes, typically three dimensions (X, Y, and Z). By measuring acceleration along each axis, the sensor can provide information about an object's motion, tilt and orientation in space.

To accurately measure acceleration, G-sensors often contain additional components such as amplifiers, filters, and calibration circuitry to improve sensitivity, accuracy, and noise rejection. These improvements ensure the sensor provides reliable and accurate acceleration measurements in a wide range of applications.[23]

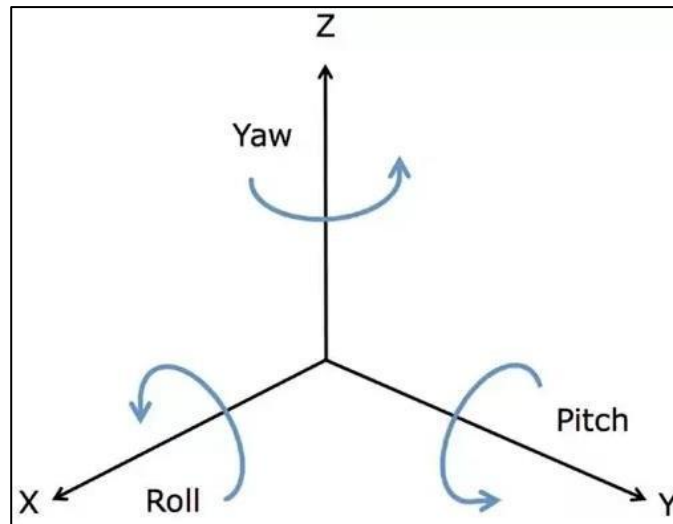


Figure III.13: G sensor

I.12 Conclusion

In this chapter, we've looked at the types of true autonomous vehicles, their different levels of autonomy, and an overview of some of their key components to get a general idea of our project's design environment.

The next chapter will be devoted to presenting the different Arduino boards, the connection chip, and the components of the project.

Chapter 2:

The Arduino programmable device

II.Introduction

Today, electronics are increasingly being replaced by programmed electronics, the aim of which is to simplify electronic schematics and thus reduce the use of electronic components, resulting in high-performance systems for less space. What we'll be learning in this work is a combination of electronics and programming. We'll be talking about embedded electronics, which is a sub-field of electronics that has the potential to unite the power of programming with the power of electronics.

II.1 Arduino

Arduino is a platform for electronics that anyone can use, with both hardware and software that are open-source. An input, such as a light on a sensor, a finger on a button, or a tweet, can be transformed into an output, such as starting a motor, turning on an LED, or publishing anything online, by using Arduino boards. The microcontroller on the board executes instructions that you submit to it. These directives can be created using the software (IDE) and wiring-based Arduino programming language (which is used with the Arduino ECU). Over the years, Arduino has been used in numerous applications, ranging from straightforward to complex. This open source platform has attracted a large international community of developers, including professionals, students, hobbyists, artists, programmers, and programmers. Thanks to their contributions, this community has amassed an incredible body of knowledge that is beneficial to both novices and experts. With no prior knowledge of electronics or programming, Arduino was created at the Interaction Design Institute in Ivrea as a quick and simple prototyping tool for students. The Arduino board evolved as it gained popularity, moving beyond its original purpose as a simple 8-bit board to include products for the Internet of Things, wearable technology, 3D printing, and a variety of other embedded contexts.[24]

II.1.1 Arduino Architecture

The Arduino board's processor essentially employs the Harvard design, which separates the memory used for program code from program data. Program memory and data memory are just two examples of its two memories. where the code is kept in the flash program memory and the data is kept in the data memory. The Atmega328 microcontroller runs at a 16MHz clock speed and features 32kb of flash memory, 2kb of SRAM, and 1kb of EPROM. [25]

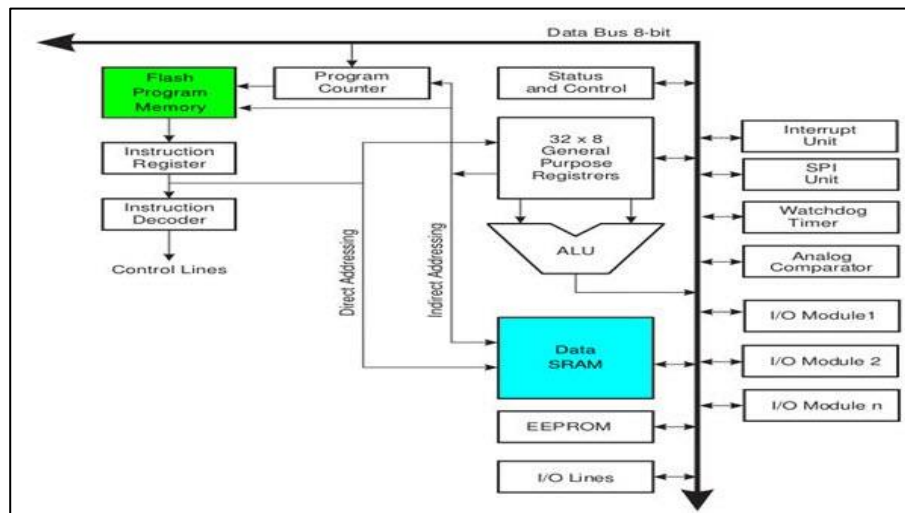


Figure IV.1: Arduino Architecture

II.2 Type of Arduino board

II.2.1 Arduino UNO

One of Arduino's standard boards is the UNO. The Italian word UNO here is for "one." To identify the initial release of the Arduino Software, it was given the moniker UNO. It was also the first USB board that Arduino had ever released. It is regarded as a strong board that is employed in many projects. The Arduino UNO board was created by Arduino.

The ATmega328P microprocessor is the foundation of the Arduino UNO. Compared to other boards, like the Arduino Mega board, etc., it is simple to use. The board is made up of shields, additional circuitry, and digital and analog Input/Output pins (I/O).

The Arduino UNO has 14 digital pins, a USB port, a power jack, and an ICSP (In-Circuit Serial Programming) header in addition to 6 analog pin inputs. The programming language used is called IDE, or integrated development environment. Both online and offline platforms can use it.

The IDE is common to all available boards of Arduino.[26]



Figure II.2: The Arduino Uno board

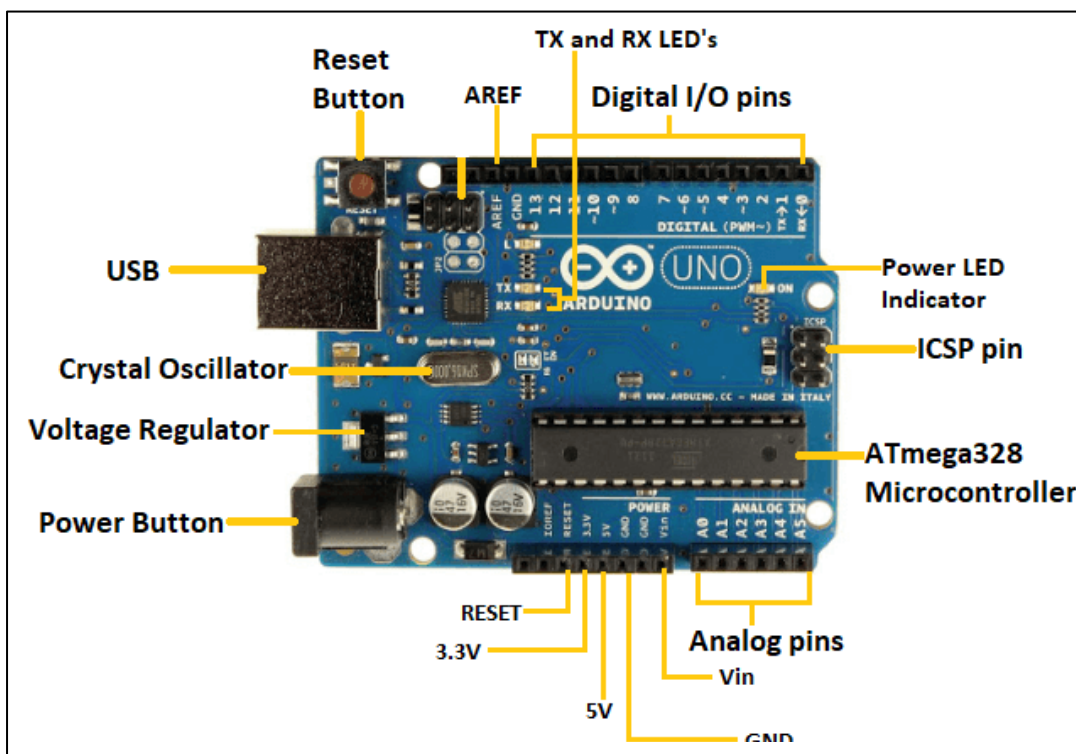


Figure II.3: The components of Arduino UNO

Let's discuss each component in detail:

- ATmega328 Microcontroller- It is a single chip Microcontroller of the ATmel family. The processor code inside it is of 8-bit. It combines Memory (SRAM, EEPROM, and Flash), Analog to Digital Converter, SPI serial ports, I/O lines, registers, timer, external and internal interrupts, and oscillator.
- ICSP pin - The In-Circuit Serial Programming pin allows the user to program using the firmware of the Arduino board.
- Power LED Indicator the ON status of LED shows the power is activated. When the power is OFF, the LED will not light up.
- Digital I/O pins- The digital pins have the value HIGH or LOW. The pins numbered from D0 to D13 are digital pins.
- TX and RX LED's- The successful flow of data is represented by the lighting of these LED's.
- AREF the Analog Reference (AREF) pin is used to feed a reference voltage to the Arduino UNO board from the external power supply.
- Reset button- It is used to add a Reset button to the connection.
- USB- It allows the board to connect to the computer. It is essential for the programming of the Arduino UNO board.
- Crystal Oscillator- The Crystal oscillator has a frequency of 16MHz, which makes the Arduino UNO a powerful board.
- Voltage Regulator The voltage regulator converts the input voltage to 5V.
- GND- Ground pins. The ground pin acts as a pin with zero voltage.
- Vin- It is the input voltage.
- Analog Pins- The pins numbered from A0 to A5 are analog pins. The function of Analog pins is to read the analog sensor used in the connection. It can also act as GPIO (General Purpose Input Output) pins.

II.2.1.1 Technical Specifications of Arduino UNO

The technical specifications of the Arduino UNO are listed below:

There are 20 Input/Output pins present on the Arduino UNO board. These 20 pins include 6 PWM pins, 6 analog pins, and 8 digital I/O pins.

The PWM pins are Pulse Width Modulation capable pins.

The crystal oscillator present in Arduino UNO comes with a frequency of 16MHz.

It also has a Arduino integrated WiFi module. Such Arduino UNO board is based on the Integrated WiFi ESP8266 Module and ATmega328P microcontroller.

The input voltage of the UNO board varies from 7V to 20V.

Arduino UNO automatically draws power from the external power supply. It can also draw power from the USB.

II.2.2 Arduino Nano

A compact Arduino board called the Nano is built around an ATmega328P or ATmega628 microcontroller. The board for the Arduino UNO has the same connectivity.

A sustainable, compact, reliable, and adaptable microcontroller board is referred to as the Nano board. In comparison to the UNO board, it is modest in size. The Arduino (IDE), which is available for a number of platforms, is used to arrange the Arduino Nano. Integrated Development Environment is referred to in this sentence.

The Arduino IDE and micro USB are the tools needed to get our projects running on the Arduino Nano board. On the aforementioned laptop or desktop, the Arduino IDE program needs to be installed.

The Arduino Nano board receives the code from the computer via the tiny USB. Drawback: The DC power jack is absent in Nano. Thus, we cannot use a battery to apply any external power supply.[28]

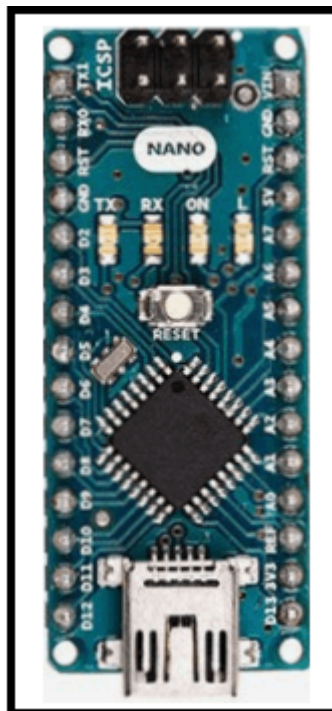


Figure II.4: The Arduino Nano board

II.2.2.1 Technical Specifications

The Arduino Nano board has the following technical specifications:

- The operating voltage of the Nano board varies from 5V to 12V.
- The total pins in Nano are 22 Input/Output pins.
- There are 14 digital pins and 8 analog pins.
- There are 6 PWM (Pulse Width Modulation) pins among the 14 digital pins. The 6 PWM pins in Arduino Nano are used to convert the digital signals into the analog signals. The conversion takes place by varying the width of the pulse.
- The crystal oscillator present in Arduino Nano comes with a frequency of 16MHz.
- The Arduino Nano is used in various applications such as Robotics, Control System, Instrumentation, Automations, and Embedded Systems.
- The projects created using Arduino Nano are QR Code Scanner, DIY Arduino Pedometer, etc.
- We can also connect Arduino Nano to the Wifi.
- The functionality of Nano is similar to the Arduino UNO.
- The flexibility and eco-friendly nature of Nano make it a unique choice to create electronic devices and projects with compact size.[29]

II.2.3 Arduino Mega

The ATmega2560 Microcontroller is the foundation of the Arduino Mega. It is an 8-bit microprocessor called the ATmega2560. To get started with it, all we need is a basic USB cord to connect to the computer and an AC to DC adapter or battery.

The Arduino (IDE), which is available for a number of platforms, is used to arrange the Arduino Mega. Integrated Development Environment is referred to in this sentence.

The Arduino Mega operates similarly to other Arduino Boards. We don't need any additional parts for it to function.

The majority of the shields for the Arduino UNO work with the ATmega2560 microcontroller.[30]

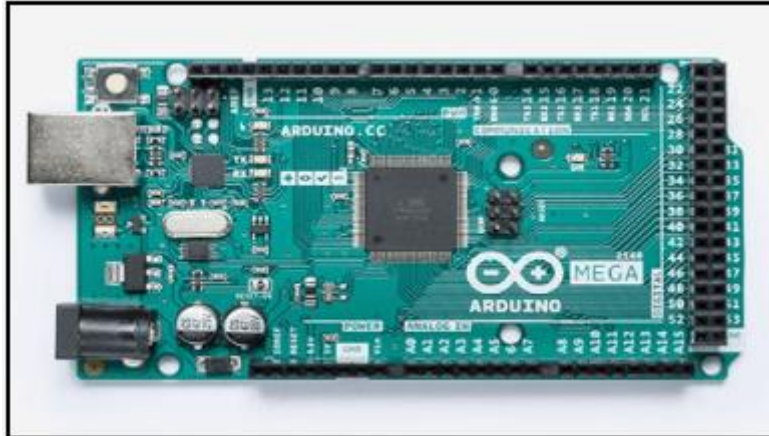


Figure II.5: The Arduino Mega

II.2.3.1 Technical Specifications of Arduino Mega

The technical specifications of Arduino Mega are listed below:

- There are 54 Input/Output digital pins and 16 Analog Input/Output (I/O) present on the Mega board.
- The 15 pins from the 54 digital I/O pins are PWM output pins. The PWM pins are Pulse Width Modulation capable pins.
- The input voltage of the Mega board varies from 7V to 12V.
- The crystal oscillator present in Arduino Mega comes with a frequency of 16MHz.
- The functionality of Mega is similar to the Arduino UNO.
- The operating voltage of the Arduino Mega is 5 V.
- The Mega board is considered superior in terms of SRAM memory space.
- It is well-suited for most of the Arduino shields.
- The bootloader is used to eliminate the exterior burner utilization.
- It is generally used to create complex projects due to its structure.
- The projects that use Arduino Mega board are IOT Applications, 3D Printers, temperature sensing, monitoring of real-time applications, etc.[31]

II.3 Bluetooth

Bluetooth is a well-known technology that is used to provide wireless communication for a variety of devices that require short-range connectivity, including wireless headphones, mobile phones, laptops, and computer mouse. This technology has significantly advanced and grown to now offer more than just fixed short-range audio streaming for M2M applications and mesh networking for the Internet of Things. This technology offers much greater flexibility,

lightning-fast speed, and capabilities. An overview of Bluetooth is covered in this article.[32]

II.3.1 Bluetooth Technology

In order to link phones or other portable devices together, Bluetooth technology uses a high-speed, low-power wireless link. IEEE 802.15.1 is a specification for the use of low-power radio communications to connect phones, computers, and other network devices over short distances without cables. Short distances, often up to 30 feet, are covered by Bluetooth wireless transmissions (10 meters).

It is achieved by embedded low-cost transceivers into the devices. It supports the frequency band of 2.45GHz and can support upto 721KBps along with three voice channels. This frequency band has been set aside by international agreement for the use of industrial, scientific, and medical devices (ISM).rd-compatible with 1.0 devices.

It can establish point-to-point or multipoint connections with up to "eight devices" at once, each of which offers a distinct 48-bit address from the IEEE 802 standard.[33]

II.3.2 Bluetooth Architecture

The Bluetooth architecture uses two networks like Piconet and Scatternet.

II.3.2.1 Piconet Network

Piconets are minimally eight-station Bluetooth networks, with one serving as the master node and the remaining seven as slave nodes (maximum of 7 slaves). The main station in charge of running the little network is called a master node. Secondary stations that are synchronized with the parent station are called slave stations.

One-to-one or one-to-many communication between a master node and a slave node is possible. However, there is no direct interaction between slaves. Each station, whether a master or a slave, has a 48-bit fixed device address assigned to it.

Besides the seven active slaves, there can be up to 255 numbers of parked nodes. These are in a low power state for energy conservation. The only work that they can do is respond to a beacon frame for activation from the master node.[34]

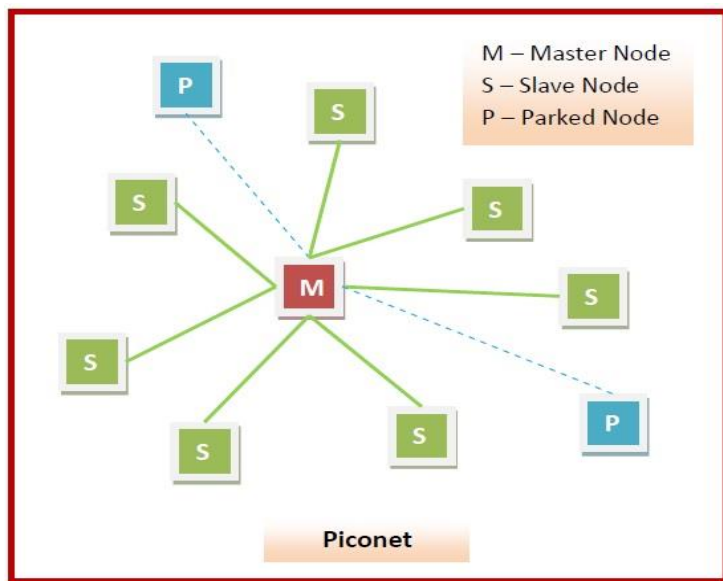


Figure II.6: Piconet Network

II.3.2.2 Scatternet Network

Different piconets can be used to create the Scatternet Network. One piconet has a slave that serves as the master; otherwise, it would be referred to as the primary in other piconets. This type of node therefore receives a message from the master within one piconet and delivers the message to its slave within another piconet where it functions as a slave. Therefore, this type of node is known as a bridge-node. A station cannot be master in a two piconet network.[35]

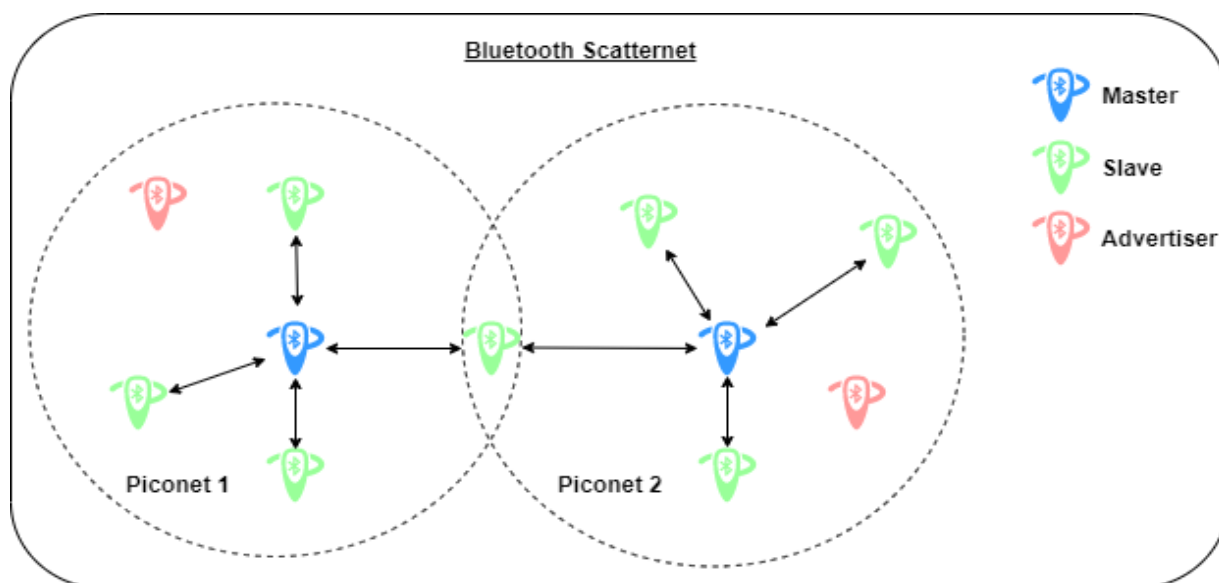


Figure II.7: Scatternet Network

II.4 Connections

Devices connected using Bluetooth are often fairly secure against hackers. As they operate on several frequencies, a technology known as the "frequency-hopping spread spectrum" uses gadgets to switch between these frequencies hundreds of times per second.

II.4.1 BluetoothHC-05

The Bluetooth HC-05 module is an easy-to-use Bluetooth SPP (serial port protocol) module designed for setting up a seamless wireless serial connection. Its communication is via serial communication, which makes it easy to interface with the controller or PC. Bluetooth HC-05 module provides switching mode between master and slave mode, which means it can use neither data reception nor transmission.[36]

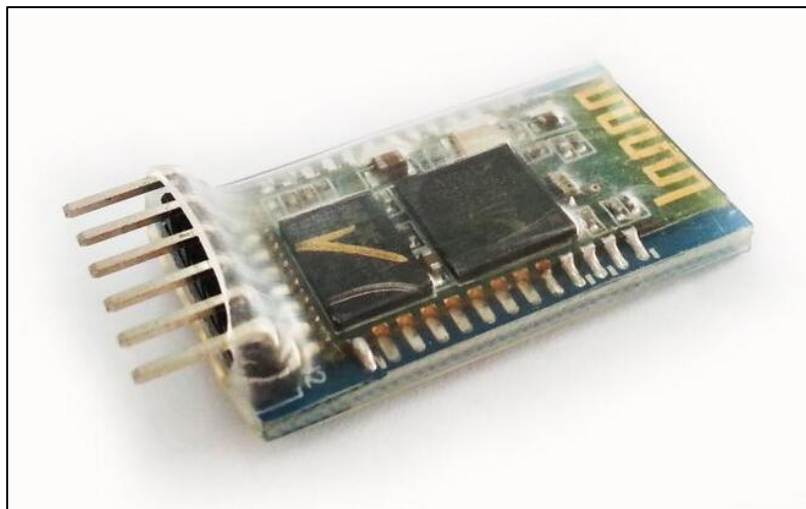


Figure II.8: The Bluetooth HC-05 module

II.4.1.1 Specification:

Model: HC-05

- Input voltage: DC 5V
- Communication method: serial communication
- Master and slave modes can be changed
- VCC + 5V Connect to + 5V
- GND Ground Connect to Ground
- TXD UART_TXD, Bluetooth serial signal sending PIN.
- Connect with the RXD PIN of the MCU (microcontroller, etc.).
- RXD UART_RXD, Receive Bluetooth serial signal PIN.
- Login with the TXD PIN code of the MCU (Microcontroller, etc.).
- KEY mode switch input.[37]

II.4.1.2 HC-05 Pinout Configuration

1	Enable / Key	This pin is used to toggle between Data Mode (set low) and AT command mode (set high). By default it is in Data mode
2	Vcc	Powers the module. Connect to +5V Supply voltage
3	Ground	Ground pin of module, connect to system ground.
4	TX Transmitter	– Transmits Serial Data. Everything received via Bluetooth will be given out by this pin as serial data.
5	RX Receiver	– Receive Serial Data. Every serial data given to this pin will be broadcasted via Bluetooth
6	State	The state pin is connected to on board LED, it can be used as a feedback to check if Bluetooth is working properly.
7	LED	Indicates the status of Module <ul style="list-style-type: none"> • Blink once in 2 sec: Module has entered Command Mode • Repeated Blinking: Waiting for connection in Data Mode • Blink twice in 1 sec: Connection successful in Data Mode
8	Button	Used to control the Key/Enable pin to toggle between Data and command Mode

Table 2: Pins of HC-06=5

II.5 Driver motor L298N

The twin H-Bridge motor driver L298N enables simultaneous speed and direction control of two DC motors. The module can run DC motors with peak currents up to 2A and voltages between 5 and 35V.

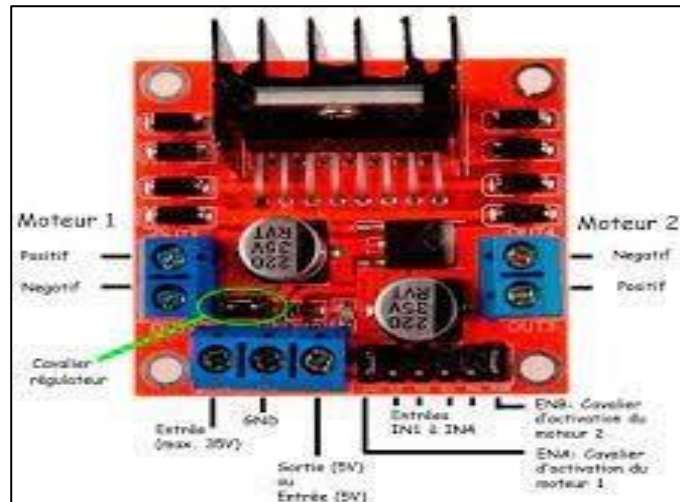


Figure II.9: Driver motor L298N

Let's examine the L298N module's pinout in more detail and discuss its operation. The module features two screw terminal blocks for motors A and B, one screw terminal block for each of the ground, motor's VCC, and 5V pins, which may be used as inputs or outputs.

The voltage applied at the motor's VCC determines this. A jumper controls the module's internal 5V regulator, which may be turned on or off. We can enable the 5V regulator if the motor supply voltage is up to 12V, and the 5V pin may then be utilized as an output, such as to power our Arduino board. However, if the motor voltage exceeds 12V, we must disable the jumper since the onboard 5V regulator would be harmed. As a 5V power source must be connected to the 5V pin in order for the IC to function correctly, it will be utilized as an input in this instance.

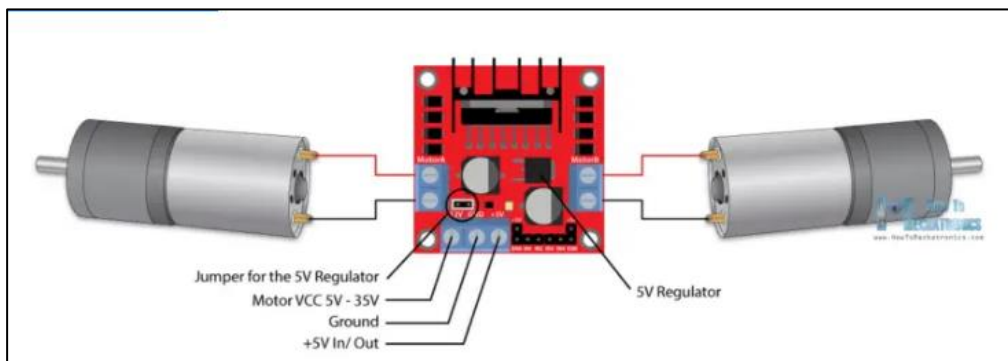


Figure II.10: the connection between driver motor and DC motor

The logic control inputs come next. The motor speed is enabled and managed via the Enable A and Enable B pins. If a jumper is present on this pin, the motor will be activated and operate at its maximum speed; however, if the jumper is removed, a PWM input may be connected to this pin, allowing us to regulate the motor's speed. The motor will not operate if this pin is connected to ground.

The rotation direction of the motor A is then controlled by the inputs 1 and 2, and the motor B's inputs 3 and 4. We can really control the H-Bridge switches within the L298N IC using these pins.

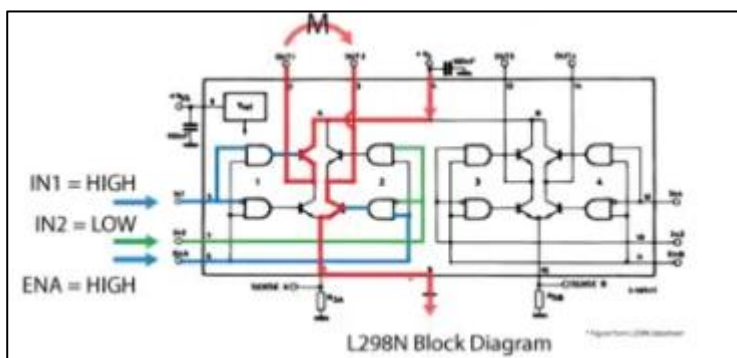


Figure II.11: work principal of l298n

The motor will drive forward if input 1 is LOW and input 2 is HIGH, and the opposite is true if input 1 is HIGH and input 2 is LOW. The motor will halt if both inputs are the same, either LOW or HIGH. The same holds true for the motor B and the inputs 3 and 4. [38]

II.5.1 Power supply

- **power supply " power part " (pin Vs)**

As seen in the previous paragraph, the L298N requires two power supplies to operate: one for the power part, and another for the control part. Here, we will focus on the "power" supply, that is to say the one that will supply the motors. This one is noted "Vs" on the manufacturer's documentation.

Its practical value is in fact to be determined according to the motors that you intend to supply. For example: if you want to power a 12V DC motor, this power supply must be at least 14 volts. Because you have to take into account the voltage drop generated by the Hdu L298N bridges. On this subject, you should know that the voltage drop of these H-bridges can go from 1.8 to 4.9 volts, in the worst case (if you try to draw the maximum current). So be careful not to under power your motors.

- **Power supply "control part" (Vss pin)**

This is the second power supply to provide to the L298N, not to supply the motors this time, but rather the control logic, internal to this integrated circuit. Because the power transistors are controlled via an internal logic device requiring a lower power supply. This voltage is noted "Vss" by the manufacturer. The control voltage Vss must be between 4.5 and 7 volts (typically 5 volts).

In practice, one should avoid supplying the L298N permanently with 7 volts, so as not to shorten its life. Because it is here its maximum admissible voltage ("Absolute Rating"), which should not be maintained for long. It is therefore preferable to use a power supply stabilized at 5V, rather than something else.[39]

II.5.2 Principle of operation

The L298N module: is based on the integrated circuit of the same name, the L298N circuit is a double H-bridge allowing to modify the direction and the intensity of the voltage at the terminal of two electrical loads. The characteristics of the L298N module are:

- Drive motor with nominal voltage from 5 to 35V.
- 2A maximum current (peak).
- 5V voltage accepted on the Input pins.[40]

II.6 Conclusion

In this chapter, we have provided an overview of the Arduino development platform used and its types, as well as explained the basic components that our project requires.

The next chapter will be devoted to the details of the project design and the different phases that are carried out to ensure the correct operation of our autonomous vehicle.

Chapter 3:

Practical realization of the Robot

III.Introduction

After presenting different mobile cars in the first chapter, and after getting an idea in the second chapter about the Arduino development platform and some of the basic components in the project, we will in this chapter, present the process of creating the project, as well as explaining some of the programs used.

III.1Project design

For this project we will use a toy car chassis. This car will have 4 engines. The two motors on the right will be used to provide the car to turn left and the two motors on the left will be used to turn right. The four motors will also be used to drive the car forward and backward.

The Bluetooth module will be used to receive instructions from the mobile app and pass them to the Arduino UNO to control the system. This module has 6 pins 4 of them are used, RX and TX pins are directly connected to TX and RX and the Vcc for the power and ground pin connected to the Arduino.

The motor driver for the car is connected to the arduino to power the car. It contains input pins which are connected to the Arduino digital pins.

A 9V battery is used as the power supply for the entire circuit.

We have divided the project into two sections which will help in final product.

In First step we had gather the list of components required for this project:

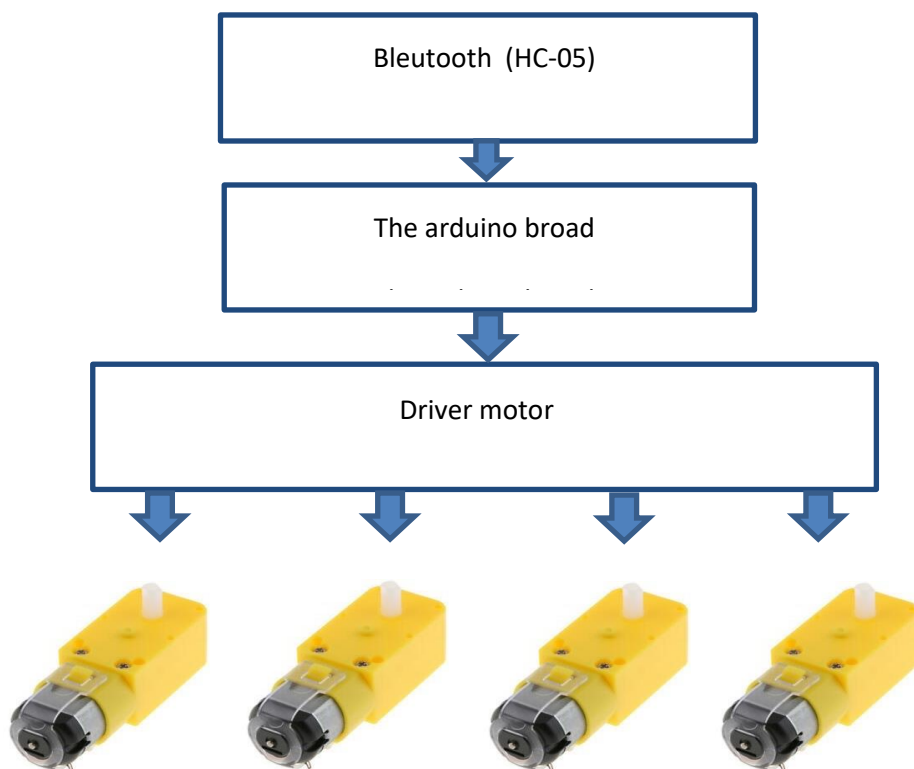
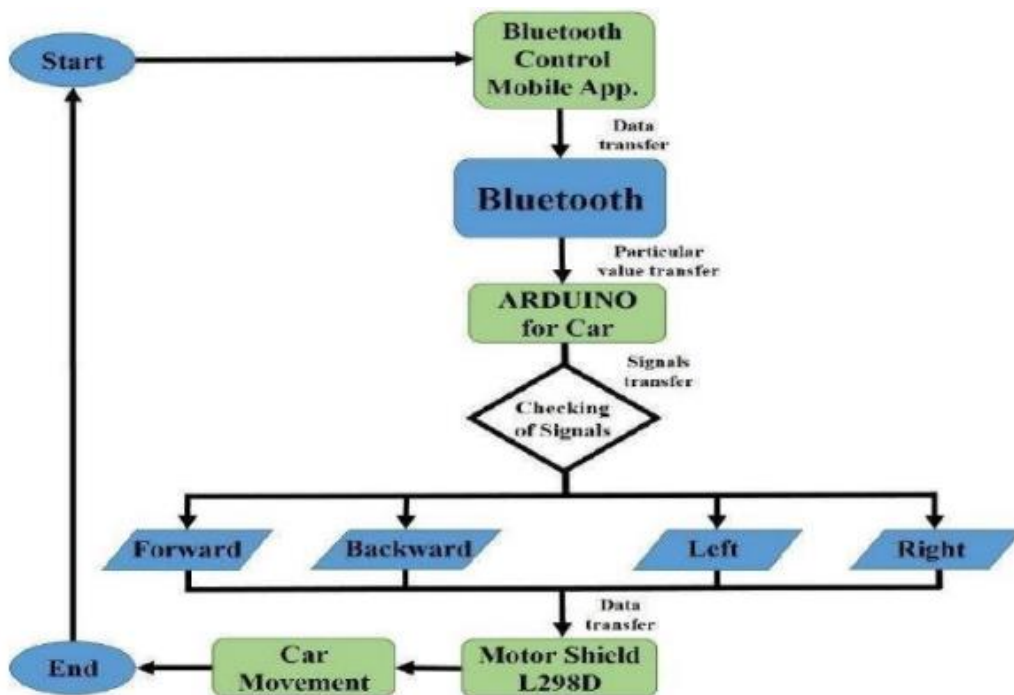
III.1.2 Hardware used :

1. Arduino Uno Board
2. Bluetooth Module (HC-05)
3. Motor Driver Module (L298n)
4. Battery
5. Car Chassis

III.1.3 Software Used:

1. Arduino Bluetooth Controller Application
2. Arduino Software Code
3. Proteus logical

III.1.4 Flow chart for working of module



III.2 Programming environment for Arduino boards (Arduino IDE)

The Arduino development environment is a cross-platform Java application (runs on multiple operating systems) that acts as a code editor and compiler, and can download firmware (programs) over an asynchronous serial connection. The programming language is a variant of C/C++, simplified and restricted to using the board, its inputs/outputs and associated libraries.[41]

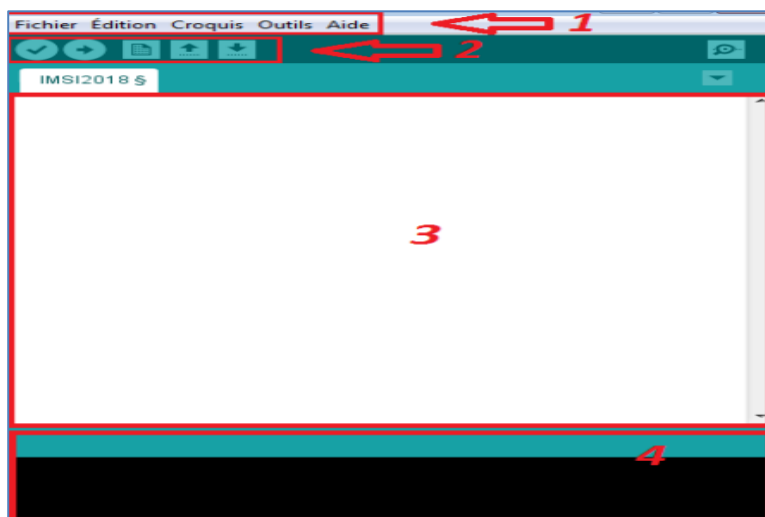


Figure III.1: Overview of the main software parts (Arduino IDE)

Frame N°1: these are the configuration options of the software.

Frame N°2: it contains the buttons that will be used during the programming of the cards.

Frame N°3: this block will contain the program that we will create

Frame N°4: this one is important, because it will help us to correct the faults in our program, it is the debugger.

III.2.1 Injection of program in the Arduino board

Before sending the program to the board, select the board type (Arduino UNO) "1" and the USB port number (COM 1 in our case) "2".

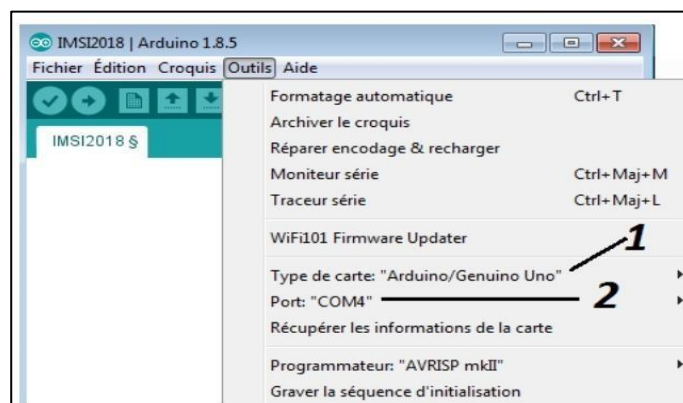


Figure III.2: Select card type and USB port.

III.2.2 Structure of a Arduino program

An Arduino program is a sequence of instructions in textual form .The board reads and performs the instructions one after the other in the order defined by the lines of code.[42]

```
// declaration of the variables and constants

Voidsetup() // initialization function of the card
{//contenu de l'initialisation
}

Voidloop()//fonction de la boucle infinie
{//suite des lignes de programmes qui seront exécutées à l'infinie
}
```

III.2.3 Instructions de base de programmation

a) Instructions for the assignment of the adapter's ports

The Arduino board has digital and analog ports that can be used as input or output:

For use as input: pinMode(num de pin,INPUT)

For use as an output: pinMode(num de pin,OUTPUT).

b) Instructions for activating an output

digitalWrite(num de pin,HIGH).

c) Instructions for deactivating an output

digitalWrite(num de pin,LOW).

d) Reading a logic input

digitalRead(num de pin).

e) Reading an analog input

analogRead(num de pin)

III.2.4 Arduino code

```
/* RemoteXY select connection mode and include library */
#define REMOTEXY_MODE__SOFTWARESERIAL
#include <SoftwareSerial.h>
#include <RemoteXY.h>

/* RemoteXY connection settings */
#define REMOTEXY_SERIAL_RX 2
#define REMOTEXY_SERIAL_TX 3
#define REMOTEXY_SERIAL_SPEED 13800

/* RemoteXY configurate */
```

```
unsigned char RemoteXY_CONF[] =
  { 3,0,23,0,1,5,5,15,41,11
    ,43,43,1,2,0,6,5,27,11,5
    ,79,78,0,79,70,70,0 };

/* this structure defines all the variables of your control interface */
struct {

  /* input variable */
  signed char joystick_1_x; /* =-100..100 x-coordinate joystick position */
  signed char joystick_1_y; /* =-100..100 y-coordinate joystick position */
  unsigned char switch_1; /* =1 if switch ON and =0 if OFF */

  /* other variable */
  unsigned char connect_flag; /* =1 if wire connected, else =0 */

} RemoteXY;

/* defined the right motor control pins */
#define PIN_MOTOR_RIGHT_UP 7
#define PIN_MOTOR_RIGHT_DN 6
#define PIN_MOTOR_RIGHT_SPEED 10

/* defined the left motor control pins */
#define PIN_MOTOR_LEFT_UP 5
#define PIN_MOTOR_LEFT_DN 4
#define PIN_MOTOR_LEFT_SPEED 9

/* defined the LED pin */
#define PIN_LED 13

/* defined two arrays with a list of pins for each motor */
unsigned char RightMotor[3] =
  {PIN_MOTOR_RIGHT_UP, PIN_MOTOR_RIGHT_DN, PIN_MOTOR_RIGHT_SPEED};
unsigned char LeftMotor[3] =
  {PIN_MOTOR_LEFT_UP, PIN_MOTOR_LEFT_DN, PIN_MOTOR_LEFT_SPEED};

/*
  speed control of the motor
  motor - pointer to an array of pins
  v - motor speed can be set from -100 to 100
*/
void Wheel (unsigned char * motor, int v)
{
  if (v>100) v=100;
  if (v<-100) v=-100;
  if (v>0) {
    digitalWrite(motor[0], HIGH);
```

```
    digitalWrite(motor[1], LOW);
    analogWrite(motor[2], v*2.55);
}
else if (v<0) {
    digitalWrite(motor[0], LOW);
    digitalWrite(motor[1], HIGH);
    analogWrite(motor[2], (-v)*2.55);
}
else {
    digitalWrite(motor[0], LOW);
    digitalWrite(motor[1], LOW);
    analogWrite(motor[2], 0);
}
}

void setup()
{
    /* initialization pins */
    pinMode (PIN_MOTOR_RIGHT_UP, OUTPUT);
    pinMode (PIN_MOTOR_RIGHT_DN, OUTPUT);
    pinMode (PIN_MOTOR_LEFT_UP, OUTPUT);
    pinMode (PIN_MOTOR_LEFT_DN, OUTPUT);
    pinMode (PIN_LED, OUTPUT);

    /* initialization module RemoteXY */
    RemoteXY_Init ();
}

void loop()
{
    /* event handler module RemoteXY */
    RemoteXY_Handler ();

    /* manage LED pin */
    digitalWrite (PIN_LED, (RemoteXY.switch_1==0)?LOW:HIGH);

    /* manage the right motor */
    Wheel (RightMotor, RemoteXY.joystick_1_y - RemoteXY.joystick_1_x);
    /* manage the left motor */
    Wheel (LeftMotor, RemoteXY.joystick_1_y + RemoteXY.joystick_1_x);
}
```

III.3 The Simulation part :

III.3.1 Proteus Software

Proteus is a software suite used for simulation and design of electronic circuits. It is commonly used by engineers, students, and hobbyists to simulate and test the functionality of electronic circuits before they are built. Proteus is developed by Lab center Electronics and is available for Microsoft Windows.

Proteus consists of two main components: ISIS and ARES. ISIS is the schematic capture and simulation module, while ARES is the PCB layout module.

The software also includes a library of electronic components that can be used in circuit design, such as resistors, [43]

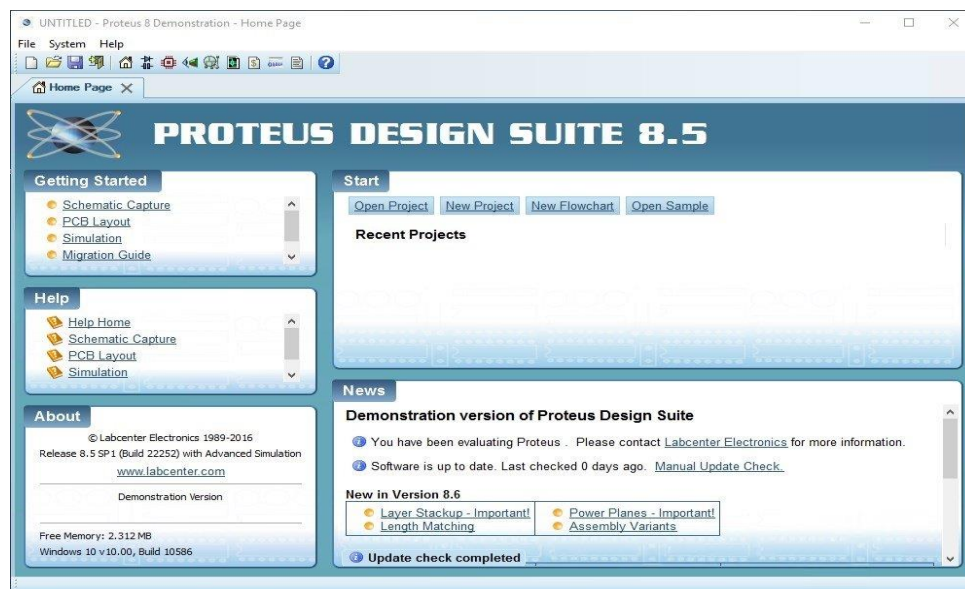


Figure III.3: the Proteus Software

III.3.2 Using the Proteus Software

With Proteus, users can create schematics, simulate circuits, and test their designs in a virtual environment. The software can simulate the behavior of analog and digital circuits, as well as microcontroller-based systems. Proteus also allows users to debug their circuits and analyze the behavior of individual components in real-time.

In addition to simulation, Proteus can be used to design and layout printed circuit boards (PCBs). Users can create PCB layouts from their schematics and generate Gerber files for manufacturing. Proteus includes tools for manual routing, auto-routing, and design rule checking.

Overall, Proteus is a powerful software suite for electronic circuit design and simulation. It offers a comprehensive set of tools for schematic capture, simulation, and PCB design, making it a valuable tool for engineers, students, and hobbyists alike.[44]

III.4 The simulation of the circuit

III.4.1 The simulation of Arduino Uno board and Bluetooth

In this part , we are testing the Bluetooth connection with the phone, and in order to achieve this, we simulated the Arduino board and the Bluetooth in the Proteus software, and using the Arduino DIE software, we wrote a code that allows the smartphone connect to the Bluetooth, and when the connection is happened, the lamp turns on

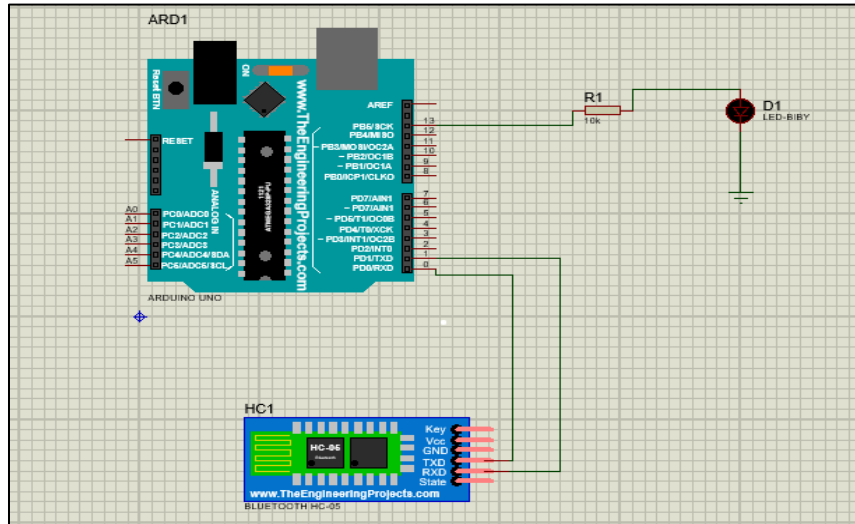


Figure III.4: Connecting HC-05 with Arduino UNO using Proteus

III.4.2 The simulation of Arduino Uno board and L298N motor driver

I In this example, we are simulating the process of controlling 4 DC motors through a motor driver and an Arduino board, where we have connected 4 DC motors to a motor driver has already connected to the Arduino.

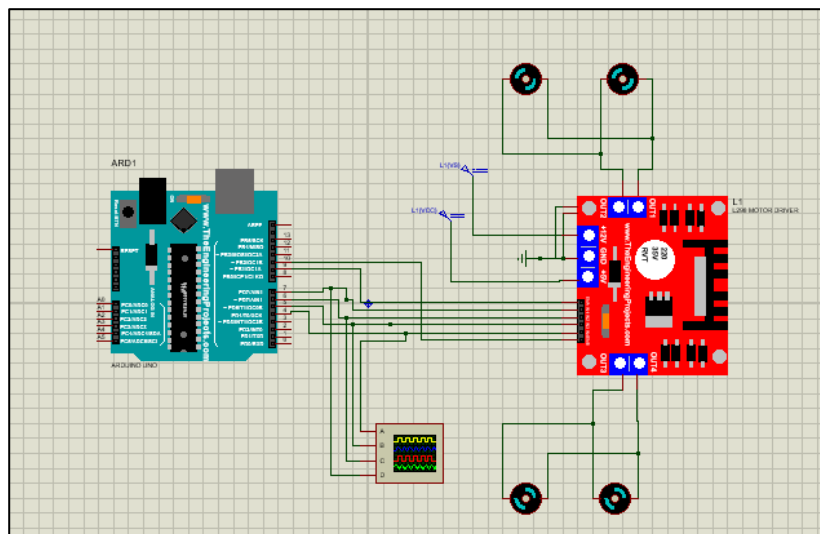


Figure III.5: Connecting, Motor Driver with Arduino UNO using Proteus

After that, we wrote a code by using the DIE software that code enables us to control the running of the motors and also deciding the direction of their rotation

III.4.3 The simulation of Arduino with G sensor

In this part we are simulating how is the G sensor Work by using 3 potentiometers.

- Pot1 for X axis
- Pot2 for Y axis
- Pot3 for Z axis

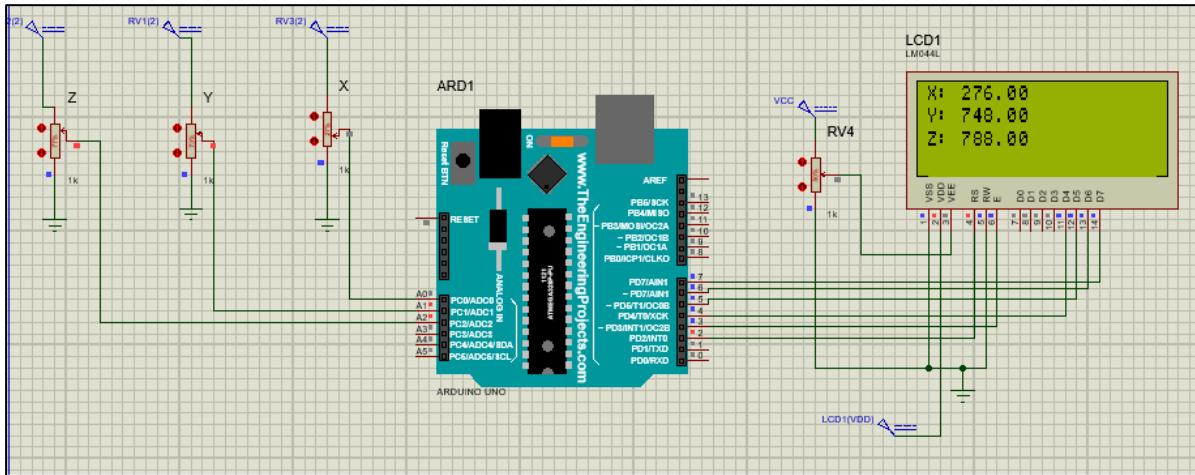


Figure III.6: Simulation of Arduino with G sensor

The operation way of this simulation depend on change in the 3 potentiometers that represent in the real G sensor the three axis X Y Z.

The value given by the resistors is read and processed by the Arduino board and then displayed on the LCD board.

III.4.4 The simulation of the project

After the previous simulations of the 3 parts, we are now in the process of collecting all the previous parts into one simulation that represents a total simulation of the project.

Where we connected the motors with the driver motor and then connected the motor driver and bluetooth with the Arduino. We also use the mobile application to transfer commands from the G-sensor and transfer them to the Arduino via Bluetooth.

The simulation process is to connect the Bluetooth to the mobile phone, and then use the control application and send commands by moving the phone.

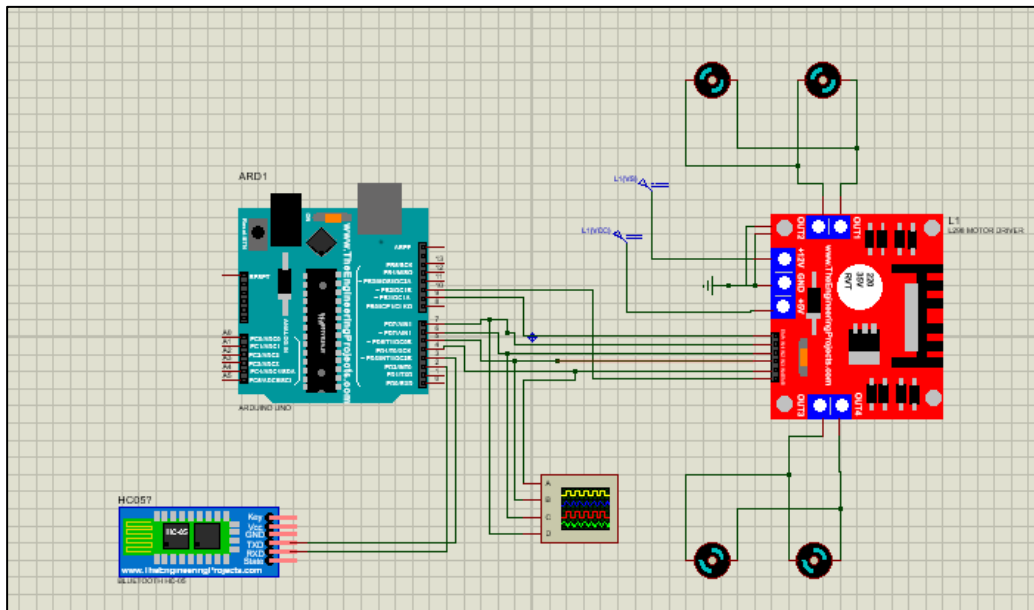


Figure III. 7: Assembly of the prototype under ISIS.

III.5 Control system via Bluetooth :

It is a Bluetooth-based smartphone interface for controlling our autonomous vehicle remotely.

To implement the car control application, we utilized RemoteXY.

III.5.1 RemoteXY

is a platform and mobile application that allows you to create graphical interfaces for remote control of microcontrollers or Arduino boards. It provides a user-friendly interface where you can design custom control panels or dashboards for your projects. It is platform supports various communication protocols, such as Bluetooth, Wi-Fi, and USB, allowing you to establish a connection between your mobile device and the microcontroller.

To use RemoteXY we need to install the RemoteXY mobile app on your smartphone and upload the RemoteXY library to the Arduino board. The library provides the code needed to establish a connection between the microcontroller and the mobile app via Bluetooth.[45]

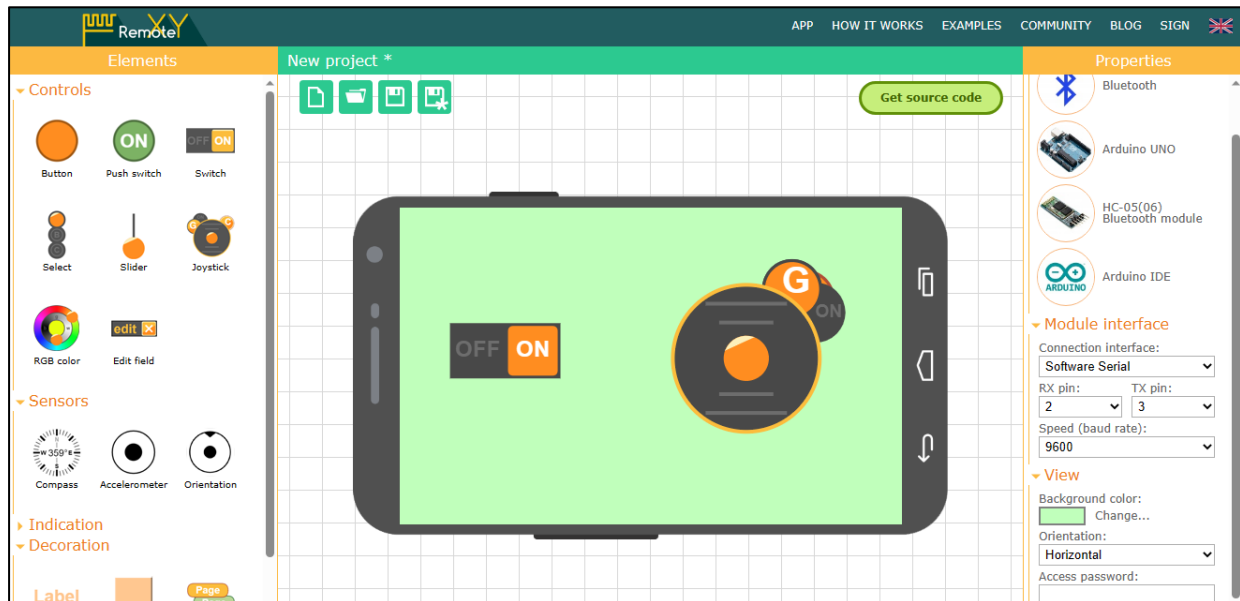


Figure III.8: RemoteXY web site

III.6 Implementation part :

- The first step is to setup the four wheels and motors on the chassis

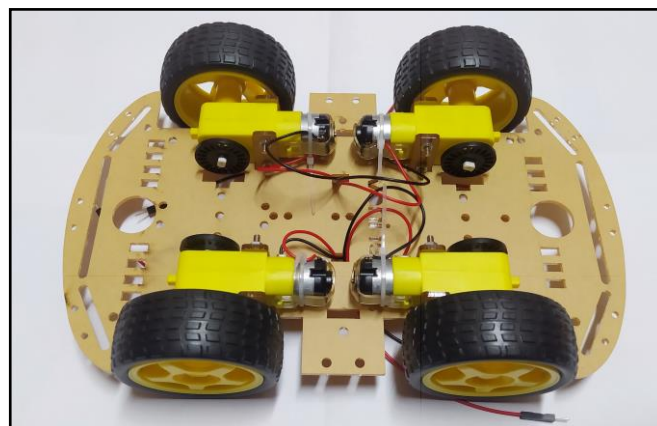


Figure III.9: The four wheels and motors on the chassis

- The next step is to install the Arduino board with the motor driver and Bluetooth.

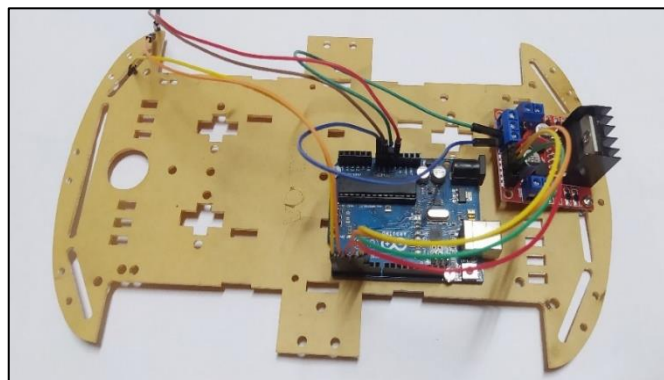


Figure III.10: The Arduino board with the motor driver and Bluetooth.

➤ In this step we are assembling all the elements together the battery, the Arduino board, the motor driver, the bluetooth and the motors with the wheels in order to test the project.

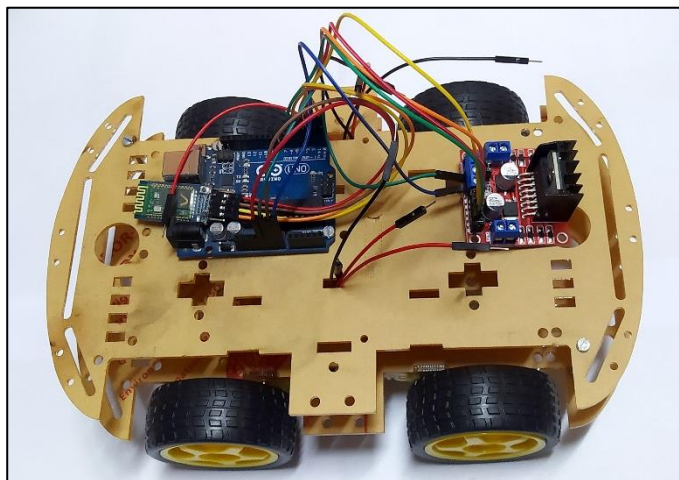


Figure III.11: Installing project components

Digital pins	bleu	Carte Arduino UNO	13	
Analogic pins	bleu		12	
Porte de communication	D.M		11	
+VCC (5V)	5V		10	ENB
Ground	A0		9	ENA
	A1		8	
	A2		7	IN4
	A3		6	IN3
	A4		5	IN2
	A5		4	IN1
			3	TX
			2	RX
			1	
			0	

Table 2: Connecting electronic components to the Arduino board

III.7 Conclusion

In this last chapter, we explained the different steps that allowed us to realize our autonomous car system from the simulation part, to the remote control part.

We also gave a general description of the Arduino software and the main components that we used in our project, and at the end we carried out various tests related to the operation of the project that show the proper functioning of the system and its remote control.

General conclusion

In this main topic, we were able to use all our knowledge in electronics, electrical, mechanics, automation, and computer science to produce an autonomous vehicle prototype.

We made a small remote-controlled car with Bluetooth, G-sensor, and a mobile phone.

This car moves on 4 wheels. The car is steered by two right-side wheels to rotate to the left side and rotate in the reverse direction to the left side. The two wheels on the left side are controlled. The movement forward and backward is carried out by the rotation of the four motors.

The information processing is performed by the Arduino UNO board which receives it from the phone app via Bluetooth whose main source is the G-sensor.

This work allowed us to deal with practical problems and validate our theoretical knowledge gained during our training.

As a result of continuous work, we have been able to reach our goal and meet the specifications, but this does not mean that it is complete. We suggest that the realized robot should be the basis for a whole series of improvements that we did not do due to a lack of time and materials.

For the purpose of continuity and improvement of this work, we see that it is necessary to develop the control range of the robot by replacing Bluetooth with the Internet or satellites and adding a renewable source to reduce the time required for recharging and all this in order to ensure high efficiency and continuity of the robot.

Bibliographic references

- [1] B. Abdelaziz, « Véhicule autonome : Les systèmes de perception embarqués », Institut National des Sciences Appliquées de Rouen, STPI/P6, 2019
- [2] « [https://www.kronobase.org/chronologie-categorie V%C3%A9hicule+autonome.html](https://www.kronobase.org/chronologie-categorie/V%C3%A9hicule+autonome.html) ». consultée le 01/06/2022
- [3] <https://learn.g2.com/types-of-robots>
- [4] <https://www.geeksforgeeks.org/top-10-applications-of-robotics-in-2020/>
- [5] <https://www.rankred.com/different-types-of-robots/>
- [6] https://link.springer.com/chapter/10.1007/978-3-319-62533-1_1
- [7] <https://www.geeksforgeeks.org/top-10-applications-of-robotics-in-2020/>
- [8] What Is A Robot Manipulator? by Robotic Automation Systems
- [9] What is a mobile robot? Definition from WhatIs.com. (techtarget.com) Mobile App Development » StudyMuch/
- [10] <https://robotnik.eu/mobile-robotics-see-the-advantages-it-brings-to-your-sector/>
- [11] <https://builtin.com/robotics/autonomous-mobile-robots>
- [12] <https://www.gideon.ai/resources/the-pros-and-cons-of-autonomous-mobile-robots/>
- [13] <https://byjus.com/physics/dc-motor/>
- [14] <https://www.elprocus.com/dc-motor-basics-types-application/>
- [15] <https://www.linquip.com/blog/shunt-dc-motors/#:~:text=A%20shunt%20motor%20%28known%20as%20a%20shunt%20wound,windings%20are%20exposed%20to%20the%20same%20supply%20voltage.>
- [16] <https://www.electrical4u.com/compound-wound-dc-motor-or-dc-compound-motor/>
- [17] <https://electrical-engineering-portal.com/the-direct-current-dc-motor-principle-of-operation>
- [18] <https://www.theengineerspost.com/servo-motor/>
- [19] <https://www.globalspec.com/reference/10801/179909/chapter-3-ac-and-dc-motors-servomotors-general-principles-of-operation>
- [20] <https://realpars.com/types-of-sensors/>
- [21] <https://deepbluembedded.com/different-types-sensors-applications/#:~:text=Different%20Types%20of%20Sensors%201%20Temperature%20Sensors%20Semiconductor,6%20Vibration%20Sensor%20...%207%20Sound%20Sensors%20>
- [22] <https://www.sciencelearn.org.nz/resources/1602-electricity-and-sensors>
- [23] <https://www.omega.com/en-us/resources/accelerometers>
- [24] What is Arduino? | Arduino Documentation
- [25] <https://www.watelectronics.com/arduino-technology-architecture-and-applications/>

- [26] <https://www.educba.com/what-is-arduino-uno/>
- [27] <https://components101.com/microcontrollers/arduino-uno>
- [28] <https://www.makerguides.com/arduino-nano/>
- [29] <https://techzeero.com/iot-devices/arduino/arduino-nano/>
- [30] <https://www.theengineeringprojects.com/2018/06/introduction-to-arduino-mega-2560.html>
- [31] <https://docs.arduino.cc/hardware/mega-2560>
- [32] <https://www.britannica.com/technology/Bluetooth>
- [33] <https://www.britannica.com/technology/Bluetooth>
- [34] <https://www.tutorialspoint.com/bluetooth-architecture>
- [35] <https://www.tutorialspoint.com/what-is-scatternet>
- [36] <https://maker.pro/custom/tutorial/hc-05-bluetooth-transceiver-module-datasheet-highlights>
- [37] <https://components101.com/wireless/hc-05-bluetooth-module>
- [38] <https://components101.com/modules/l293n-motor-driver-module>
- [39] <https://www.electroduino.com/introduction-to-l298n-motor-driver-how-its-work/>
- [40] <https://electronicsmith.com/how-to-use-l298n-motor-driver/#:~:text=L298N%20works%20on%20the%20principle%20of%20Dual%20H,maximum%20power%20consumption%20of%20the%20driver%20is%2020W.>
- [41] <https://www.theengineeringprojects.com/2018/10/introduction-to-arduino-ide.html>
- [42] <https://arduinogetstarted.com/tutorials/arduino-code-structure>
- [43] <https://www.theengineeringknowledge.com/introduction-to-proteus/>
- [44] <https://technologitouch.com/tech-tips/what-is-proteus-software-used-for/>
- [45] <https://all3dp.com/2/remotexy-arduino-control-guide/>