جامعة الإسكندرية
ALEXANDRIA UNIVERSITY

GOODFELLAS

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Table of Contents:

Word about our team:

As a team of students entering LMR competition, we believe that it's an excellent opportunity to showcase our skills and knowledge. It requires us to work together, combining our technical expertise, creativity, and teamwork, to design, build, and program a robot that meets the competition's objectives and outperforms other teams.

Reasons for participation:

We recognize that participating in the competition provides us with a unique chance to learn and grow in various areas beyond technical skills. For instance, we learn about project management, communication, and leadership. The process of designing and building a robot helps us develop critical thinking, problem-solving skills, and creativity.

While winning is essential, we understand that the primary goal of the competition is to learn and have fun. Each competition is an opportunity to improve and learn from our mistakes. Therefore, we strive to enjoy the process and not get discouraged by setbacks or failures.

Expected performance in competition:

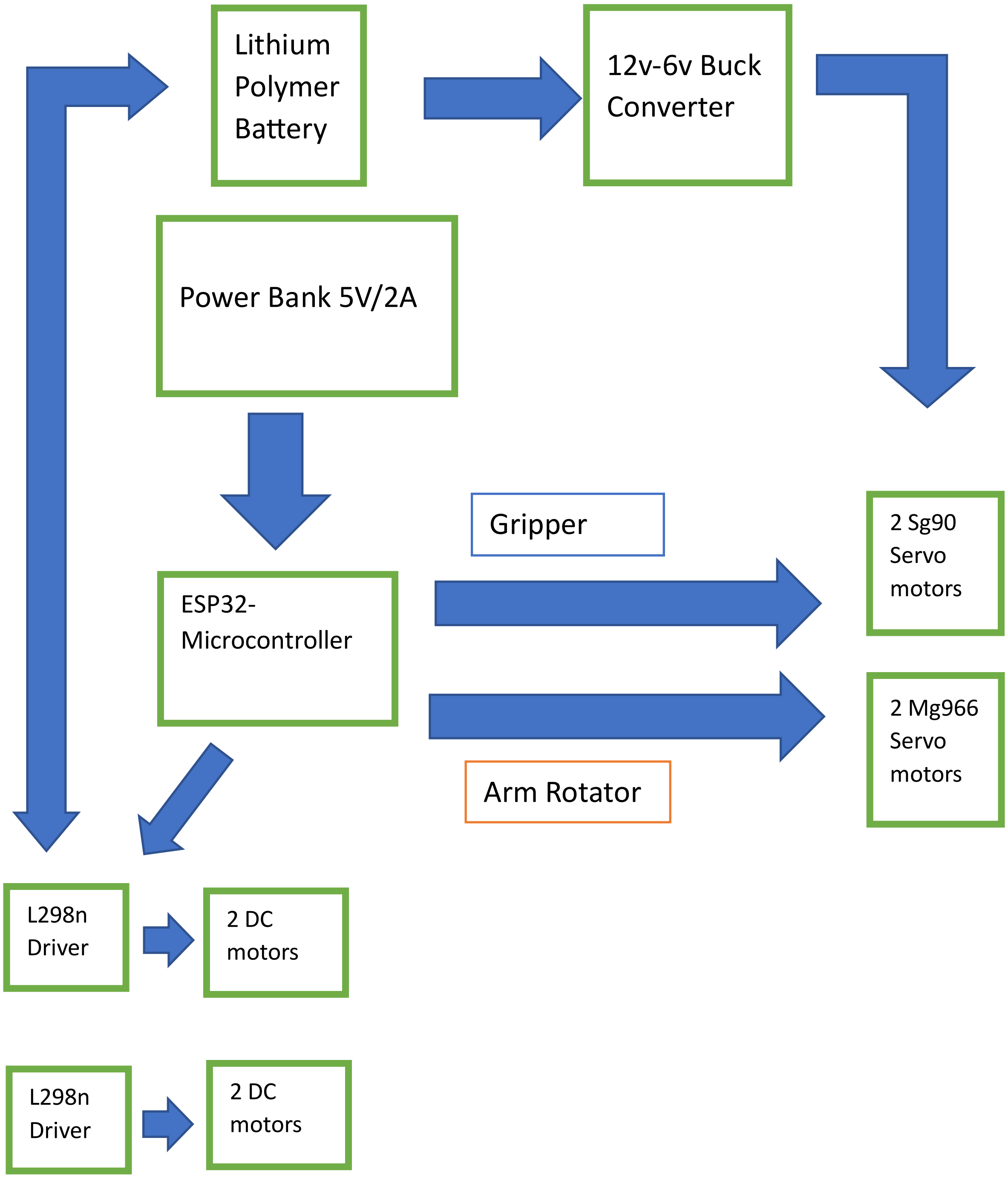
We are confident in our technical abilities, creativity, and teamwork, which we believe will enable us to design, build, and program a robot that performs well in the competition.

In terms of our expected performance, we aim to meet the competition's objectives and outperform other teams. We understand that the competition will be challenging and that we will face obstacles along the way. However, we are committed to working together, learning from our mistakes, and continuously improving to achieve our goals.

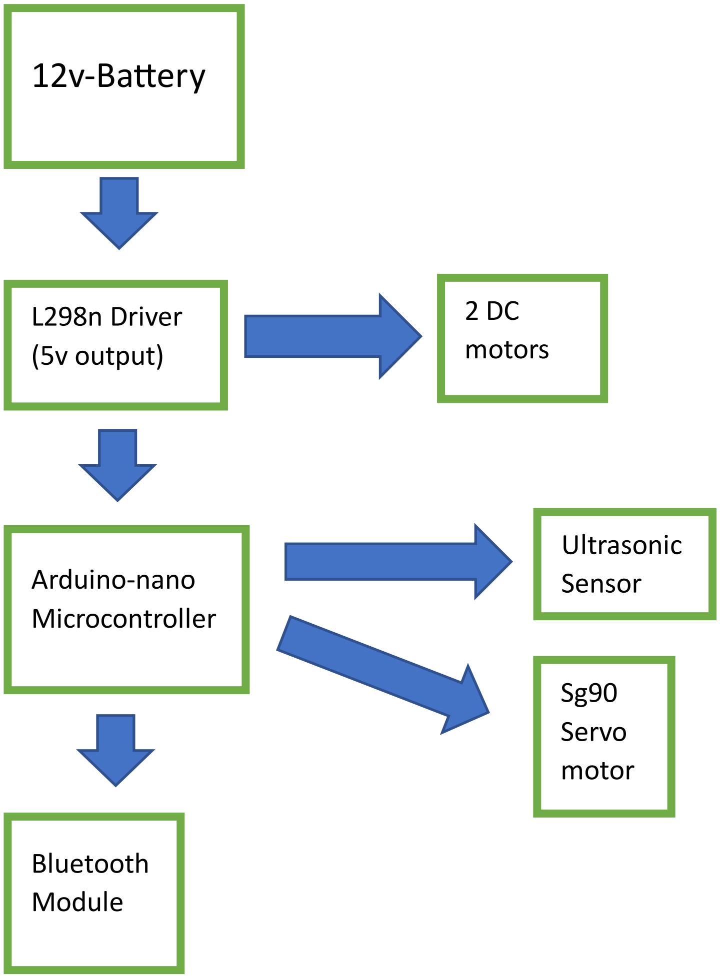
Overall, we are confident in our abilities as a team and our commitment to learning, improving, and achieving our objectives.

Technical content:

System Interconnection Diagram (SID) for the Main Robot:



System Interconnection Diagram (SID) for the Micro Robot:

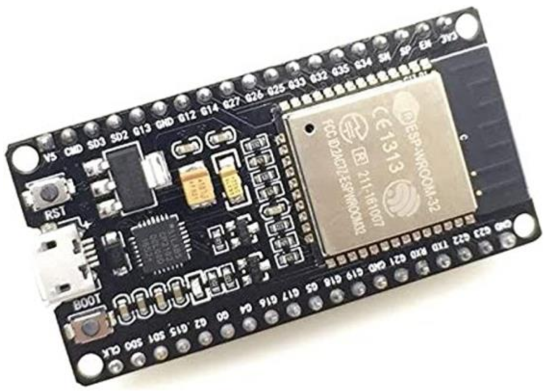


System components with selection reasons:

The Main Robot Components:

1- ESP32 Microcontroller:

There are several reasons that we used the Esp32 instead of an Arduino :



- Cheaper than the Arduino Mega
- More GPIO pins: The ESP32 has more GPIO pins than the Arduino Mega, which means that you can connect more sensors, and other components.
- Built-in Wi-Fi and Bluetooth: One of the most significant advantages of the ESP32 is that it has built-in Wi-Fi and Bluetooth connectivity, which means that you can easily connect your projects to the internet or other wireless devices without needing additional hardware (no Bluetooth module needed).
- More processing power: The ESP32 has a dual-core processor with higher clock speed and more memory than the Arduino Mega, which makes it more powerful and capable of handling more complex tasks.
- Lower power consumption: The ESP32 is designed to be more power-efficient than the Arduino Mega, which makes it a better choice for battery-powered projects or projects that need to run for extended periods without being plugged in.

2-Lithium-Polymer Battery:

Since that we want to power 4 Dc motors and 2 Mg966 Servo motors and 2 SG90 Servo motors, we needed to select a battery with certain specifications:

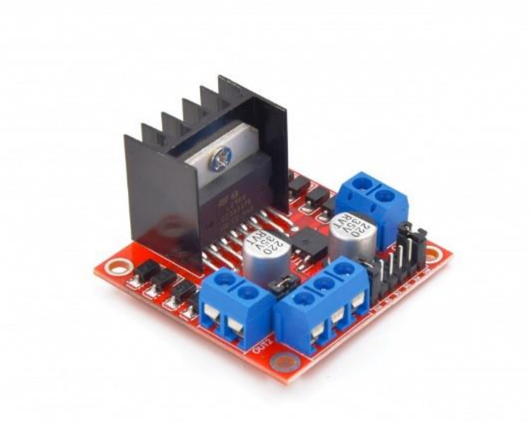
- 12v to be able to power the l298n drivers.
- 4500mAh capacity as each Dc motor can draw up to 1.2A maximum but we wont reach that so we can say each DC motor will draw 0.7Ah approximately, so 4 Dc motors combined may reach 2800mA, and for the 2Mg966 Servo motors can draw from 500mA to 900mA under small loads so we can say 700mA and 1400mA combined, and as for the 2 Sg90 Servo motors can draw 150mA approximately, and 300mA combined, so the total current that could be drawn is 4500mAh or lower as this calculations may vary according to the operations performed.

3-Wireless communication:

As mentioned before, the ESP32 has built-in Bluetooth connectivity, so we managed to connect the ESP32 directly to a PS4 controller, by downloading a PS4 controller library from Git-hub, and adding it to the Arduino IDE libraries, then getting the mac address of the esp32 and assigning it to the ps4 controller using **Sixaxis Pair Tool app**.

4-Motor driver:

We are using 2 of the l298n motor driver to control the 4 Dc motors and some of its advantages are:



- High current capacity: The L298N driver is capable of handling high current loads of up to 2A per channel, making it suitable for driving larger motors or multiple motors simultaneously.
- Dual H-bridge configuration: The L298N driver has a dual H-bridge configuration, which means that it can control the speed and direction of two motors independently. This makes it a good choice for projects that require precise motor control.
- Easy to use: The L298N driver is relatively easy to use and can be controlled using simple digital signals from a microcontroller or other control board.

5-Servo Motors:

A-180 degrees SG90:

We are using this servo motor to open and close the gripper, since we don't need a very high torque to open and close the gripper and we don't need to rotate it more than 180 degrees, this type will do the job.

B-360 degrees SG90:

Which is also known as a continuous rotation servo motor, We are using it to rotate the gripper 360 degrees if needed, as it will be useful in rotating a button. It is also easy to control using a simple pulse-width modulation (PWM) signal.

C-Two of MG966 (180 degrees):

We are using this type of servo motors in the arm rotator part due to several advantages as:

- Higher torque: The MG966 has a higher torque rating than the SG90, which means it can exert more force and is better suited for applications that require a greater amount of power.
- Metal gears: The MG966 has metal gears, which are more durable and resistant to wear and tear than the plastic gears used in the SG90. This makes the MG966 better suited for applications that require high reliability.
- Higher precision: The MG966 has a higher precision than the SG90, which means it can achieve more accurate movements and is better suited for applications that require precise control over position and speed.

6-Motors:

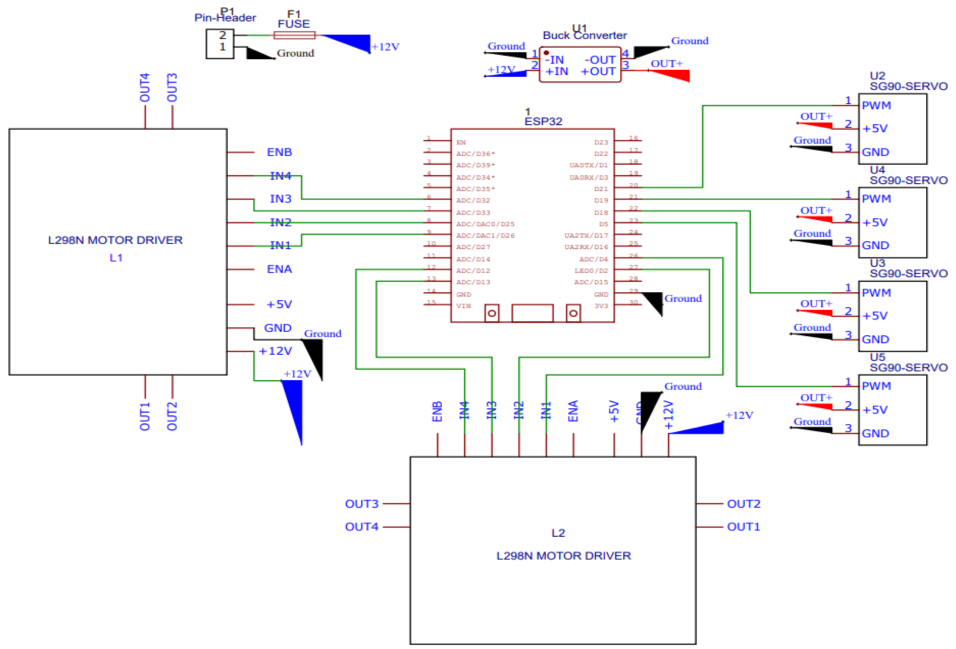
We chose to use Metal Geared Dc motors of **20kgcm** torque and **133 rpm** for the following reasons:

- High torque: A DC motor with 20kgcm torque is capable of producing a high amount of rotational force, making it suitable for applications that require high torque, such as in heavy-duty machinery, robotics, or electric vehicles.
- Moderate speed: A motor with 133rpm is a moderate speed, making it suitable for applications that require a balance between speed and torque.
- Easy to control: DC motors are easy to control using a simple voltage controller or a motor driver.

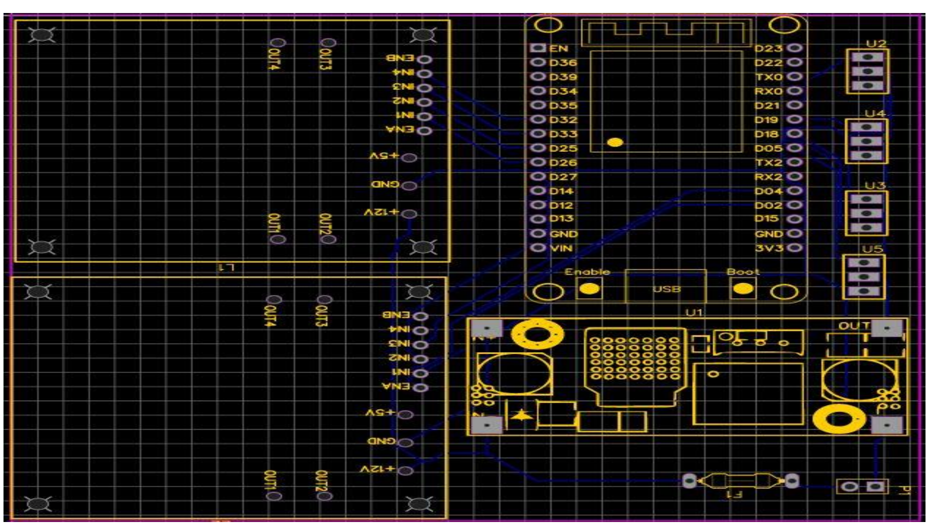
- Easy to maintain: DC motors are relatively simple devices and are easy to maintain. They require minimal maintenance and can be easily repaired or replaced if necessary.
- Having a 20kgcm torque ensures that the robot will be able to climb a ramp and can carry the robot weight easily.

7-PCB Design:

A-Schematic



B-Design



The Micro Robot Components:

1- Arduino nano Microcontroller:

There are several reasons why we chose to use an Arduino Nano microcontroller board:

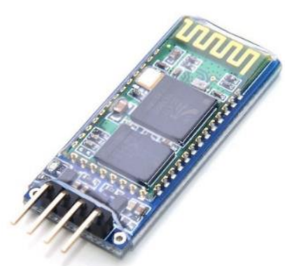
- Small Size: The Arduino Nano is a compact board that measures just 18mm x 45mm. This makes it an ideal choice for projects with limited space or for use in portable devices.
- Low Cost: The Nano is an affordable option that is priced lower than other Arduino boards, making it a great choice.
- Easy to Use: The Arduino Nano is easy to use and program, even for those who have no prior experience with microcontrollers. It has a simple interface and can be programmed using the Arduino IDE.
- Wide Compatibility: The Nano is compatible with a wide range of sensors, modules, and shields, which makes it a versatile choice for a variety of projects.
- Breadboard Friendly: The Nano has a standard pin spacing of 0.1 inches, which makes it easy to use with a breadboard and other prototyping tools.
- Pinout: The Arduino Nano has 22 digital I/O pins and 8 analog input pins. It also has 6 PWM (Pulse Width Modulation) pins for controlling motors, LEDs, and other devices.

2-Lithium-Ion Battery:

There are several reasons why we chose to use 3 lithium-ion (Li-ion) batteries with a nominal voltage of 3.7V:

- We used 3 of them which would make 11.1v approximately, which is enough to power up the l298n driver which would control the motors.
- High Energy Density: Li-ion batteries have a high energy density, which means they can store a lot of energy in a relatively small and lightweight package. This makes them ideal for portable devices where weight and size are important factors.
- using a lithium-ion battery with an Arduino Nano is a straightforward process that can provide a portable and flexible power source for our micro robot.

3-Bluetooth Module:

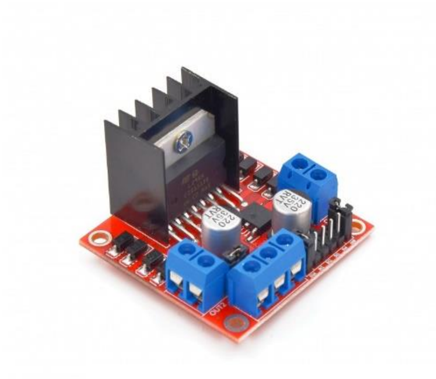


- Wireless Communication: Bluetooth modules provide a convenient way to establish wireless communication between devices. This can eliminate the need for cables and wires.
- Universal Compatibility: Bluetooth modules can communicate with a wide range of devices, including smartphones, tablets, laptops, and other Bluetooth-enabled devices.
- Short-range Communication: Bluetooth modules have a relatively short communication range (typically up to 10 meters).
- Easy to Use: Bluetooth modules are easy to use and can be programmed using a variety of programming languages and development environments.
- Low Cost: Bluetooth modules are available at a range of price points, making them affordable.

4-Motor driver:

We are using it for the same reasons mentioned before in the main robot, but we are only using one driver to control the 2 motors of the micro robot.

We are also using the 5v output of the driver to power up the Arduino nano.



5-Sensors:

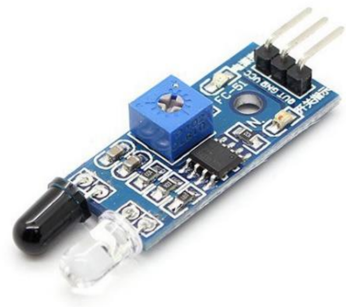
A-Ultrasonic Sensor:

We are using it to detect any obstacles in the way of the robot and it's mounted on top of a 180 degrees servo motor to detect any obstacles near the micro robot.

- Distance measurement: Ultrasonic sensors can accurately measure distances between the sensor and an object, making them useful in applications such as robotics, level sensing, and detection of objects.
- Detection of transparent objects: Ultrasonic sensors can detect transparent objects that are difficult to detect with other types of sensors, such as optical sensors.
- Immunity to environmental factors: Ultrasonic sensors are unaffected by environmental factors such as color, shape, and texture of the object being measured, as well as changes in temperature, humidity, and air pressure.
- Low power consumption: Ultrasonic sensors consume very little power, making them suitable for use in battery-powered devices.
- Wide range of detection: Ultrasonic sensors can detect distances from a few centimeters to several meters, depending on the sensor's specifications.
- Easy to use: Ultrasonic sensors are easy to use and require minimal calibration or adjustment, making them suitable for use by non-experts.

B-Infrared Sensor:

We are using the IR sensor to stop the micro robot when detecting a black mark on the ground, An IR (infrared) sensor works by detecting infrared radiation emitted by objects, When an object is in the vicinity of the sensor, it absorbs some of the infrared radiation emitted by the emitter and reflects the rest. The detector then measures the amount of reflected radiation and uses this information to detect the presence of the object.



6-Servo motor:

The SG90 (180 degrees) is used to rotate the ultrasonic sensor left and right for obstacle detection.

7-Motors:

We are using two mini–DC Gearbox Motors for the following reasons:

- Compact size: Mini DC gearbox motors are small and lightweight, making them a good choice for applications where space is limited, such as in drones, RC cars, or small appliances.
- Precise speed control: DC motors offer precise speed control.
- Easy to control: Mini DC gearbox motors are easy to control using a simple motor driver.
- Low cost: Mini DC gearbox motors are typically less expensive than other types of motors, such as stepper motors or brushless DC motors, making them a cost-effective option for the micro-robot.

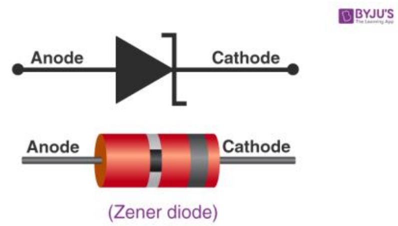
Safety:

Overload and Short Circuit Protection:

We used **Resettable fuses** which are a type of electrical protection device that automatically disconnects a circuit when current flow exceeds a certain threshold. Unlike traditional fuses, resettable fuses can be reset after tripping, allowing the circuit to resume normal operation once the fault is cleared, they are designed to protect against overcurrent conditions and short circuits.

Reverse voltage protection:

We used Zener diodes in controlling the motors as when they are placed parallel with the motor, it can prevent back EMF from damaging the motor or other components in the circuit.



Indication Elements:

1. Warning lights: To indicate potential hazards or malfunctions. For example, a warning light may indicate a low battery (present in the power bank),
2. Emergency stop button: An emergency stop button is a critical safety feature that can be used to immediately stop the car's operation in case of an emergency. It should be easily accessible.

Wires and tracks size calculations:

To calculate the appropriate size of a wire or track, you can use the following formula: $R = (\rho \times L) / A$

Where:
R = Resistance of the wire or track (in ohms)
ρ = Resistivity of the material (in ohms/meter)
L = Length of the wire or track (in meters)
A = Cross-sectional area of the wire or track (in square meters)

The resistivity of copper, which is commonly used in PCBs, is 1.7×10^{-8} ohms/meter.

So, after some calculations we found 0.8cm is the best track size for our PCB.

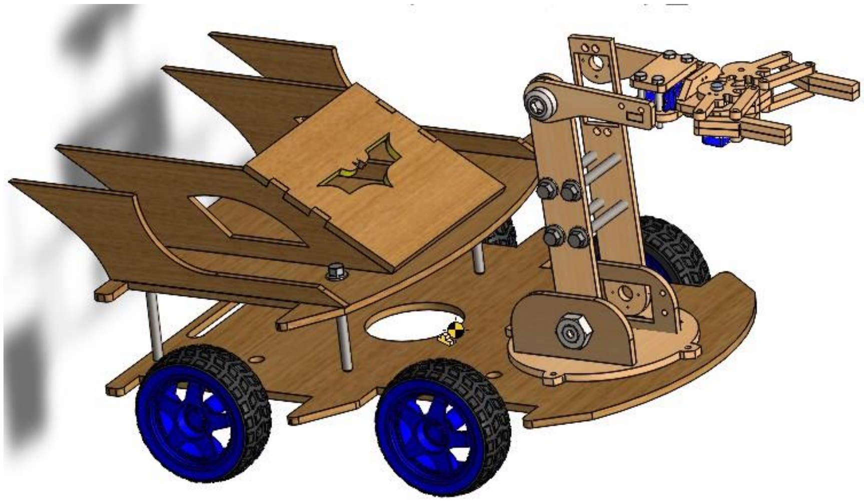
Mechanical design:

1- CAD design full robot with basic dimensions:

Height= 14.5cm

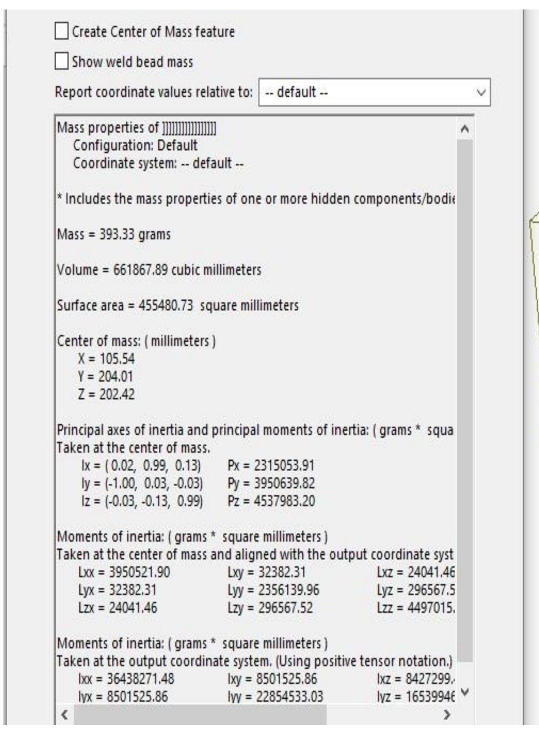
Width= 33cm

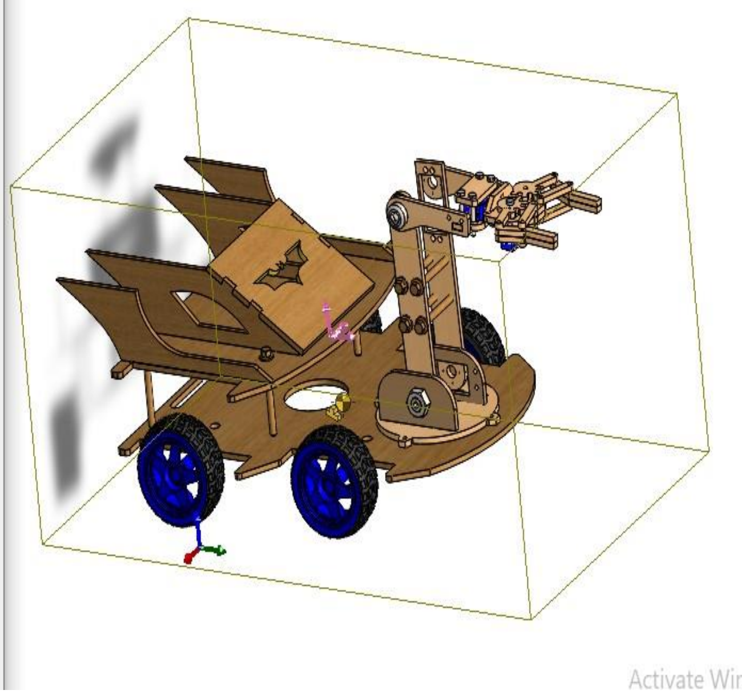
Length= 26cm



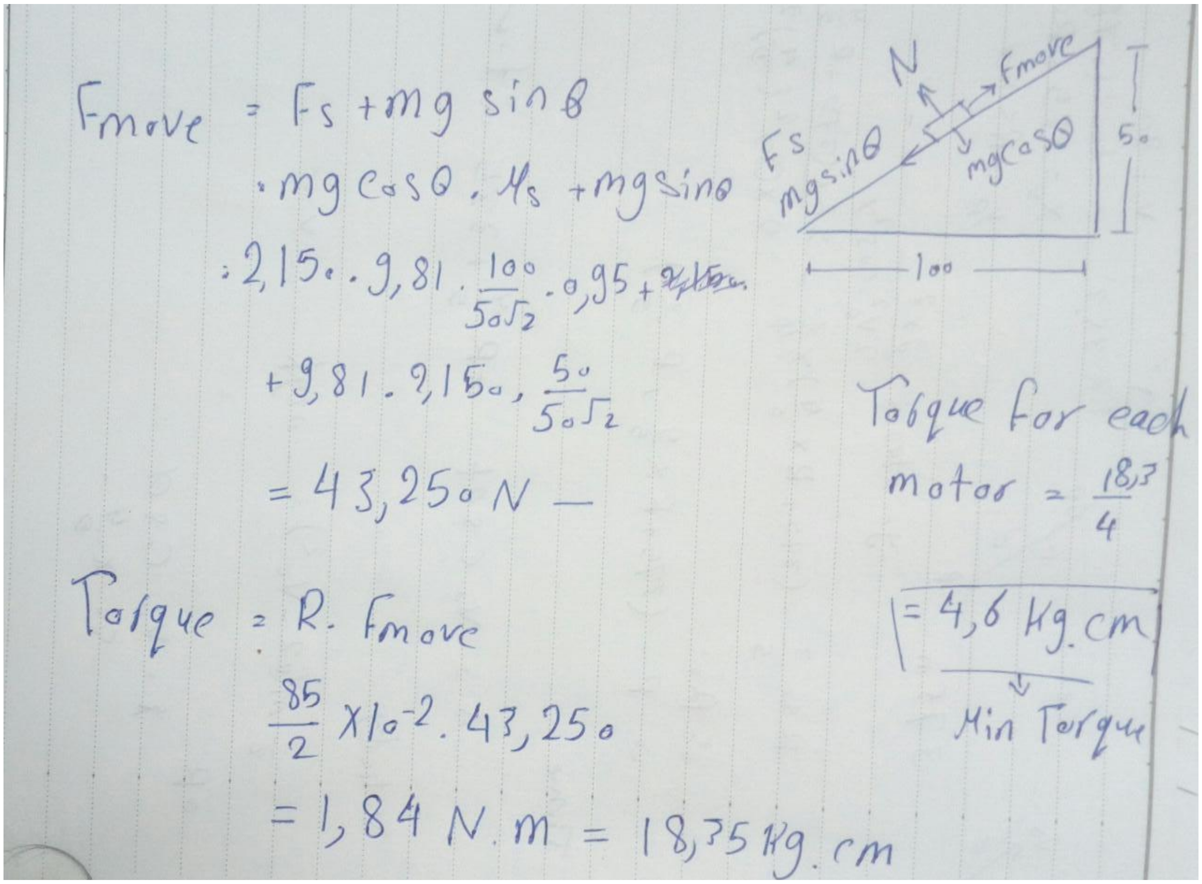
2- force and moment calculations and motor selection:

Software calculation:





Manual calculation:



$$F_{move} = F_s + mg\sin\theta$$
$$= mg\cos\theta \cdot \mu_s + mg\sin\theta$$
$$= 2{,}150 \cdot 9{,}81 \cdot \frac{100}{50\sqrt{2}} \cdot 0{,}95 + 9{,}81 \cdot 2{,}150 \cdot \frac{50}{50\sqrt{2}}$$
$$= 43{,}250\ N$$

$$\text{Torque} = R \cdot F_{move}$$
$$= \frac{85}{2} \times 10^{-2} \cdot 43{,}250$$
$$= 1{,}84\ N.m = 18{,}35\ Kg.cm$$

Torque for each motor $= \frac{18{,}3}{4}$

$\boxed{= 4{,}6\ Kg.cm}$ → Min Torque

Motor selection:

In our calculation the minimum motor torque for climbing the competition ramp is 4.6Kg.cm and minimum force is 44N.

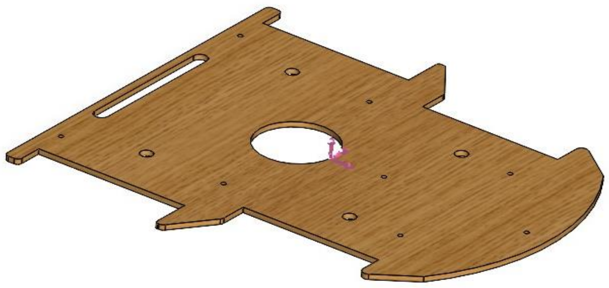
So, we chose to use a motor of 20 Kg.cm to be sure that our robot will climb the ramp.

3- CAD design of the base (dimensions, weight, and C.G):

Mass=108g

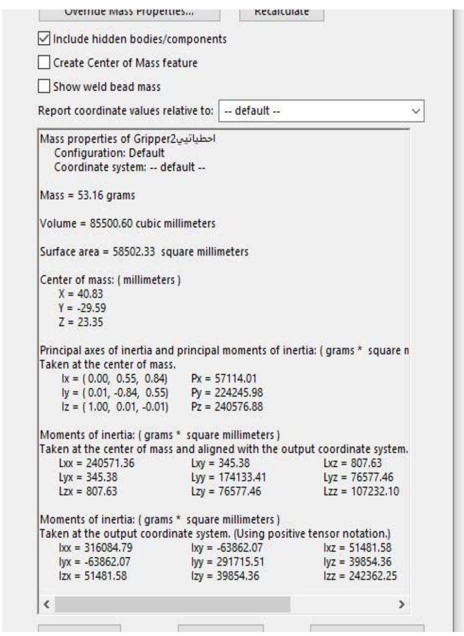
Length=27cm

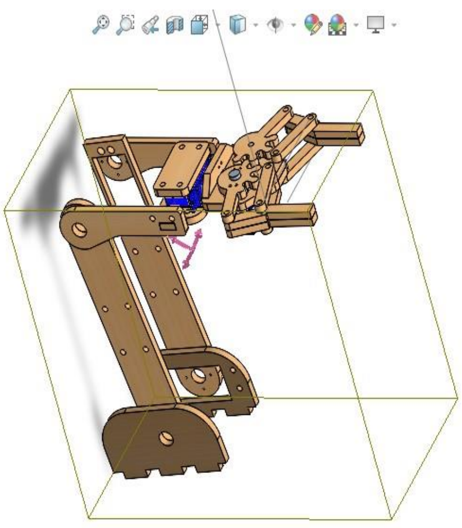
Width=26cm



4- Mechanism and robot arm:

The robot arm consists of 2 MG966 servo motors so that they can withstand lifting heavy objects, and a 360 Sg90 servo motor to rotate the gripper, and Mg90 servo motor in the gripper to open and close.





6- The time needed to finish the competition tasks: