

# Homework 04

EN2533 - Robot Design and Competition



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## 1 Introduction

The purpose of this project is to design an initial prototype of a mobile robot capable of performing the tasks outlined in this module. This report details the robot's components and design considerations, including CAD drawings and a breakdown of sensors, actuators, batteries, and other key components.

## 2 CAD Drawings

This section includes CAD drawings that show the robot's design from multiple views: top, side, and back. Each component, including sensors, motors, batteries, wheels, and the chassis, is labeled.

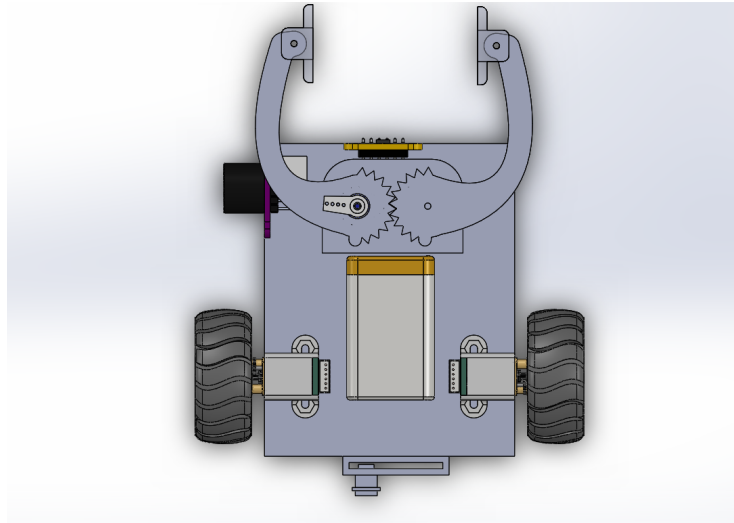


Figure 1: **Top View of the Robot**

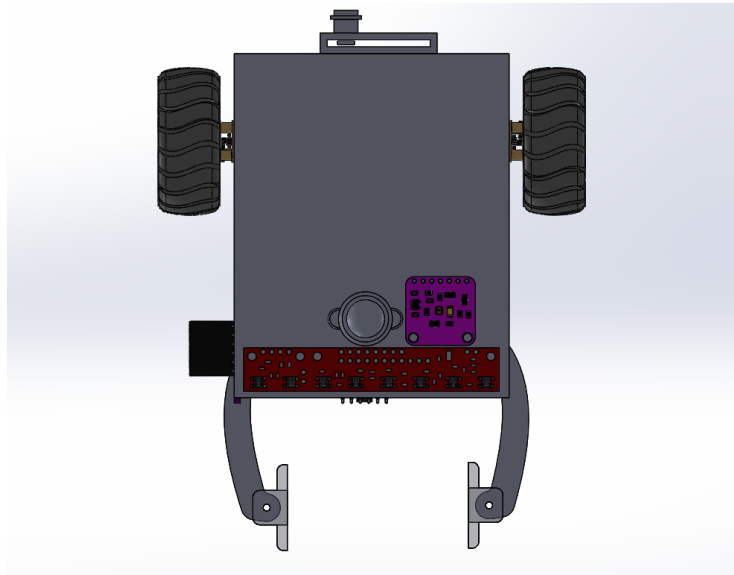


Figure 2: **Bottom View of the Robot**

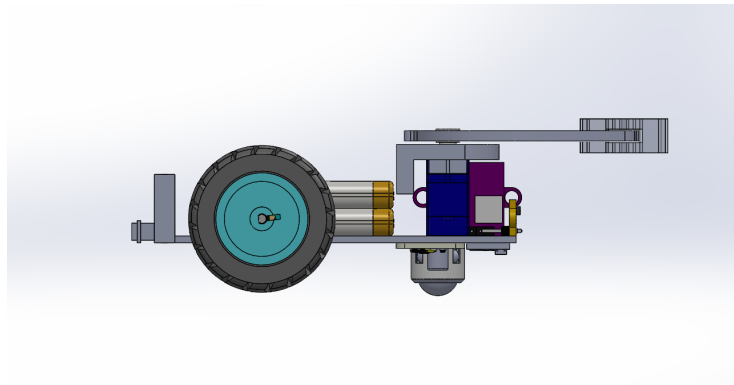


Figure 3: Left Side View of the Robot

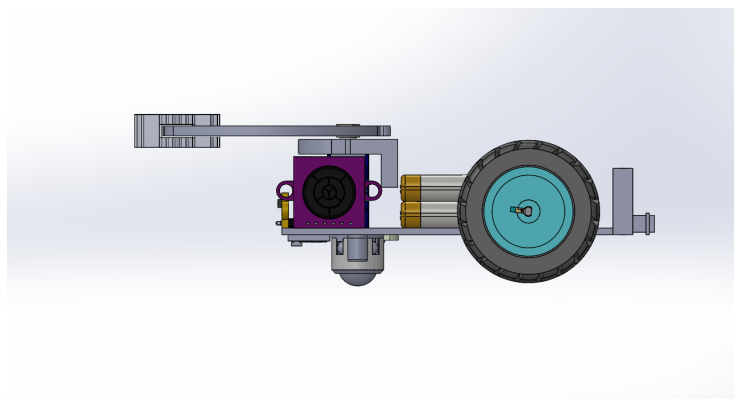


Figure 4: Right Side View of the Robot

### 3 Labeled CAD Drawings

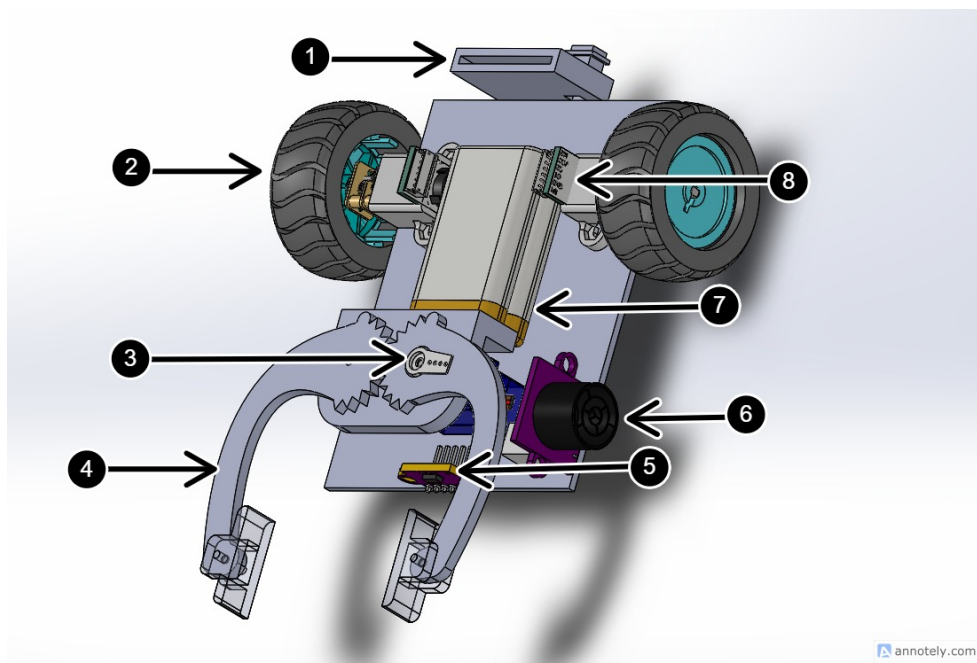


Figure 5: Overall View of the Robot with Labels

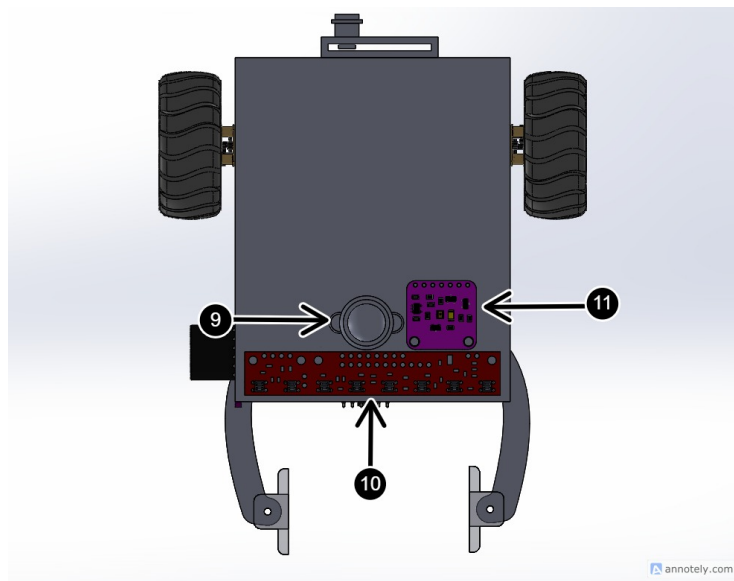


Figure 6: Bottom View of the Robot with Labels

#### Key Components:

- 1 - Coin Dispenser
- 2 - D-hole Big Rubber Wheel
- 3 - Servo Motor
- 4 - Clamp Mechanism
- 5 - Time of Flight (TOF) VL53L5CX Distance Sensor
- 6 - GY-US42 Ultrasonic Sensor
- 7 - 3.7V Li-po Battery
- 8 - N20 Motor with Encoder
- 9 - Caster Wheel
- 10 - 8 Array IR Sensor
- 11 - TCS34725 RGB Color Recognition Sensor

## 4 Explanation of Components

### 4.1 Sensors

#### 4.1.1 TOF Sensor (Time of Flight VL53L5CX)

**Purpose:** The TOF sensor measures the distance between the robot and obstacles using light. It calculates how long it takes for a light pulse to return after reflecting off an object. It is used to measure the height of the box in **Task 6**.

**Placement:** Typically placed at the front for obstacle detection.

**Specifications:** This sensor can measure distances up to 2 meters with  $\pm 1$  cm accuracy.

#### 4.1.2 Color Sensor(TCS34725)

**Purpose:** Detects surface colors, used in line following or object recognition.

**Placement:** Placed under the robot for surface color detection, especially to detect red and blue in **Task 2 and Task 3** in the competition.

**Specifications:** Capable of detecting standard colors like red, blue, and green.

#### 4.1.3 8 Array IR Sensors

**Purpose:** Used for line following, detecting reflectivity differences between a black line and a white surface.

**Placement:** Located at the base of the robot.

**Specifications:** An array of 8 IR sensors ensures precise line tracking.

#### 4.1.4 Ultrasonic Sensor ( GY-US42 )

**Purpose:** Measures distance using ultrasonic waves, which is effective for obstacle detection and wall detection. The Gy US42 is more precise and has a longer range than other ultrasonic sensors, allowing us to detect walls while moving. It is very useful in Task 2.

**Placement:** Mounted on the left side of the robot.

**Specifications:** Can measure up to 7 meters with  $\pm 3$  cm accuracy.

### 4.2 Actuators

#### 4.2.1 N20 Motor with Encoder

**Purpose:** Drives the robot with precise control over speed and direction.

**Placement:** Mounted on the chassis and connected to the wheels(using **N20 motor mount** to fix the motor to the chasis).

**Specifications:** A **6V N20 motor** with 500 RPM and encoder feedback with 360 PPR for precise movement. The **encoder** is a built-in magnetic encoder operating at 3.3V to track the position of the robot accurately.

#### 4.2.2 Servo Motor

**Purpose:** The servo motor is used to control the position of robotic arms or components with precision. It operates by receiving a signal that specifies the desired angle of movement, allowing for accurate positioning in various tasks. It is helpful for making the claw lift the box.

**Placement:** Top of the robot chasis .

**Specifications:** servo motor can rotate between  $0^\circ$  to  $180^\circ$  and provide a torque range of up to 10 kg·cm.

### 4.3 Power System

#### 4.3.1 3.7V 1200mAh LiPo Battery (BA0017)

**Purpose:** Supplies power to motors, sensors, and control units.

**Specifications:**

- **Voltage:** 3.7V
- **Capacity:** 1200mAh
- **Weight:** 20-30g
- **Discharge Rate:** 10C

**Series Configuration:** Two batteries are connected in series to provide a total of 7.4V while maintaining the capacity at 1200mAh. This configuration is useful for systems requiring higher voltage.

**Battery Placement:** Positioned near the center of the robot for optimal weight distribution.

## 4.4 Wheels

### 4.4.1 Caster Wheel

**Purpose:** Provides support for stability and enables easy turning.

**Placement:** Placed at the back of the robot for balance.

**Specifications:** A 2-inch nylon caster wheel for low-friction movement.

### 4.4.2 D-Hole Big Rubber Wheel

**Purpose:** Designed to provide traction and stability for the robot, enabling smooth movement over various surfaces.

**Placement:** Typically mounted on the chassis in conjunction with N20 motors to enhance mobility.

**Specifications:** Dimensions: 43x19x3mm

## 5 Mechanisms

### 5.1 Claw Mechanism with Servo Motor

The claw mechanism is designed to grab and lift boxes in the robot's path. It is controlled by a **servo motor** that provides precise movement for opening and closing the claw. The gears in the claw mechanism allow for smooth and controlled movement, ensuring that the boxes are held securely.

**Components:**

- **Servo Motor:** Controls the opening and closing of the claw.
- **Claw Structure:** Includes 2 gears (each connected to one arm of the claw) for smooth and precise grabbing action.
- **Purpose:** Enables the robot to interact with objects by grabbing and moving them.

### 5.2 Coin Dispenser

The **coin dispenser** holds a two-rupee coin. It has a small knob that holds the coin in place. When needed, the knob is released, and the coin falls from the dispenser.

## 6 Conclusion

This report presents the design and component selection for the initial prototype of the mobile robot. The integration of sensors, motors, and power systems enables the robot to autonomously navigate and perform its designated tasks. The CAD models and component explanations highlight the key elements of the design.