Report on CAD Design

Team Cosmo

1 Introduction

Our robot features a two-tiered design, which can be easily visualized in the attached CAD model. This design includes a gripper that can slide up or down, adding flexibility to its functionality. Our team worked collaboratively to collect ideas and work on different concepts, eventually settling on this design. It comprises two compartments where we've placed various components preserving overall dimensions. The placement of these components is clearly depicted on the CAD model, providing a visual representation of the robot's design.

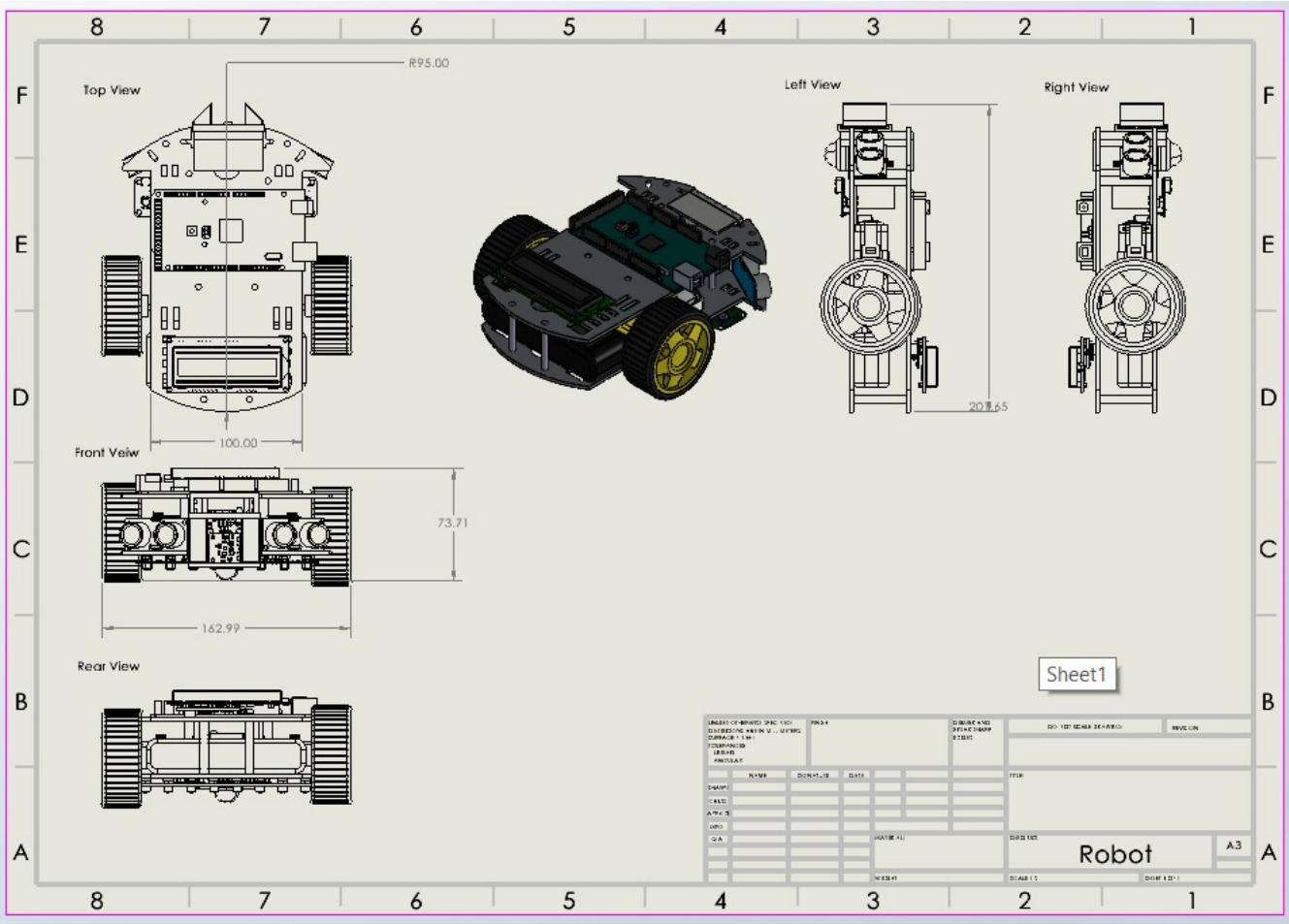


Figure 1: Projected views of the CAD model

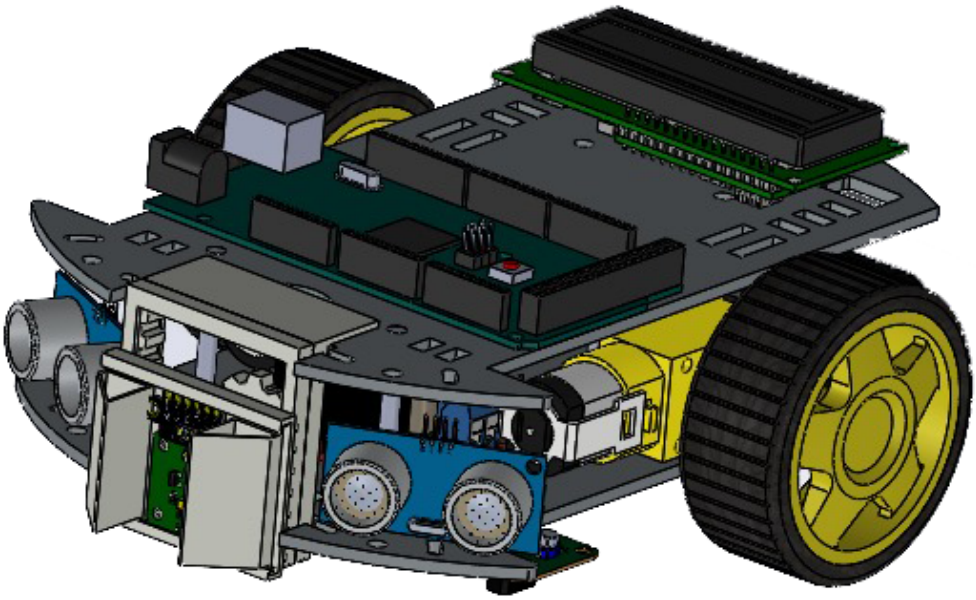
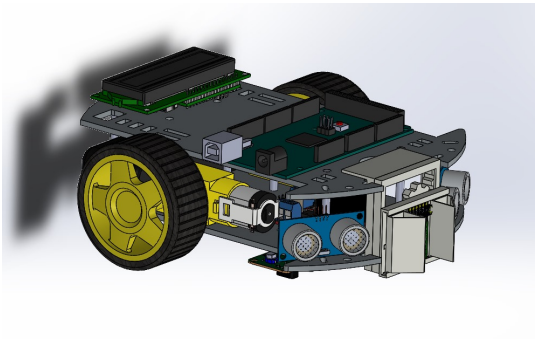


Figure 2: 3D view

2 Robot's Mechanical Design Overview

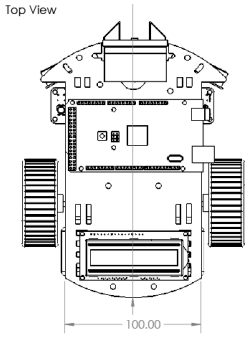
In terms of dimensions, our robot measures 163 cm in width, 201 cm in length, and 76 cm in height. We decided to use plastic gear motors instead of metal gears on purpose. We made this choice because we wanted the motors to be much lighter and work faster. After a lot of testing, we found that the plastic gear motors work fine without even motor encoders. However, we've decided to put in optical encoders to better track the robot's movements.



One special thing about our design is that it has a gripper arm at the front of the robot. This arm has small RGB and distance sensors and can slide up when the robot needs to go up ramps, making it able to work in different places.

We've been really careful about where the robot's weight is because it makes a big difference in how well the motors work, how smoothly the robot moves, and how stable it is when going up ramps. To make it more stable, we added a metal caster wheel at the front, right before the IR sensor, so the robot can move safely and stay steady on ramps.

3 Arrangement of components

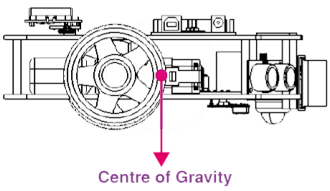


Our robot is equipped with two compartments. To ensure weight distribution the upper compartment houses the Arduino Mega and the motor driver as they are relatively lightweight. For sound wave capture we strategically position the sensor at the highest point of the robot. Maintaining stability is crucial, during component placement so we focus on aligning the center of gravity with the center of the robot. To achieve this heavier components like motors and batteries are placed in the compartment to concentrate mass.

To enable sensing capabilities we utilize two sensors and one TOF sensor to detect obstacles on both sides and in front of the robot. For reverse line following two general IR sensors are positioned at the end.

For accuracy in line following tasks we ensure that our line following sensor is positioned closer, to the ground. Thus we place it below the bumper with ground clearance while maintaining proximity to facilitate precise readings. When positioning elements, like the buck converter and the gyroscope various factors come into play. These factors include considering the weight, size, arrangement of wires, accessibility of components and how easy it is to remove or components (especially when replacing a faulty one).

4 Center of Gravity

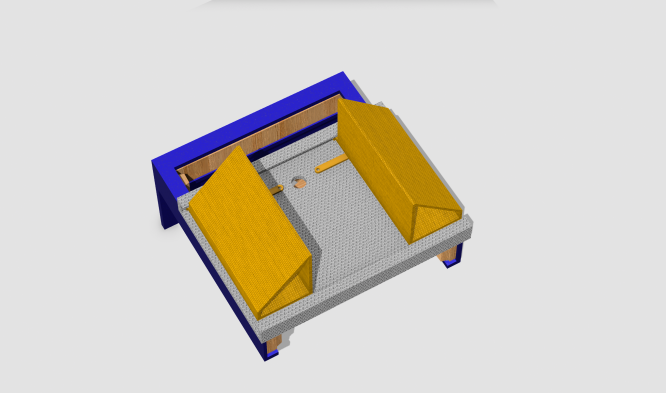


The location of the center of gravity of the robot is very important for a mobile robot. Since the robot is intended to travel specially on inclined surfaces and manipulate objects with a movable arm, it is vital to have the center of gravity as lower as possible (closer to the bottom of the robot), to increase the stability of the robot. This can be achieved by placing relatively heavy objects like batteries and motors close to the bottom. Other than that, the length and the expected spanning distance of the robot arm should also be considered because the movement of the arm, and having external objects carried by the arm, cause the center of gravity to move.

The angle of inclination of the ramp also plays a part in how big the effect of the location of the center of gravity is. If the angle of inclination is too steeper, the robot should have its center of gravity very low. However, since this information is given, the constraints (height and horizontal distances) for the location of the center of gravity can be calculated considering the robot's dimensions, weight, and weight distribution.

5 Robot arm actuator

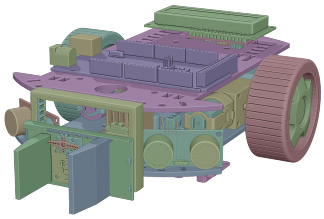
A mechanical arm is integrated into the mobile robot in order to give it the capability to manipulate the objects found along the path. These manipulations can include objects dragging, lifting, turning, carrying, and placing them in another place, etc. Since the given objects are expected to be light-weight and cause low-friction when dragging, a plastic robot arm is adequate.



When the arm is not in use or when grabbed an object, it will be slided up to rest without interfering with other sensors and modules. However, when it is needed, the arm will be lowered to the front of the robot. Servo motors are used for the precise movement of the arm.

It is expected that the arm must be designed to have 2 degrees of freedom (DOF) for the seamless completion of the required tasks. As a result, a minimum of two servo motors will be used to control the movement of the robot arm.

6 Progress on the Mechanical Design



Currently, we're actively testing the robot, and our main goal is to make it better by adding mechanical improvements to make it more stable and perform even better.

While we were testing, we started with a robot arm in our design. But when we found some problems and limitations, we decided to switch to a lighter gripper design that can move up better. This change is meant to make the robot more adaptable and work better.

In terms of distance measurement, we used to use ultrasonic sensors to measure distances, but when we tested them, we found that they were too bulky and not always very accurate. So, we made another change and switched to smaller and more accurate Time-of-Flight (ToF) sensors. These new sensors are not only more precise but also make the robot's design simpler. We also started using Sharp IR sensors at the front of the robot to detect walls and objects, which helps the robot move around more efficiently.