Initial Prototype of the Mobile Robot-CAD drawings

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1 Overview

This report outlines the preliminary design of our robotic system .The core components such as motors,sensors,and modules will be taken from existing manufacturers, while the remaining structural and functional elements are designed by ourselves.To facilitate the development process, CAD drawings have been created to visualize the overall mechanical design and dimensions of the robot. To ensure flexibility and efficieny,we are planning to design a custom PCB for the system therefore the specific placement of motor drivers and microcontrollers are not specifically mentioned in this report.

2 Robot Layout

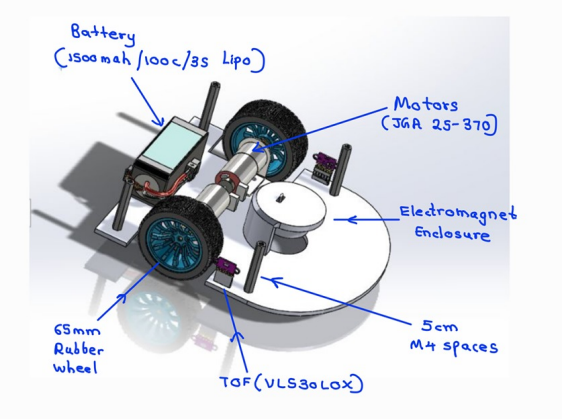


Figure 1

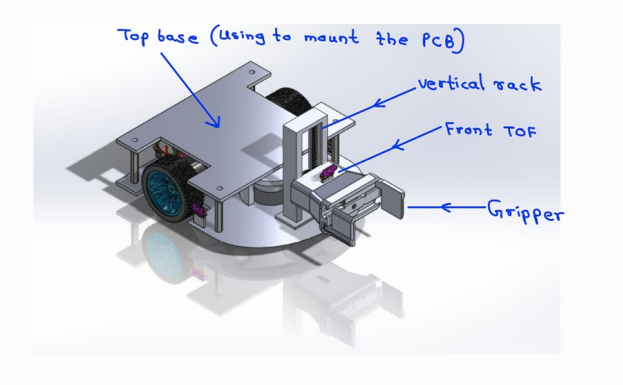


Figure 2

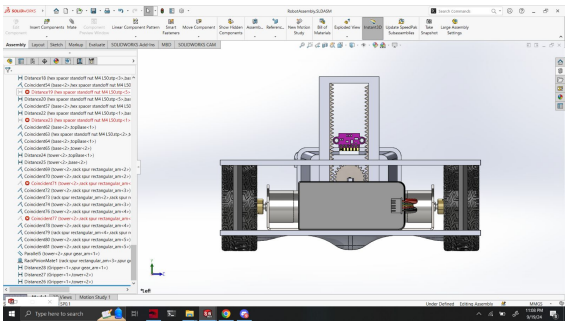


Figure 3: Front View

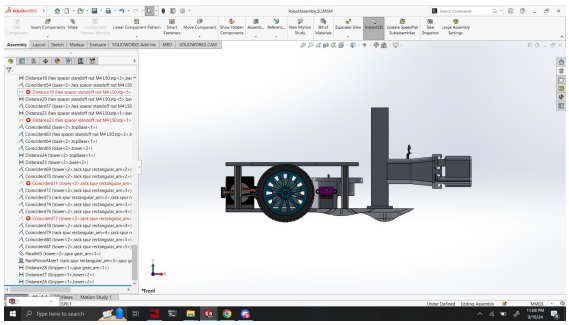


Figure 4: Side View

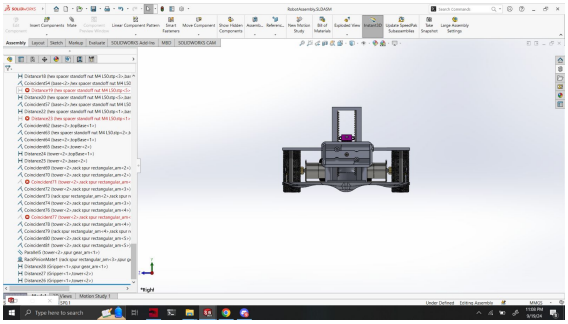


Figure 5: Rear View

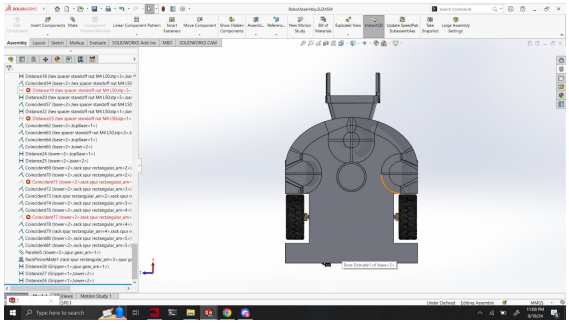
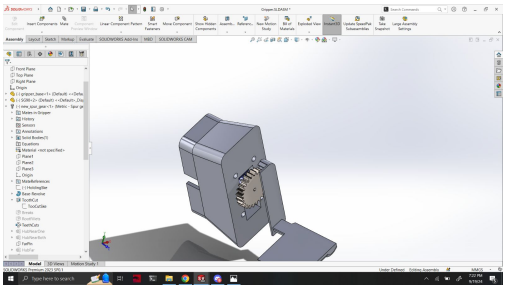


Figure 6: Bottom Veiw

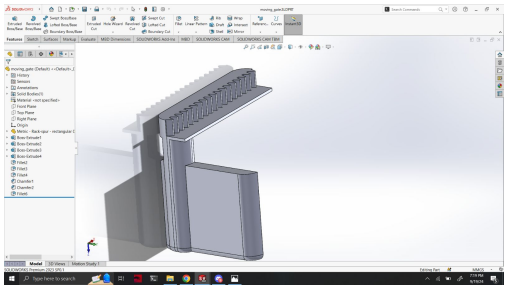
3 Actuator Mechanisms

3.1 Gripper Mechanism

The robot will utilize rack and pinion mechanism for its parallel gripper.The gripper has a very small thickness of only 4mm, enabling it to navigate tight spaces.With a maximum opening of 6.9cm, the gripper can grasp the 5cm box which is ideal for our purposes. Even while holding the box the combined width of the gripper arm (4mm) and the grasped box (5cm) adds up to 5.8cm, leaving enough space to pass through the 7cm x 7cm chamber opening.



(a) Pinion



(b) Rack

3.2 Vertical rack and pinion mechanism

3.2.1 Box Height Detection

The gripper has a vertical range of motion, allowing it to move up and down to identify boxes of 5cm, 10cm, and 15cm.This gripper has a vertical range of 2.5cm to 12.5cm.

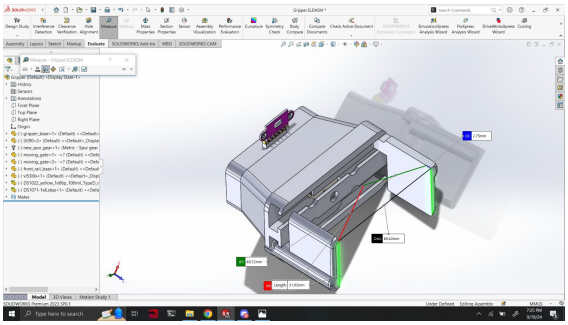


Figure 8: Front ToF mounted on the gripper for detecting height

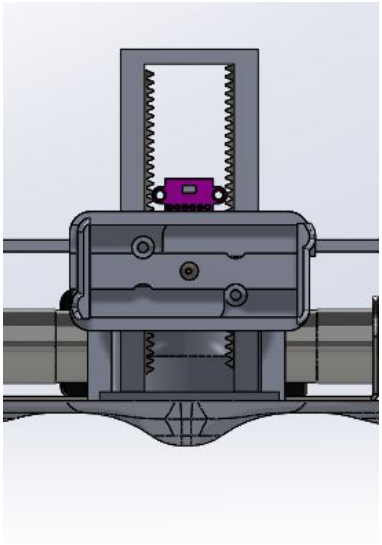


Figure 9: Gripper is free to slide on the vertical rack

3.2.2 Moving Boxes Vertically

The robot will pick up the boxes and lift them 5cm high using the gripper before placing them in the destination.

3.3 Coin Drop Mechanism

The robot will use a electromagnet to securely hold the coin.Once the robot reaches the designated drop point, a KK P20/15 3kg solenoid (selected locally available electromagnet) will be de-energized, releasing the coin from the gripper's magnetic hold. This controlled release ensures that the coin falls gently and accurately at the intended location.

4 Robot Base

The base is positioned 11mm above the ground.During line-following and other tasks, only the front center of the base makes contact with the ground, providing precise control.To enhance stability and prevent tipping on uneven terrain, two additional contact points are located on the sides of the base, each measuring 8mm.These side contact points ensure that the robot remains firmly grounded.We have already tested a similar base for another application in the past.

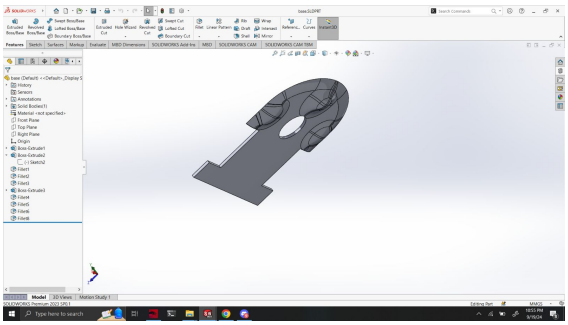


Figure 10

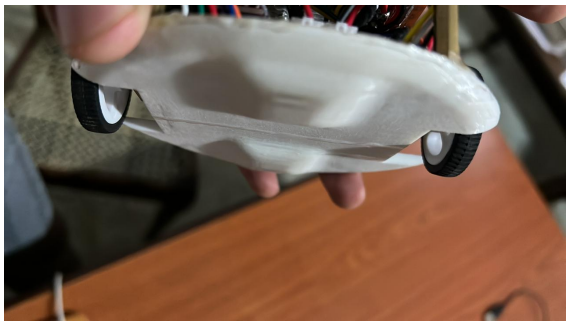


Figure 11

5 Actuators

5.1 MG90 Servo Motor

The MG90 servo motor will be used to drive the gripper across the vertical rack. MG90 was specifically selected for this purpose because it has torque of 2.2kg/cm and will be capable of lifting both the boxes and the gripper

5.2 SG90 Servor Motor

SG90 servo will be used to open and close robot's parralel gripper arms throuth the rack and pinion mechanism. We have selected this servo as this appication does not require much torque as the servo needed for hoisting the gripper and the boxes.

Figure 12: MG90

Figure 13: SG90

Both the servos might need to be modified to do the 360 degree rotation by removing the potentiometers inside. Because simple 90 degree rotation to either direction will not rotate the spur gears through the entire length of both our vertical and horizontal racks.

5.3 JGA 25-370 DC motor with encoders

For applications demanding higher power and continuous motion, the JGA 25-370 brushed DC motor was chosen. Its robust design and ability to deliver substantial torque make it suitable for driving wheels or powering heavy-duty components.

Figure 14: JGA 25-370 DC Motor

6 Sensors and their mounting positions

6.1 TCS34725 - Colour Sensor Array

For the line following task, we will construct and place a color sensor array on the front curved line of the robot. This array will consist of 5 TCS34725 color sensors strategically positioned at 3cm intervals.

6.2 VLS30L0X - ToF

We will incorporate three Time-of-Flight sensors. One ToF sensor will be strategically placed on the gripper. Additionally, two ToF sensors will be mounted on the base of the robot, providing valuable information for detecting nearby walls when moving in uneven terrain.

7 Conclusion

In conclusion, this report has outlined the preliminary design our robot, highlighting key components such as mechanisms, sensors, actuators, and the chassy. The robot's rack and pinion-driven gripper, vertical lifting mechanism, and coin drop system are designed for efficient object handling in tight spaces. Actuators like the MG90 and SG90 servos, along with the JGA 25-370 DC motor, ensure smooth operation and movement. Additionally, the placement of color and Time-of-Flight sensors enhances environmental interaction. This design forms a solid foundation for further development, with flexibility for custom PCB integration and future testing.