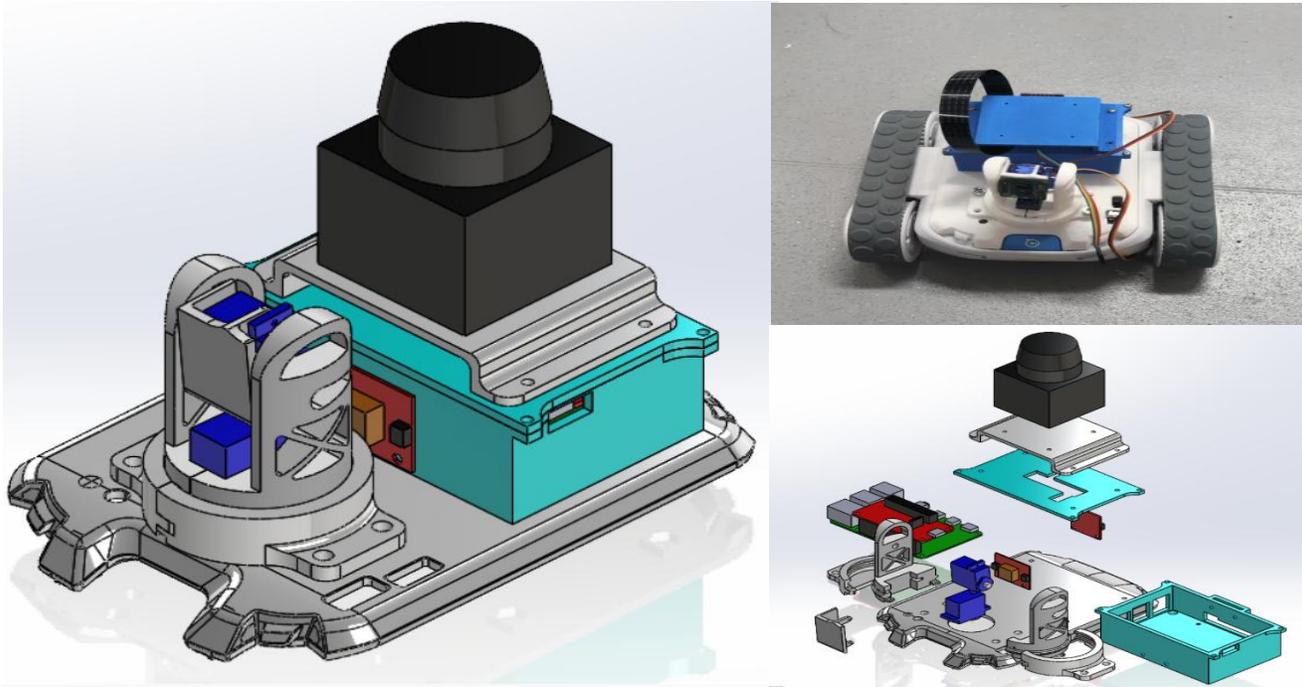


# Index

1.	Introduction .....	2
2.	Problem Statement .....	2
3.	Solution Overview .....	2
4.	Initial Design Overview .....	3
	• First Design Attempt .....	3
	• Issues with First Design .....	4
5.	Camera Protection Challenges .....	4
6.	Assembly Process .....	5
7.	Space Constraints in the First Design .....	5
8.	New Design Approach .....	6
9.	Designing the Front Camera Mechanism ...	7
10.	Assembly Process for New Design .....	8
11.	Rotation Issue and Solution .....	8
12.	Detailing and Mechanism Design .....	9
13.	Exploded View of Components .....	9
14.	Arduino Circuit with Servo Motor .....	10
15.	3D-Printed Waste Parts .....	11
16.	Conclusion and Future Modifications ..	11
17.	Acknowledgments .....	11

# Advanced Mechanism for Sphero RVR Robot



This car is designed to help students learn coding through hands-on experience with technologies like ROS, ROS2, Gazebo, and many other robotics frameworks. It bridges the gap between simulation and real-world applications, providing an interactive platform for coding and robotics education.

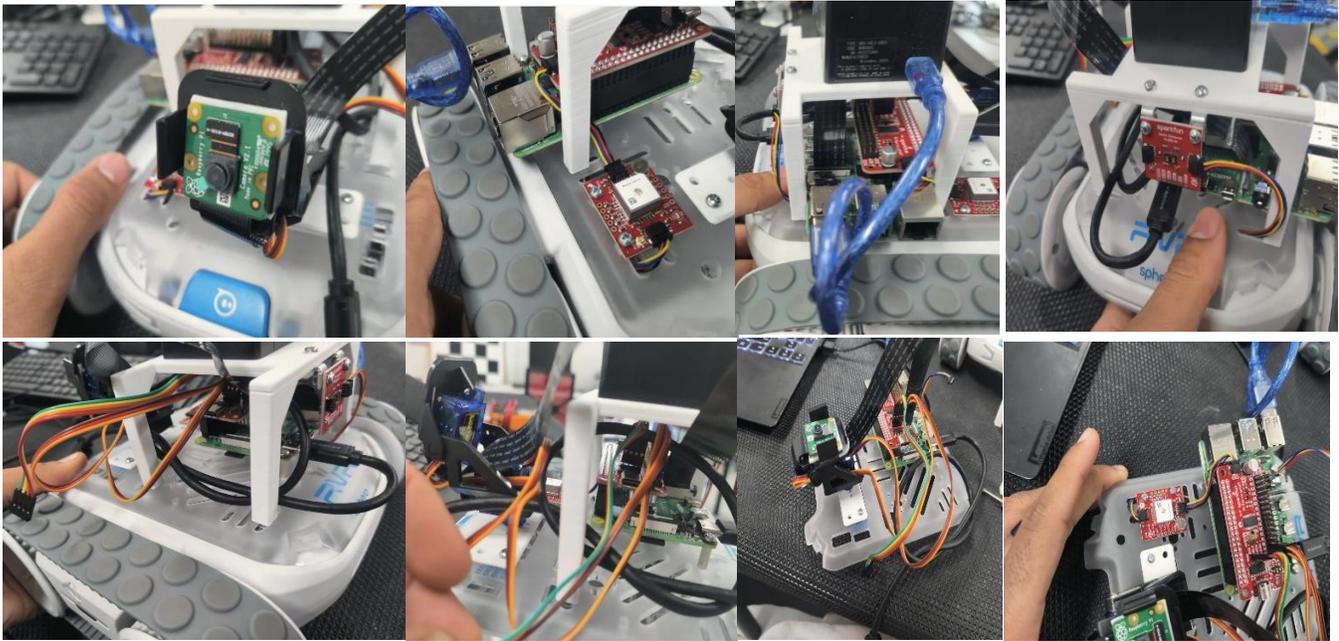
## Problem

The previous design had exposed components, which posed several challenges. The most significant issue was that if the robot malfunctioned, it could collide with objects like sofas or tables, leading to direct damage to the front camera.

## Solution

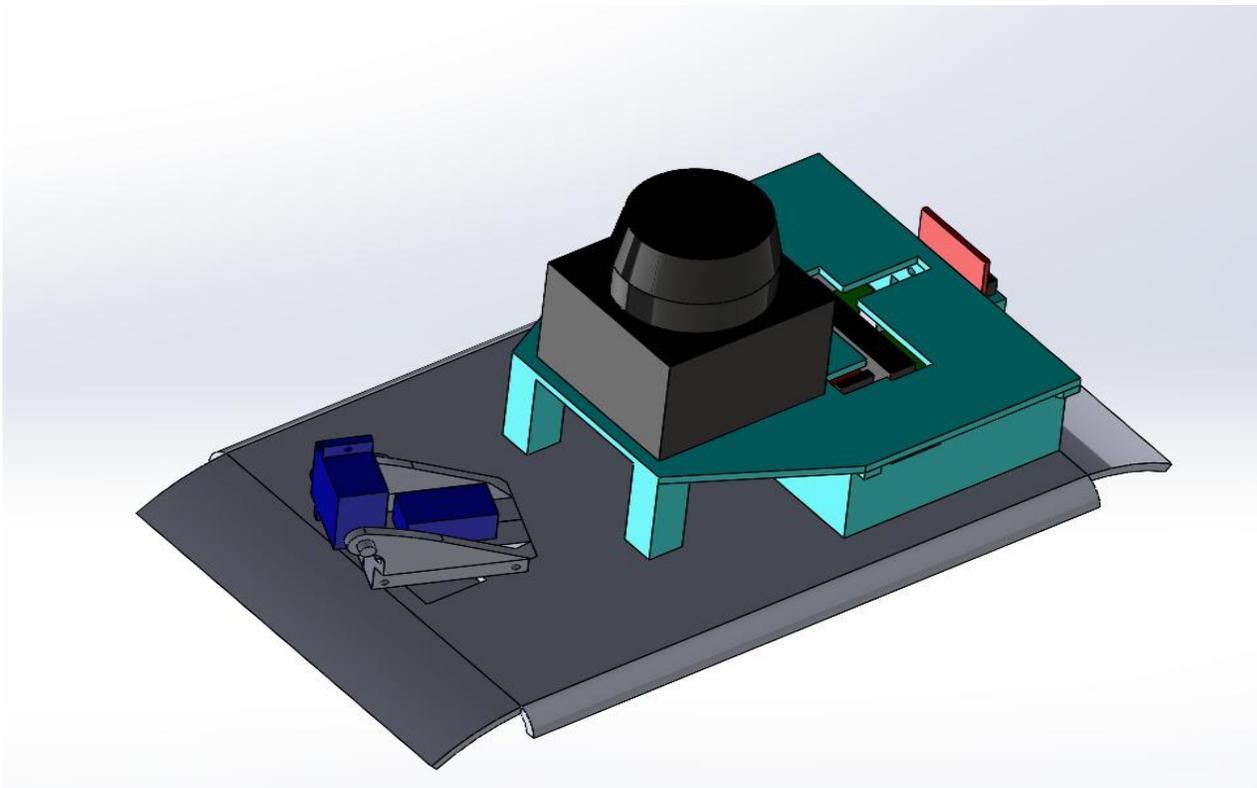
To address these issues, I redesigned the car to eliminate vulnerabilities. Most components are now enclosed within a 3D-printed protective cover, making the structure as compact as possible. This design not only ensures better cable management but also allows the robot to rotate in most directions while keeping the camera and other components protected.

## Initial Design Overview



In the first design, the car featured several open and exposed components. While functional, this design had significant limitations. The exposed parts left critical components vulnerable to damage, especially in cases of accidental collisions or malfunctions. For instance, if the robot hit an object like a sofa or table, the front camera was directly at risk of being damaged. This initial version highlighted the need for a more robust and protective design to enhance durability and functionality.

## First Design Attempt

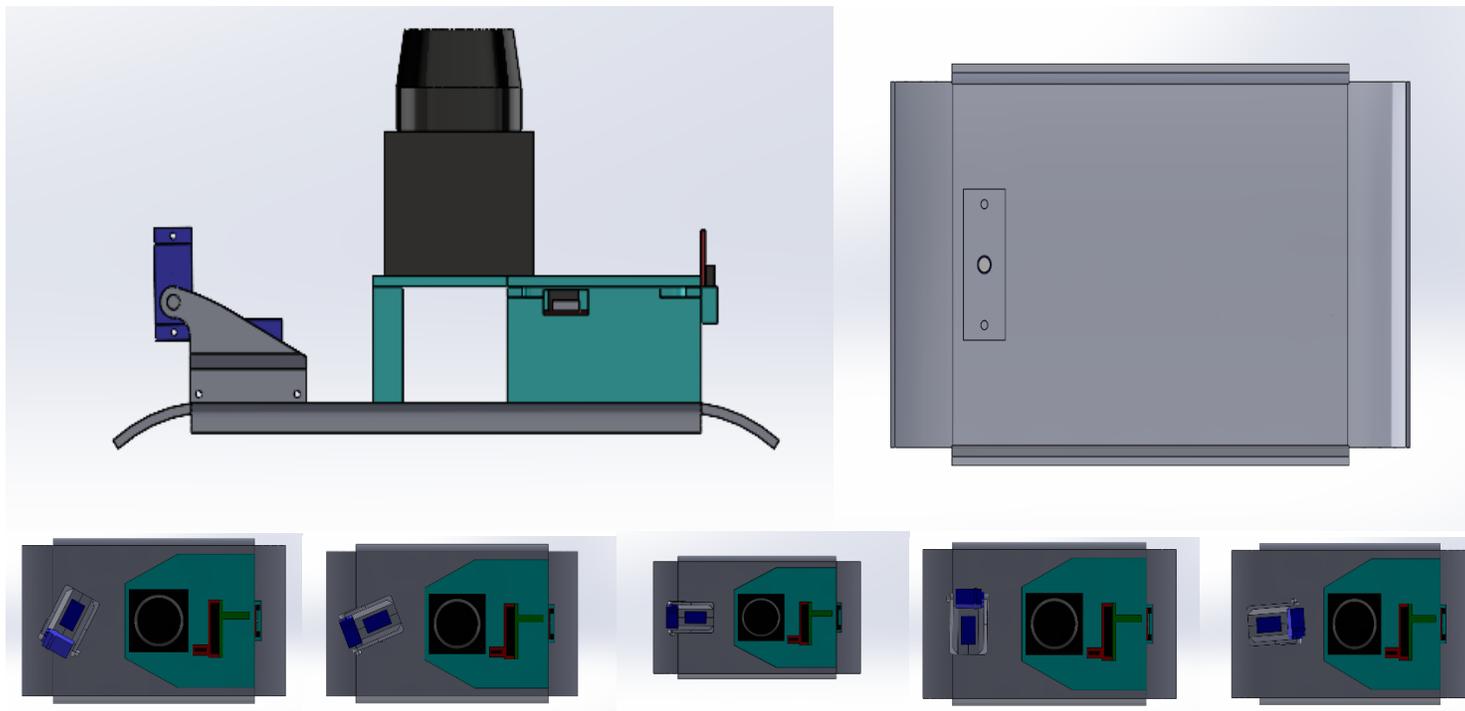


## Issues With the First Design

There were several challenges with this initial design:

1. Camera could not rotate properly.
2. Camera lacked adequate protection.
3. There was insufficient space to modify or implement a new design for the front camera.

### Camera Could Not Rotate Properly

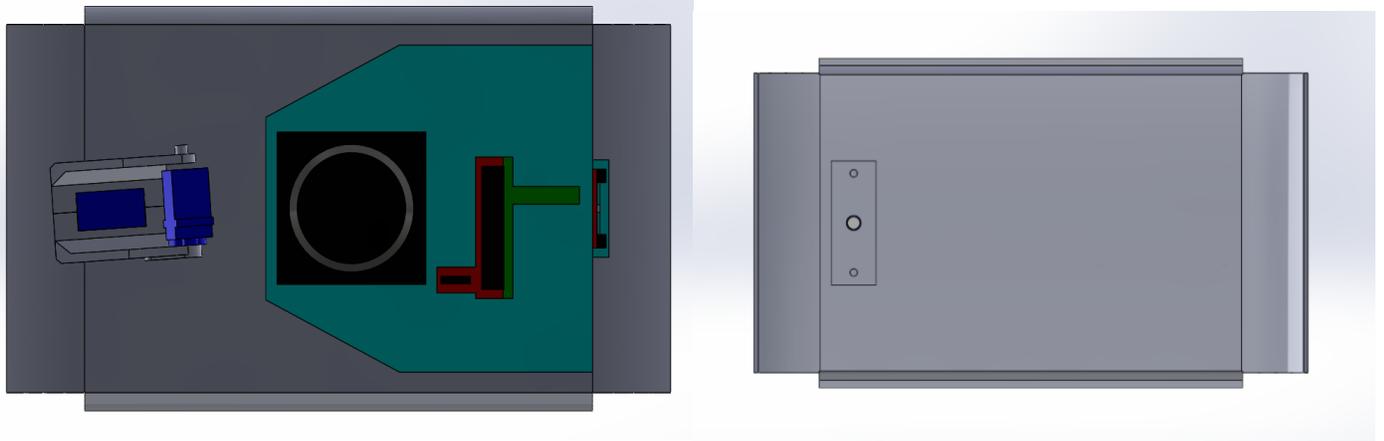


As seen in the image, the cover in the revised design is in direct contact with the base plate, unlike the old design where there was a gap between the cover and the base plate. I initially believed this gap made the structure unstable. To address this, I modified the design to eliminate the gap, ensuring the cover touched the base plate.

However, the actual issue was not the gap but the fact that the entire structure relied on a single point of connection — the servo motor shaft. This single-point connection caused instability, preventing the camera from rotating smoothly as intended, as shown in the second image.

The last five images demonstrate the rotation setup in CAD software. Unfortunately, I forgot to save the old version, so I recreated this old design note based on what I had available

## Assembly Process

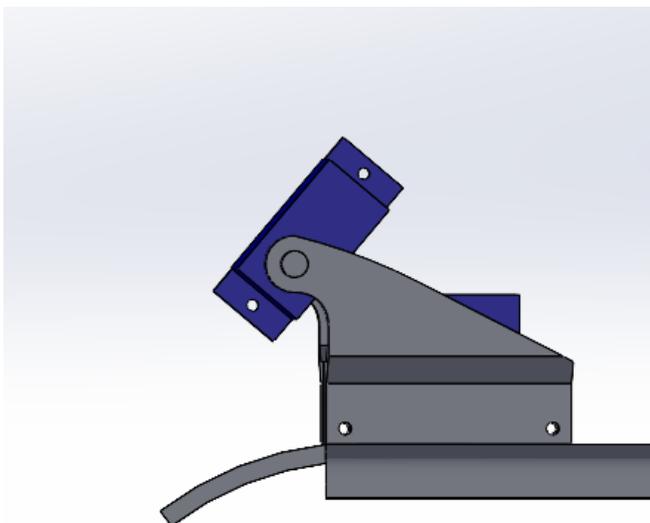


The assembly process is straightforward and follows these steps:

1. Coupling the Main Parts:
2. Align the left and right sections of the assembly.
3. Secure them together using Allen bolts and nuts, with the servo motor positioned between the two parts.
4. Attaching the Base Plate:
5. Attach the base plate to the bottom of the structure by aligning the mounting holes, as shown in the second image.
6. Securing the Servo Shaft:
7. Connect the servo motor shaft to the designated hole on the base using screws to ensure a firm connection.
8. Camera Mount:
9. Use the existing mounting components from the previous design to attach the camera to the servo motor.

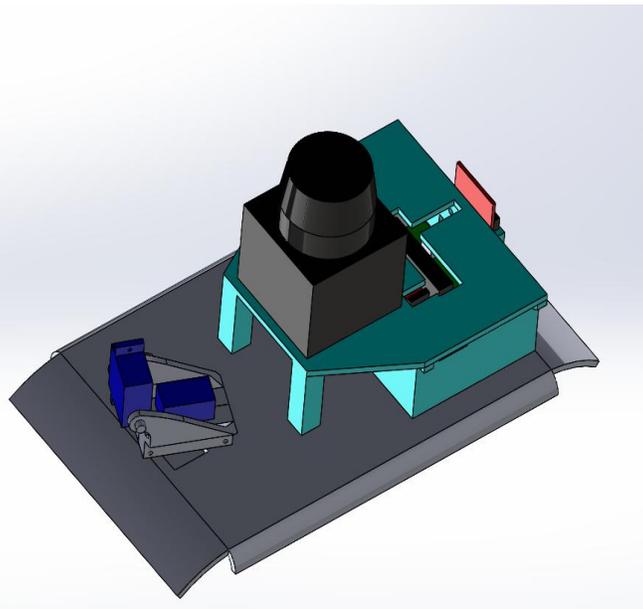
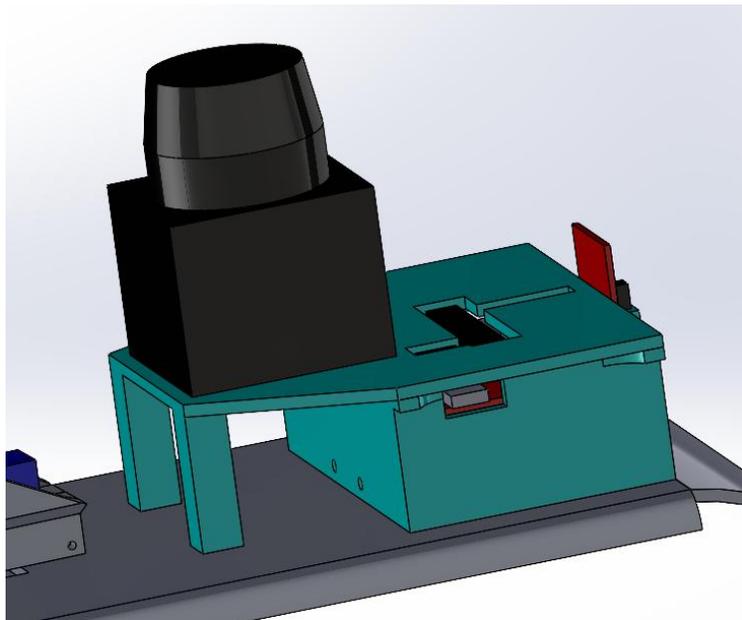
Once completed, the base and camera assembly will be ready for operation.

## Camera Lacked Adequate Protection



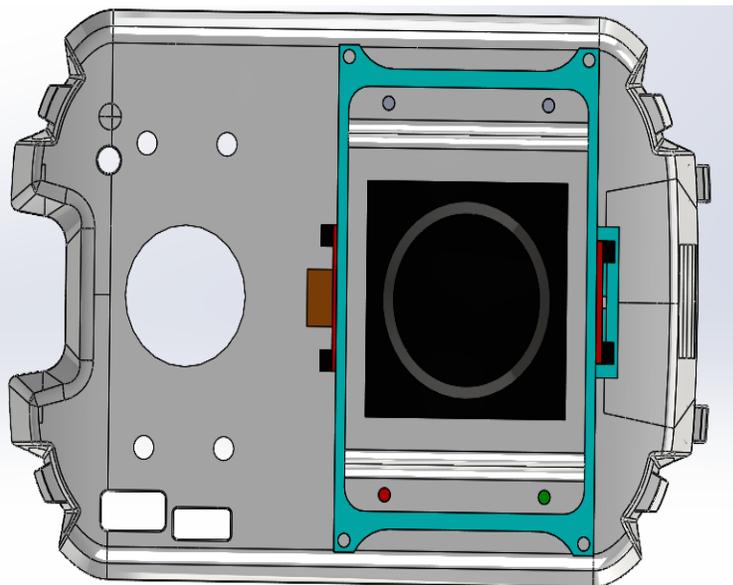
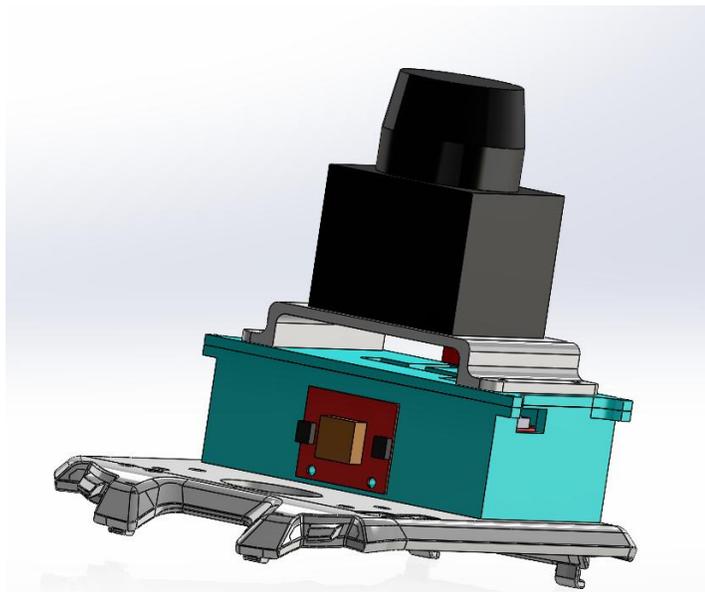
As shown in the image, the front camera is directly exposed to impact from external objects. Since the camera assembly is connected to the base through a single-point connection via the servo motor shaft, any forceful strike to the camera can cause significant damage to both the camera and the base structure. This design lacks adequate structural reinforcement to absorb or distribute the impact, making it highly susceptible to damage.

## There Was Insufficient Space to Modify or Implement a New Design for the Front Camera.



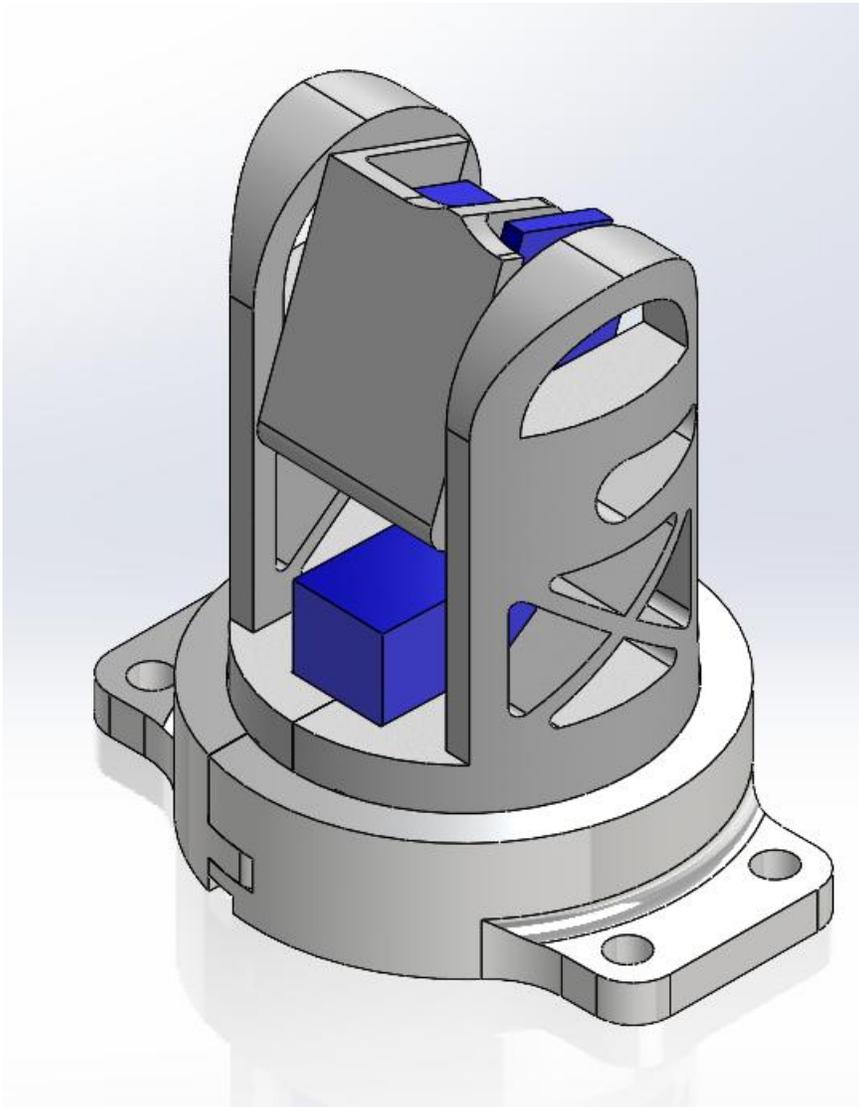
As seen in the image, a significant portion of the available space is covered by the blue component I designed. This was done to ensure easier wire management and to prevent the Lidar sensor from being obstructed by any other parts of the robot. However, this design also creates limited space for modifications. If changes or upgrades are needed for the camera, there is insufficient room to adjust or implement a new design.

## Starting Fresh with a New Design



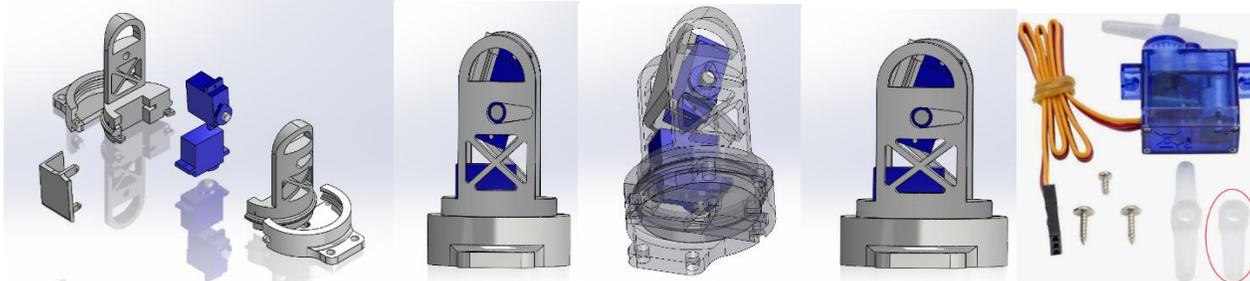
I decided to start from scratch to address the space limitations. The first step was to create enough room for future modifications, particularly for the front camera. To achieve this, I added a mounting plate on top of the blue component, providing sufficient space for wiring and easy access for future attachments. Additionally, I mounted the Lidar sensor on top of the new plate to ensure it remains unobstructed and properly positioned. This design allows for easier modifications and better overall accessibility.

## Designing the Front Camera Mechanism



With the newly created space, I began brainstorming a more efficient solution for the front camera. I was inspired by bearing mechanisms and decided to design a coupling-type system that incorporates bearing features. This mechanism allows for smoother rotation and improved stability. The servo motor is securely attached using a few nut bolts, ensuring a robust connection while enabling precise movement of the front camera. This design offers better control and durability for the camera's functionality.

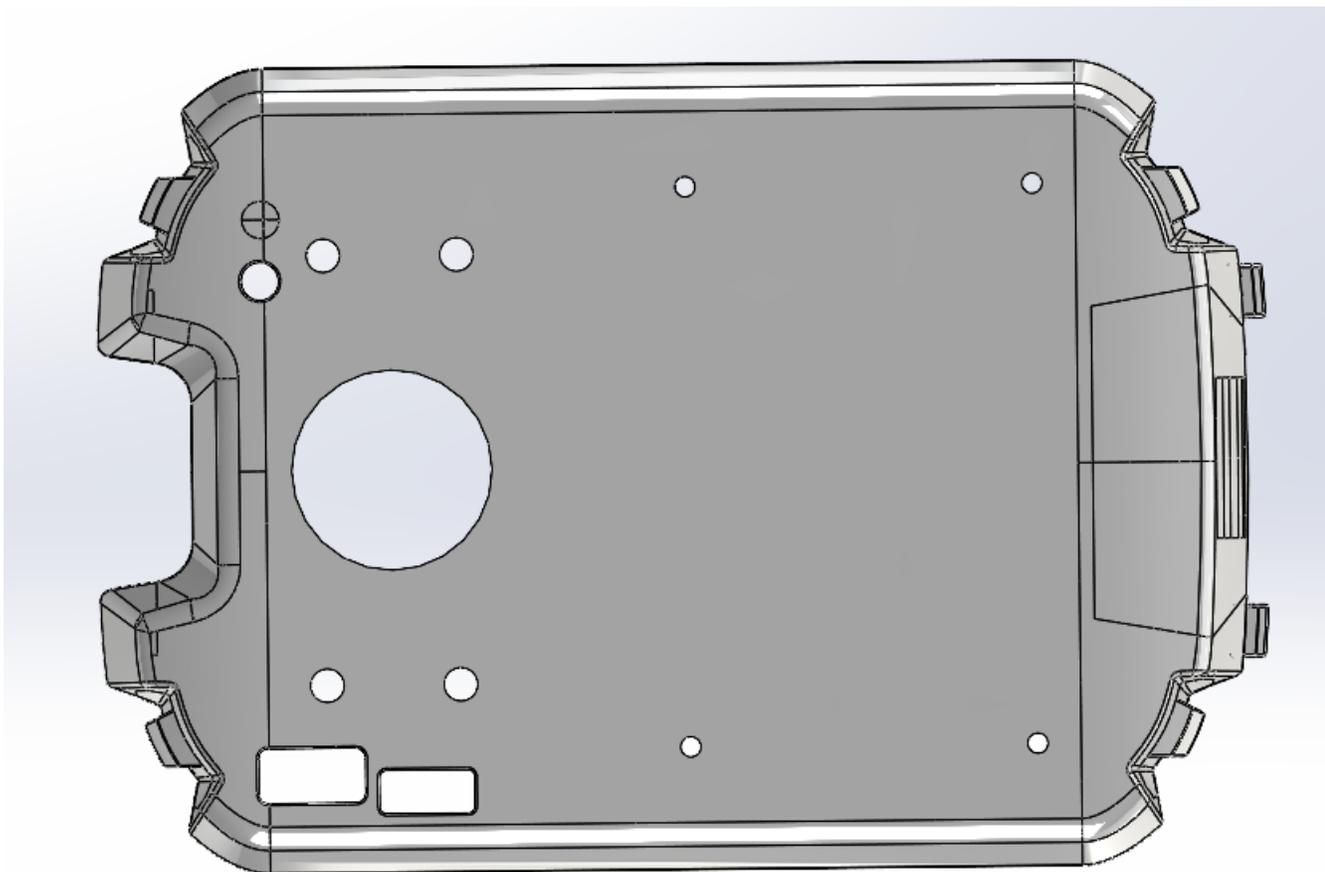
## Assembly Process



The entire assembly is divided into four main parts, which can be easily connected. The bottom two parts feature a cavity design that allows the inner two components to move smoothly along a pathway, facilitating rotation with the assistance of the motor.

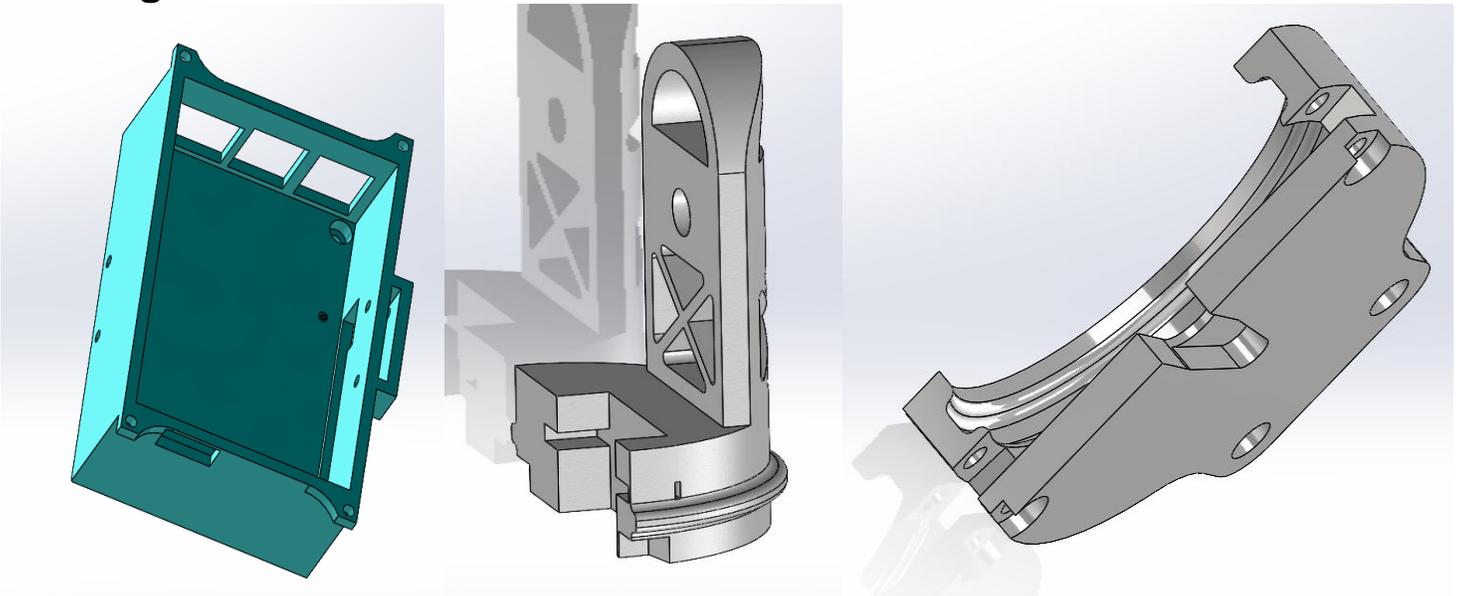
In images 3 and 4, you can observe the motor mount slots, as shown in image 2. These slots are designed to securely fix the motors onto the components, ensuring stable attachment and proper alignment during operation.

## Rotation Issue and Solution



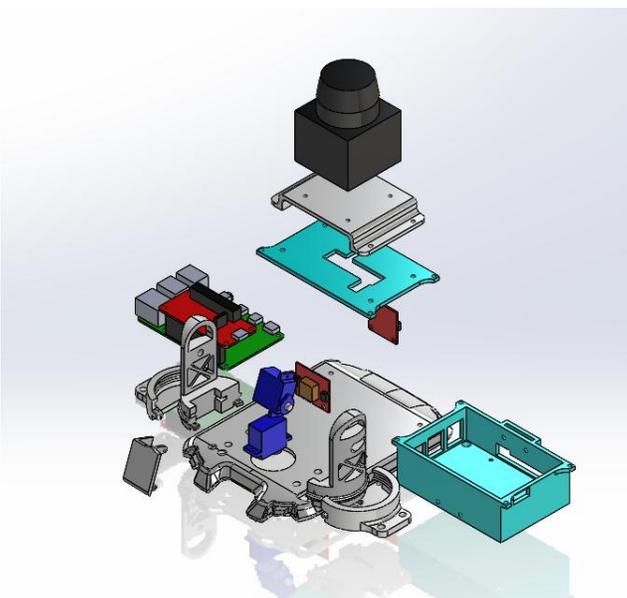
The system is functioning properly, but occasionally, it gets stuck due to the bolt interfering with the base plate. To resolve this, I created a cutout at the center of the motor shaft, providing extra clearance. This modification allows the shaft to move freely without contacting the bolt, ensuring smooth rotation and preventing any obstruction or binding with the base plate.

## Detailing and Mechanism Design: Concealed Bolt Holes and Curved Locking Mechanism



This section covers the work done on the bolt hole depth to ensure the bolts are hidden from the outer surface, as well as the design of the mechanism for securing and locking each component.

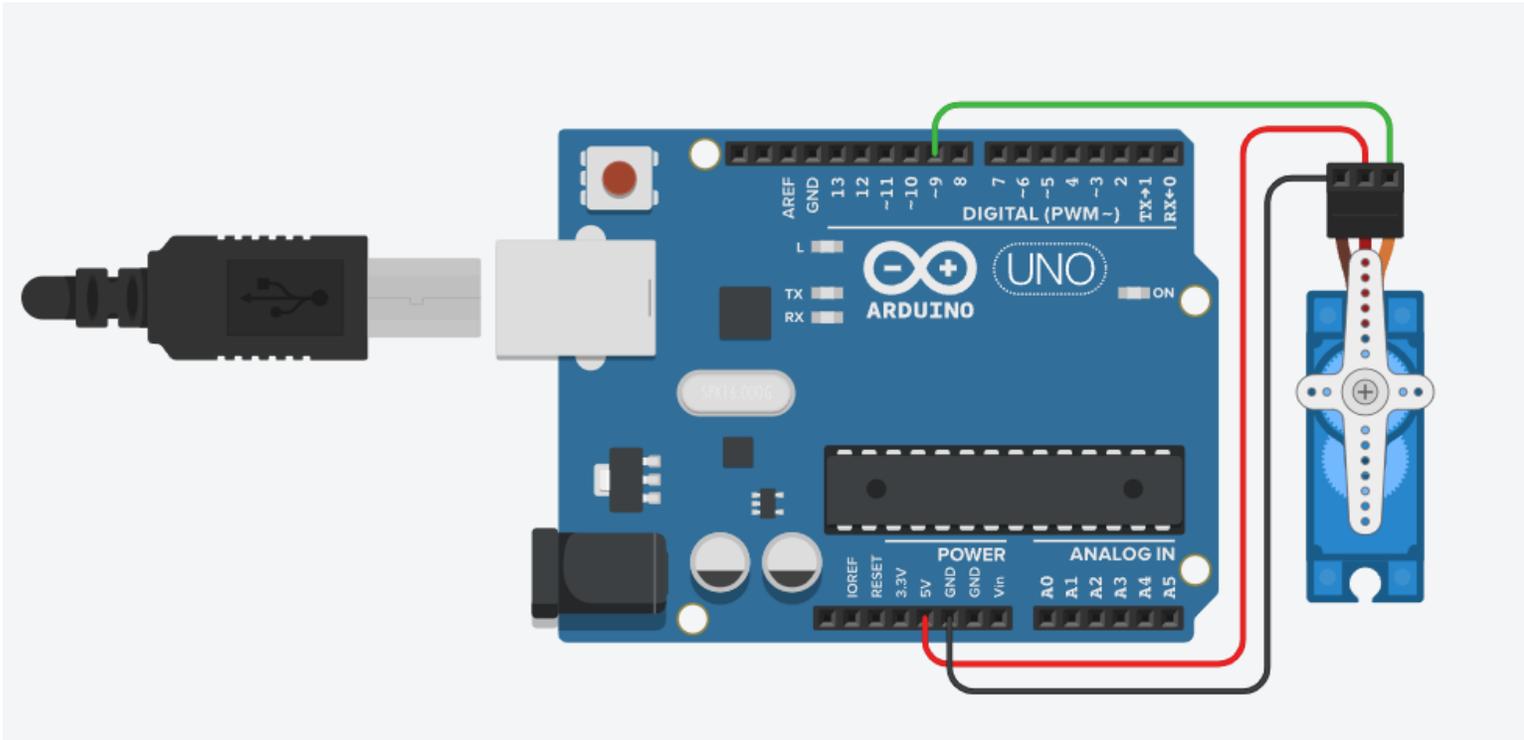
## Exploded View



Below is a list of key components:

1. LiDAR Sensor
2. Rear-Facing Camera
3. 3D-Printed Structural Parts
4. Servo Motor
5. Main Control Circuit

# Arduino Circuit with Servo Motor in Tinker cad | Step-by-Step Tutorial and Code



This video demonstrates how to build an Arduino circuit with a servo motor in Tinkercad, including the complete Arduino code for the project.

## Code: -

```
#include <Servo.h>
int pos = 0;
Servo servo_9;
void setup()
{
servo_9.attach(9, 500, 2500);
}
void loop()
{
for (pos = 0; pos <= 180; pos += 1) {
servo_9.write(pos);
delay(15);
}
for (pos = 180; pos >= 0; pos -= 1) {
servo_9.write(pos);
delay(15);
}
}
```

## 3D-Printed Waste Parts from All Experiments



### Conclusion and Future Modifications

This project successfully addresses the limitations of the initial Sphero RVR robot design by introducing a 360-degree rotating servo camera mechanism and a compact 3D-printed enclosure to protect all components. The new design ensures smooth camera rotation, robust impact protection, and efficient space utilization, making the robot more durable and functional for real-world applications.

Future Modifications:

- **Enhanced Stability:** Improve the bearing mechanism for even smoother rotation and reduced friction.
- **Modular Design:** Create interchangeable parts for easier upgrades and customization.
- **Advanced Materials:** Experiment with stronger or lightweight materials for improved durability and performance.
- **Integration with AI:** Incorporate AI-based object detection and tracking for autonomous navigation.
- **Wireless Control:** Implement wireless communication for remote operation and monitoring.

This project lays a strong foundation for further innovation, offering a versatile platform for robotics enthusiasts and educators to explore advanced functionalities.

### Thanks

Due to time constraints, this design meets the project requirements, but there's still potential for further modifications. I'm grateful to assist with more details and collaborate with anyone interested in improving or having doubts about the project.