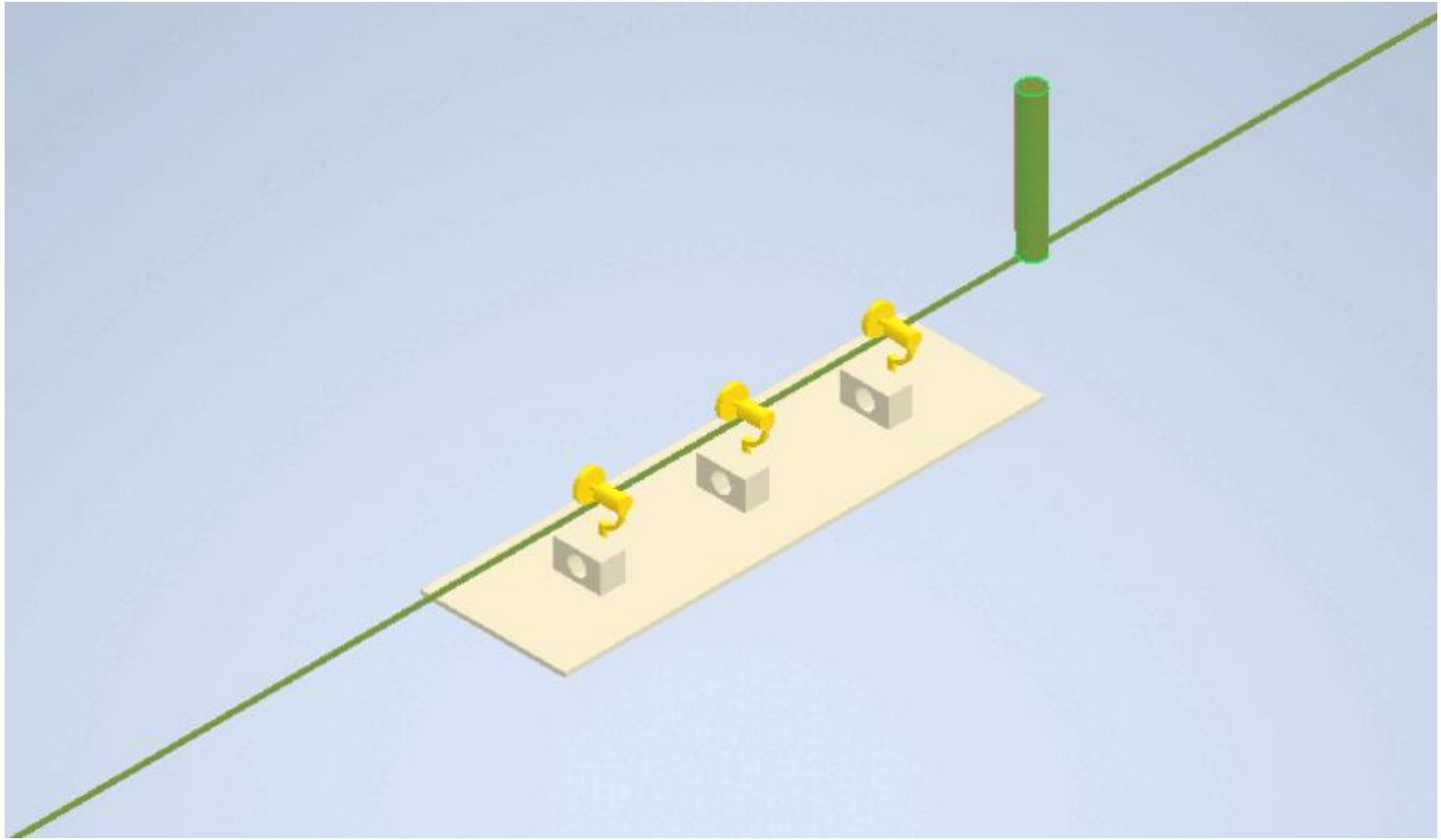
High-Voltage Electrical Transmission Line Inspection Robot

Problem Statement

Design a robotic device that can autonomously inspect high-voltage transmission wires, reducing human intervention and risk. The robot must:

- **Traverse wires** while smoothly overcoming obstacles like insulators and junctions.
- **Engage and disengage wheels** mechanism without causing vibrations on the wire.
- **Maintain stability** with a weight balancing mechanism
- **Use sensors** to inspect the wire condition.

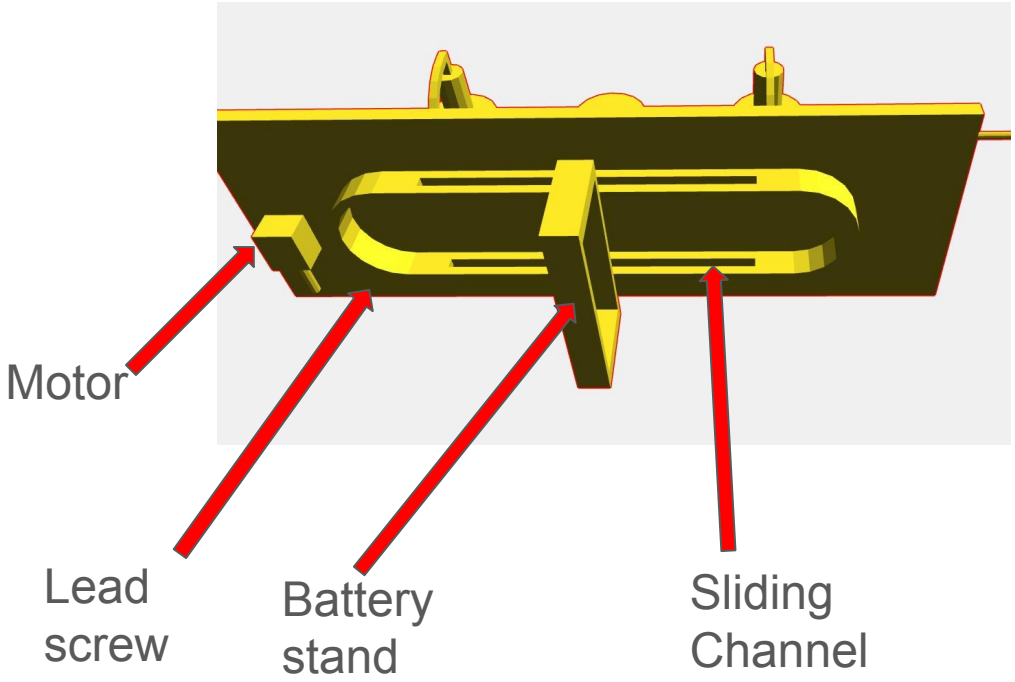
Sequential Engagement Mechanism



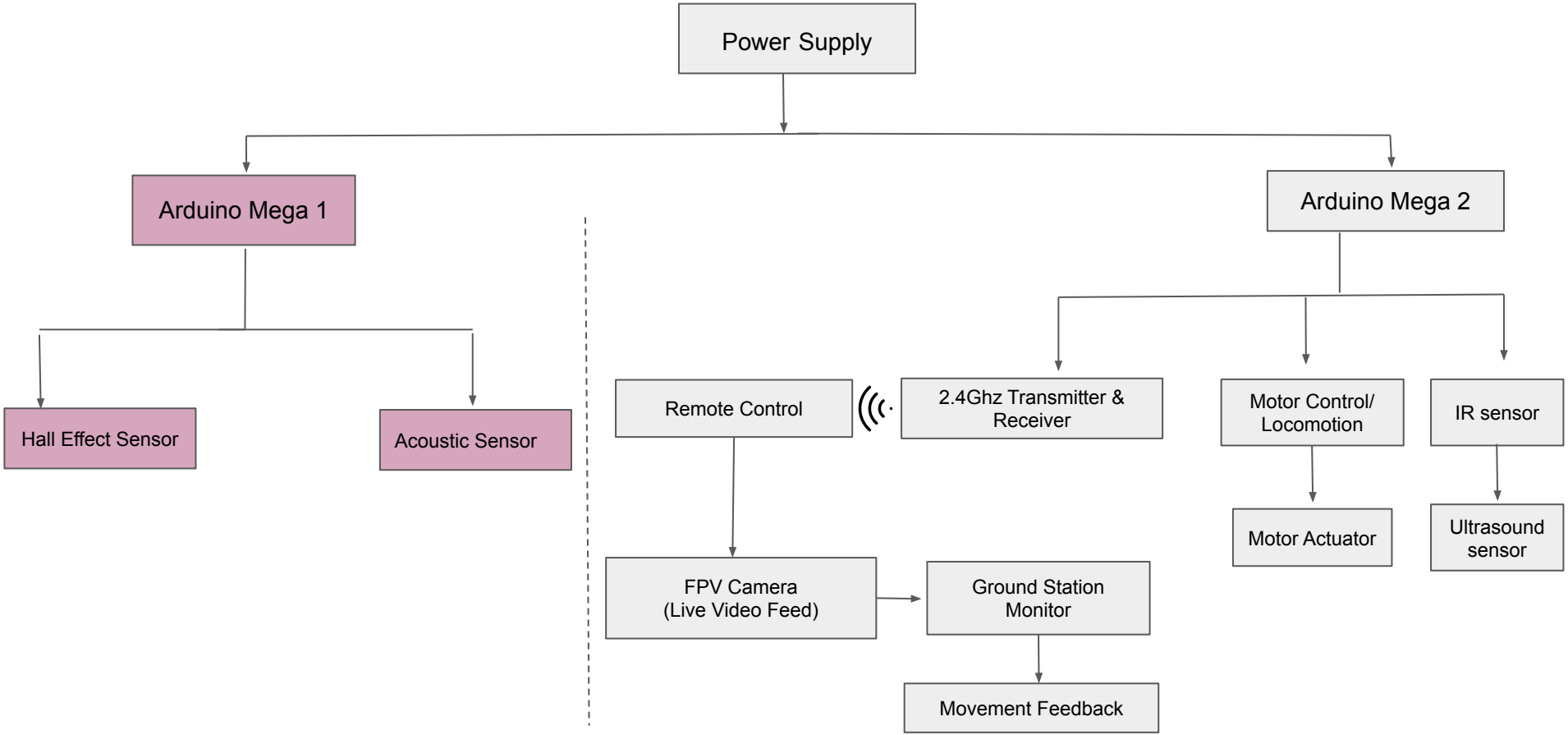
* 3-Arms on chassis

Weight Balance Mechanism

To avoid tipping, the battery (CoM) is shifted towards the remaining two arms during the crossing process.

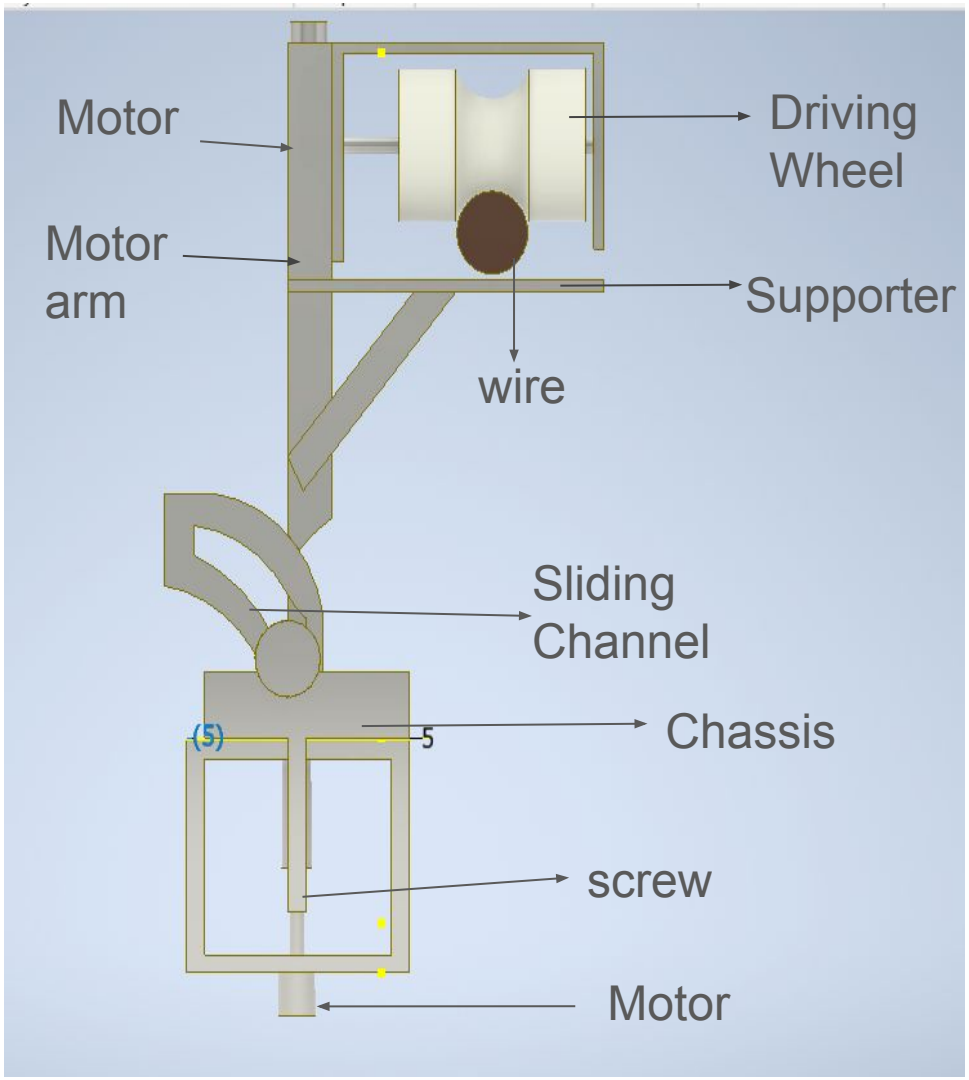


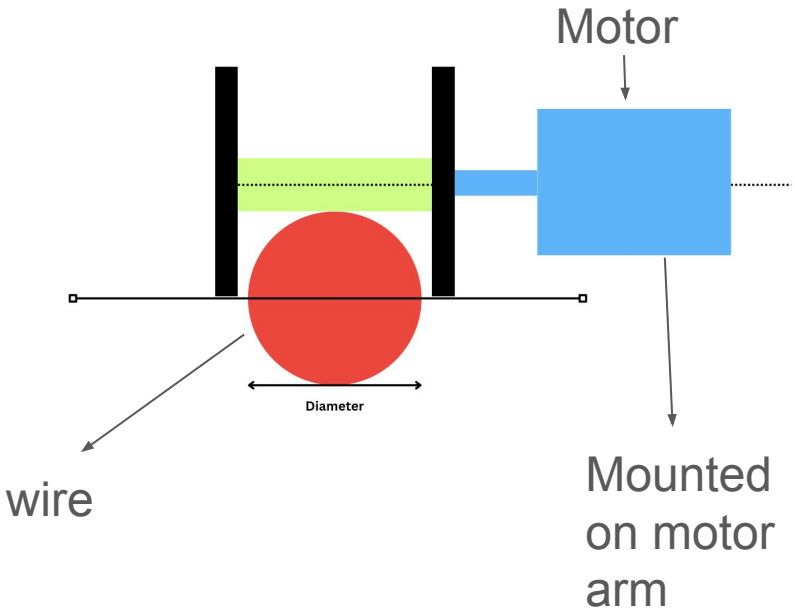
Mechatronic Architecture

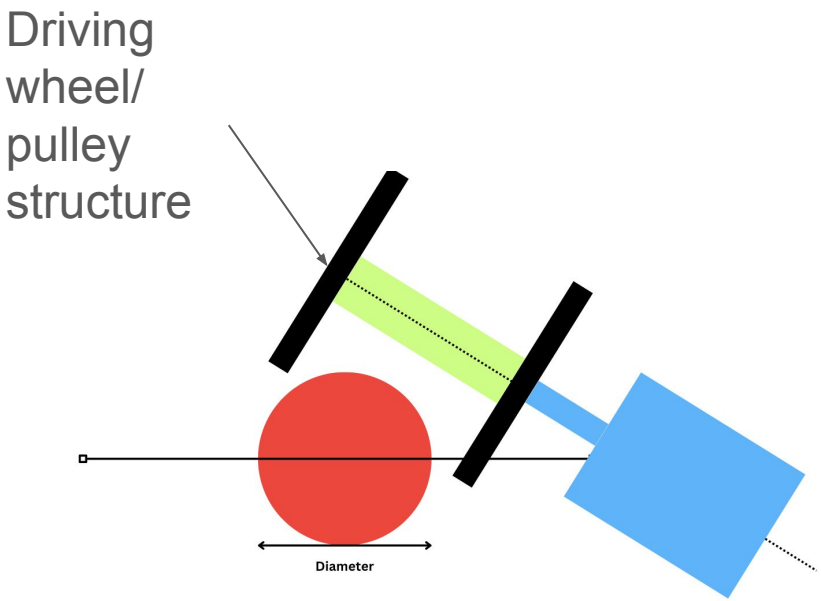


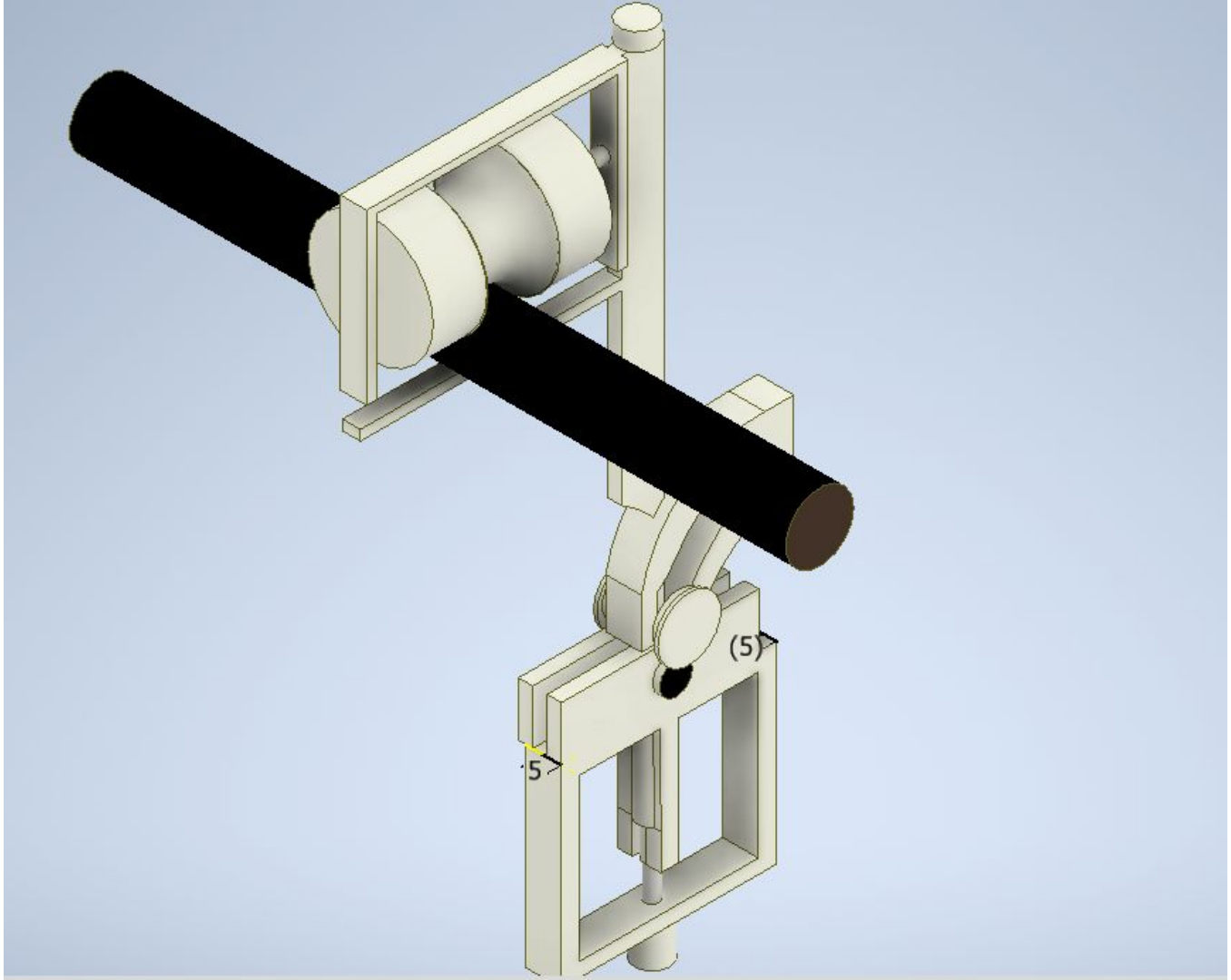
Detailed CAD Design for 1 arm

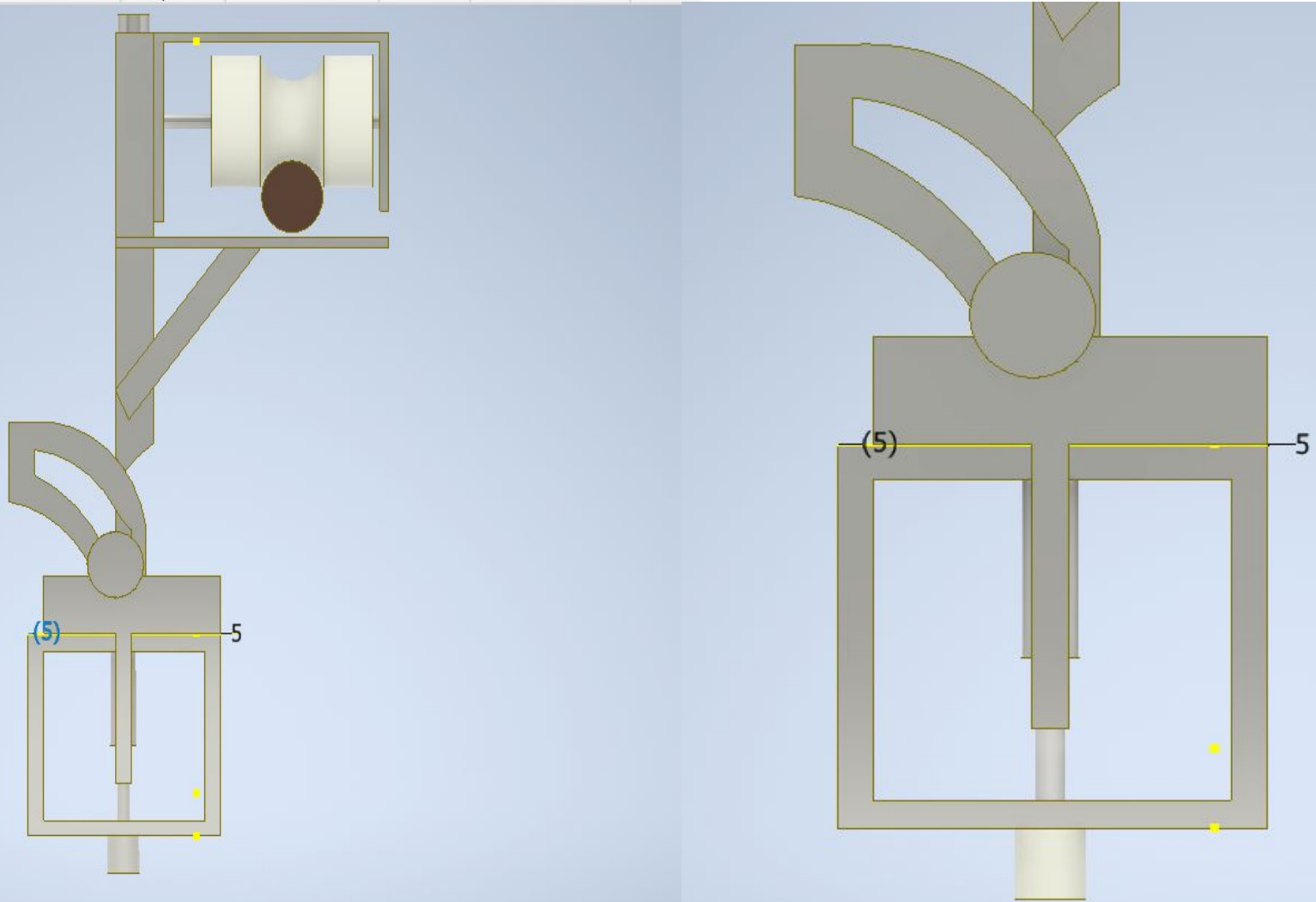
- Sliding channel to tilt the motor arm to 45 degree and first lift it above 2 cm above the cable
- Supporter wheel will be placed to grip on the wire which would be controlled using servo




Motor
Diameter
wire
Mounted on motor arm


Driving wheel/ pulley structure
Diameter


(5)
5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Torque Calculation

Given the following relationships:

1. **Force equation** along the incline:

$$ma = f - mg\sin\theta$$

This describes the net force acting along the incline.

2. **Torque equation**:

$$T = fR$$

This relates the torque to the friction force f and the radius R of the wheel.

Step-by-Step Solution:

1. From the **force equation** $ma = f - mg\sin\theta$, solve for f:

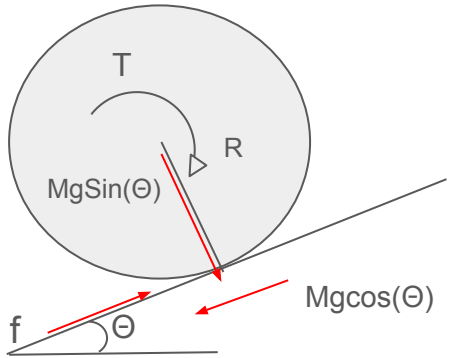
$$f = ma + mg\sin\theta$$

2. Now, substitute this expression for f into the **torque equation** $T = fR$:

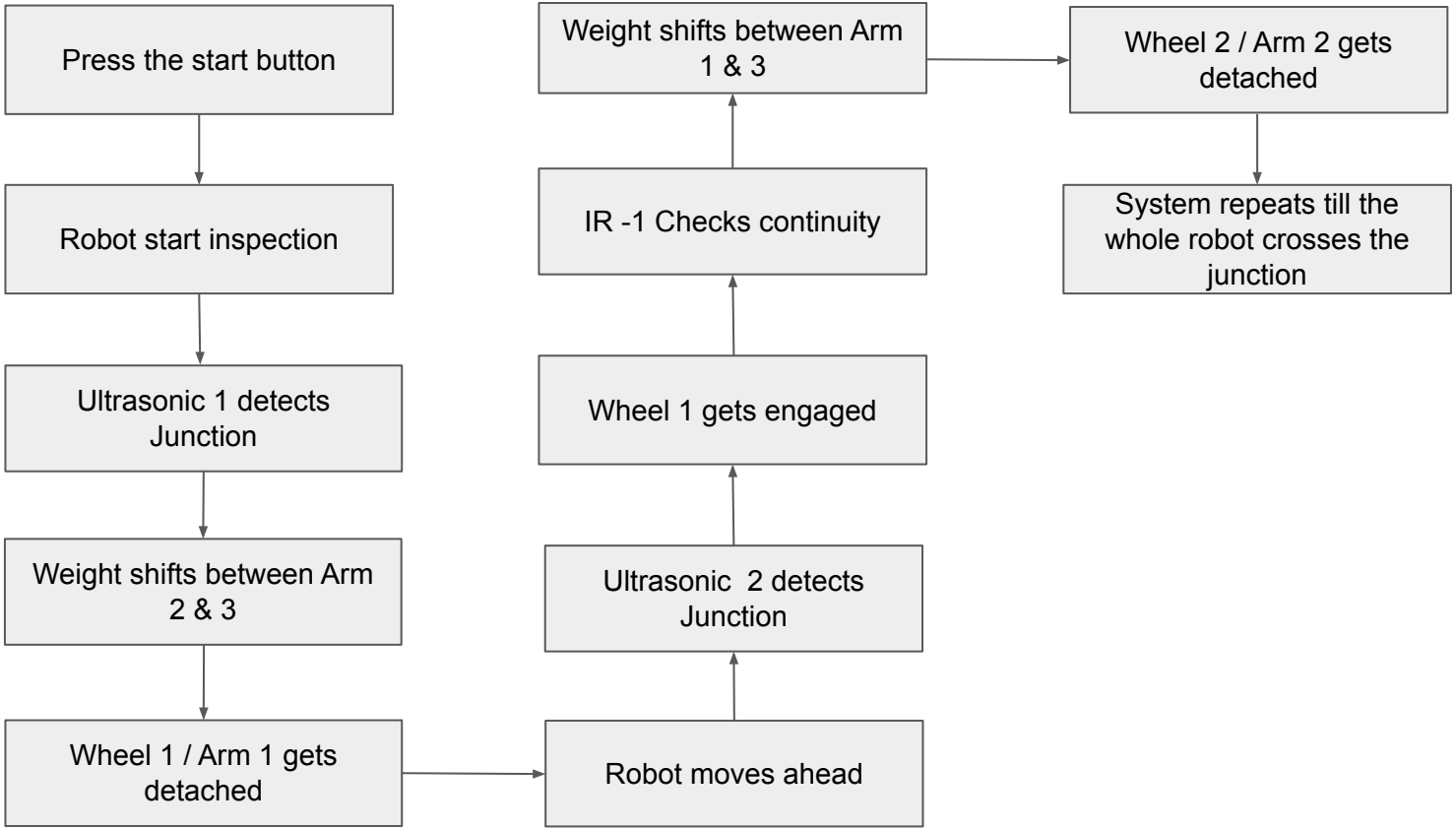
$$T = (ma + mg\sin\theta)R$$

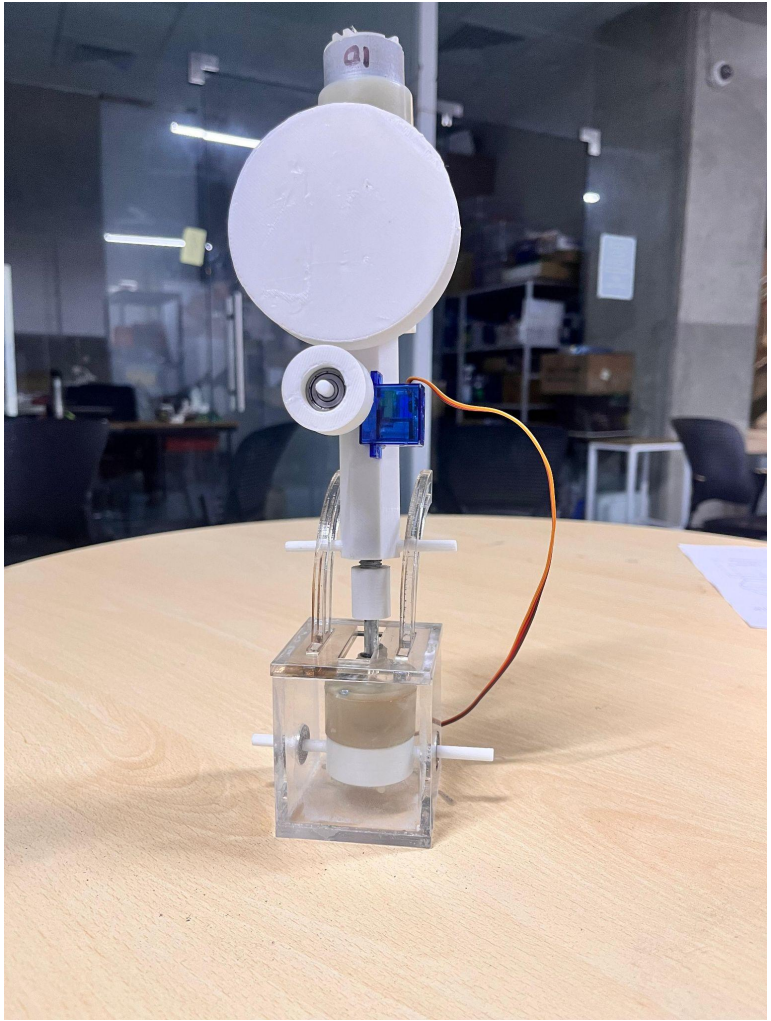
Thus, the **torque T** in terms of mass m, acceleration a, gravitational force mg, incline angle θ, and the wheel's radius R is:

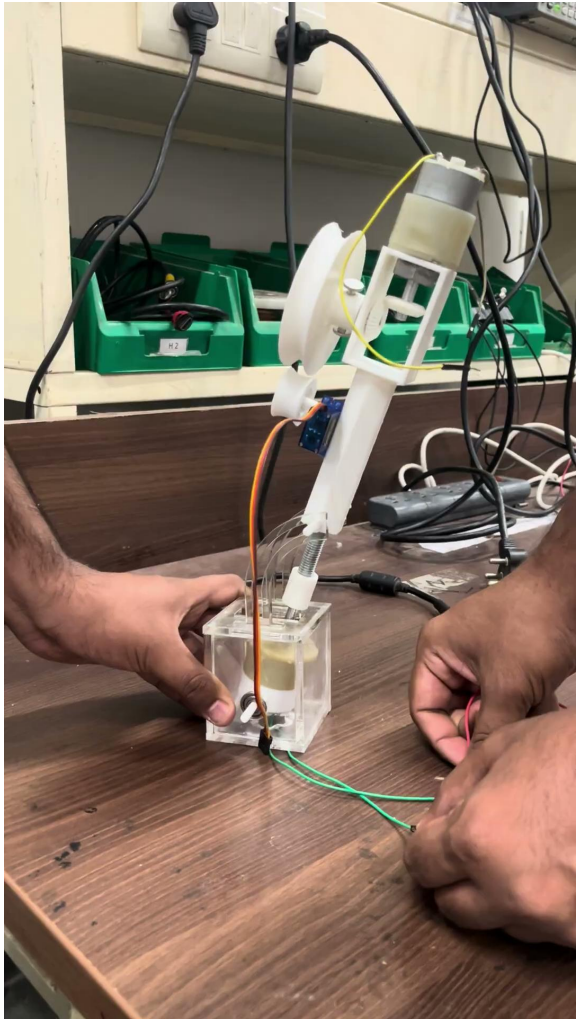
$$T = R\,(ma + mg\sin\theta)$$

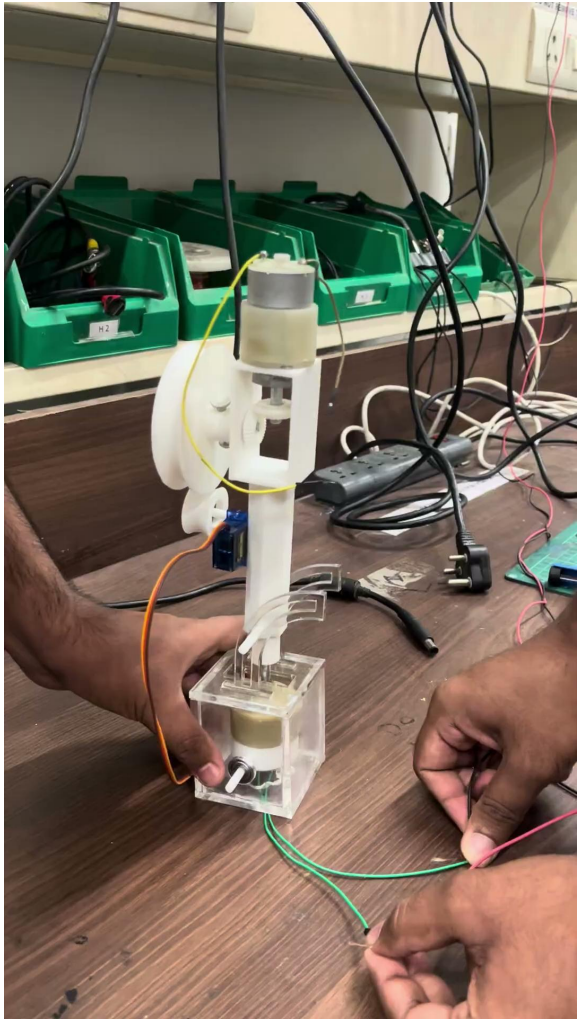


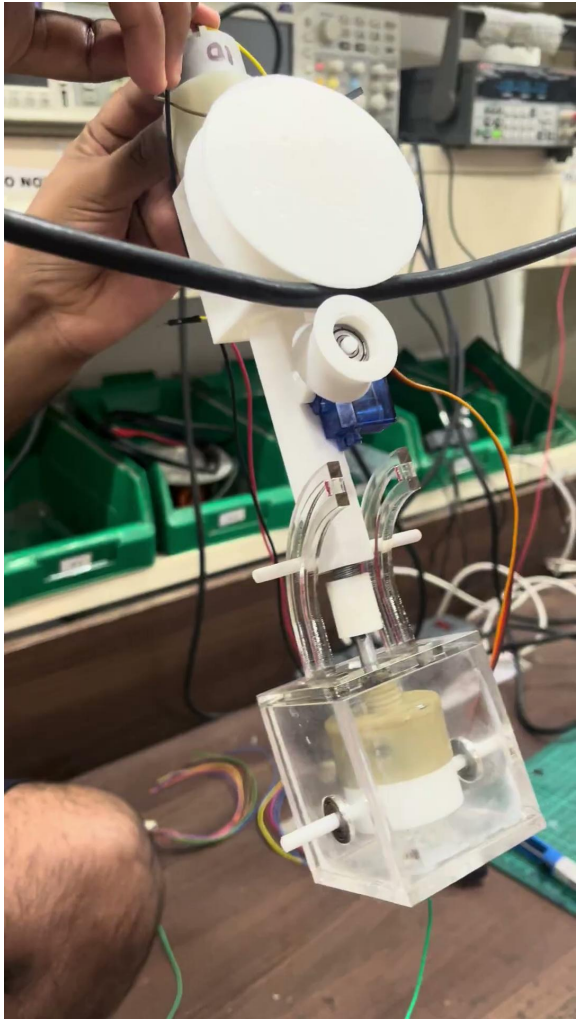
Flow Chart

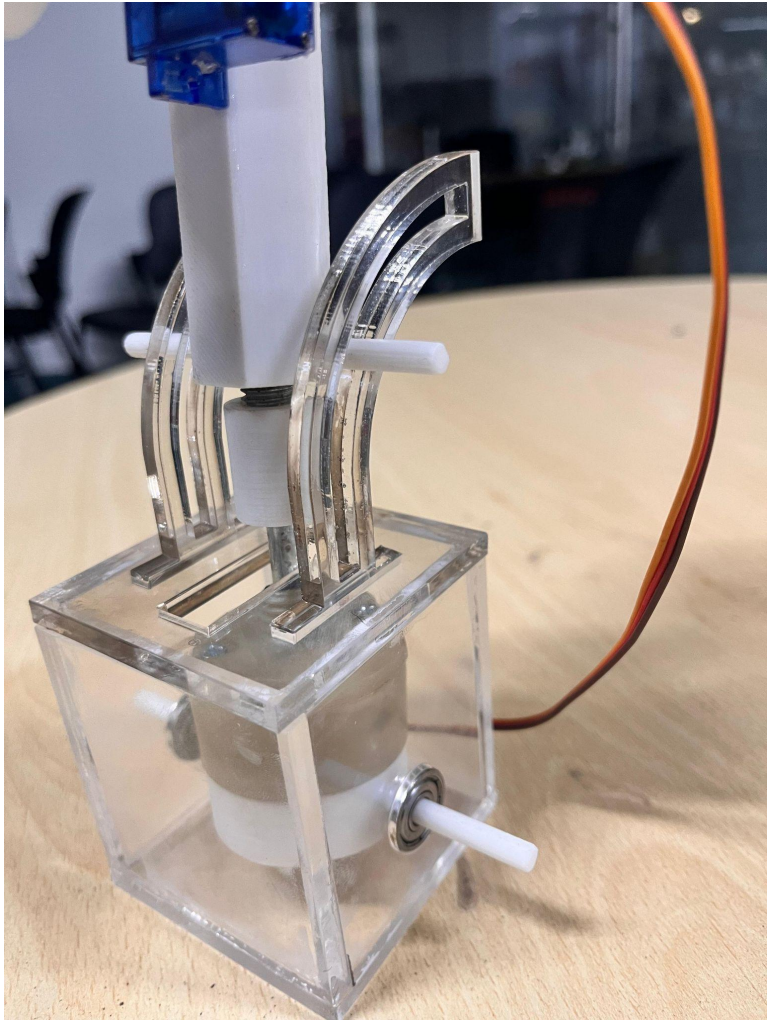

Press the start button
Robot start inspection
Ultrasonic 1 detects Junction
Weight shifts between Arm 2 & 3
Wheel 1 / Arm 1 gets detached
Robot moves ahead
Ultrasonic 2 detects Junction
Wheel 1 gets engaged
IR -1 Checks continuity
Weight shifts between Arm 1 & 3
Wheel 2 / Arm 2 gets detached
System repeats till the whole robot crosses the junction

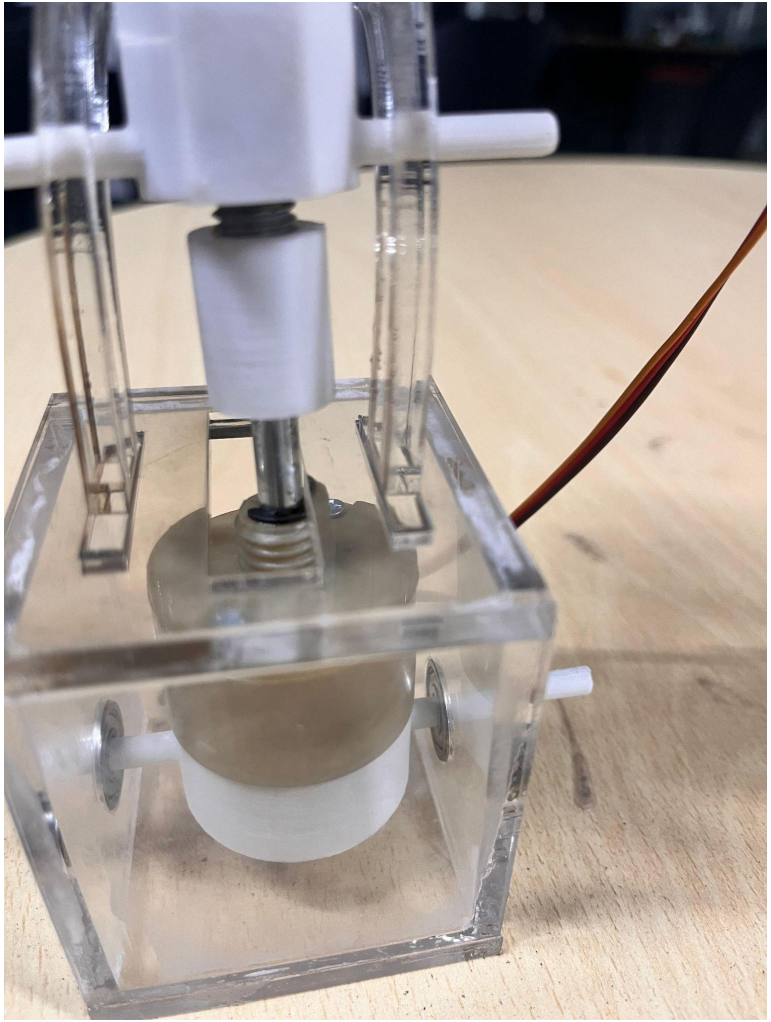


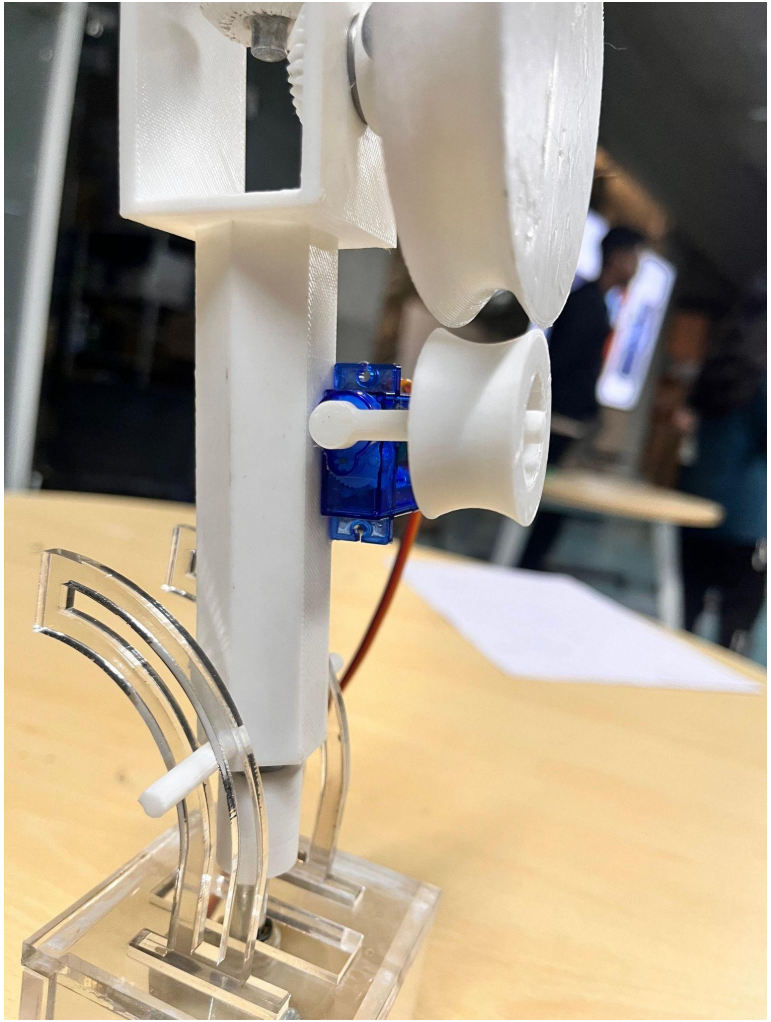


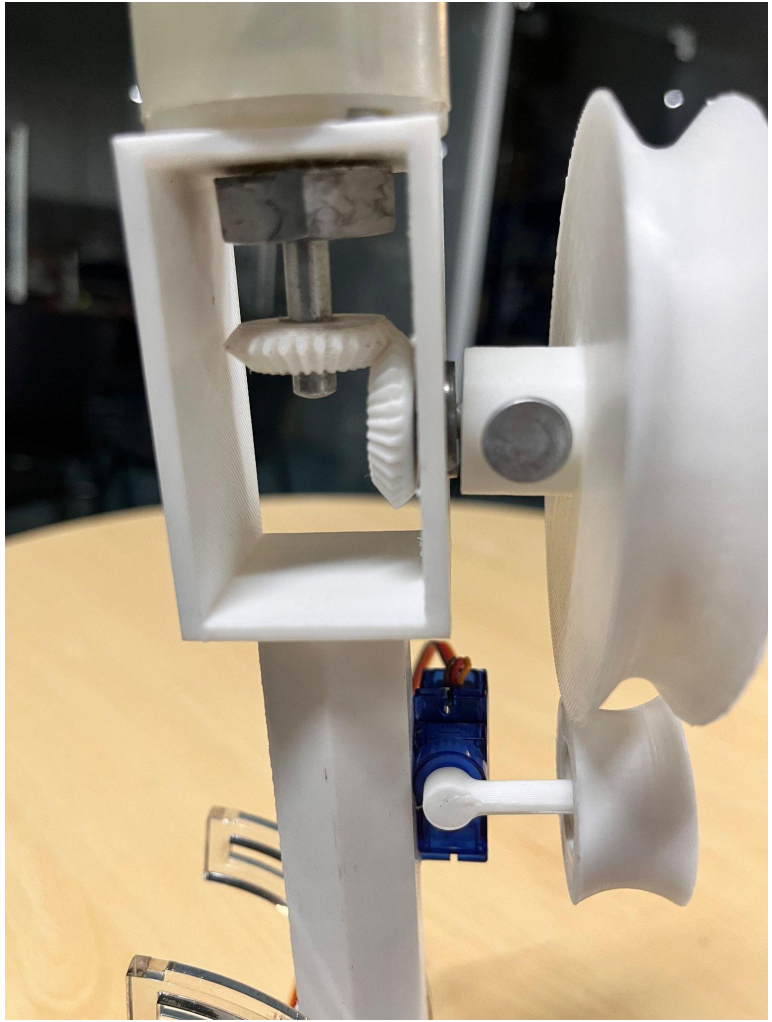












Remaining Work

1. Chassis Designing and fabrication (by this week)
2. Weight balance mechanism structure (by next week)
3. Electrical connections and automation (parallely by third week)
4. Final testing

FeedBack