Origami Wheel Transformer for Scouting Planetary Mini Rovers

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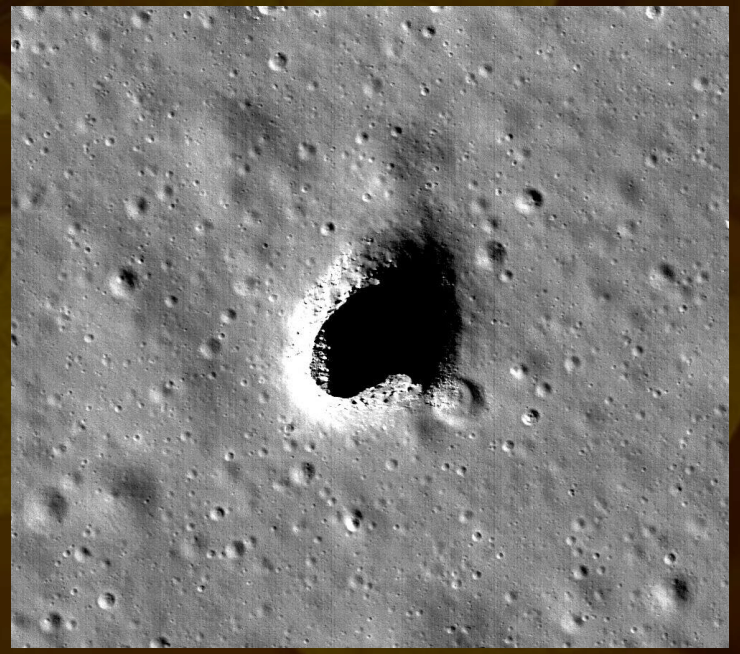
UNDER THE GUIDANCE OF PROF. BRISILLA R.M

Mission Concept

In future missions, when a parent spacecraft encounters terrains of interest that are better accessed with small scouting rovers, it could eject the rover and then guide the rover to the new terrain, controlling them and receiving data from the instruments that they carry.

The small size provide unique mobility benefits that would enable the rover to maneuver in extreme terrains inaccessible to the parent rover.

- Allows the scientific study of areas having large surface-areas.
- Region of Interest: Lunar Terrains



Proposed Concept

Small, Light Weight and Reliable

- Aimed Weight: Under 500 gm
- Aimed Rover Dimensions: 30 cm x 20 cm x 15 cm

* Dimensions could be visualised in terms of a standard shoebox size

Highly Cost Effective

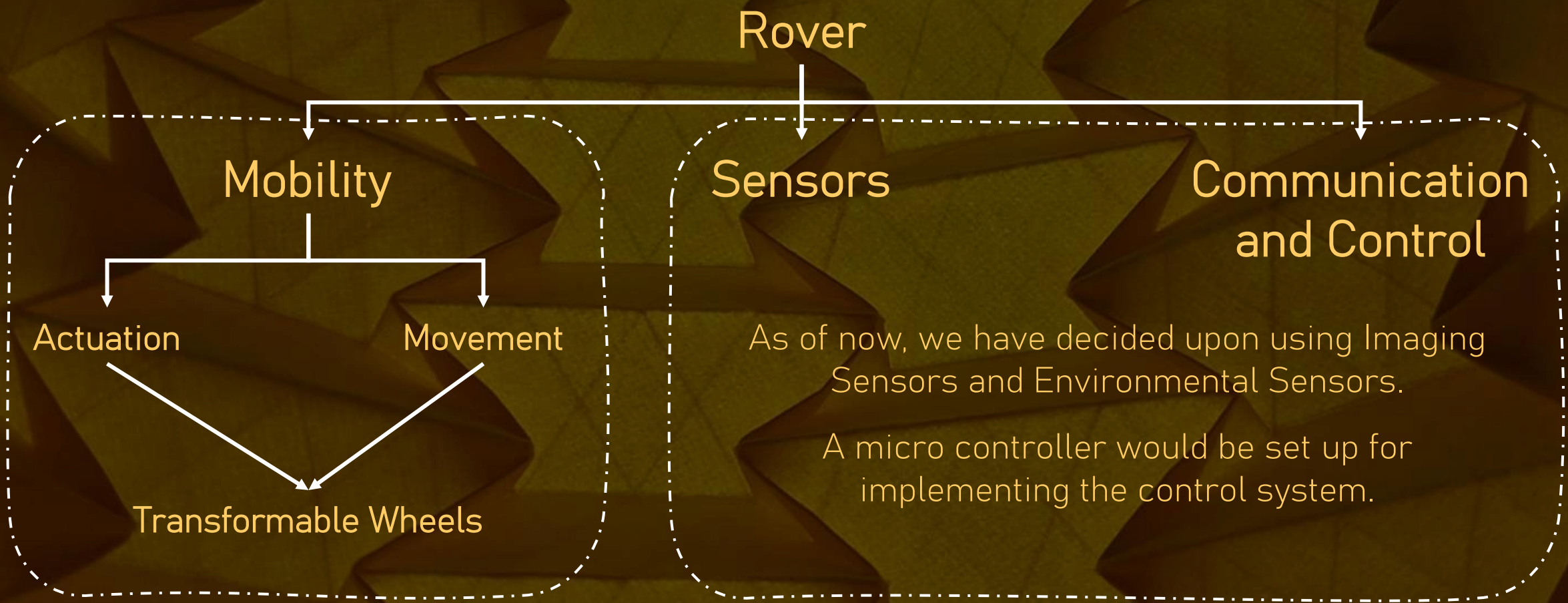
For the Initial Stage

- Highly durable polyimide film coated on a sheet of paper
- A dual layer polyimide film (Kapton) ensures the required flexibility and stiffness of the paper

Autonomous

- On board power, communications and sensing

Proposed Subsystems



The current phase we are working on

Later Phase

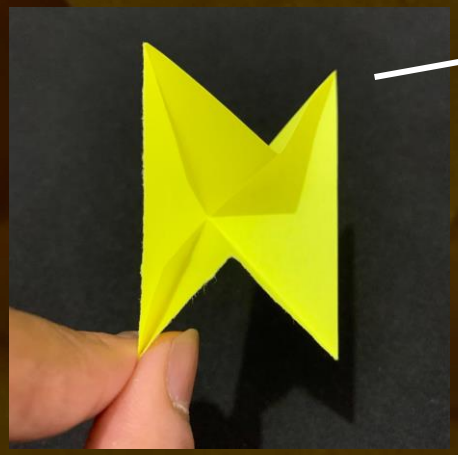
Mobility: Transformable Wheel

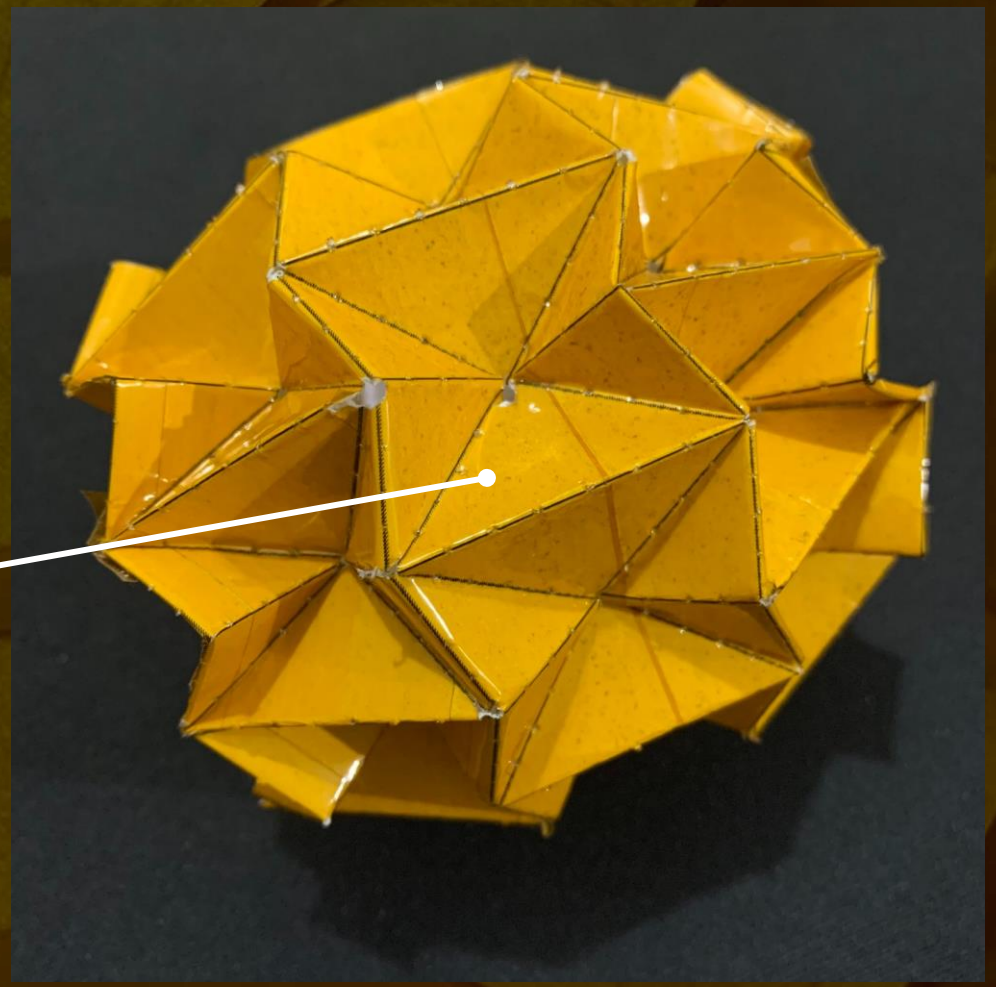
Magic Air Ball Pattern

- Involves Waterbomb Tessellation Pattern
- Highly Flexible Origami Folding
- Oripa Design acts as the building Block

The pattern is known for changing its shape from a long cylindrical tube to a flat circular tube.

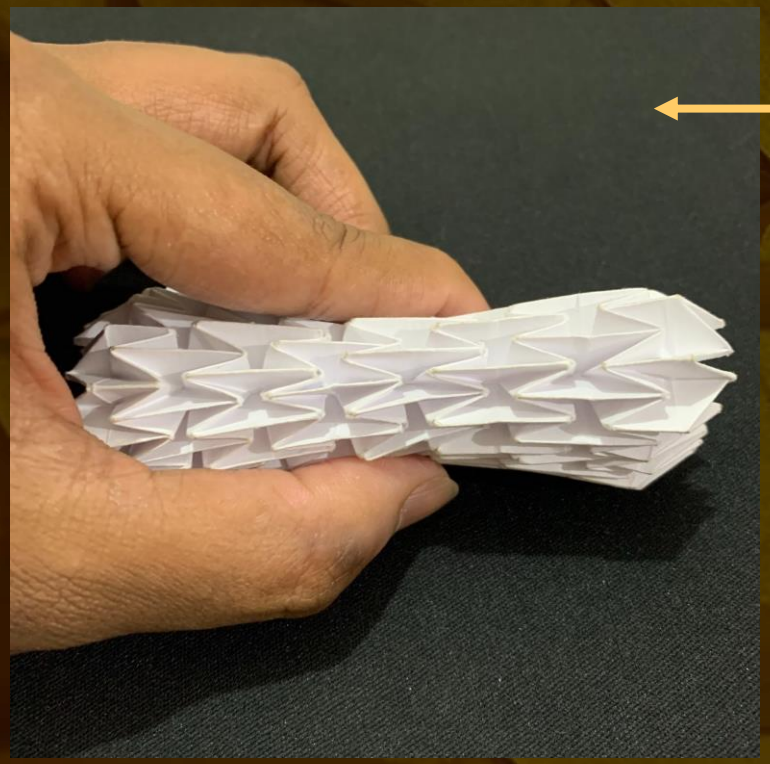
The deformable wheel can be built without using many mechanical parts, only with a single piece of sheet with specific folds.



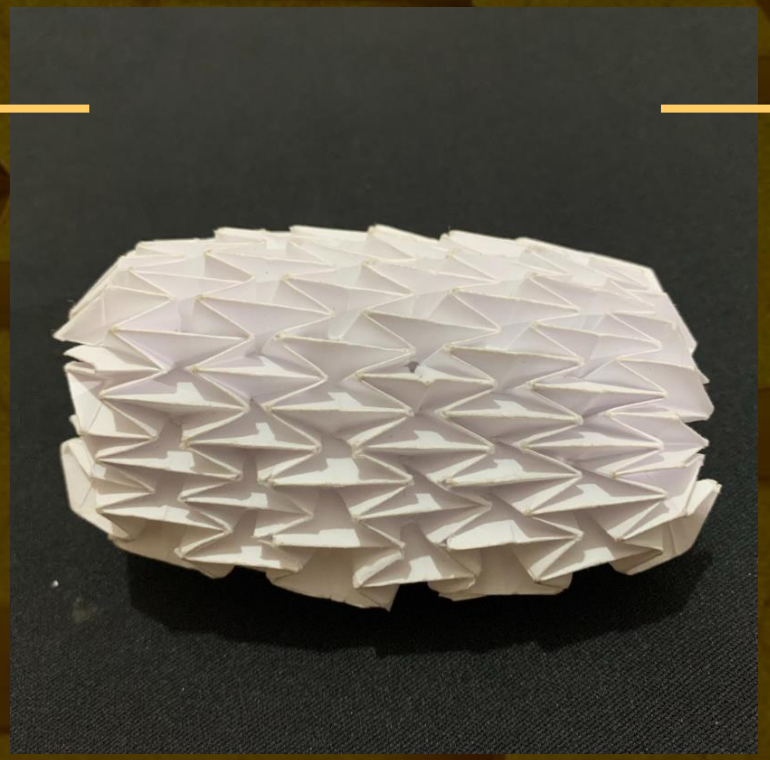


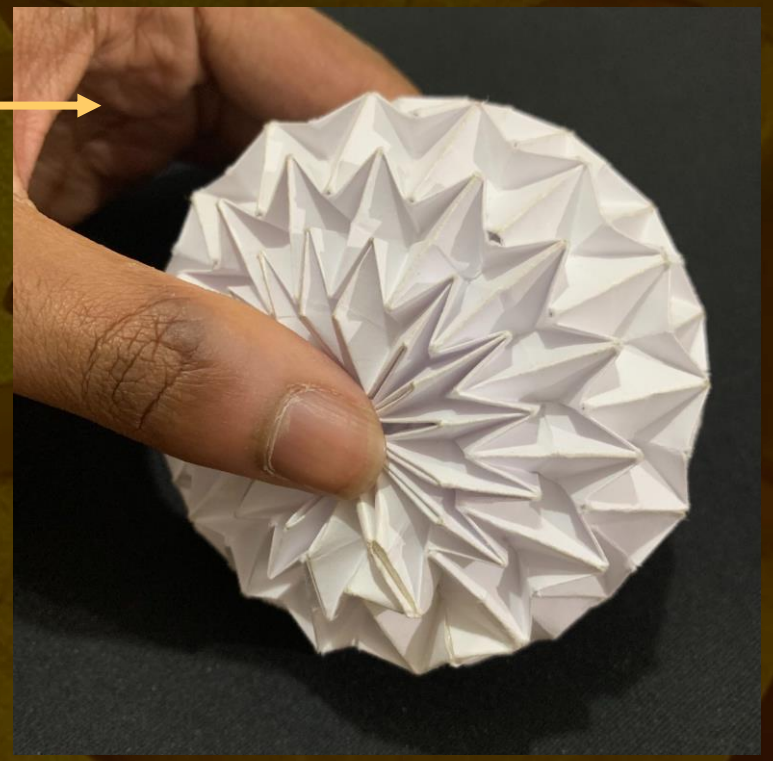
Mobility: Transformable Wheel

Magic Air Ball Pattern (9 Mountain Configuration)



Expanded from ends

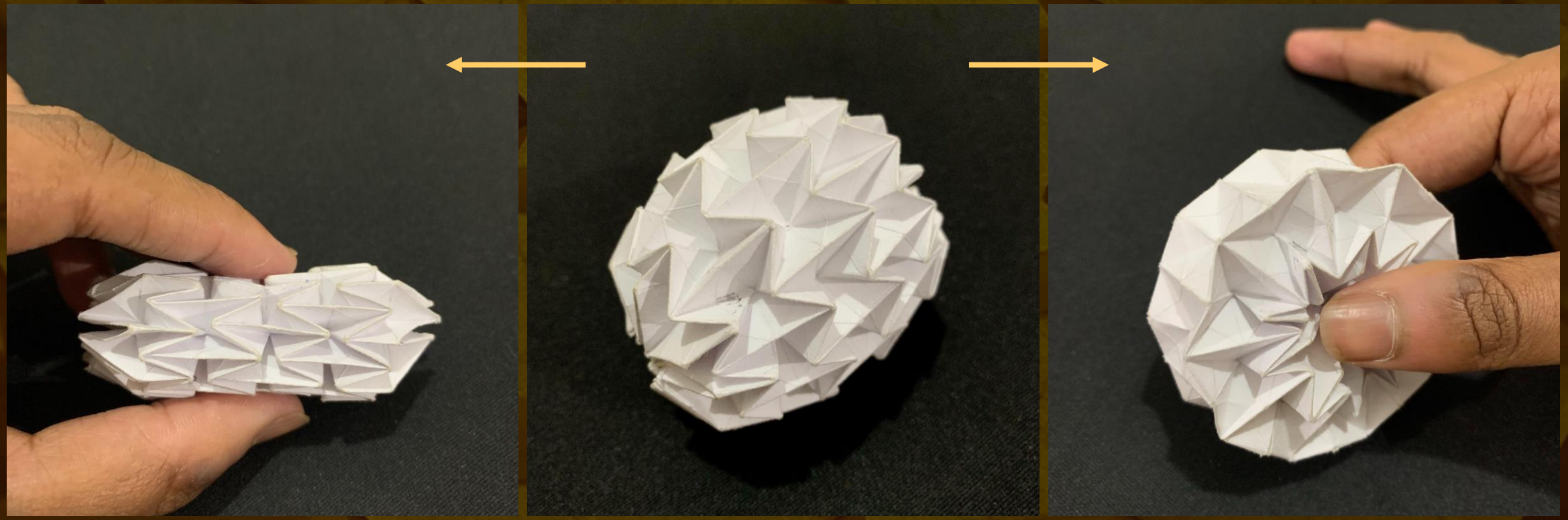




Compressed from ends

Mobility: Transformable Wheel

Magic Air Ball Pattern (5 Mountain Configuration)

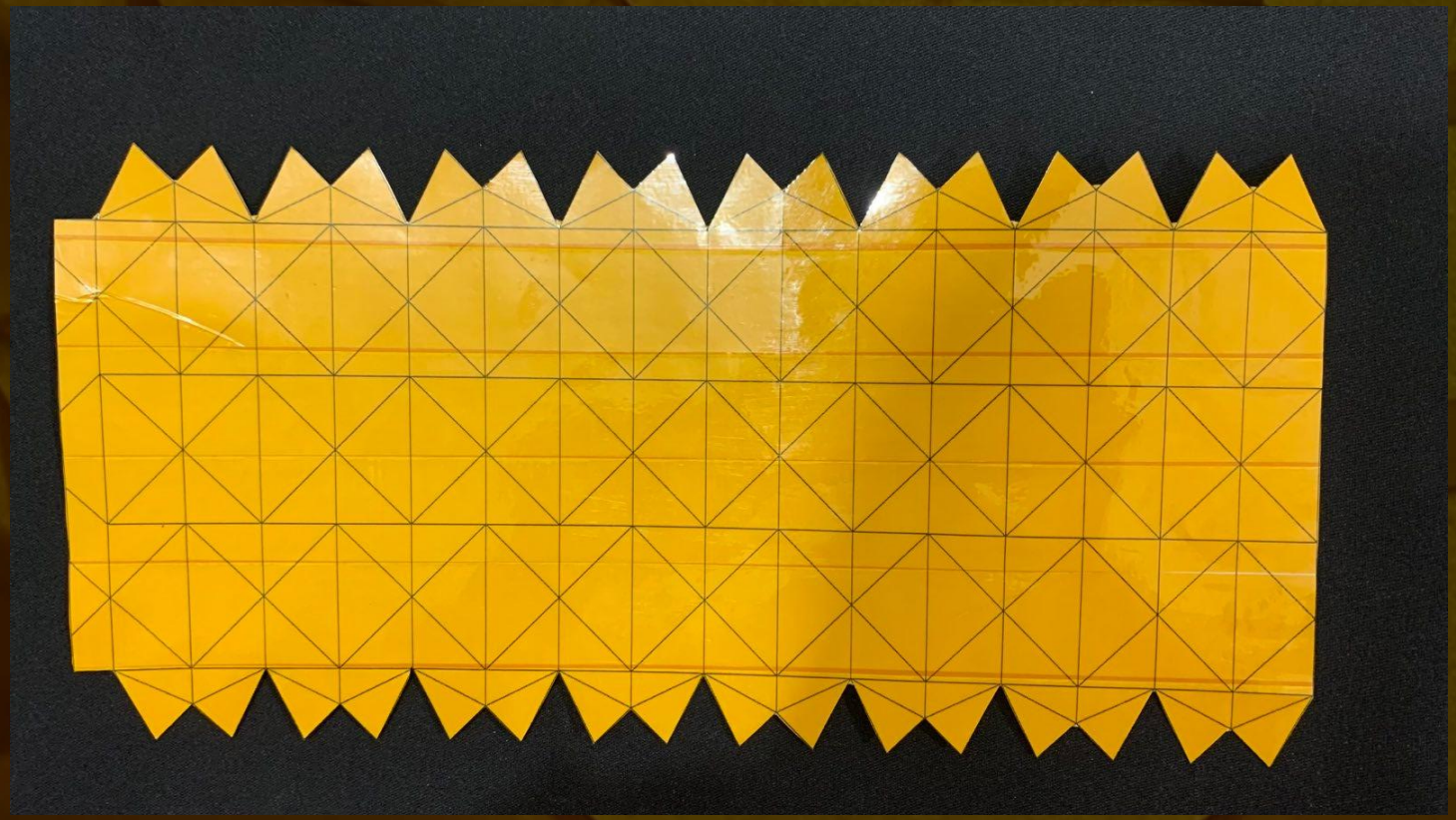


Expanded from ends

Compressed from ends

Mobility: Transformable Wheel

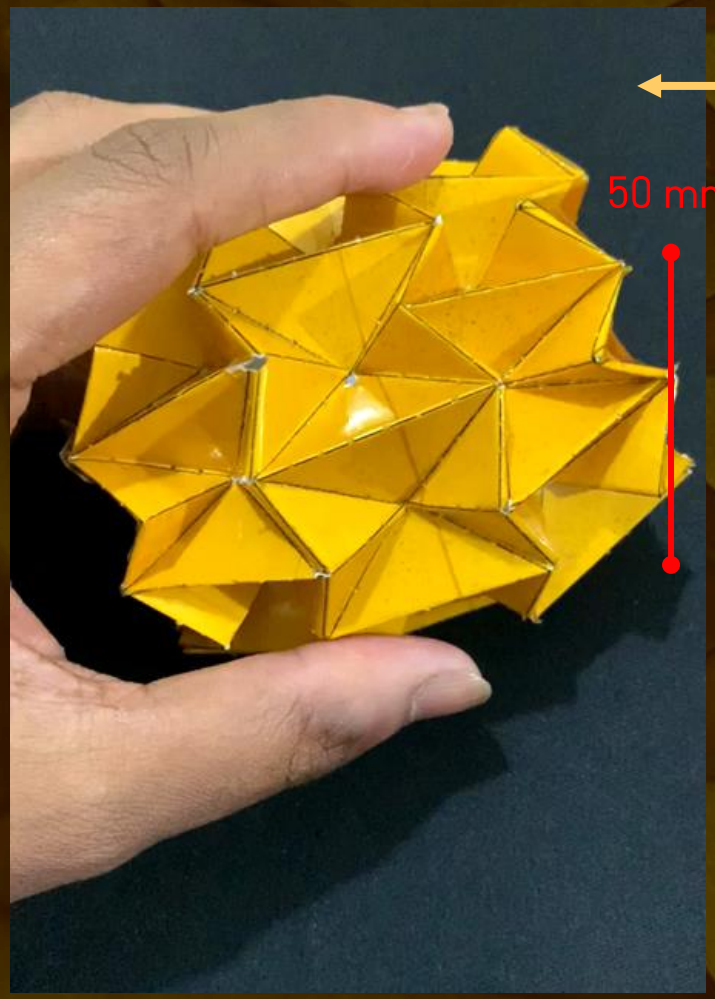
General Pattern

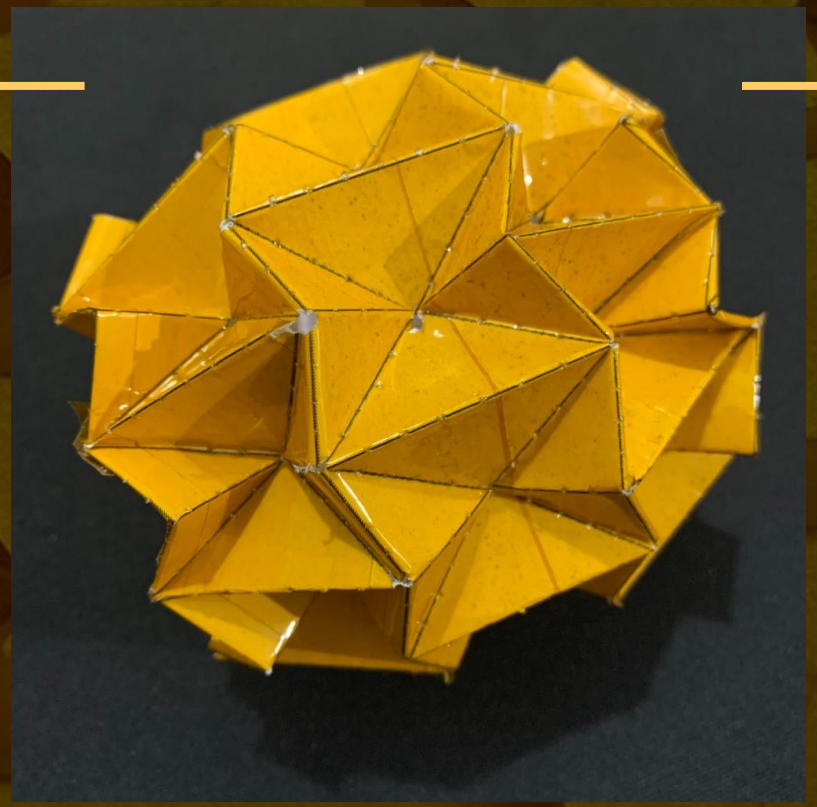


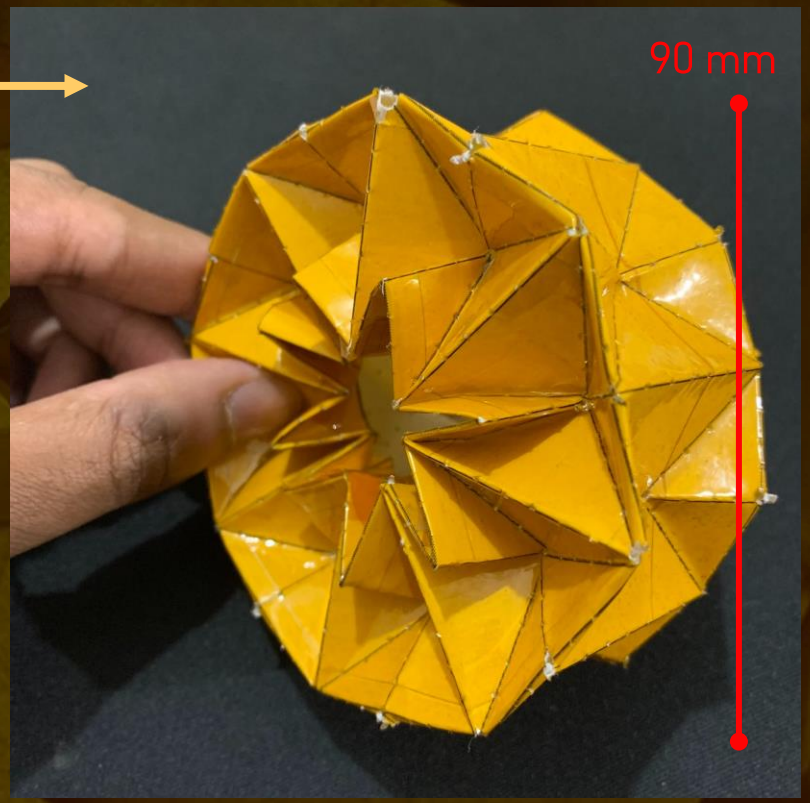
Holes are made to form better creasing

Mobility: Transformable Wheel

Sheet + Kapton







A4 size sheet was covered with Polyimide Film having adhesive on one side.

Mobility: Actuation

A Dual Rack and Pinion

- Simultaneous Linear actuation of wheels
- 3D Printed

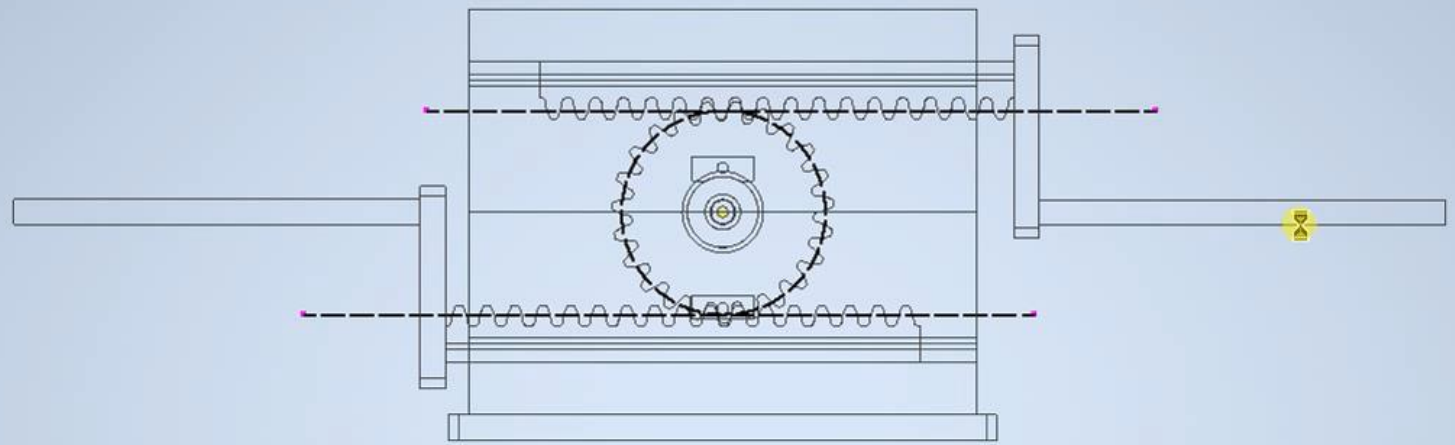
Assembly Process:

1. Rack Inserted to Housing Bottom
2. Servo Mounted with Gear attached to Housing Bottom
3. Rack 2 inserted to Housing Top
4. Rack 2 along with Housing Top attached to Housing Bottom

We aimed on simplifying the assembly process.

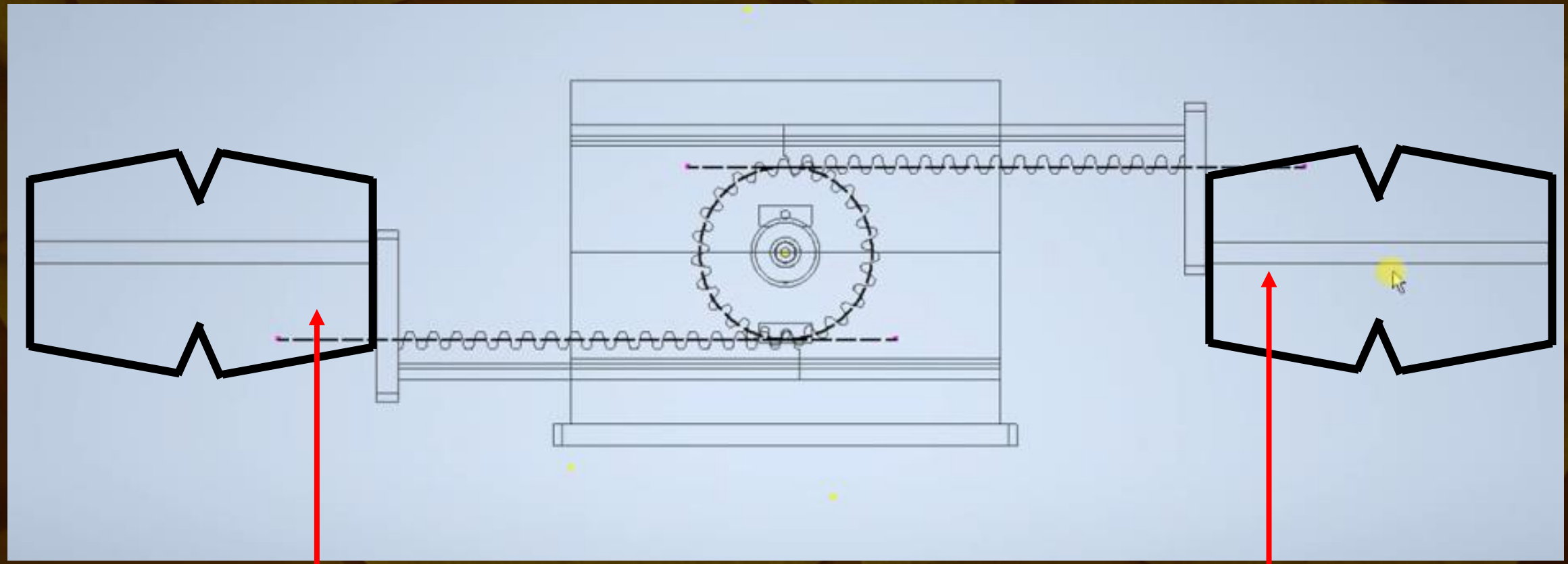
Mobility: Actuation

Micro Servo SG90 → Torque Capacity: 1.3 kg-cm

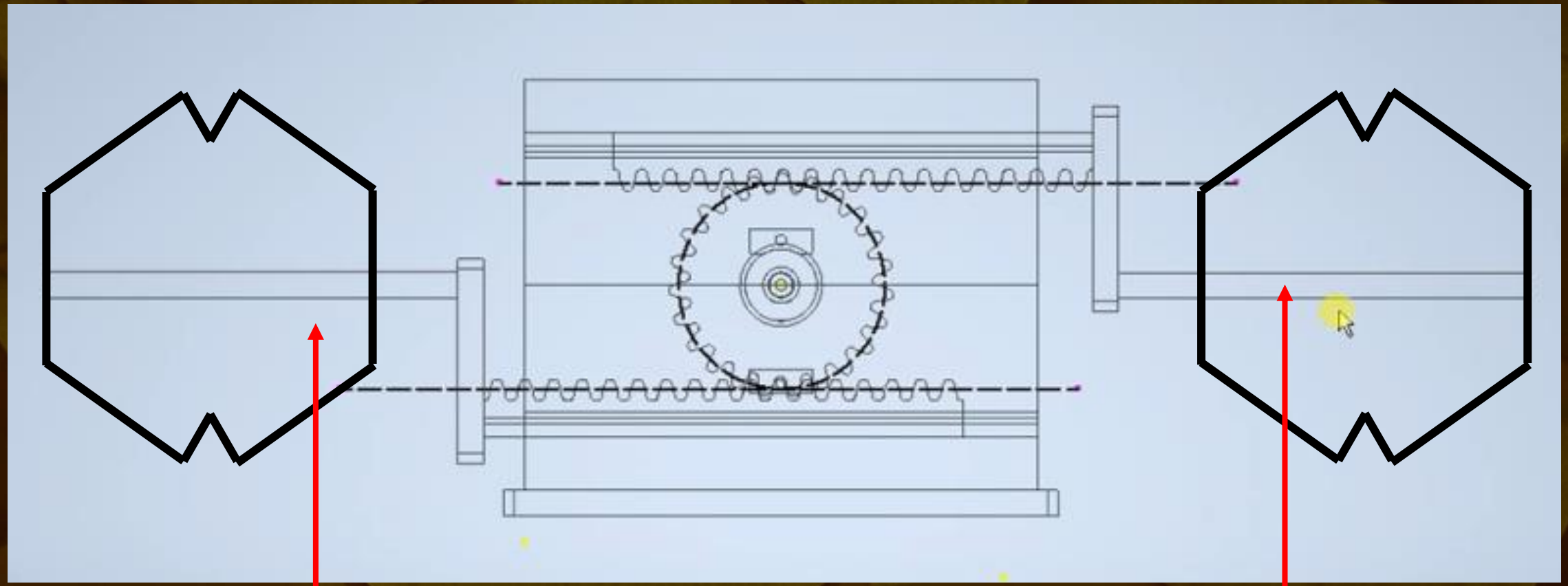


The Rack continues to move on the traced path maintaining the Pitch Circle Diameter of the Pinion,

Mobility: Actuation



Mobility: Actuation

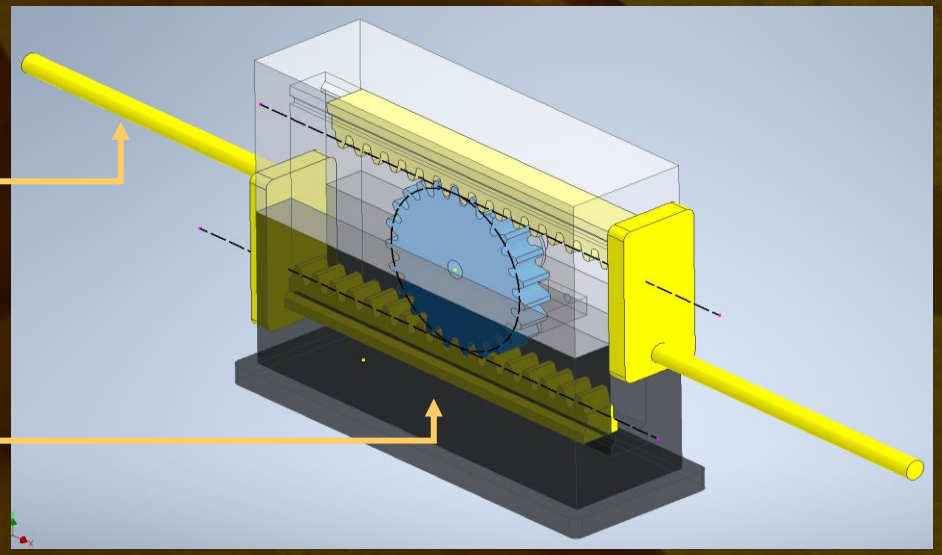


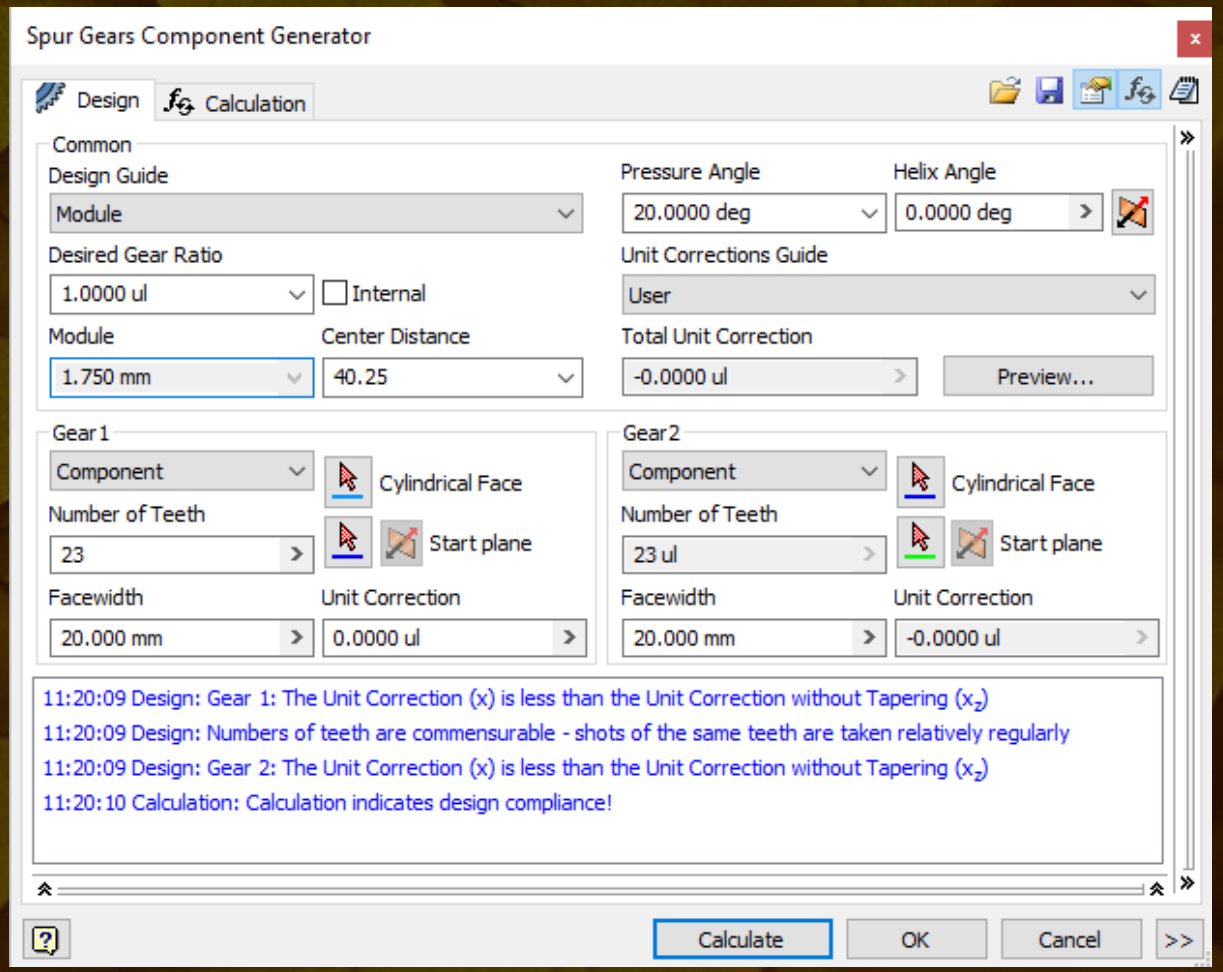
Mobility: Actuation

Approximate Calculations

NOTE: The values would be subjected to change depending on the size of origami wheel pattern size.

Parameter	Value
Shaft Length	70 mm
Rack Length	93.5 mm
Pinion PCD	40.25 mm
Rack Teeth	17





What should be Next?

- 3D printing the design parts
- We'll be attaching a wheel plate to the end of the origami wheel and perform it's actuation with the help of Arduino.
- Once the actuation is done with confidence, we'll shift our focus on designing the body of the rover.
- Simultaneously, we'll be simulating the design over ROS and Gazebo

Thankyou !