IRoC-U24

PROPOSAL PRESENTATION
TEAM DYAUS

TEAM ID : 10072

*(*The Presentation summarizes only the topics that we think will give a complete idea about our Rover Design. The proposal report provides detailed explanations of the topics that are not included here. Not all sections have been summarized in this PPT to adhere to the given restriction of 15 pages and <5MB.)*

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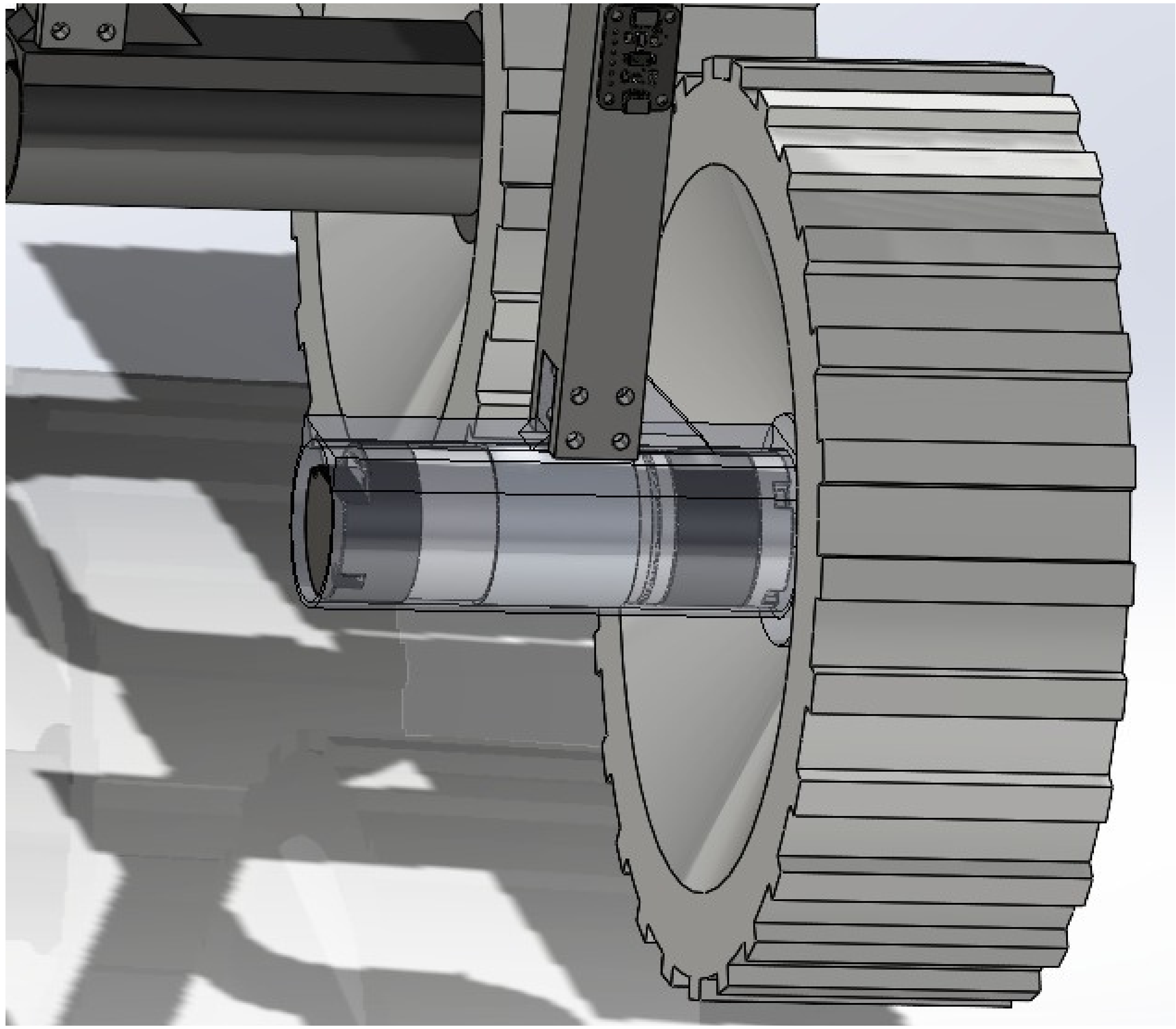
Rover Mobility and Control

Powering the Wheels

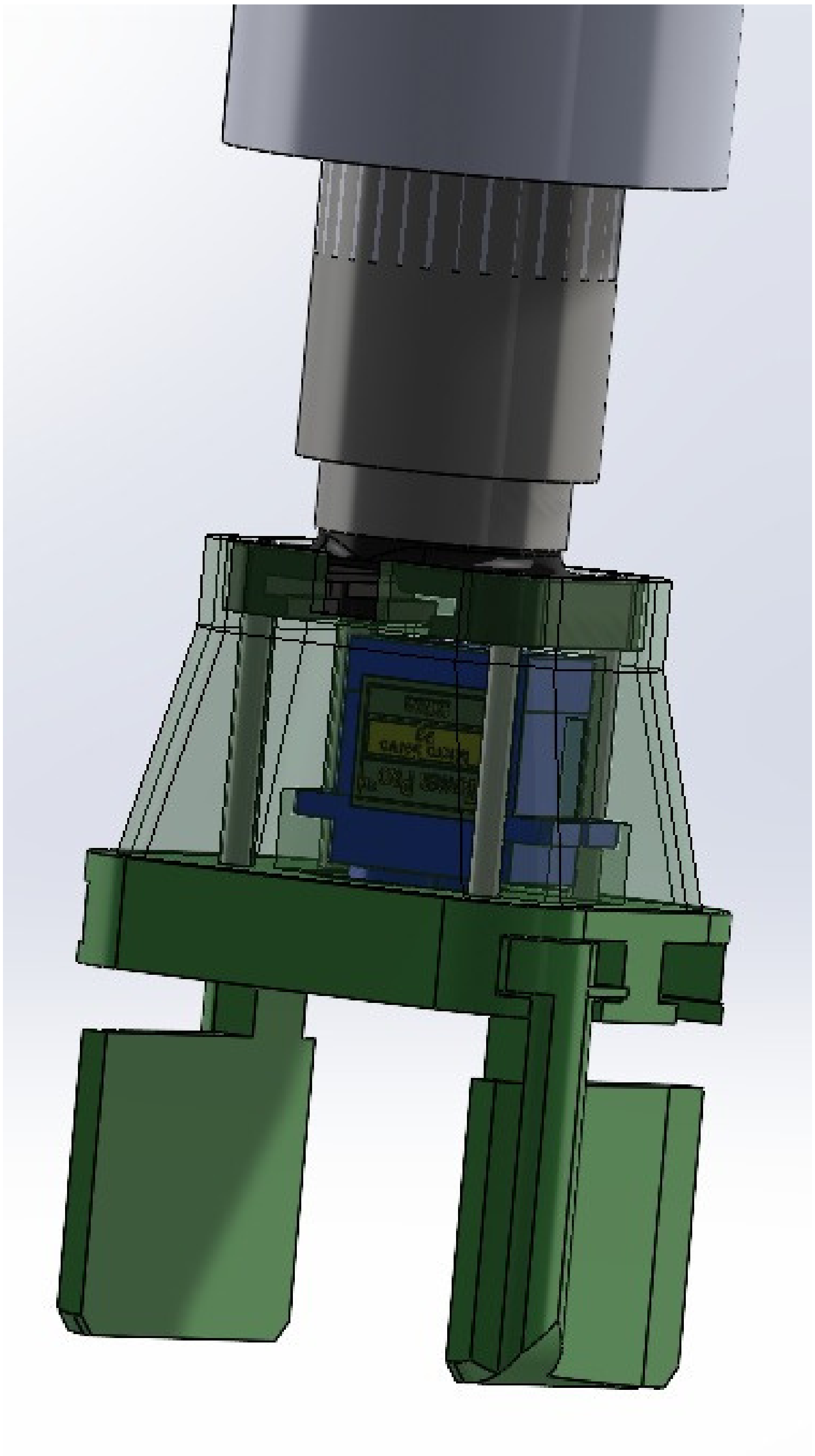
- Independent DC motors power all six wheels.
- Enables precise control over speed and torque for adaptive terrain navigation.
- Enhances turning capabilities for obstacle avoidance, especially on slopes.
- Dynamic control ensures optimized traction, stability, and agility.
- Adaptability to Varying Terrain: The rover can effectively traverse diverse landscapes by adjusting wheel speed and torque.



Sample Pick-and-Place Mechanism

Target Identification and Gripper Design

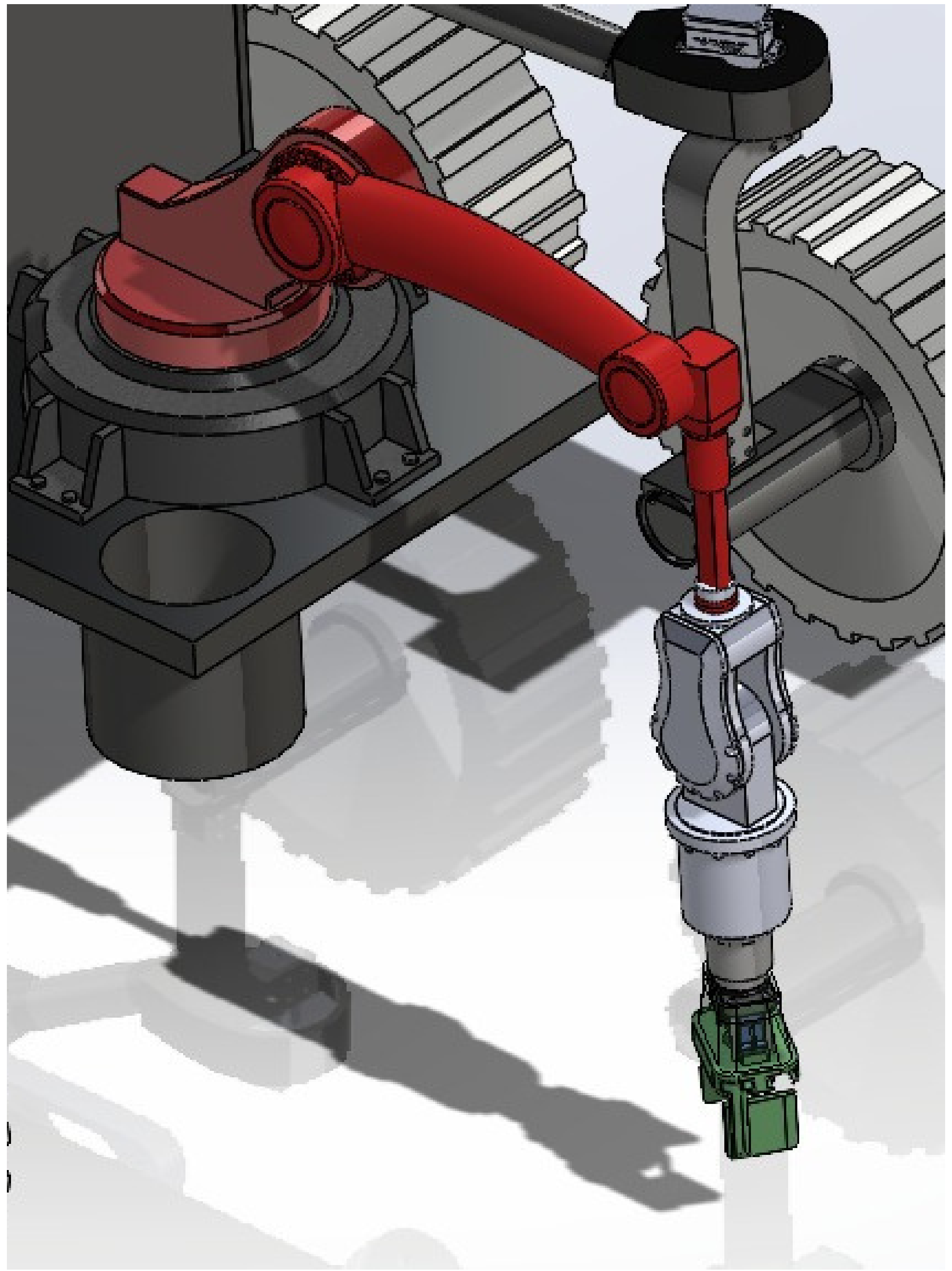
- A specialized camera on the rover captures coordinates of the sample tube for precise identification.
- Inverse kinematics enable the gripper to navigate and pick up the test tube accurately.
- Gripper design includes adjustable fingers with rubber pads for a secure hold.
- Frictional and compressive forces aid in holding and lifting the tube.
- Gripper reorients to avoid collisions during tube placement in the container.



Picking, Loading, and Mobility

Picking and Loading on Rover Chassis

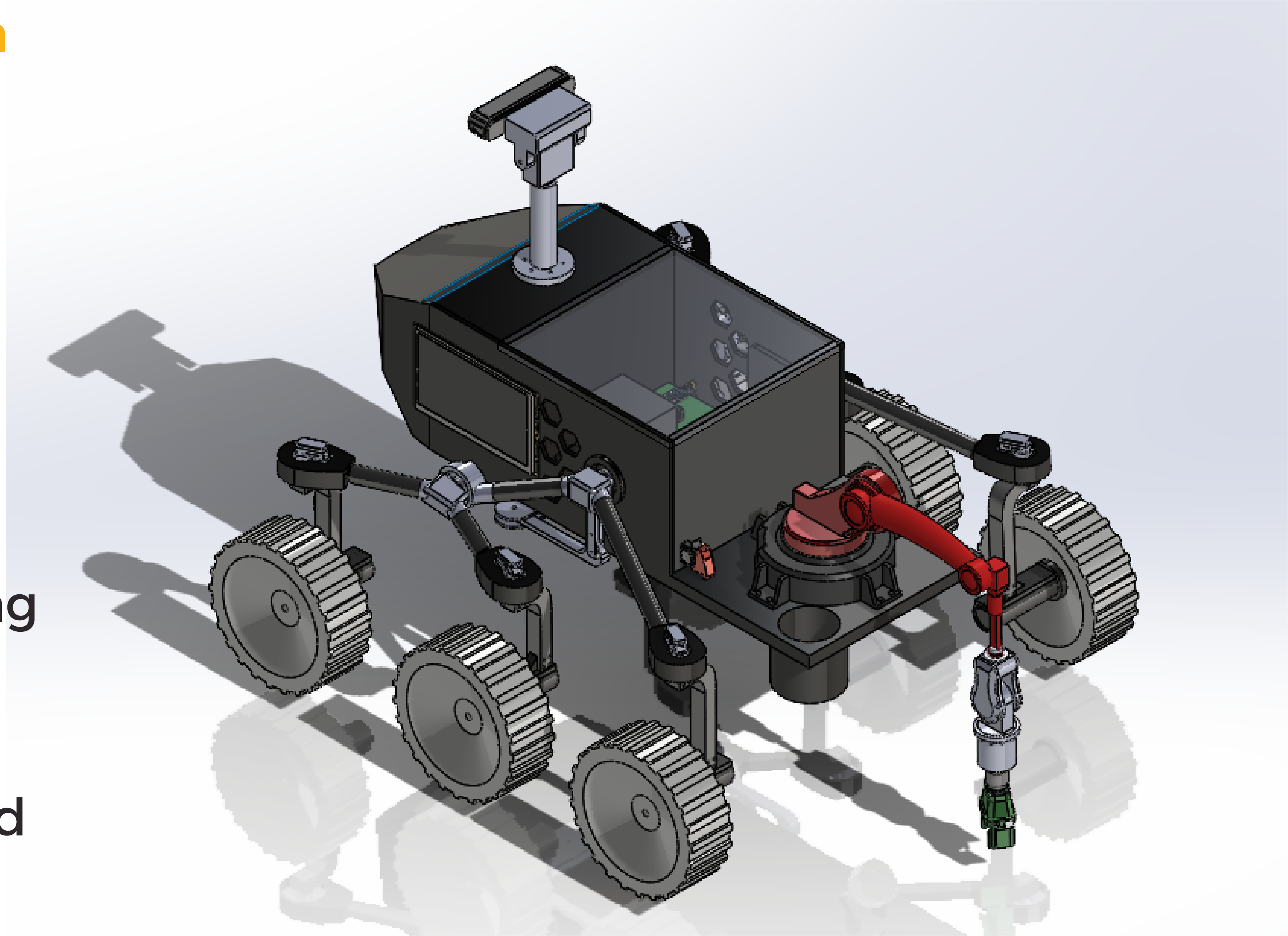
- The 4-DOF manipulator arm moves precisely to the identified tube location.
- Gripper securely holds and lifts the sample tube onto a designated area on the rover chassis.
- Rover initiates autonomous traversal only after loading the sample tube.
- Measures to secure the manipulator arm during rover mobility to avoid interference.



Target Location Identification, Unloading, and Coordination

Target Location Identification and Coordination

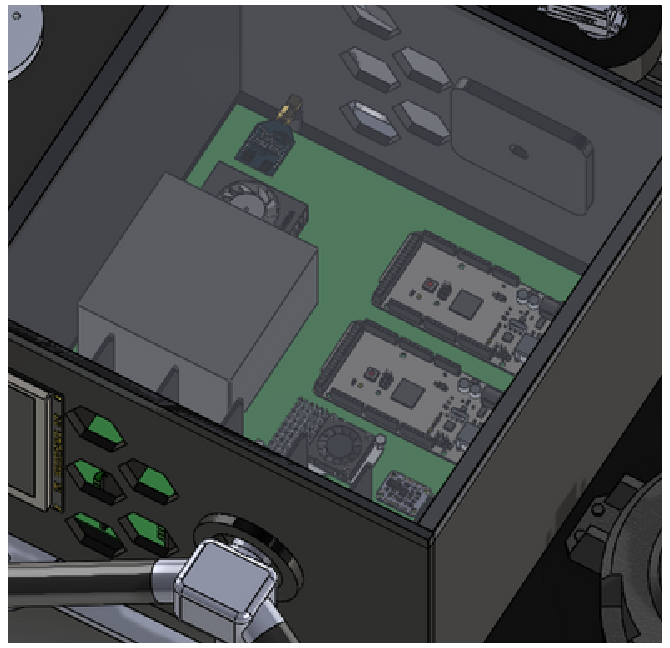
- Sensors and rover camera identify the target location during traversal.
- Manipulator arm positions itself over the marked circle at the destination.
- Tube is dropped into the marked circle with precision.
- Coordination and control involve kinematic equations, sensor feedback, and programming algorithms.
- Safety measures, including force and torque sensing, handle uncertainties and unexpected conditions.

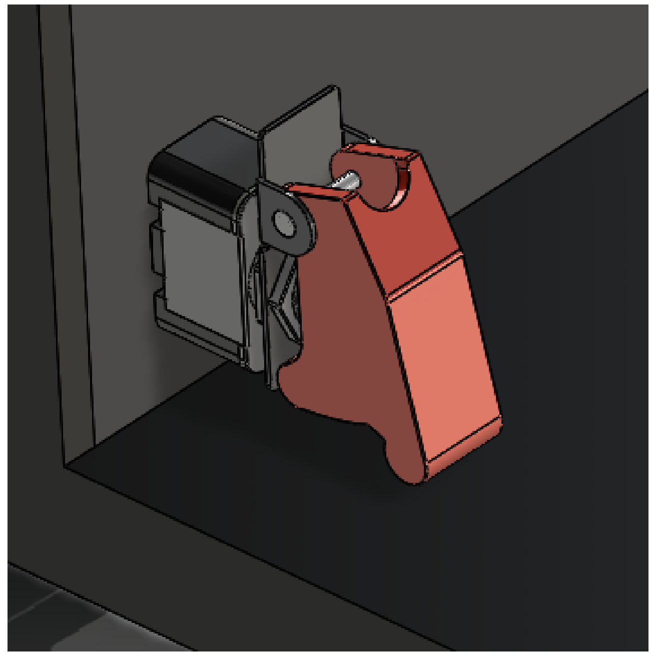


Emergency Response System Overview

- To ensure the rover mission's success, robust safety protocols are in place. Continuous terrain monitoring, facilitated by onboard cameras and TOF Lidar, allows the rover to pause and assess paths in the face of deviations.
- Redundant sensors guarantee obstacle and crater detection, seamlessly transitioning to backups upon visual sensor failure. A Battery Monitoring System oversees voltage, triggering emergency shutdowns and automatic returns during critical power loss.
- Autonomous behavior is pre-programmed for communication losses, with a return to normal operation upon restoration. Abnormal resistance prompts the rover to adjust paths or enter safe mode, with the capability to call for assistance.
- Manipulator safety is ensured through obstacle detection during sample pickup. Gripper and arm reliability include force and gripping feedback sensors, emergency responses, and re-gripping capabilities.
- Backup visual sensors and a localization system continuously monitor and adjust for identification challenges. Emergency power supplies and fail-safe mechanisms address power failure or manipulator arm dysfunction, while integrated kill switches enable controlled shutdown in the event of rover mechanical or electronic failures.

Emergency Response System Overview





Comprehensive Safety Measures

1. 7-Inch Touch Screen Integration
   - Real-time updates on motor RPM, battery voltage, and current.
   - Intuitive GUI for user interaction and dynamic monitoring.
2. Heatsink for Thermal Regulation
   - Strategically employed heatsinks prevent overheating.
   - Efficient thermal regulation ensures reliable and efficient rover functioning.

Rationale for Emergency Response System

- Reliable, safety-oriented response system with
- redundant sensors and fail-safe designs.
- Real-time monitoring and adaptation to changing conditions.
- Redundancy enhances system resilience and minimizes failure risks.
- Autonomous decision-making capability in emergencies for enhanced mission success and safety.

Obstacle and Crater Identification Algorithm

YOLO and Stereo Depth Camera Integration

1. Object Detection with YOLO
   - YOLO algorithm enables fast, accurate real-time object detection.
   - 2-DOF camera enhances field of view for improved perception.

2. Crater Detection and Depth Visualization
   - YOLO locates craters, stereo depth camera estimates sizes.
   - Accurate distance measurement aids navigation; 3D visualization provides depth information.

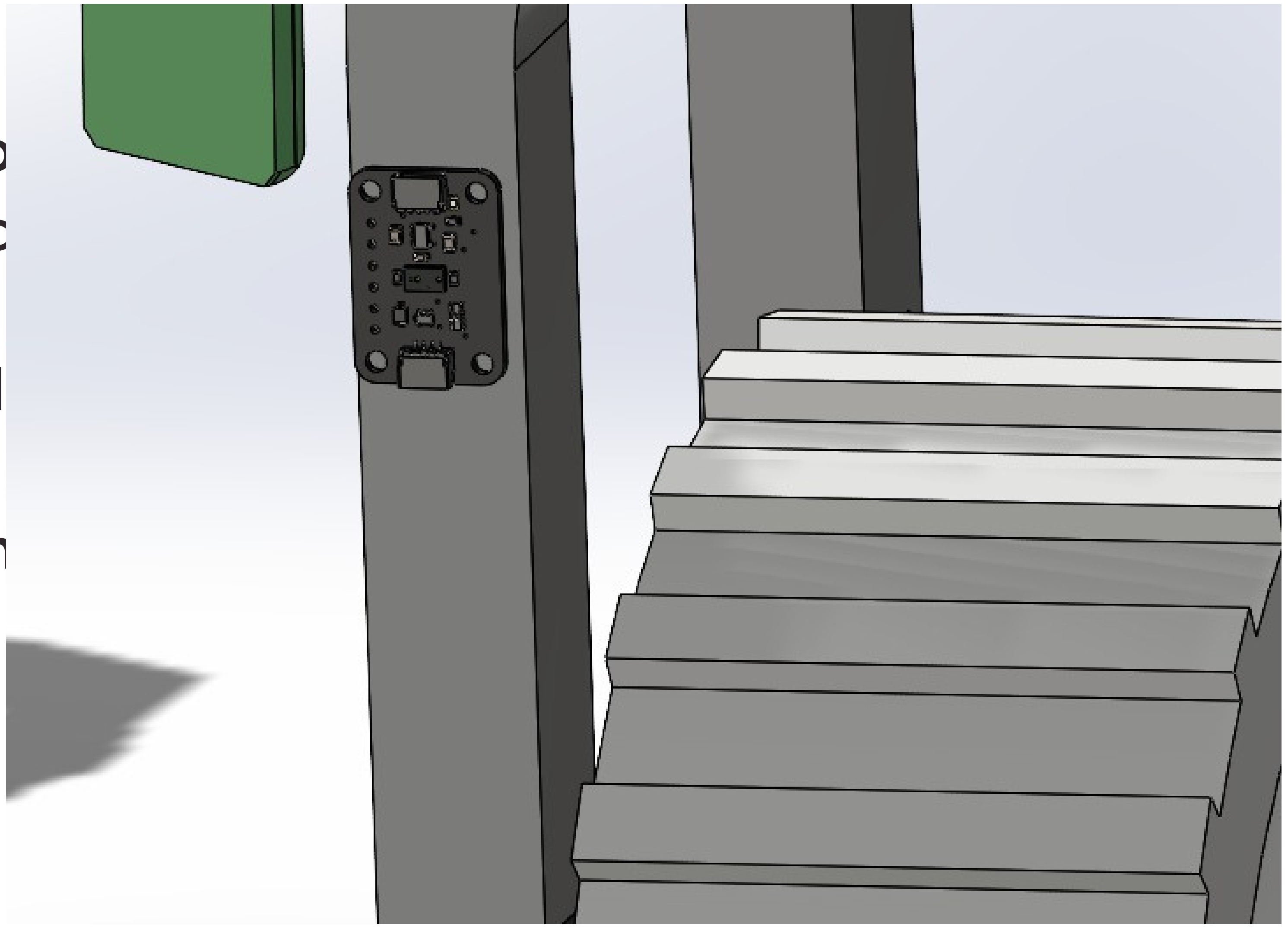
3. Intelligent Path Planning
   - YOLO and depth camera data inform real-time decisions.
   - Adaptive color recognition enhances perceptual skills.
   - Spatial information processing in the navigation system ensures obstacle-free path planning.

TOF-Based LIDAR Laser Distance Sensors

TOF-Based LIDAR for Fail-Safe Operation

1. TOF-Based LIDAR Laser Distance Sensors
   - LIDAR sensors on all six wheels create real-time terrain map
   - Laser beams measure object distances, adding rapid obstac detection.
   - Complements YOLO-based object detection, acting as a fail safe.
   - Enables near real-time responsiveness crucial for challengin terrains.

2. Comprehensive Rover Perception System
   - Integration of YOLO, stereo depth cameras, and TOF-based LIDAR.
   - Ensures informed navigation and collision avoidance.
   - Provides redundancy for object detection in varying terrains.



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Path Planning Algorithm

Fast Gap Method for Efficient Obstacle Avoidance

1. Motion Planning and Obstacle Avoidance
   - Gap-based strategy prioritizes the largest gap for obstacle avoidance.
   - Angle of avoidance calculated using equidistant points from obstacles.
   - Monte Carlo simulation and real-world tests validate algorithm effectiveness.

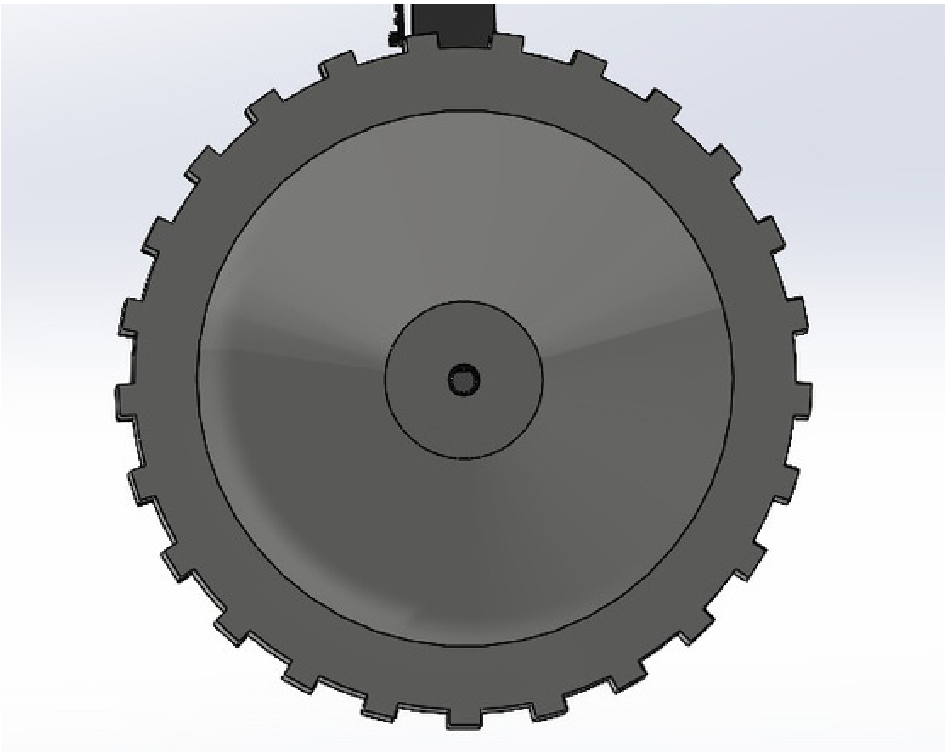
2. Fast Gap Method (FGM) and Fast Obstacle Circle Method (FOCM)
   - FGM introduced for efficient navigation around obstacles.
   - Comparison using Monte Carlo simulation shows FGM provides safer paths.
   - Python-based independent nodes implement both FGM and FOCM.

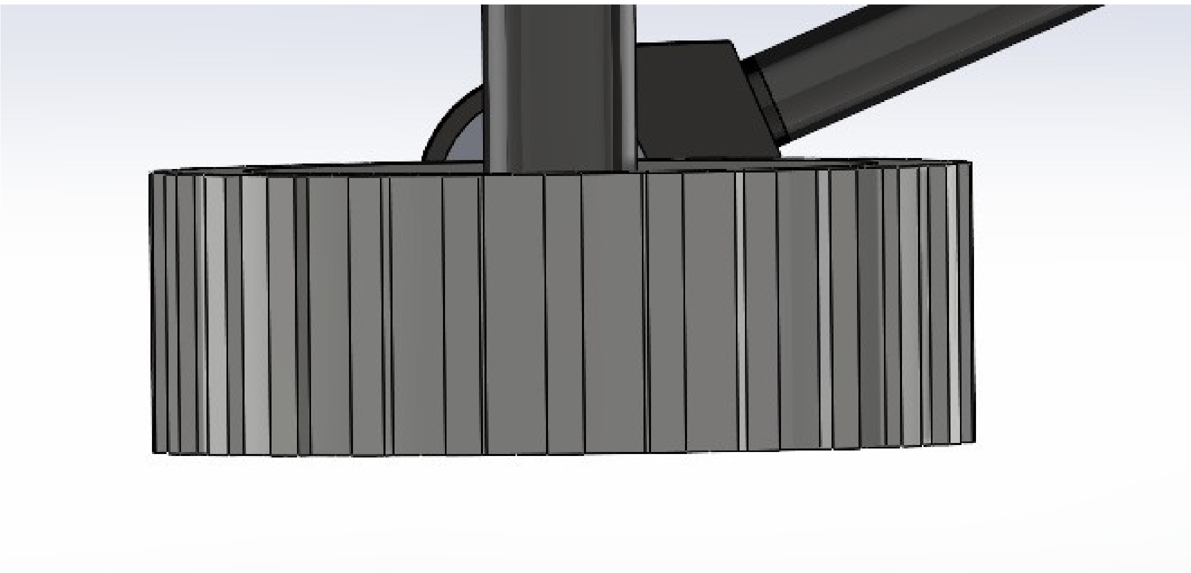
The Fast Gap Method ensures safer navigation. The comprehensive perception system, including YOLO and LIDAR, coupled with adaptive recognition and intelligent planning, enhances decision-making. Safety is ensured through sensor redundancy and fail-safes, while multiple technologies improve obstacle identification. The rover demonstrates real-time adaptability and informed decision-making for efficient navigation across diverse terrains.

Wheel Design Innovation

Innovative Wheel Design for Optimal Performance

- The wheel design prioritizes key requirements such as grip, stability, high strength-to-weight ratio, durability, and replaceability.
- Employing 3D printing with PETG, the design integrates innovative characteristics and facilitates the inclusion of motor mounts.
- To enhance friction, a rubber sleeve is utilized, maximizing power transfer to the ground for improved rover movement, steering, and braking, Optimal dimensions, including a 22cm diameter and 8cm thickness, ensure proper motor placement, torque utilization, stability, and pressure distribution.
- Fin-like structures on the wheel exterior enhance grip and relieve stress from the inner wheel, aiding in the secure fitting of the rubber sleeve.





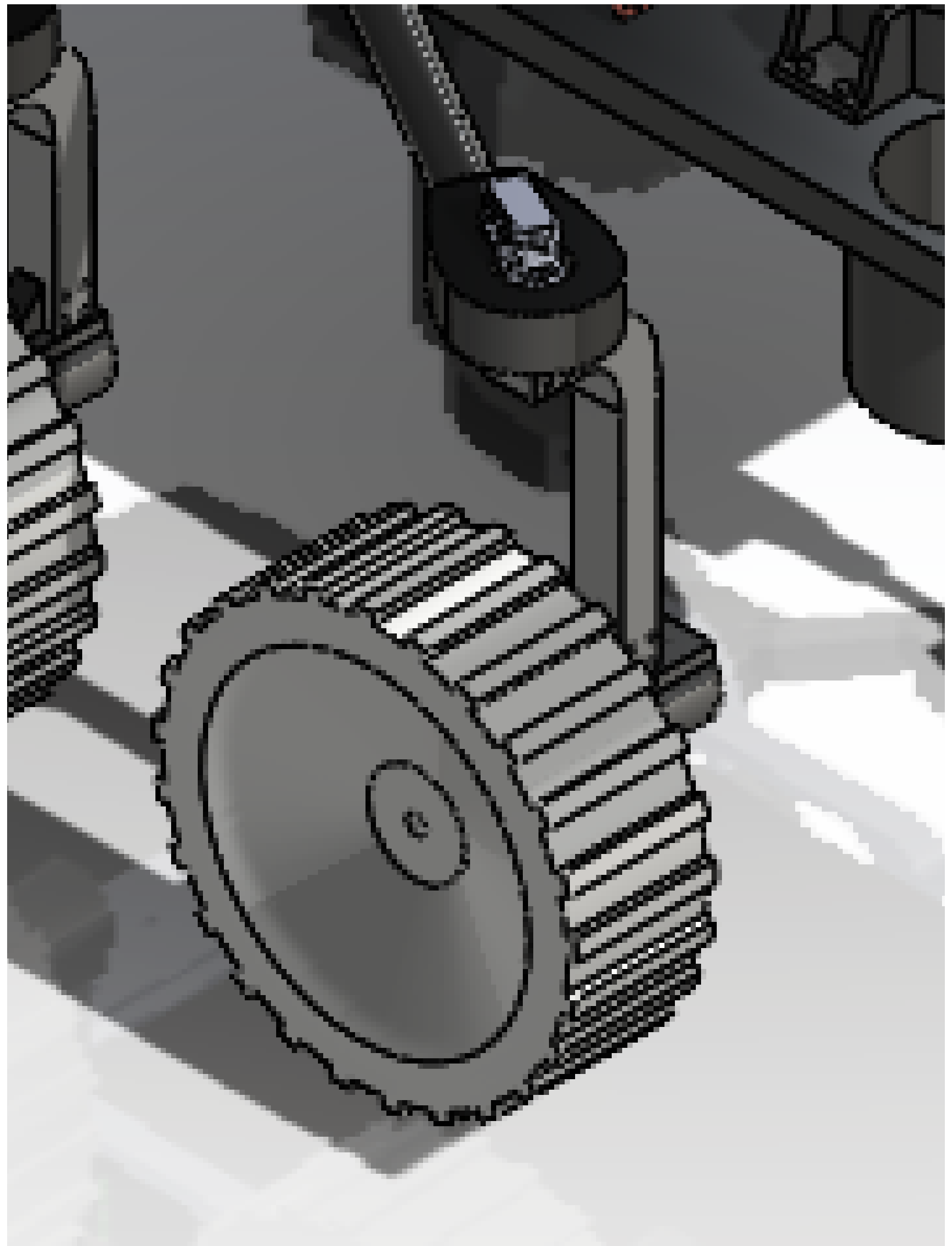
Steering Mechanism Advancements

Precision Steering for Enhanced Maneuverability

1. Motorized Steering
   - Dedicated servo motor for each wheel's steering motion.
   - Minimizes wear and tear, ensuring rover mobility throughout its mission.
   - Holonomic drive capability for independent maneuvering in confined spaces.

2. Reduced Wear and Tear
   - Minimized stress on wheel components for prolonged operational life.
   - Enhanced longevity, ensuring continuous rover mobility.

3. Holonomic Drive Capability
   - Independent maneuvering for navigation through confined spaces.
   - Crucial for scientific experiments and precise exploration movements.
   - Enables agility and adaptability in varied exploration scenarios.



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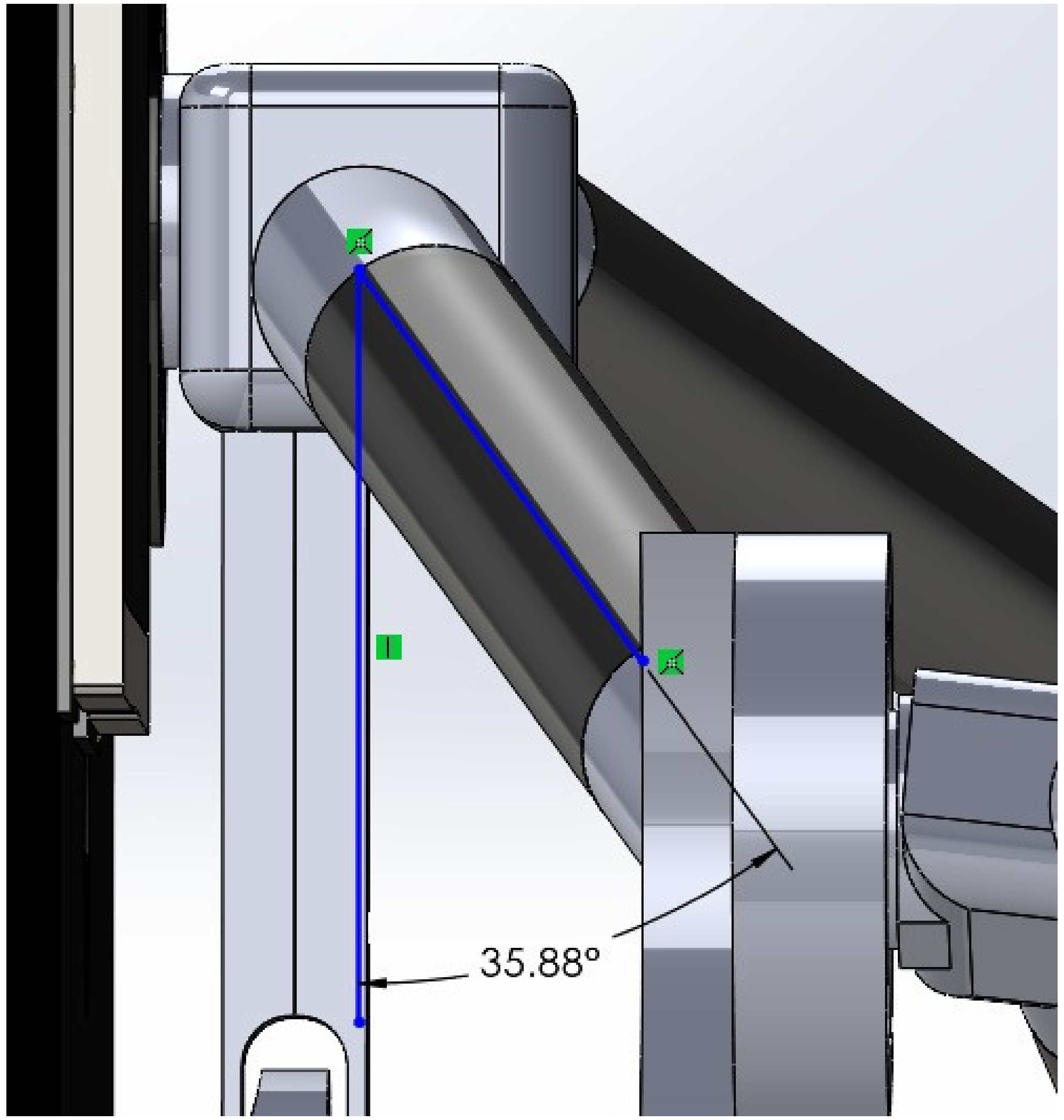
Rocker Bogie Suspension Optimization

Novel Rocker Bogie Suspension Configuration

1. Angled Links with 36-Degree Orientation
   - Departure from traditional 90-degree configuration for weight distribution.
   - Optimizes stress distribution, enhancing stability and performance.
   - Tailored engineering solution for challenging terrains, particularly off-road scenarios.

2. Efficiency and Adaptability
   - Innovative 36-degree angle introduces efficiency in load dynamics.
   - Improved mobility and reliability in rugged landscapes.
   - Marks a new era in addressing challenges posed by challenging terrains.



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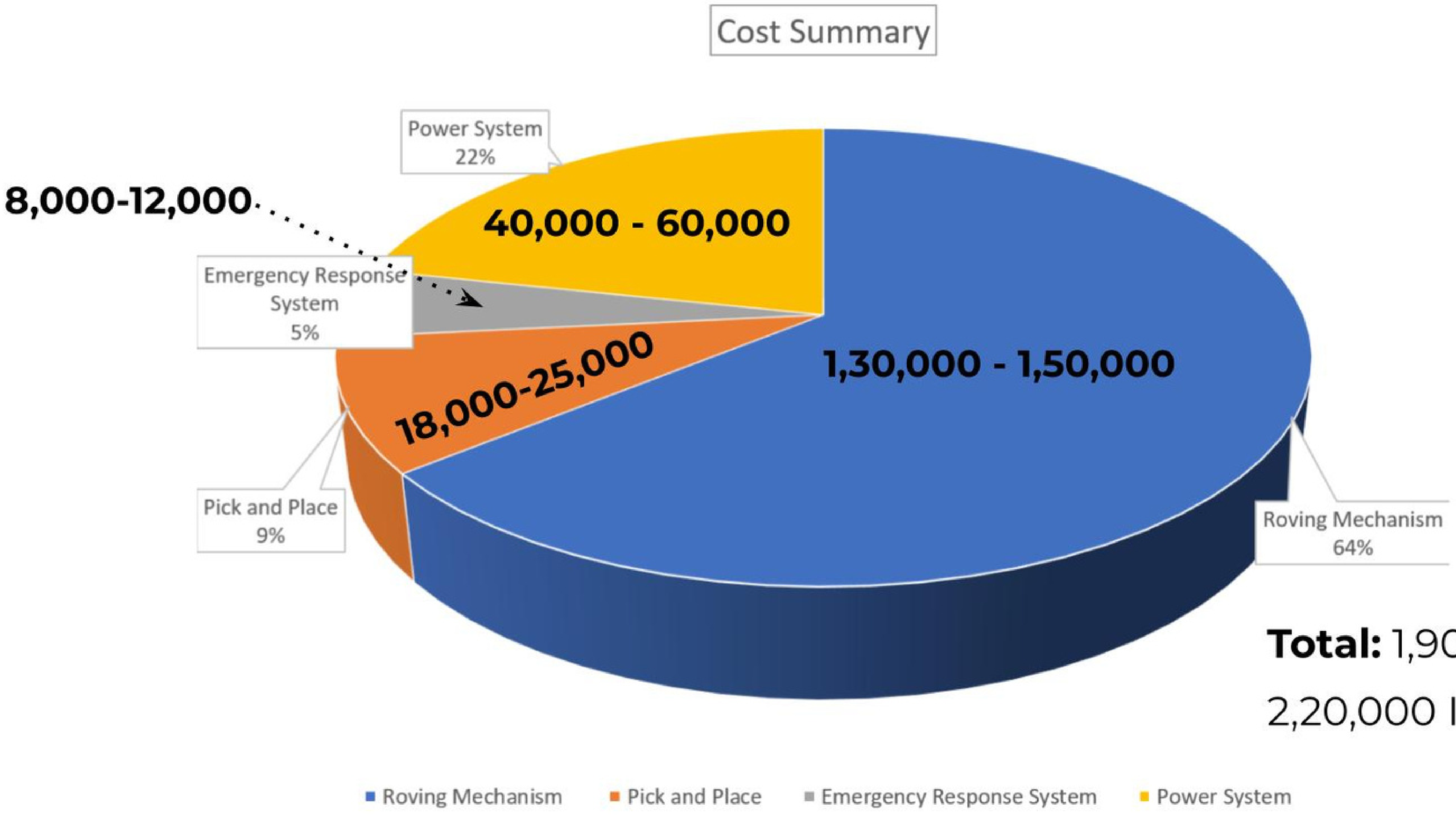
Proposed Budget



Total: 1,90,000 to 2,20,000 INR

Photos