SYSTEM ACCEPTANCE REVIEW

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During the development of our Mars Rover, Team Atlas has carefully followed the systematic methodology described in our Critical Design Review (CDR). The following provides a thorough rundown of how we've handled each stage of the system development life cycle:

1. Planning: We carefully outlined the technological requirements and specifications for our rover during this phase of planning. To find the best technologies and approaches that support our goals, we carried out a thorough analysis of the market. Consideration was carefully given to elements including communication capability, power requirements, weight, and size. We produced a thorough plan that included the duties, deadlines, and materials needed to finish the project successfully.

2. Design: We turned our conceptual concepts into comprehensive technical designs during the design phase. We produced accurate three-dimensional (3D) models of the rover's parts and subsystems using sophisticated computer-aided design (CAD) tools. We were able to conceptualize and perfect the arrangement with the help of these models, making sure that every component fit together perfectly. We concentrated on adding cutting-edge features including intelligent sensing and communication systems, powerful power systems, and autonomous navigation.

3. Construction and Integration: After the design was complete, we proceeded to the fabrication stage, employing top-notch materials and cutting-edge manufacturing methods to assemble the rover's components. The chassis was constructed from aerospace-grade aluminum for strength and endurance, and carbon fiber composites were used for secondary components to save weight. Before each subsystem was incorporated into the finished assembly, it underwent extensive development and testing.

4. Testing and Evaluation: To confirm the rover's dependability and performance, extensive testing and evaluation were carried out at every stage of development. We conducted a battery of environmental stress testing, functional tests, and simulated trials of Martian terrain on the rover in order to find and fix any problems or weaknesses. Through this iterative process, we were able to continuously improve and optimize the rover's capabilities.

5. Continuous Improvement: We iteratively improved the rover's functionality and design in response to user requirements and testing input as part of our dedication to continuous improvement. We made hardware changes, software updates, and system optimizations to make sure the rover could handle the Australian Rover Challenge 2024.

Overall, rigorous planning, careful design, sturdy construction, extensive testing, and ongoing improvement have been hallmarks of our team's execution of the system development life cycle. We're sure that our strategy has set us up for success in the competition and adequately prepared us for the challenging challenges that lie ahead.

Sub System Overview: We present the detailed architecture and operation of our integrated rover system for the Australian Rover Challenge 2024 in this System Acceptance Review (SAR) report. Our system has been painstakingly designed to fulfill and surpass the specifications stated in the challenge regulations, guaranteeing top performance, dependability, and security in the Martian environment.

Final Technical Design Overview

The chassis and mobility subsystem, the power and energy management subsystems, the communication and control systems, the sensory and navigation systems, and the scientific instruments and experimentation are some of the essential components of our integrated rover system. In order to guarantee flawless operation and compatibility with the entire rover system, each subsystem has undergone extensive design, testing, and integration processes.

Figure: Initial vs Final Technical Design

Chassis and Mobility Subsystem

Our Mars Rover's chassis and mobility subsystem provide the fundamental structure that allows for mobility across a variety of Martian environments while safely enclosing vital components. Our chassis is built with aerospace-grade aluminum that is reinforced with iron bars and stainless steel to provide maximum strength and longevity. Furthermore, a combination of aluminum and stainless steel alloy offers the strength and light weight required for structural integrity and mobility on Mars. Crucial wheel structural portions have iron bars inserted into them to improve resistance in rough terrain. Durability, mobility, adaptability, weight reduction, and resilience to environmental changes are the top priorities in our design. The material selection process utilizes aerospace-grade aluminum, carbon fiber, and protective coatings, which provide superior strength-to-weight ratio, flexibility, and resistance to environmental conditions and corrosion.

Rover Arm:

Our rover has a strong, adaptable robotic arm that can perform a variety of activities including the collecting and manipulation of samples effectively. The rover arm's low-energy-consumption, highly efficient motors provide the necessary strength and control for the arm's functions while ensuring optimal power management.

The rover arm's design places a high value on accuracy and dependability, which makes it ideal for Mars' harsh environment. The arm's motors maximize the rover's operational efficiency by providing the required torque and speed while consuming the least amount of energy, whether the arm is being used for collecting soil samples, moving obstacles, or performing maintenance.

Moreover, the arm can easily move in delicate situations and handle complex terrain because to its fine control skills. This level of accuracy is necessary for carrying out research studies, managing fragile equipment, and engaging in regulated interactions with the rover's environment.

All things considered, the rover arm is an essential part of our rover's toolbox that enables it to carry out a variety of duties efficiently, save energy, and guarantee mission success on the Martian surface.

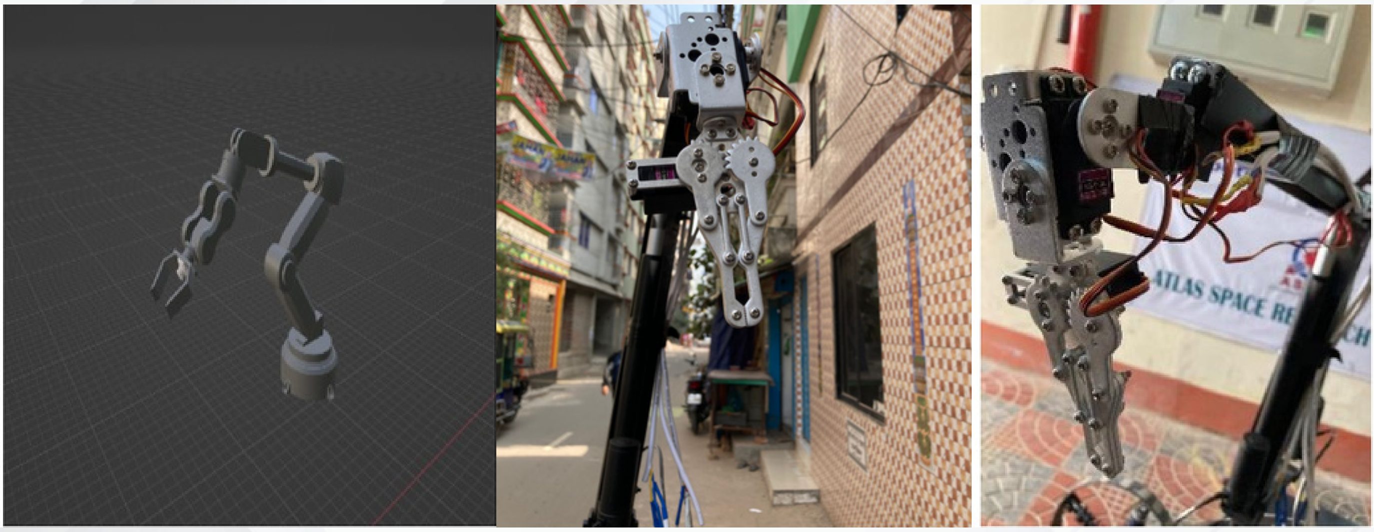


Figure: Initial vs Final Robotic Arm Design

Wheel: We have included a novel elastic suspension technology in the design of our rover's wheels. This design makes sure that the wheel absorbs the majority of the vibration or shaking, protecting the rover's upper body and motor from potential harm.

In addition, the wheel's elasticity enables us to capture rotational energy and transform it into electrical energy. The rover has a steady supply of electricity because to this energy production that takes place while the wheel turns.

The rover's batteries can be efficiently recharged by using this renewable energy, allowing it to continue operating even in the most isolated Martian areas.
This dual capability improves the rover's ability to generate electricity while also making a major structural and safety contribution.

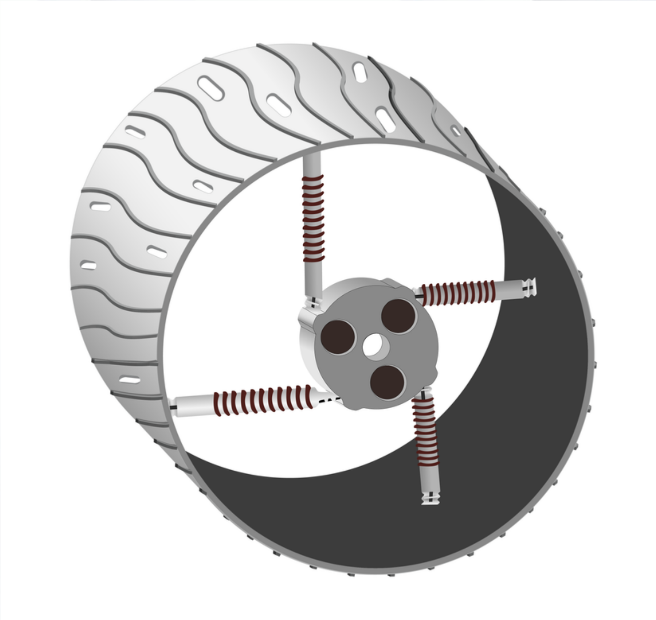


Figure: Initial vs Final Wheel Design

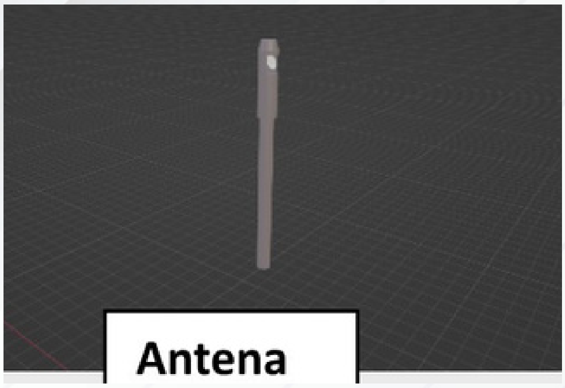
Figure: The spring & the full body with wheel

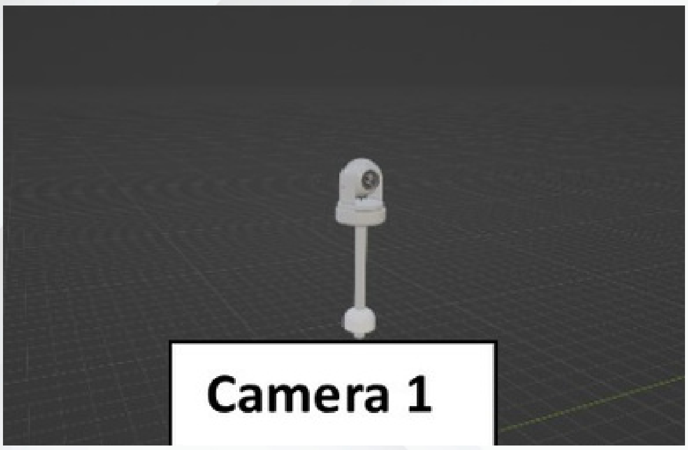
Power and Energy Management Subsystems
The subsystems of our rover's power and energy management are designed to maximize both sustainability and operational efficiency on Mars. We supply power to our rover through sophisticated energy distribution systems, high-density lithium-ion batteries, and effective motors.

New techniques improve power efficiency, such as turning rotational energy into electrical energy. There is more than enough power thanks to a 100-watt solar panel that supports extra generation and a combination of big dry cell batteries, lithium polymer batteries, and E Rickshaw Batteries. Our energy management technology ensures uninterrupted operation even in low-energy situations by allocating electricity according to operational needs. Smooth integration with other systems facilitates general functionality, including communication with Earth, scientific experimentation, and mobility.

Systems for Control and Communication

We can send data from the rover to mission control on Earth across long distances because to our communication technology. Coordinated command execution and dependable communication are made possible by RF transceivers, centralized control units, and high- and low-gain antennas. For both autonomous and manual operation modes, the control interface has specially designed software that guarantees accurate control even in the event of signal lag.





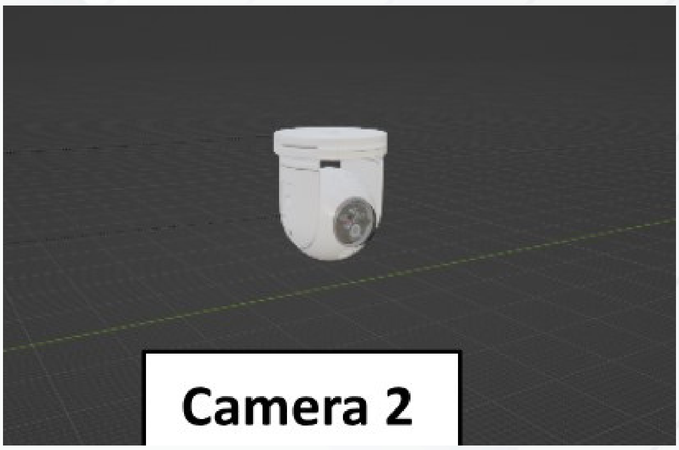


Figure: Demonstration of the Control & Communication system

Sensory and Navigation Systems:

Our rover is well-equipped for independent Martian exploration. These include ultrasonic sensors for obstacle detection, gyroscope modules for precise navigation, and RPM sensors for measuring speed. Furthermore, laser modules help with precise distance measurement. Safety measures that guarantee prompt response to possible risks include smoke sensors and circuit breakers. Our rover's capabilities are further improved by the integration of Lidar sensors, which offer precise mapping and real-time positioning that are essential for navigation tasks. Our sensory suite records a wide range of information, including environmental factors like humidity and temperature as well as 3D photographs. GPS, gyroscopes, and IMUs are examples of navigational sensors that guarantee accurate orientation and location tracking. Our rover can navigate the Martian environment and avoid obstacles with ease thanks to autonomous navigation software. Our rover features an advanced

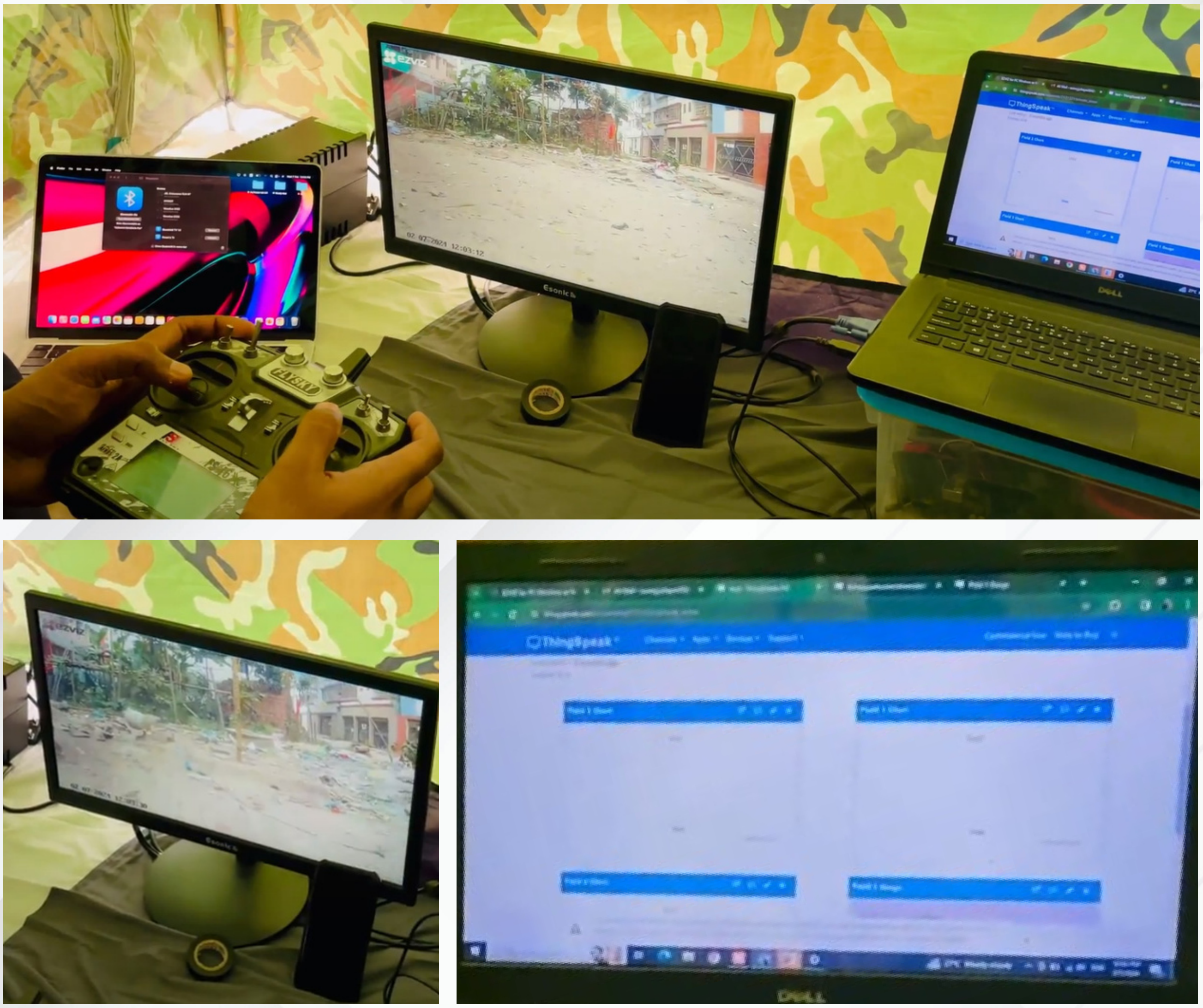


Figure: Demonstration of our rover's Navigation System

Scientific Instrumentation and Experimentation:

Our Mars Rover is outfitted with a suite of sophisticated scientific instruments meticulously designed to unlock the mysteries of the Martian environment and contribute to our understanding of the planet's past and present conditions. The instrumentation onboard includes:

1. Spectrometers: We included the spectrometers in the suite of instruments on our rover. These tools are essential for determining the chemical composition of rocks and soil on Mars, which offers important information on the surface's geology.

2. Weather Station: With the weather station on our rover, we can keep an eye on the Martian atmosphere. This provides vital information for atmospheric research and contains variables like temperature, wind speed, humidity, and atmospheric pressure.

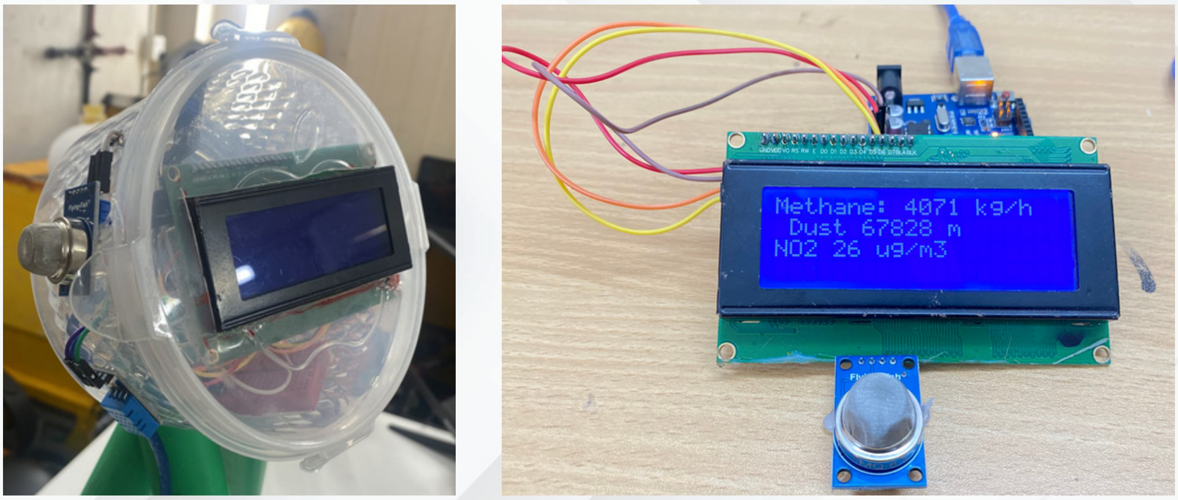


Figure: Demonstration of weather station

3. Soil and Rock Analysis Tools: We have equipped our rover with drills, scoops, and onboard laboratories so that we can perform in-depth chemical studies of Martian rocks and soil. These instruments help with geological research by allowing us to gather samples and examine their physical and chemical characteristics.

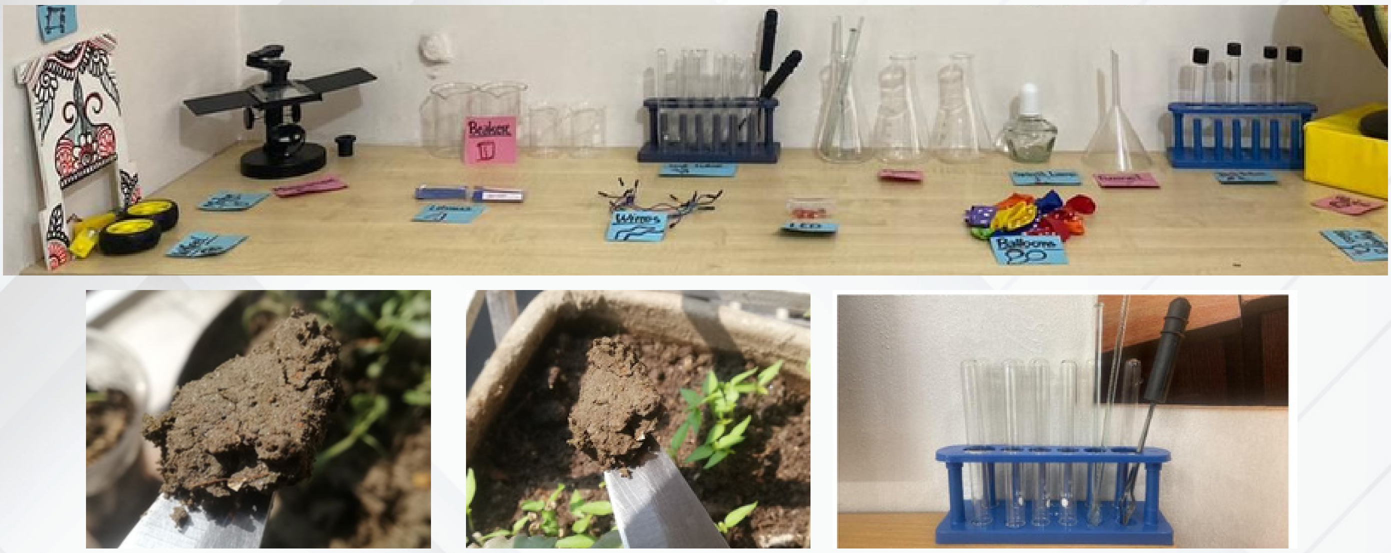


Figure: Demonstration of Soil & Rock analysis tool in Rover

4. Cameras: Our rover's design includes high-resolution cameras that will enable geological and atmospheric research on Mars. These cameras record films and photos in a range of spectra, giving researchers and scientists access to invaluable visual data for investigation and analysis.

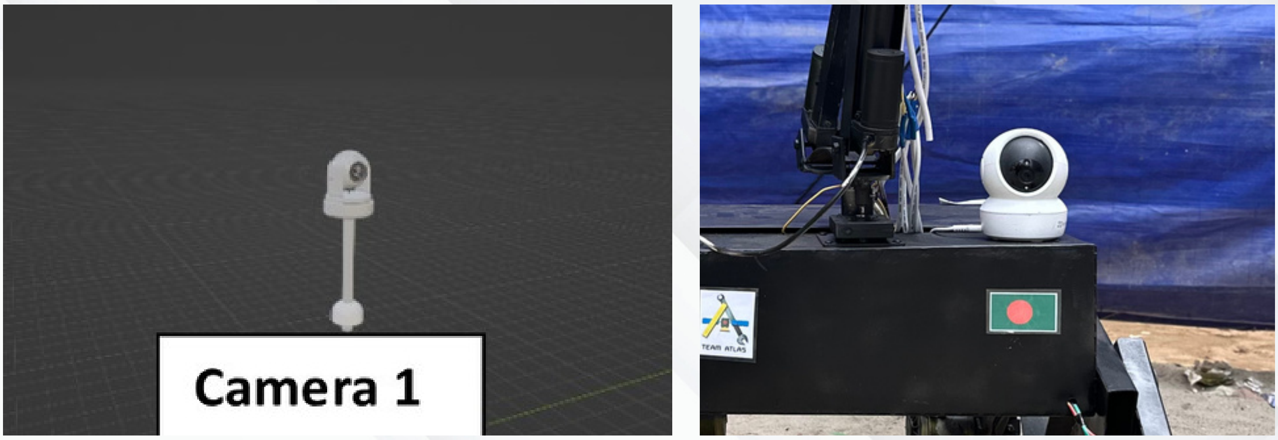


Figure: Demonstration of our Camera in Rover

Experimentation

The rover that we have is capable of carrying out geological surveys on Mars. We want to learn more about the geological history and evolution of the planet by examining surface characteristics and rock formations.

1. Atmospheric Analysis: We have created experiments to investigate Martian atmospheric conditions and weather patterns. To study the Martian climate better, this includes keeping an eye on changes in temperature, air pressure, and dust dynamics.

Figure: Demonstration of Atmospheric Analysis in Rover

2. Look for Water: The instruments on our rover can find water on Mars' surface as well as beneath the surface. These tests are designed to evaluate historical habitability and pinpoint possible resources for missions in the future. We are still working on it.

Meeting Rover Requirements

Our integrated rover system satisfies every important criteria specified in the rules, having successfully met the demanding standards set by the Australian Rover Challenge 2024. We describe below how our rover satisfies each of these criteria:

1. Size: The length, breadth, and height of our rover are 1.3 m * 0.7 m * 1.06 m, which is within the challenge regulations' allowed size range. This sturdy yet small design allows for adequate room to house vital subsystems and instrumentation while guaranteeing agility through tight places.

Figure: Our Rover's Height, length & breadth

2. Weight: Our rover satisfies the weight requirements set forth in the challenge guidelines by weighing less than 50 kg. Without sacrificing structural integrity, this lightweight design improves mobility and lowers energy consumption to enable effective traversal across a variety of Martian terrains.

3. E-STOP: Our rover now has an e-stop system in place. The deployment of an Emergency Stop (E-STOP) system guarantees the security and safety of our rover's general operation and operational protocols. This mechanism comprises of a red latching button with a yellow surround that is readily accessible and visible on the rover's exterior. The E-STOP switch reduces potential dangers and guarantees the rover's safety in the case of an emergency, such as a battery fire, by instantly stopping all movement and cutting off all battery power.

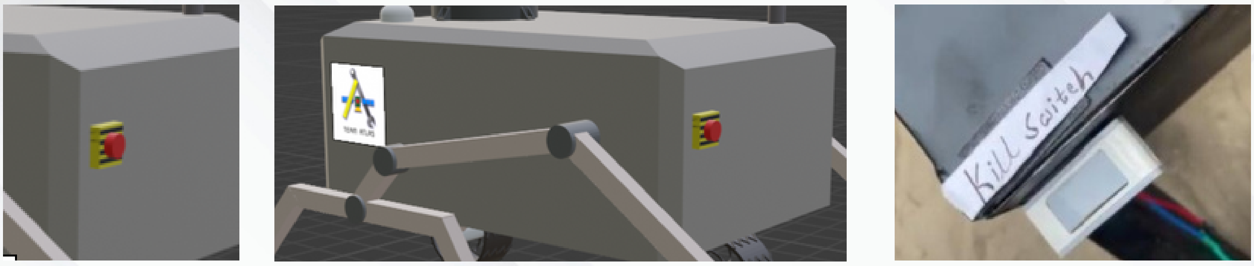


Figure: Demonstration of Kill Switch in the Rover

4. Communication and Control: The control and communication systems of our rover are built to address the challenges of wireless communication and remote operation. By employing a directional antenna for communication within the rover and a centralized control unit to oversee navigation, instrumentation, and data gathering, our approach guarantees accurate command fulfillment and uninterrupted data transfer during the mission.

Figure: Demonstration of Remote Control & Communication System

5. Safe Carry: In order to ensure the safe transportation of equipment unique to the mission, our rover is designed with a secure payload enclosure. During the rover's investigation of the simulated Martian surface, this housing protects the sensitive instruments from potential damage and interference, ensuring their integrity.

Figure: Demonstration of the joints which can be unscrewed and carry easily

Our integrated system exhibits readiness and competence for the Australian Rover Challenge 2024 by carefully attending to these rover requirements and putting strong design solutions into place. We are sure that the functioning and design of our rover will allow for successful navigation, testing, and exploration in the harsh Martian environment, eventually establishing us as formidable competitors.

<u>Video Test Details and Description</u>

Video Test Overview:
The accompanying video provides a concise yet comprehensive overview of the rover's capabilities, highlighting its performance during the Distributed Field Test (DFT) and other key testing activities. Key segments include:

- **Mobility Demonstration**: Showcasing the rover's terrain navigation, obstacle avoidance, and stability across different surfaces.

- **Instrument Operation**: Highlighting the functionality and precision of the instruments handling (wire, bottle)

- **Communication Test**: Demonstrating the effectiveness of the rover's communication system to base station.

- **E- Stop**: The emergency stop system in case of any emergency.

Description and Timestamps:

The video description includes detailed timestamps for each test or demonstration segment, allowing viewers to easily navigate to points of interest. For instance:

- **0:00-0:15**: Introduction of Atlas Mars rover with key movements: Introducing the key features (Wheel, Arm) and movements (Incline, Landing) of the Rover.

- **0:15-0:20**: Introducing the team and the sections: Teams working collaboratively by sections of Design, Mechanical and Control

- **0:20-0:25**: Rover Body and movement with the point of view camera of rover.

- **0:25-0:30**: Controlling the rover from the base station. (Field Team and control team), command execution.

- **0:30-0:35**: The specialty of the wheel with power generating method through the movement.

- **0:35-0:40**: Arm functionalities (picking wire and bottle handling) which are similar to competition tasks.

- **0:40-0:45**: Field team is turning on the E-Stop button of the rover by communicating with the control team.

- **0:45-0:50**: Climbing capability, movement toward different surfaces, obstacles handling.

- **0:50-0:60**: Night vision camera and navigation system of our rover to tackle challenges.

Planned Activities: The team's **planned activities** for preparing the rover for the challenge involve a comprehensive schedule spanning several weeks:

1. Systems Check Preparation (Weeks 1-2): Our main priorities will be to complete and thoroughly test the optical inspection, navigation around, and evacuation ramp descent algorithms. To guarantee a reliable and well-equipped rover, damage assessment techniques utilizing onboard cameras and sensors are developed and tested.
2. Site Evaluation & Communication Setup (Weeks 3-4): Combining navigation systems to enable supply cache access and verifying vocal communication protocols with the base station judge. RFID integration emphasizes adaptability and effective communication in dynamic contexts by facilitating the efficient capture and delivery of instructions.
3. Processing Plant Maintenance (Week 5): Thorough testing of the robotic arm's capabilities using fictitious maintenance chores that replicate different controls and items that are expected at the processing plant. guarantees the rover's preparedness for on-the-spot maintenance difficulties throughout the tournament.
4. Propellant Hose Connection (Week 6): Using mock drills, we will concentrate on improving and streamlining propellant hose hookup procedures. Connectors are precision- and reliability-engineered during design and manufacture. Sessions to improve your ability to perform this vital function in simulated environments.

For the Space Resources Task:

1. Prospecting Tools Development (Weeks 1-2): We are going to design and test prospecting equipment specifically for ilmenite and ice identification. creation of techniques for measuring resources in samples in order to guarantee precise resource evaluation.
2. Excavation and Processing Equipment Integration (Weeks 3-4): We'll integrate excavating equipment to gather regolith sample collection and test the processing unit within predetermined parameters. simulated the extraction of water from regolith and measured the result for effective resource use.
3. Presentation Preparation (Week 5): We're going to validate the data collecting and processing procedures while we draft the Space Resources Presentation. To guarantee a coherent and powerful presentation, team members should receive training on presentation techniques and technical aspects.

For the Excavation & Construction Task:

1. Excavation and Rock Clearing (Weeks 1-2): To guarantee a smooth workflow, we will develop and test mechanisms and procedures for cleaning rocks as well as validate regolith transport strategies.
2. Paver Construction (Weeks 3-4): In order to successfully complete the construction assignment, we will design and produce pavers in accordance with competition standards, test dust-mitigating features thoroughly, and validate the interlocking mechanism.

For the Mapping & Autonomous Task:

1. Autonomous Navigation Development (Weeks 1-2): We will create algorithms for autonomous navigation, validate autonomous imaging and relay capabilities, and test landmark navigation.
2. Exploratory Mapping and Presentation (Weeks 3-4): We will create a comprehensive mapping system, implement methods for exploratory mapping, and prepare a thorough presentation that highlights the team's inventiveness in mapping and navigating in dynamic landscapes.

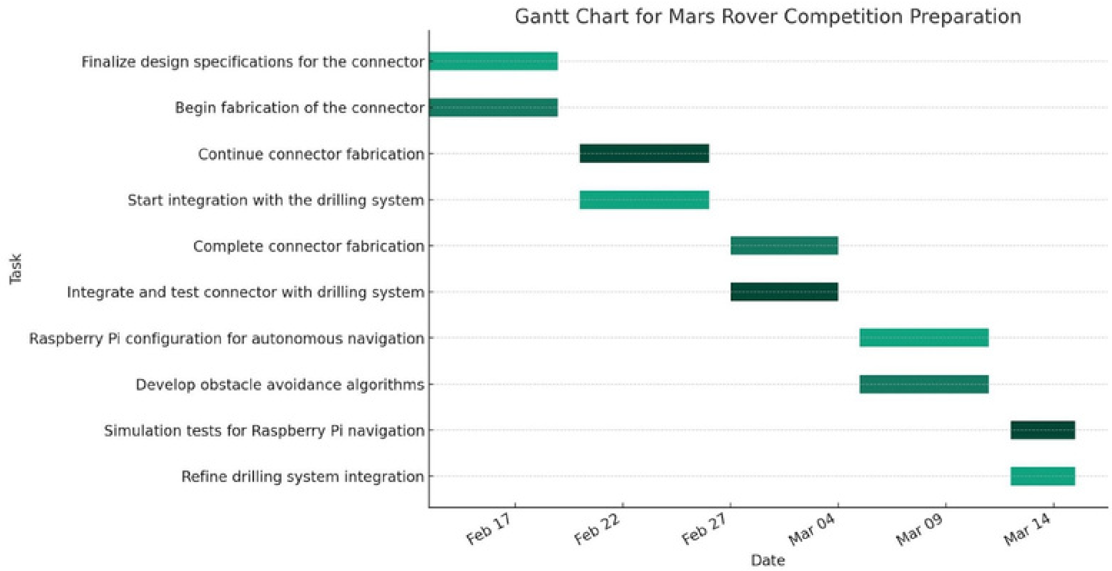


Fig: Gantt Chart (Work Plan Timeline)

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