ISRO - ROBOTICS 2024

Design & Test Report By

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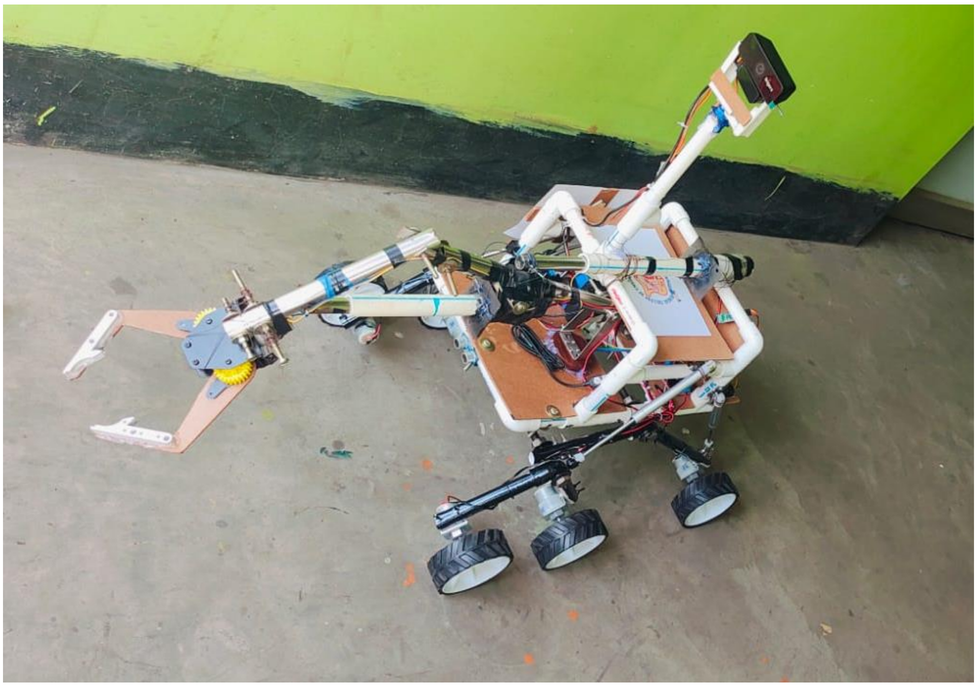
1. ABSTRACT

Rovers stand as technological marvels in the realm of space exploration, embodying the pinnacle of innovation and scientific achievement. Within the ambit of ISRO (Indian Space Research Organization), rovers play a crucial role in unlocking the secrets of celestial bodies. These robotic emissaries are designed to navigate and explore the surfaces of planets and moons, providing a wealth of data that contributes to our understanding of the cosmos.

One notable example is the Mars Rover mission, where ISRO's rover technology has proven instrumental. These rovers are equipped with an array of sophisticated instruments, including cameras, spectrometers, and analyzers, enabling them to capture high-resolution images, study mineral compositions, and conduct experiments. The data transmitted by these rovers has significantly expanded our knowledge of Mars, offering insights into its geology, climate, and potential habitability.



2. INTRODUCTION

Furthermore, the success of the Chandrayaan missions, which included a lunar rover, exemplifies ISRO's dedication to comprehensive planetary exploration. The rover, equipped with cutting-edge scientific instruments, traversed the lunar surface, collecting crucial data about the Moon's topography and mineral composition. Such missions showcase India's capability to design and deploy rovers that contribute significantly to our understanding of the solar system.

ISRO's rovers stand as symbols of India's technological prowess and scientific curiosity in the field of space exploration. As ISRO continues to push the boundaries of space research, the role of rovers remains paramount in unraveling the mysteries of the cosmos and expanding our understanding of the universe. The development and deployment of these robotic explorers underscore India's position as a key player in the global space community.

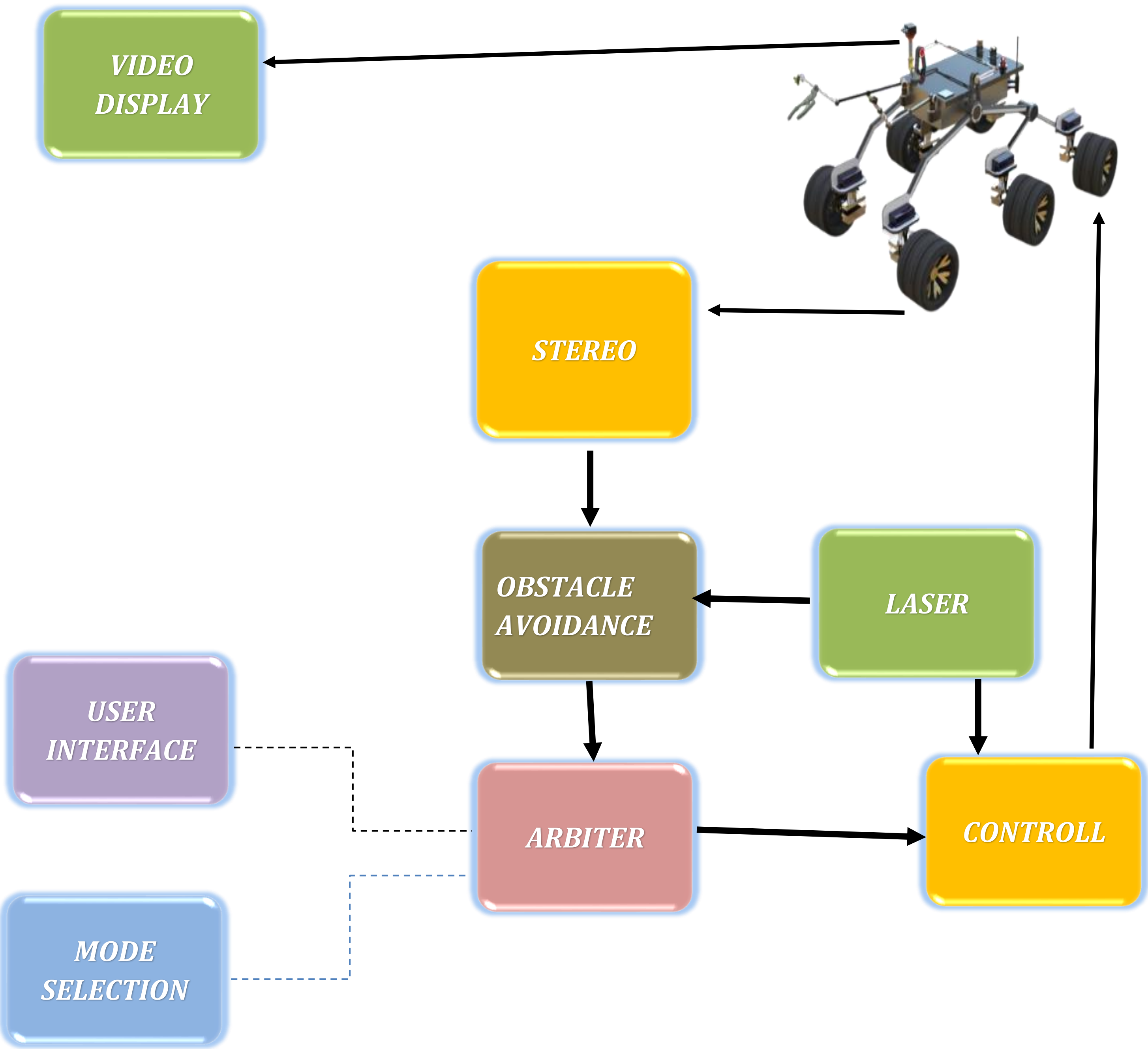
ISRO's commitment to innovation is evident in the development of indigenous rover technologies. These robotic explorers are engineered to withstand the harsh conditions of extraterrestrial environments, including extreme temperatures, rugged terrains, and low-gravity conditions. The ability of ISRO's rovers to adapt to such challenging landscapes demonstrates India's prowess in space technology and engineering.

3. SYSTEM ARCHITECTURE

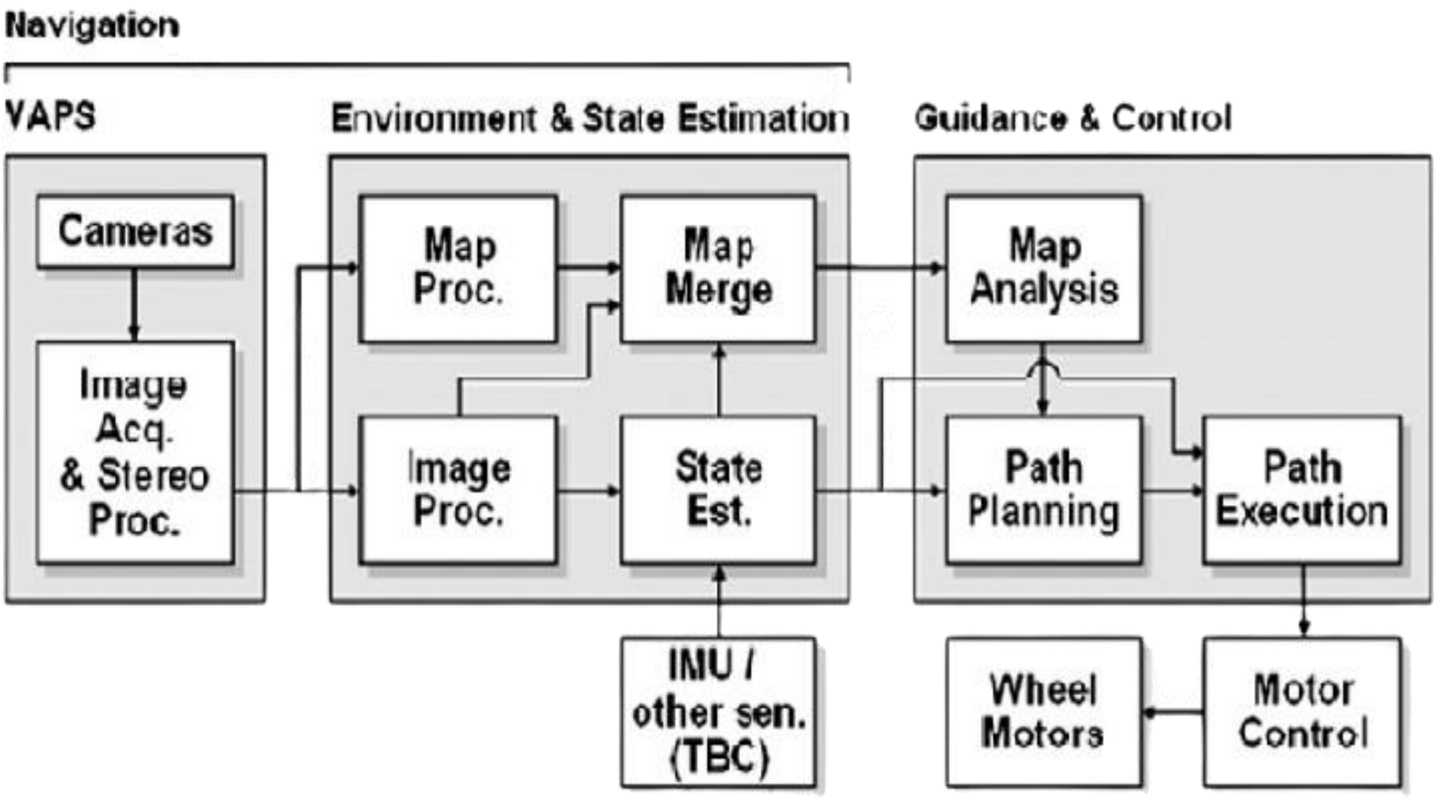
System architecture is a critical aspect of any technological infrastructure. It defines the structure, behavior, and interaction of the elements that compose a system. This report aims to provide an overview of system architecture of ROVER.

Designing a rover involves various aspects of system architecture to ensure its functionality, adaptability, and reliability. Here's a breakdown of the essential system architecture components for a rover:

3.1 Navigation System Architecture:



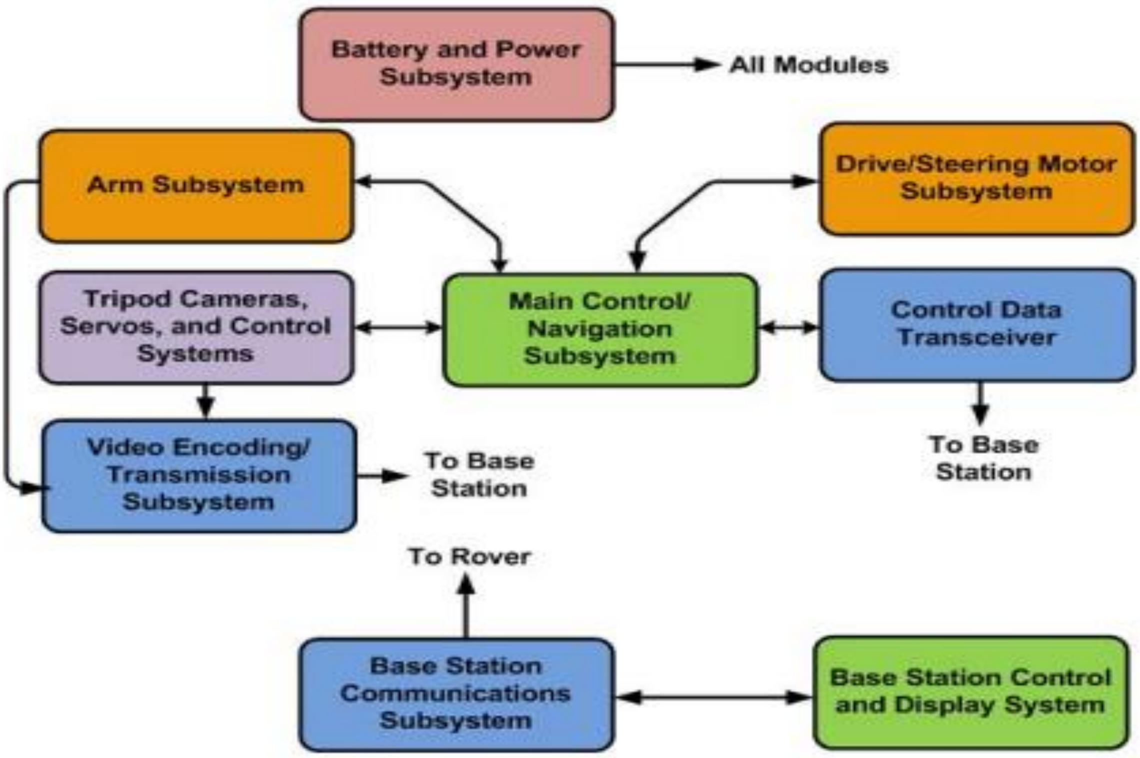
- **COMMINCATION HARDWARE:** _Communication Hardware enables the rover to communicate with Earth or other satellites for data transmission and command reception.



- **MECHANICAL STRUCTURE:** The physical body of the rover, including wheels, chassis, joints, and moving parts. This is designed for durability, stability, and adaptability to the terrain.

- **SENSORS:** Sensors are used for determine the rover's ability to perceive its environment and interact with it. Here the sensors includes: Ultrasonic Sensor, Temperature sensor, camera(night vision),Soil temperature sensor.

3.2 Rover Electrical System Architecture:



- **POWER SYSTEM:**_ Power system is used for providing the necessary electricity to run the rover's systems. The batteries we are using is of [12V 10(amp)] and [9V]

4. ROVING MECHANISM

The rover design is characterized by a hexagonal chassis featuring a 6-wheel drive system, where each wheel operates independently for exceptional maneuverability and efficient obstacle clearance. The design prioritizes adaptability, facilitated by a modular wheel configuration that allows for easy interchange based on the lunar terrain, whether sandy expanses or rugged landscapes.

A key component of the rover's architecture is the active suspension system, employing individually controlled shock absorbers that dynamically adjust to the lunar terrain in real-time. This not only ensures stability during traversal but also contributes to smooth and efficient movement. Notably, the suspension system incorporates energy harvesting during descents, enhancing operational efficiency and sustainability.

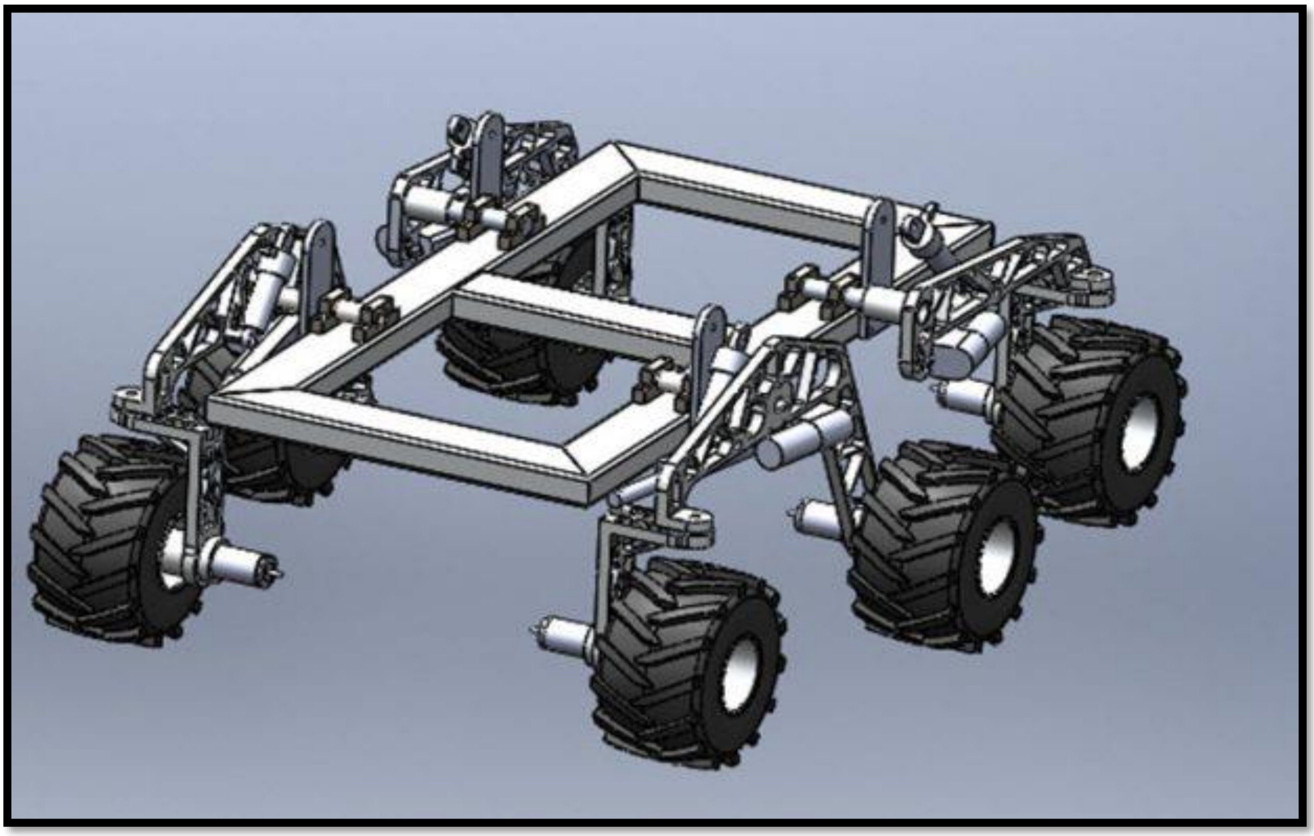
Navigation and obstacle avoidance are achieved through advanced technologies. The rover is equipped with LiDAR technology for 3D mapping and precise obstacle detection in conditions of low visibility. Additional support comes from the Inertial Measurement Unit (IMU) and odometer systems for accurate positioning and tracking. A redundant control system enhances operational robustness, ensuring mission continuity in the face of potential system failures.

The rover's adaptability is further emphasized by its modular design, allowing for the seamless interchange of wheels, sensors, and manipulator arms. This design philosophy accommodates diverse lunar environments, enabling the rover to customize its configuration for each specific mission. Artificial Intelligence (AI) is harnessed for path planning, utilizing data from onboard sensors to optimize routes based on lunar terrain characteristics and object locations.

Efficiency remains a central focus, driven by a power system comprising a 12 Volt 10 Ampere battery as the primary power source for sustained rover operations. This battery provides ample energy for various rover components and modules. Additionally, a 9 Volt Amazon battery serves as a supplementary power source for specific components, enhancing versatility by supporting lower voltage requirements. Both batteries contribute to the rover's sustained and reliable operation on the lunar surface.

Precision is achieved through the integration of advanced technologies, including an ESP8266 Camera module for visual capabilities, aiding in remote exploration, obstacle detection, and lunar surface analysis. AI algorithms power object recognition and grasping mechanisms, allowing for accurate selection and safe manipulation. Proximity sensors add an extra layer of precision, enabling fine-grained object manipulation and collision avoidance.

Communication is facilitated by RF Transmitter and Receiver modules, enabling rover communication over long distances. These modules play a crucial role in data exchange for remote operations and control, ensuring reliable command transmission during lunar exploration missions.



The computational core of the rover is a Raspberry Pi along with a Raspberry Pi Camera, providing advanced computational capabilities and supporting high-quality visual data acquisition on the lunar surface. This enhances overall mission efficiency and facilitates scientific analysis.

5. Mechanism for Sample Pick-and-Place Activity

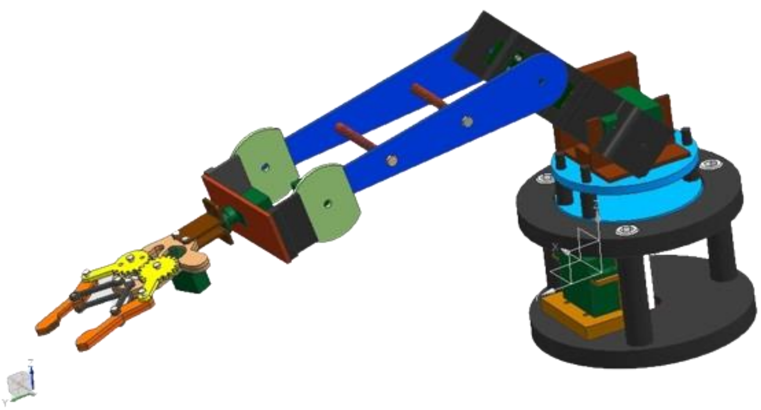
Pick and place robots are commonly used in modern manufacturing environments. Pick and place automation speeds up the process of picking up parts or items and placing them in other locations. Automating this process helps to increase production rates. Pick and place robots handle repetitive tasks while freeing up human workers to focus on more complex work.

5.1 Pick and Place Mechanism:

A sample pick-and-place mechanism typically involves a system with components like robotic arms, grippers, sensors, and controllers to perform the task of picking up objects from one location and placing them in another. Here's a breakdown of the components and their functions:

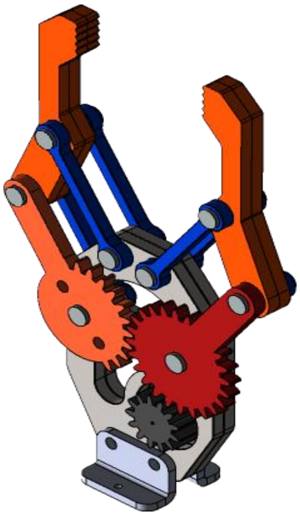
5.2 Robotic Arm:

This is the main component responsible for movement. It can be a simple single-arm design or a more complex multi-axis arm for better maneuverability. It's equipped with joints, allowing it to move in various directions A 5-axis robotic arm robot can be used for standard pick and place applications where objects are picked up and moved to other locations in a single plane. A 6-axis robotic arm robot is used for more complex applications, such as when objects must be twisted or re-oriented before being placed in another location.



5.3. Gripper / End Effector:

The end effector is attached to the robotic arm and is used to grasp objects. Grippers come in various forms such as mechanical claws, suction cups, electromagnets, or even specialized tools designed for specific objects.



5.4 Sensors:

These are essential for providing feedback to the system. Sensors can include cameras, proximity sensors, force sensors, or other types of detectors. They help the system identify the location, orientation, and characteristics of the objects to be picked and placed.

5.5 Controller/Software:

The control system manages the overall operation. It processes input from sensors, determines the position and orientation of the object, calculates the necessary movements for the robotic arm, and controls the gripper to pick up and release the object accurately.

5.6 Collaborative:

Collaborative robots augment the work of humans by leading associates to pick locations and guiding associates through each task. By optimizing routes in real-time and keeping associates on task, collaborative robots help associates work more efficiently.

The process generally involves the following steps:

Detection:

Sensors identify the location, orientation, and properties of the object to be picked.

Planning:

The controller calculates the necessary movements required to reach and pick up the object.

Execution:

The robotic arm moves to the object's location, guided by the controller, and the gripper grasps the object securely.

Transport:

The arm then moves to the desired location while holding the object.

Release:

Once at the destination, the gripper releases the object as instructed by the controller.

Feedback:

Sensors provide feedback to ensure successful placement, and the system may adjust if necessary.

6. Emergency Response

If a rover encounters an unexpected obstacle or a critical system failure, it may trigger an emergency response. The rover's AI would analyze the situation, possibly sending an alert to Earth and implementing predefined protocols. Depending on the severity, it might autonomously attempt to navigate around the obstacle or shut down non-critical systems to conserve power until further instructions are received from mission control.

Emergency response in a rover, like those used in space exploration or autonomous vehicles, requires a comprehensive system to address various potential issues.

Here are key aspects of emergency response in a rover:

6.1 Monitoring Systems:

- **Sensors:** Rovers are equipped with various sensors to monitor their surroundings, including cameras, temperature sensors, accelerometers, etc.

- **Health Monitoring:** Continuous monitoring of rover health, including power levels, mechanical stress, and system performance.

6.2 Emergency Detection:

- **Anomaly Detection:** Algorithms that can identify anomalies or deviations from normal operations.

- **Failure Prediction:** Systems capable of predicting potential failures before they occur.

6.3 Response Mechanisms:

- **Autonomous Systems:** Rovers should have autonomous decision-making capabilities to respond to emergencies without human intervention when necessary.

- **Remote Control:** Ability for human operators to take manual control if needed.

6.4 Communication:

- **Telemetry Data:** Constant communication of telemetry data to Earth for analysis and decision-making.

- **Emergency Communication:** Robust communication systems for transmitting emergency signals and receiving commands.

6.5 Emergency Protocols:

- **Emergency Power Cut :** Power is automatic cut at the emergency time.

- **Priority Actions:** Immediate actions to safeguard the rover or mitigate risks (e.g., shutting down specific systems, changing operational mode).

6.6 Redundancy and Backup Systems:

- **Redundant Components:** Backup systems for critical components to ensure functionality even if primary systems fail.

- **Software Fail-Safes:** Software-based fail-safes to prevent catastrophic failures.

6.7 Remote Diagnostics and Repair:

- **Remote Diagnosis:** Capabilities to diagnose issues remotely using collected data.

- **Remote Repair or Reconfiguration:** Some capacity to remotely fix or reconfigure systems to address issues.

6.8 Energy Management:

- **Power Management:** Prioritizing power allocation during emergencies to ensure critical systems remain operational.

7. HARDWARE IDENTIFICATION

The hardware components selected for the rover development encompass essential elements such as a powerful microprocessor, sensors for navigation and data acquisition, high-capacity batteries, a sturdy chassis, and reliable wheels for mobility. Additionally, a robust communication module is integrated to ensure seamless data transmission during rover operations. In addition to the core components, specialized modules like cameras and robotic arms enhance the rover's capabilities for specific tasks, contributing to a versatile and efficient robotic platform.

The details of the hardware components are as follows –

- Sensors –
  - Ultrasonic sensor - The ultrasonic sensor in the moon rover detects obstacles, aiding navigation, and ensures safe manoeuvring during lunar exploration missions.
  - Temperature Sensor - The temperature sensor in the moon rover gauges ambient temperature, providing vital data for monitoring lunar environmental conditions and ensuring optimal functioning during exploration missions.
- Camera –

  The camera on a moon rover is instrumental in acquiring detailed visual data, facilitating precise terrain assessment, geological analysis, and enhancing situational awareness for efficient lunar exploration and research endeavours. Additionally, it enables scientists and engineers to remotely monitor and control the rover's activities, contributing to the success of the mission.
- Body Structure –

  The moon rover's body structure incorporates a resilient design utilizing 1.5 mm cardboard, reinforced with L angles secured by nuts and bolts. The electric casing, composed of 1-inch and 1.5-inch pipes, serves as a durable framework. The integration of five glue sticks enhances structural stability. Additionally, a robotic arm, crafted from a metal plate, facilitates the investigation of soil removal characteristics using a flexible tube coring method during lunar exploration missions. This robust structure ensures the rover's ability to withstand the lunar terrain challenges while efficiently conducting soil investigations.

- ❖ Microcontrollers –
- ➢ Arduino Uno - Arduino Uno enhances the moon rover by providing a versatile micro-controller platform for efficient control, sensor interfacing, and data processing.
- ➢ ESP8266 Camera module - The ESP8266 Camera module equips the moon rover with visual capabilities, aiding in remote exploration, obstacle detection, and lunar surface analysis.
- ➢ RF Transmitter and Receiver - Enable rover communication over long distances. Facilitate data exchange for remote operations and control. Essential for reliable command transmission during lunar exploration missions.
- ➢ Raspberry Pi with Raspberry Pi Camera: Equips the rover with advanced computational capabilities. Enables high-quality visual data acquisition on the lunar surface. Enhances overall mission efficiency and supports scientific analysis.
- ❖ Battery –
- ➢ 12 Volt 10 Ampere Battery - Provides a reliable power source for sustained rover operations. Ensures sufficient energy for various components and modules.
- ➢ 9 Volt Amazon Battery - Serves as a supplementary power source for specific components. Enhances versatility by supporting lower voltage requirements.

- ❖ Miscellaneous Items –
- ➢ Arduino Male-Female Jumper Wire - Facilitates flexible and organized connections between Arduino and other components. Simplifies circuit prototyping and adjustments during rover development.
- ➢ Silicone Electrical Cable - 18AWG 0.75mm² 6 Colour - Offers a durable and flexible wiring solution for rover components. Ensures efficient electrical connectivity with color-coded cables.
- ❖ Tools - Essential tools and parts for manual adjustments and repairs during rover deployment. Enhances adaptability and on-site maintenance capabilities.
- ➢ Screwdriver Tool - Facilitates the assembly and disassembly of components. Essential for securing and adjusting hardware elements in the rover.
- ➢ Soldering Iron - Enables precise and secure connections for electronic components. Enhances the durability and reliability of electrical connections.
- ➢ Black Cello Tape - Provides a versatile and adhesive solution for securing cables and components. Aids in cable management and ensures a tidy arrangement within the rover.

8. SOFTWARE IDENTIFICATION

This section includes the necessary software which are required for our various operations to be performed by the rover:

8.1 Software Requirements for Operating the Realized System:

Autonomous Navigation:
Requirement: The system must incorporate robust autonomous navigation capabilities, allowing the moon rover to traverse the lunar surface independently.
Autonomy is crucial due to the communication delay between Earth and the Moon. The rover needs to make real-time decisions to navigate safely, avoiding obstacles and selecting optimal paths.

Communication Protocol for Intermittent Connectivity:
Requirement: Implement a communication protocol, such as Delay-Tolerant Networking (DTN), to handle intermittent connectivity between the moon rover and the Earth control center.
DTN is designed to cope with delays and disruptions in communication, ensuring reliable data transmission even in challenging lunar conditions.

Power Management System:
Requirement: Develop a sophisticated power management system that optimizes the usage of the rover's power source (e.g., solar panels) during both lunar days and nights.
Efficient power management is essential for the rover's sustained operation and to maximize the scientific data collection and exploration time.

Scientific Data Processing and Analysis:
Requirement: Implement software for real-time processing and analysis of scientific data collected by the rover's instruments, such as cameras, spectrometers, and environmental sensors.
Rapid analysis of scientific data allows for timely decision-making and enhances the rover's ability to fulfill its mission objectives, providing valuable insights into the lunar environment.

Security Measures:
Requirement: Integrate security measures, including encryption and authentication protocols, to safeguard communication channels and prevent unauthorized access to the rover's control systems.
Ensuring the security of the rover's communication and control systems is vital to protect against potential cyber threats or unauthorized interference during the mission.

8.2 Algorithm Selection for Various Computation Tasks:

Path Planning and Navigation: A Algorithm*
Task: Autonomous navigation on the lunar surface.
Algorithm: A* (A-star)
A* is a search algorithm that efficiently finds the shortest path between two points, considering obstacles and varying terrain. It's well-suited for lunar navigation, providing optimal paths while avoiding obstacles.

Obstacle Detection and Avoidance: LiDAR-based Simultaneous Localization and Mapping (SLAM)
Task: Navigating around obstacles in real-time.
Algorithm: LiDAR-based SLAM
SLAM combines data from LiDAR sensors to create a map of the rover's surroundings and simultaneously locate itself within that map. This enables the rover to detect obstacles and navigate around them.

Autonomous Decision-Making: Reinforcement Learning (RL)
Task: Learning from the environment to make autonomous decisions.
Algorithm: Reinforcement Learning (RL)
RL enables the rover to learn by trial and error, adapting its behavior based on feedback from the environment. It's ideal for scenarios where the rover needs to make adaptive decisions during exploration.

Image Processing for Navigation and Exploration: Convolutional Neural Networks (CNNs)
Task: Analyzing images from cameras for navigation and scientific exploration.
Algorithm: Convolutional Neural Networks (CNNs)
CNNs excel in image recognition tasks, making them ideal for processing visual data. They can be used for identifying terrain features, scientific targets, or potential obstacles.

Communication Protocol Optimization: Delay-Tolerant Networking (DTN)

Task: Reliable communication in an environment with intermittent connectivity.

Algorithm: Delay-Tolerant Networking (DTN)

DTN is designed for situations where network connectivity is sporadic. It enables the rover to transmit data reliably, even when there are delays or disruptions in communication with Earth.

9. Hardware and Software Realization Plan

As we traverse the intricacies of hardware configurations, each component undergoes rigorous evaluation to ensure compatibility and optimize efficiency. Concurrently, the software blueprint is methodically crafted with a focus not only on immediate functionality but also on adaptability to forthcoming upgrades and technological advancements. This comprehensive approach guarantees a harmonious integration of hardware and software, fostering the development of a resilient and forward-looking system .The meticulous attention to detail during the realization phase is imperative for the seamless execution of the project, serving to minimize potential setbacks and optimize overall efficiency.

9.1 Hardware Realization Plan:

Through the careful alignment of every hardware and software facet with predetermined specifications, we establish the foundation for a successful implementation that not only meets current requirements but also anticipates and adapts to the dynamic technological landscape. In essence, this precision-driven process transforms abstract concepts into a tangible, functional reality, propelling the project toward its desired outcomes with scientific rigor, strategic foresight, and a commitment to technological excellence.

No	HARDWARE DETAILS	PROCUREMENT SOURCE (MARKET/FABRICATION)	SPECIFICATION/ REALIZATION PLAN	QUANTITY	ESTIMATED COST
1	Ultrasonic sensor	Market	Implement for obstacle detection and avoidance.	1	160
2	temperature sensor	Market	include for environmental monitoring.	1	100
3	1 inch and 1.5, inch electric casing pipe	Market	Structure		60
4	Robotics Arm	Online Marketplace	Pickup and Drop	1	1200
5	Electric casing	Market	Structure		
6	Arduino uno	Online Marketplace	Arduino Uno for basic control	1	550

7	ESP8266 Camera module	Online Marketplace	ESP8266 camera module, Raspberry Pi camera, and RF Transmitter/Receiver for video streaming and remote control.	1	700
8	RF Transmitter and receiver	Market	ESP8266 for wireless communication, RF Transmitter/Receiver for remote control, and Raspberry Pi for advanced processing.	2	1250
9	Raspberry Pi with Raspberry	Online Marketplace	Utilize the Raspberry Pi for higher-level processing and control.	2	4000
	Pi camera		Interface the Raspberry Pi camera for image/video processing		
10	12 Volt 10 ampere battery	Market	Utilize a 12V, 10A battery for main power and a 9V Amazon battery for specific components.	2	1200
	9 Volt Amazon battery			1	230
11	Arduino male female jumper wire	Market	Use Arduino male/female jumper wires for connecting components	3	200
12	Silicone Electrical Cable - 18AWG 0.75mm^2 6 Colour	Market	Employ Silicone Electrical Cable (18AWG, 0.75mm^2, 6 colors) for organized and efficient wiring	4	100

9.2 Software Realization Plan:

1. **Identification of software requirements for operating the realized system:**

No.	Realized System Name	Requirement	Working
1	Autonomous Navigation	The system must incorporate robust autonomous navigation capabilities	Autonomy is crucial due to the communication delay between Earth and the Moon
2	Communication Protocol for Intermittent Connectivity	Implement a communication protocol, such as Delay-Tolerant Networking (DTN)	DTN is designed to cope with delays and disruptions in communication
3	Power Management System	Develop a sophisticated power management system that optimizes the usage of the rover's power source	Efficient power management is essential for the rover's sustained operation
4	Scientific Data Processing and Analysis	Implement software for real-time processing and analysis of scientific data collected by the rover's instruments	Rapid analysis of scientific data allows for timely decision-making and enhances the rover's ability to fulfill its mission objectives
5	Security Measures	Integrate security measures, including encryption and authentication protocols	Ensuring the security of the rover's communication and control systems

2. **Algorithm selection for various computation tasks:**

No.	Computation Task	Task Name	Algorithm Use	Working
1	Path Planning & Navigation	Autonomous navigation on the lunar surface	A* (A-star)	A* is a search algorithm that efficiently finds the shortest path between two points
2	Obstacle Detection and Avoidance	Navigating around obstacles in real-time	LiDAR-based SLAM	It is use to create a map of the rover's surroundings and simultaneously locate itself within that map
3	Autonomous Decision-Making	Learning from the environment to make autonomous decisions	Reinforcement Learning (RL)	RL enables the rover to learn by trial and error, adapting its behavior based on feedback from the environment
4	Image Processing for Navigation and Exploration	Analyzing images from cameras for navigation and scientific exploration	Convolutional Neural Networks (CNNs)	CNN can be used for identifying terrain features, scientific targets, or potential obstacles.
5	Communication Protocol Optimization	Reliable communication in an environment with intermittent connectivity	Delay-Tolerant Networking (DTN)	DTN is designed for situations where network connectivity is sporadic

10. TEST PLAN:

Creating a test plan for a rover involves outlining the various aspects that need testing, including its hardware, software, functionalities, and performance. Here's an outline you might consider:

10.1. Identification of required tests:

1. Introduction

- **Objective:** Define the purpose of testing and the goals of the rover.
- **Scope:** Specify what will be covered in the test plan.

2. Test Strategy

- **Testing Types:** Define the types of testing to be conducted (e.g., functional, performance, stress testing).
- **Testing Approaches:** Detail how each type of testing will be performed (e.g., manual, automated).
- **Tools and Resources:** List the tools, equipment, and human resources required for testing.

3. Test Scenarios

- **Functional Testing**: Create scenarios to test each functionality (e.g., movement, data collection).
- **Navigation Testing:** Verify navigation capabilities in different terrains.
- **Communication Testing:** Ensure proper communication between the rover and base station.

4. Performance Testing

- **Speed and Movement:** Test the rover's speed and agility in various conditions.
- **Battery Life:** Evaluate battery performance and endurance during operation.
- **Sensor Accuracy:** Verify the accuracy of sensors under different scenarios.

5. Software Testing

- **Firmware Testing:** Check the reliability of the rover's firmware.
- **Code Validation:** Ensure the codebase is free of bugs and errors.
- **Compatibility Testing:** Validate compatibility across different software versions.

6. Environmental Testing

- **Temperature and Weather:** Test the rover's functionality in extreme temperatures or adverse weather conditions.
- **Terrain Testing:** Evaluate performance on different types of terrain (rocky, sandy, etc.).

7. Safety Testing

- **Emergency Procedures:** Validate emergency shutdown and safety protocols.
- **Collision Avoidance:** Test systems that prevent collisions or minimize damage.

8. Data Handling and Transmission

- **Data Collection:** Verify data collection mechanisms and accuracy.
- **Data Transmission:** Test the reliability of data transmission to the base station.

9. Documentation

- **Test Cases:** Document specific test cases and expected outcomes.
- **Logs and Reports:** Maintain logs and reports for each test scenario and its results.

10. Risk Assessment

- **Identify Risks:** List potential risks during testing and operation.
- **Mitigation Plan:** Provide strategies to mitigate or address these risks.

11. Timeline and Milestones

- **Testing Schedule:** Provide a timeline for each phase of testing.
- **Milestone Targets:** Set specific milestones to track progress.

10.2 Test plans for all identified tests:

1. Navigation Testing using robot car:

For navigation testing, we employ a small robotic car. Utilizing object-oriented programming, we assess whether the car functions correctly within a confined space. Additionally, we observe whether the car adheres to the designated path.

2. Pick up and Drop Testing:

To thoroughly assess the pickup and drop functionalities, we will manually operate a robotic arm. Utilizing a microcontroller, we aim to verify whether the arm can consistently perform precise and effective pickups as part of the testing process.

3. Coding Implement in microcontroller:

Upon completing the programming phase, we will proceed to implement the code on the Raspberry Pi. This entails verifying the proper compilation of the code and concurrently monitoring the data to ensure seamless execution.

4. Obstacle Area Testing:

As an integral aspect of our testing regimen, we will strategically position obstacles in the robot car's path to assess its navigation and obstacle avoidance capabilities thoroughly. This process aims to gauge the car's effectiveness in responding to dynamic environments.

5. Battery Capacity Testing:

Upon integrating the battery, we will conduct assessments to ensure its capability as a reliable power source. This involves evaluating power consumption by various microcontrollers and introducing additional power sources to enhance module efficiency.

6. Rough Area Stability testing:

We test our rover in rough area for testing the stability of our rover and Checking that it is properly stable or not Also checking the gyroscope sensor is working or not for stability and balance of our rover

7. Automatic Power Cut testing:

During this short circuit situation the power is automatically cut off or not we check it.

8. Identify Data and Performance:

After Implement Every Thing we Checking The Rover Modular Is Giving The Popper Data Information To Our Computer Or Not.

11. System Specification

In the development of the moon rover, meticulous attention has been devoted to the software specifications, serving as the nerve center for orchestrating the rover's diverse functionalities. This comprehensive software framework is designed to seamlessly integrate with the rover's mechanical, electrical, and control systems, ensuring optimal performance in lunar exploration. The software specifications encompass a robust operating system, an intricately crafted control algorithm implemented in a versatile programming language, and an intuitive user interface for operators. Additionally, the software details elaborate testing and safety protocols, emphasizing durability, emergency shutdown procedures, and adaptability to the lunar environment. Integration capabilities include advanced data logging and reporting, compatibility with external devices, and support for an R.C. controller. Security and privacy measures are ingrained to prevent unauthorized access, implement data encryption, and uphold privacy standards for collected data. Furthermore, the software facilitates remote operation with features like remote control capabilities, real-time sensor data streaming, and flexible communication protocol integration. Comprehensive documentation, including a user manual and technical specifications, accompanies the moon rover, ensuring operators have the necessary insights for efficient operation and maintenance.

The table specifying all the system specifications is given below –

MECHANICAL DESIGN	1/10th of RC crawler	
	Tires	
	Steering Servo	
	Mounts	
ELECTRICAL SYSTEM	Computational Unit	Raspberry Pi
		Arduino Uno
		ESP8266 Camera Module
	LIPO Battery and charger	
	Power Module	12 Volt 10 Ampere Battery
		9 Volt Amazon Battery
	Ppm encoder	
	Communication	RF Transmitter and Receiver

	Webcam	ESP8266 Camera module
CONTROL SYSTEM	Communication system (Wi-Fi)	
	Navigation	Autonomous Navigation Capabilities
		Microcontroller/Processor Specifications (Arduino Uno and ESP8266)
SOFTWARE	Operating system	GNU/Linux
	Programming	Control Algorithm and Programming Language
		User Interface

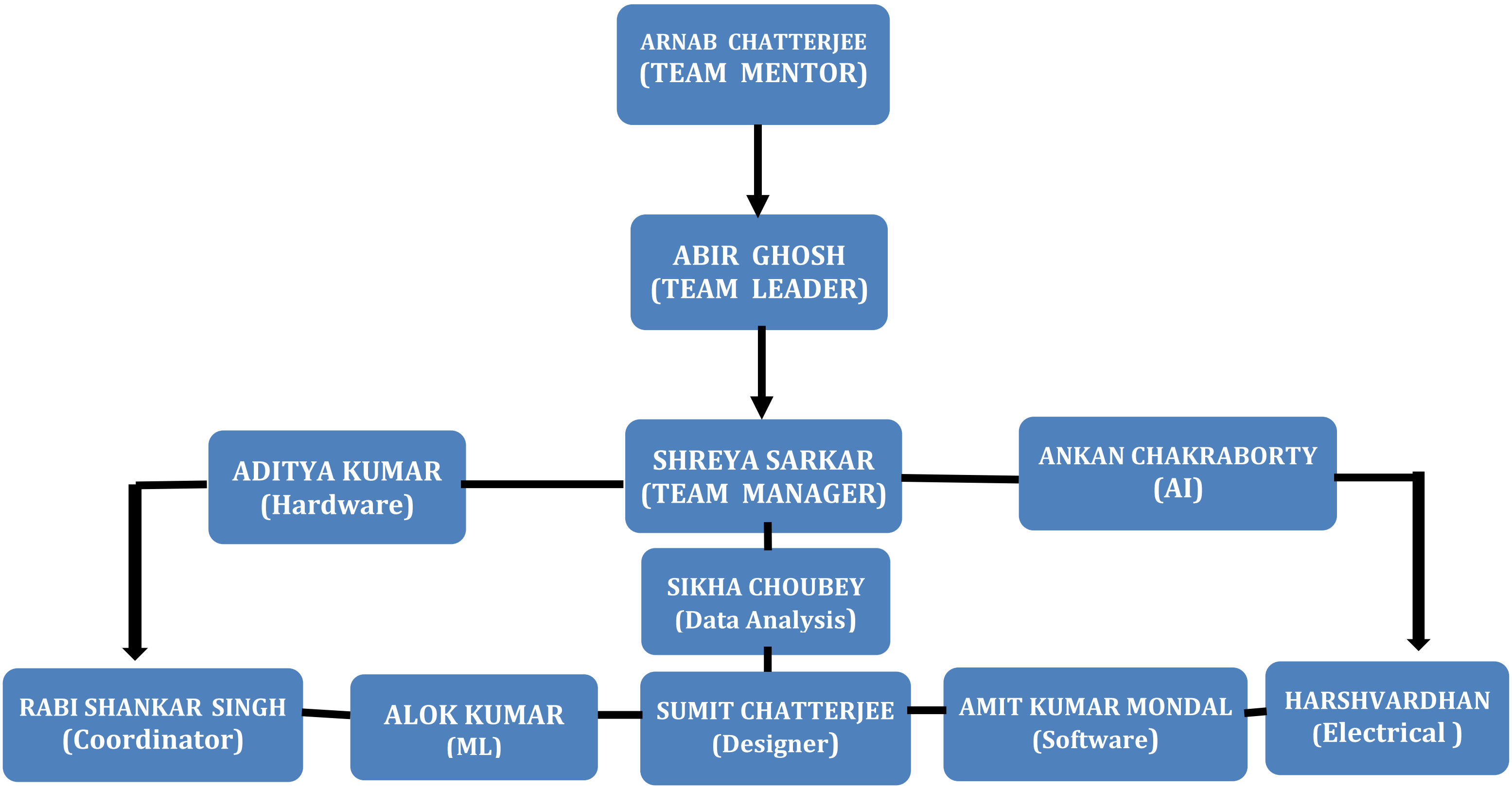
TESTING & SAFETY	Durability and stress testing procedures	
	Emergency shutdown and safety protocols	
	Environmental adaptability	Temperature Sensor
INTEGRATION	Data logging and reporting capabilities	
	System integration and compatibility with external devices	
SECURITY & PRIVACY	Security measures for preventing unauthorized access	
	Data encryption and protection protocols	
	Privacy features for any data collected during rover operations.	
REMOTE OPERATION & MONITORING	Remote control capabilities for operators	
	Monitoring	Live Streaming of Sensor Data for Real-time Monitoring
		Integration with Multiple Communication Protocols for Flexibility
DOCUMENTATION	User manual and technical documentation	

12. Project Management

Project management involves planning, organizing, and overseeing resources to achieve specific goals within a defined scope, time, and budget.

Managing a rover proposal involves outlining objectives, timelines, budgets, and resources required for the project. It includes defining the scope, detailing the technical specifications, creating a project schedule, allocating team roles, estimating costs, managing risks, and presenting a compelling proposal to secure funding or support. Precision in planning and a clear understanding of the rover's purpose and mission are crucial.

12.1 Responsibilities Among Team Members:

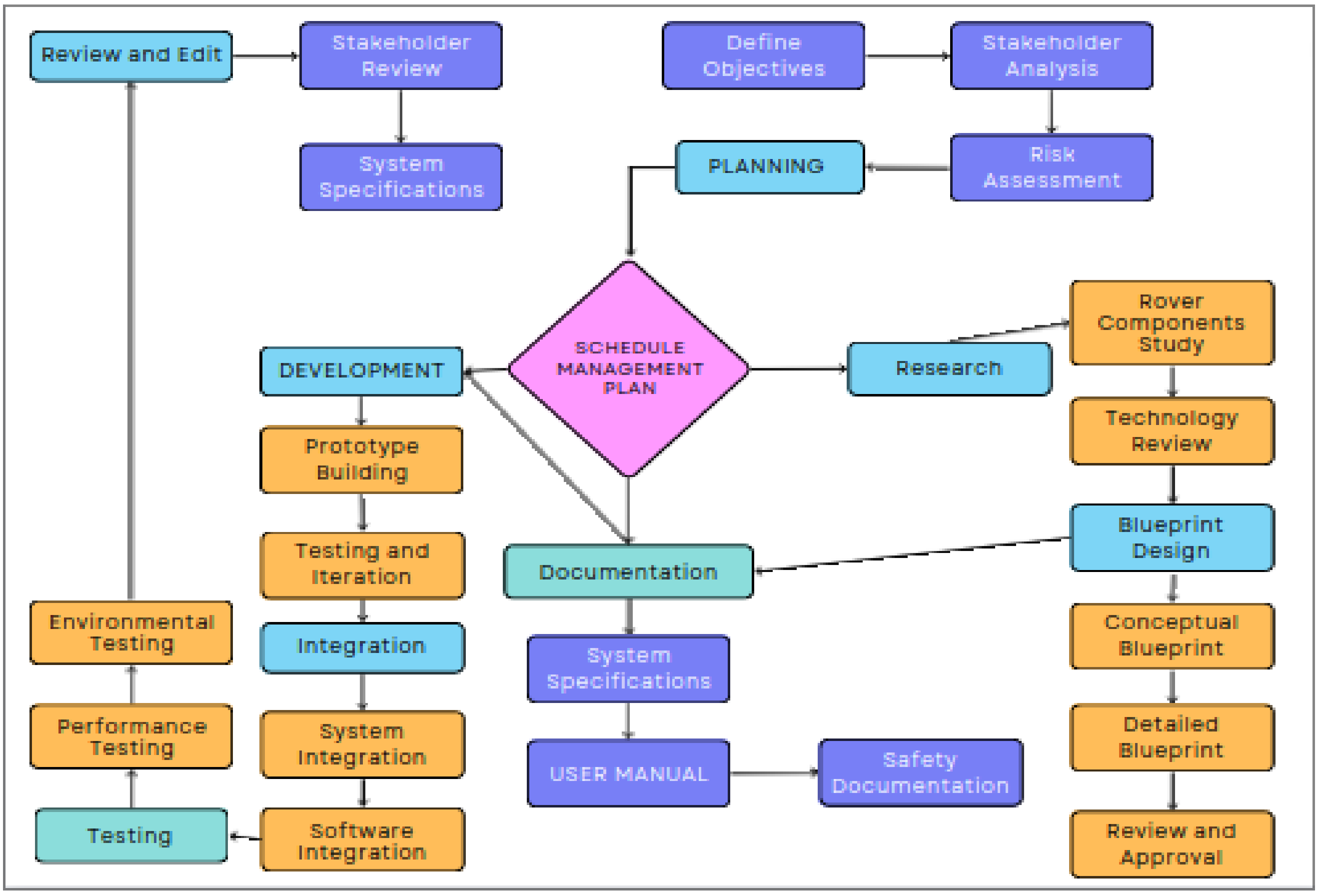


On Dec 12 2023 ISRO(Indian space research organization) has launched a robotics challenge ---
I Abir Ghosh from Talisha along with my team we all are participating for ISRO robotics challenge. Our mentor for the participation is Arnab Chatterjee ,along with my team mate Shreya (Team manager),Aditya Kumar(Proposal),Ankan Chatterjee (Overall progress),Sikh(Permission)Alok(Permission), Sumit (Information gathering)Harsh(), Amit(Technical).

By working in this Project we all get very useful information to the outer space, rover designing, some technology useful in rover path identification.
We all tried our best in the project with our full effort to design our rover something unique which might be useful in the future.

No.	Task	Main Responsibility	Deadline for Completion	Estimated Cost	Secondary Responsibility
1	ABIR GHOSH	Body Structure of the Rover	17-01-2024	3000	SHREYA SARKAR
2	ADITYA KUMAR	Rover Arm Design and Implement	02-02-2024	2080	SIKHA CHOUBEY
3	ANKAN CHAKRABORTY	Data monetization	11-03-2024	1700	ALOK KUMAR
4	SUMIT CHATTERJEE	Sensor Identification	17-02-2024	2000	HARSHVARDHAN
5	RABI SHANKAR SINGH	Tools Identification	11-01-2024	1000	SHREYA SARKAR
6	AMIT KUMAR MONDAL	Microcontroller implement	26-02-2024	4000	ABIR GHOSH
7	ALOK KUMAR	Electrical Wiring	06-03-2024	2000	ANKAN CHAKRABORTY
8	HARSHVARDHAN	Power Function	22-02-2024	2000	SIKHA CHOUBEY

12.2 Strategy for schedule management:



12.3 Cost Estimation:

Sl. no	Name of the Instrument	Cost
1	Ultrasonic Sensor	160
2	Temperature Sensor	100
3	Camera (Night vision)	1200
4	Soil Temperature Sensor	1400
5	Electric Casing	50
6	1.5 mm Cardboard	100
7	L angle with nut and bolt	200
8	Five glue stick	50
9	1 inch and 1.5, inch electric casing pipe	70
10	Robotics Arm	1700
11	Metal plate	200
12	Investigating the soil removal characteristics of flexible tube coring method for lunar exploration	700
13	Arduino uno	550
14	ESP8266 Camera module	700
15	RF Transmitter and receiver (2)	1450
16	Raspberry Pi with Raspberry Pi camera (2)	10,000
17	12 Volt 10 ampere battery (2)	1200
18	9 Volt Amazon battery	230
19	Arduino male female jumper wire	200
20	Silicone Electrical Cable-18AWG 0.75mm^{2}6 Color	100
21	Screwdriver Tool	100
22	Microscope	1200
23	Spectro meter	2000
24	Soldering Wire	70
25	Black Cello Tape	50
	TOTAL	23,780

13. Novelty in the overall proposal

- In the expansive realm of our academic pursuit, the term "novelty" assumes the role of a guiding lodestar, steering our journey towards the shores of originality and distinctiveness in research and findings. The novelty report, akin to a radiant beacon, not only illuminates our path but also stands as an enduring testament to the uniqueness intricately woven into the fabric of our project. Let us embark on a deeper exploration into the intricacies of the novelty imprinted upon our academic endeavor:

- 1. Gyroscopic Sensor-Centric Center of Mass Control:

  Innovation: This technology regulates stability by adjusting internal mechanisms, counteracting shifts in weight distribution. It enhances stability in devices like drones or stabilizers, ensuring balance and agility by dynamically managing the center of mass based on sensor feedback.
- 2. Raman Spectroscope for Rock Sample Identification:

  Innovation: A Raman spectroscope analyzes rock samples by emitting laser light to identify molecular structures. It detects unique light scattering patterns, revealing chemical composition and mineral content. This non-destructive technique aids geologists in precise rock identification, offering insights into geological history and mineralogical composition for various scientific and industrial applications.
- 3. Lightweight Drilling and Automatic Sample Collection:

  Innovation: Lightweight drilling employs compact, efficient drills for sample collection in remote or delicate environments. Automated systems enable precise drilling and sample extraction without heavy machinery. This technology accurate sample collection in challenging terrains, aiding scientific research in geology, archaeology, and environmental studies.

- 4. Integration of Satellite Data for Enhanced Analysis:

  Innovation: Integration of satellite data amalgamates various remote sensing inputs, like imagery and geospatial data, optimizing analysis precision. This method enables comprehensive monitoring of environmental changes, weather patterns, agriculture, and urban development. Integrated satellite data enhances decision-making in disaster response, resource management, and scientific research for a wide array of fields.
- 5. Robust Communication Protocols:

  Innovation :.Robust communication protocols establish reliable standards for data exchange, ensuring seamless transmission amidst network complexities, errors, and congestion. These protocols, like TCP/IP, prioritize accuracy, error handling, and stability, enabling dependable connections

- 6. Alternative Power Sources and Ongoing Project:

  Innovation: They innovate energy production, focusing on efficiency, storage, and eco-friendliness. These projects aim to diversify and enhance renewable technologies, fostering sustainability and resilience while mitigating environmental impacts in the global energy landscape.

14. Conclusion

- Engaging in such an esteemed project facilitated by the prestigious ISRO was an unparalleled privilege. Throughout this enriching endeavor, we immersed ourselves profoundly in comprehending the intricate operational principles and multifaceted functionalities inherent in the rover's design.

- Rovers, being intricately engineered compact and versatile robots, function as emissaries meticulously selected by scientists to embark on expeditions to various moons and planets. Their overarching mission is to gracefully land on the surfaces of these celestial bodies, initiating thorough and comprehensive explorations. These sophisticated robots boast a sophisticated suite of capabilities, adept at capturing high-resolution images and acquiring a diverse spectrum of information. This includes but isn't limited to meticulously gauging temperature variations and meticulously collecting an assortment of samples, spanning from geological formations to soil compositions.

- Precisely honed for scientific inquiry and discovery, the rover stands as an invaluable instrument empowering scientists to meticulously probe diverse facets. These encompass not just the intricate landscape of lunar geology and surface topography but also extend to investigating prevailing environmental conditions and delving into the potential reservoirs of invaluable resources strewn across these lunar terrains. The extensive repertoire of capabilities inherent in these rovers plays a pivotal role in conducting an extensive array of experiments and analytical pursuits. These endeavors are integral in piecing together the intricate tapestry of the Moon's history and unraveling the enigmatic processes that have contributed to its formation and evolution over time.