IRoC-U

ISRO Robotics Challenge - URSC

Let's build a space robot

Proposal Report
by

ADHVITIYA
10871

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KVG COLLEGE OF ENGINEERING

Contents

SYSTEM ARCHITECTURE

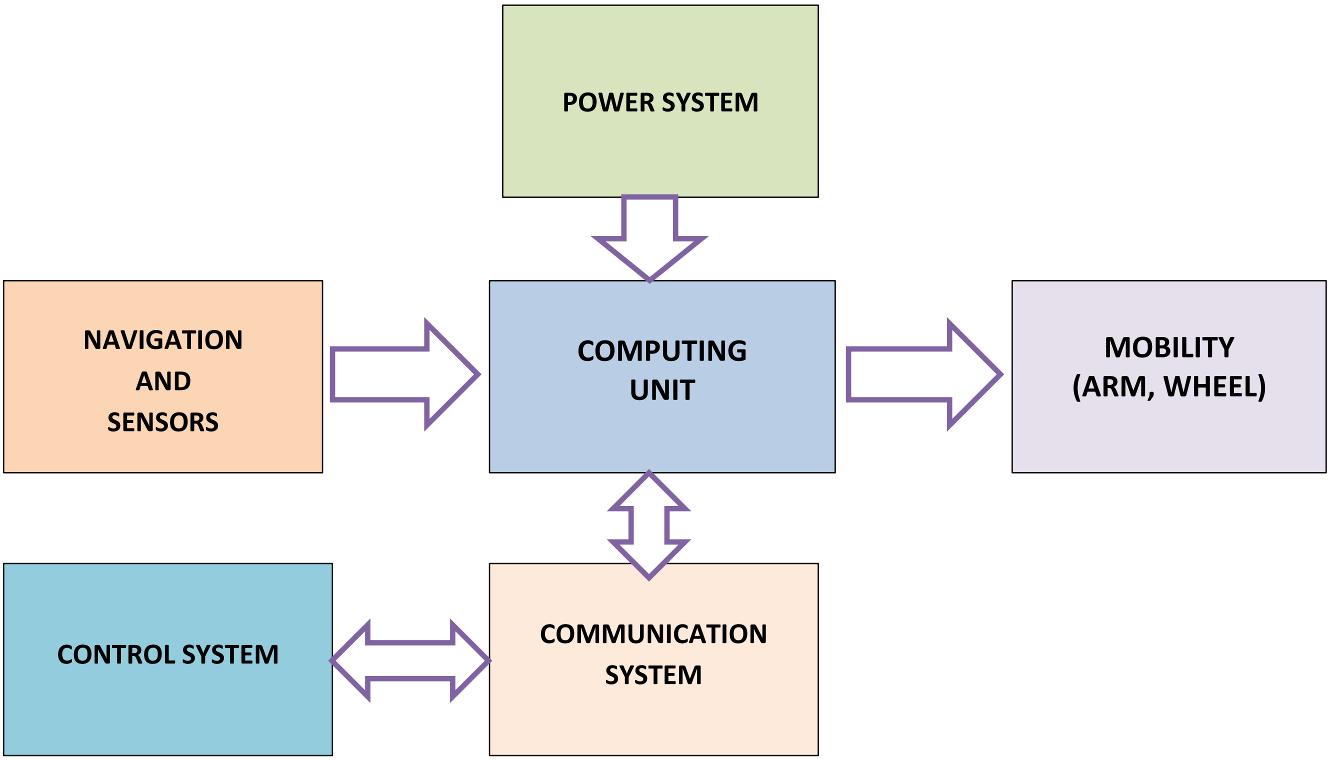


FIG 1: MAIN BLOCK DIAGRAM OF ROVER

1. Power System Unit

This unit is responsible for providing the necessary power to the entire system. It ensures a stable and reliable power supply to all components.

Components:

- Power Source: Represents the energy source, such as batteries or a generator, supplying power to the system.
- Power Management System: Controls the distribution and regulation of power to different subsystems to optimize energy usage.
- Safety Mechanisms: Includes features like overcurrent protection, voltage regulation, and fault detection to ensure the safe operation of the system.

2. Computing Unit

This unit serves as the brain of the system, managing and controlling various subsystems through computing processes.

Components:

- Central Processing Unit (CPU): Performs calculations and executes instructions to coordinate the overall system functionality.
- Memory: Stores data temporarily (RAM) and permanently (storage) for efficient processing and retrieval.
- Control Unit: Manages the flow of data and instructions between different components.
- Communication Unit: Facilitates communication between the computing unit and other subsystems, enabling data exchange.
- Mobility Unit: Controls the movement or locomotion aspects of the system, directing actions based on inputs from the computing unit.
- Navigation Unit: Manages location, orientation, and route planning, providing spatial awareness for the system.

3. Subsystem Interactions

- Communication Unit: Interacts with the Mobility, Navigation, and other subsystems to exchange information and commands.
- Mobility Unit: Receives instructions from the Computing Unit and may send feedback or status updates.
- Navigation Unit: Provides location data to the Computing Unit, which uses it for decision-making.

Overall System Interaction:

- The Computing Unit acts as the central hub, processing information and issuing commands to different subsystems based on inputs and data received.
- The Power System Unit ensures that the entire system has a stable and reliable power supply to operate effectively.

This block diagram outlines the basic architecture of a system where power and computation work together to enable communication, mobility, and navigation functionalities. Keep in mind that this is a simplified representation, and actual systems may have more complex interactions and additional components.

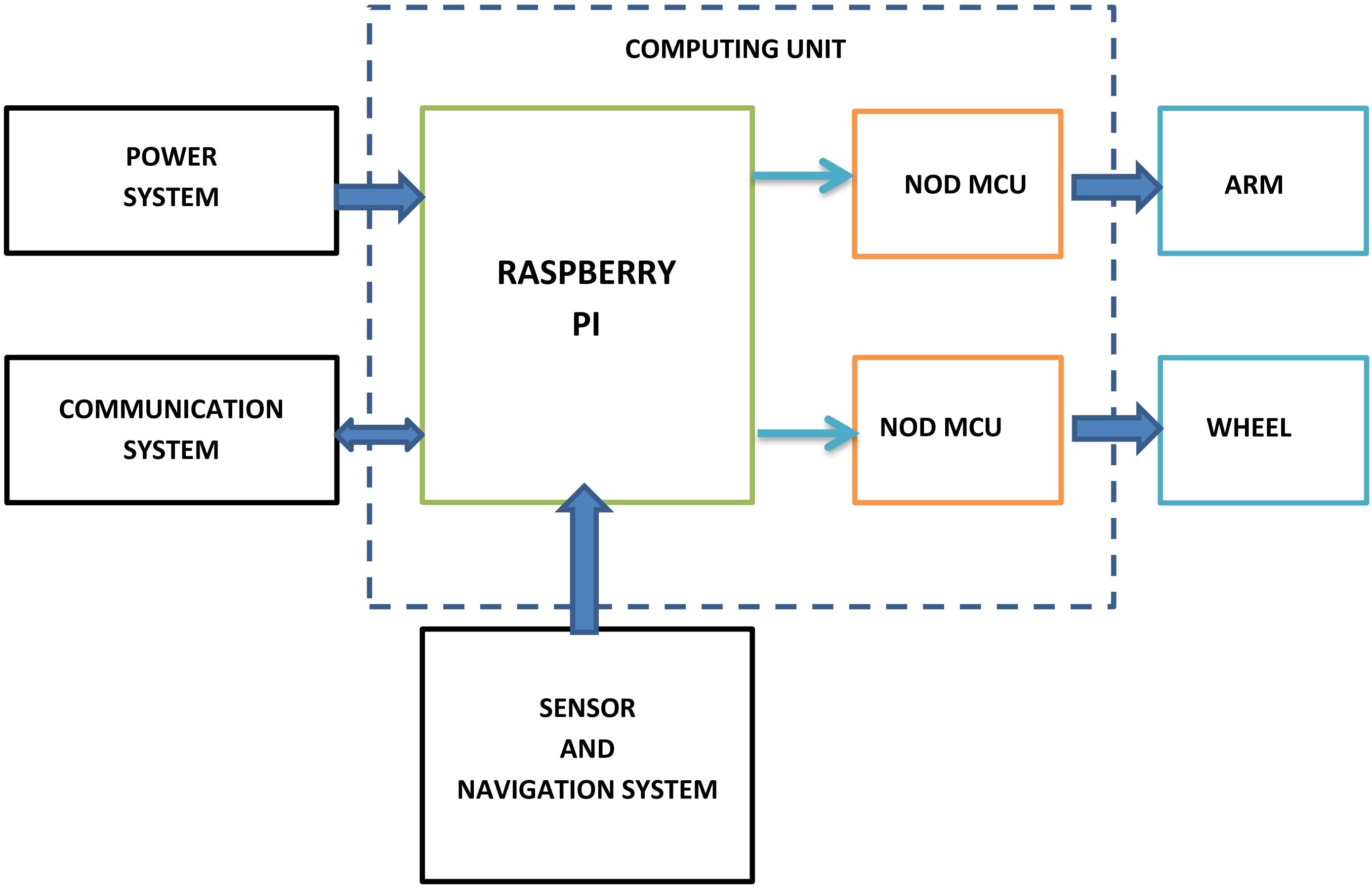


Fig 2 : COMPUTING UNIT

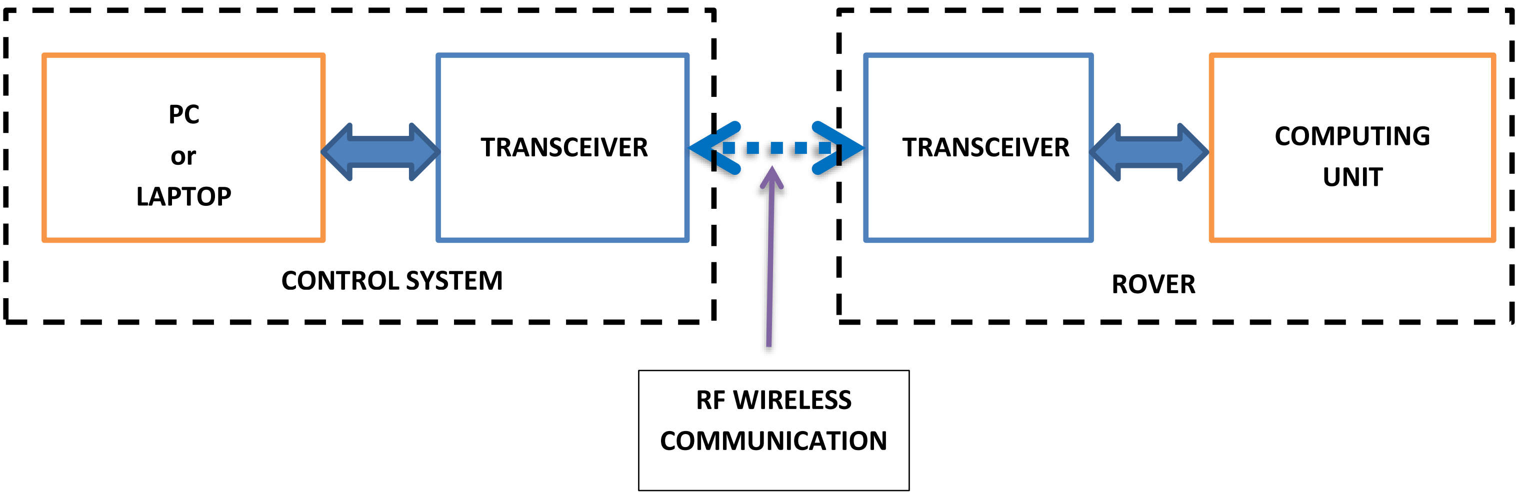


Fig 3: COMMUNICATION SYSTEM

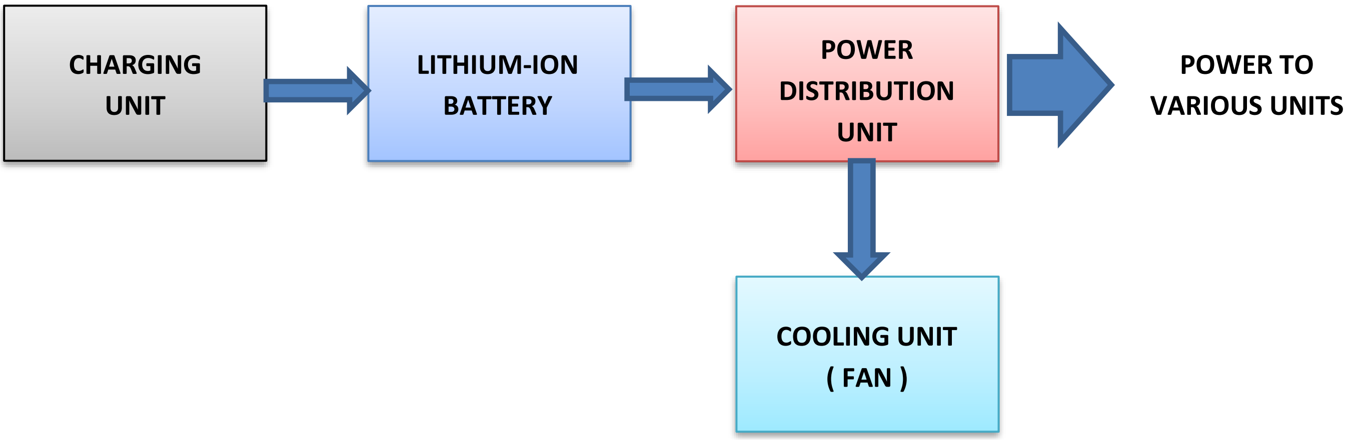


Fig 4: POWER SYSTEM

ROVING MECHANISM

The roving mechanism is a critical component in the design of mobile robotic systems, particularly in applications like planetary exploration rovers. This mechanism enables the rover to traverse its environment effectively, contributing to the success of the mission. In this overview, we will discuss the key features of the roving mechanism, provide a schematic representation, compare potential options, and justify the selection of the chosen mechanism.

Roving Mechanism Overview

The roving mechanism is responsible for the mobility of the rover. It typically includes wheels or tracks, motors for propulsion, and a steering system for directional control. The choice of the roving mechanism significantly influences the rover's performance, manoeuvrability, and adaptability to diverse terrains.

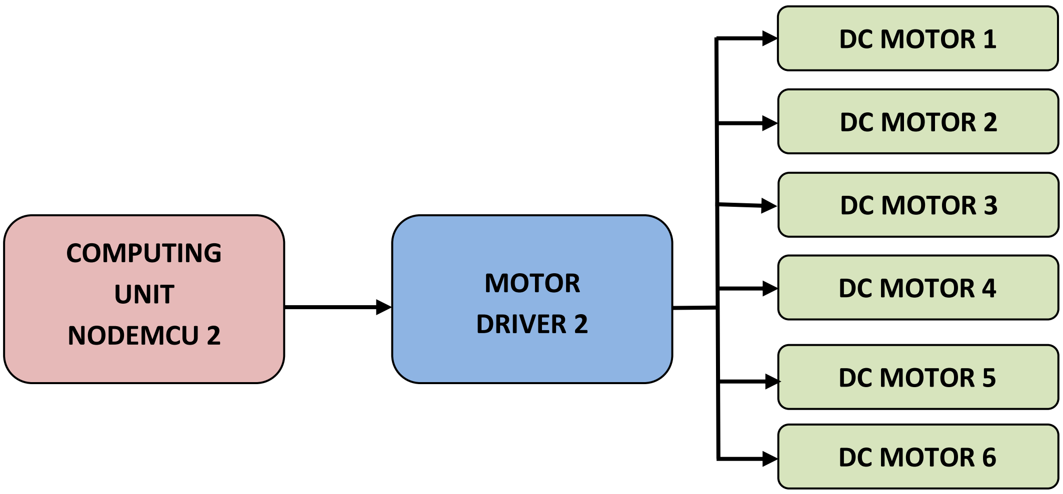


Fig 5: Schematic Representation of wheel mechanism

Comprehensive understanding of the chosen mechanism

1. Wheel Configuration:

- Consideration of various wheel configurations, such as six-wheeled, four-wheeled, or tracks, each with its advantages and disadvantages.

2. Suspension System:

- Evaluation of different suspension systems for handling rough terrains, including independent suspension or rocker-bogie systems.

3. Motor Type:

- Comparison of electric motors, brushless motors, or other propulsion mechanisms based on power efficiency and weight considerations.

Explanation for selecting the proposed mechanism

The selected roving mechanism consists of a six-wheeled configuration with a rocker-bogie suspension system and electric motors. This configuration was chosen for several reasons:

- Versatility: The six-wheeled configuration provides a good balance between stability and manoeuvrability, making it suitable for a variety of terrains encountered in planetary exploration.

- Rocker-Bogie Suspension: The rocker-bogie suspension system enhances the rover's ability to navigate uneven surfaces by allowing flexible wheel movements, ensuring that all wheels maintain contact with the ground.

- Electric Motors: Electric motors were chosen for their efficiency, precision in control, and the ability to provide sufficient power for the rover's propulsion.

MECHANISM FOR SAMPLE PICK-AND-PLACE ACTIVITY

The sample pick-and-place mechanism is a critical component designed for the efficient and precise handling of various samples in a rover's mission for planetary exploration. This mechanism plays a pivotal role in collecting geological specimens, conducting experiments, and securely stowing samples for analysis. The mechanism comprises three main elements: the end-effector, the robotic arm, and the control system.

Components

1. End-Effector:

The end-effector is the functional component responsible for directly interacting with and manipulating samples. It is equipped with a versatile gripping system capable of accommodating various sample shapes and sizes. Additionally, it may include specialized tools for tasks like drilling or scooping, enhancing the mechanism's adaptability to different surface conditions.

2. Robotic Arm:

The robotic arm provides the necessary mobility and reach for the end-effector. It is designed with multiple joints and degrees of freedom to navigate the rover's workspace effectively. The arm's construction allows it to articulate and position the end-effector precisely for sample collection, placement, and stowage.

3. Control System:

The control system governs the overall operation of the sample pick-and-place mechanism. It integrates with the rover's main control unit and includes software algorithms for autonomous operations as well as teleportation capabilities. The control system ensures coordination between the robotic arm and the end-effector, facilitating seamless sample manipulation.

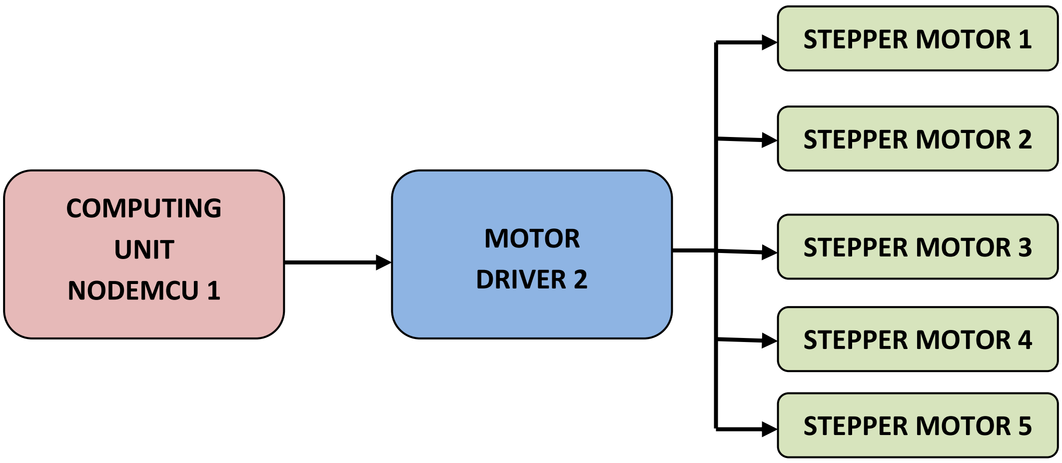


Fig 6: Schematic Representation of arm mechanism

Comparison of Potential Options

1. End-Effector Options:

Mechanical Claw:

-Simple and robust design, suitable for a wide range of sample shapes.

2. Robotic Arm Configuration:

Multi-Jointed Arm:

- Offers enhanced reach and adaptability.

3. Control Interface:

Autonomous Control:

- Enables efficient sample collection based on predefined criteria.

Teleportation:

- Allows human intervention for complex or unanticipated scenarios.

Rationale for Selected Mechanism

The selected sample pick-and-place mechanism features a vacuum gripper as the end-effector, a multi-jointed robotic arm, and a hybrid control interface that combines autonomous control with teleportation capabilities.

Multi-Jointed Robotic Arm:

Rationale: The multi-jointed robotic arm was selected for its extended reach and adaptability to various positions. This configuration ensures the mechanism's capability to access samples in diverse locations on the rover and effectively manoeuvre in complex terrains.

Hybrid Control Interface:

The hybrid control interface strikes a balance between autonomy and human intervention. Autonomous control streamlines routine operations, while teleportation allows operators to navigate the rover through unforeseen challenges or perform intricate sample manipulations.

The chosen sample pick-and-place mechanism balances versatility, precision, and adaptability, aligning with the diverse challenges of planetary exploration. The selected components and configurations aim to optimize sample collection, placement, and stowage, contributing to the success of the rover mission.

EMERGENCY RESPONSE SYSTEM

The resolution of emergency situations in a rover often involves the implementation of automated systems and protocols designed to address specific types of issues. Here are several examples of emergency situations in rovers and how they might be resolved automatically:

1. Obstacle Avoidance:

- Emergency: The rover encounters unexpected obstacles in its path.
- Resolution: Automated obstacle avoidance algorithms can reroute the rover, change its trajectory, or come to a temporary halt until a new safe path is identified.

2. Communication Failure:

- Emergency: Loss of communication with the central control or operator.
- Resolution: Rovers can be equipped with fail-safe communication protocols, such as autonomous decision-making capabilities or predefined instructions to execute in the absence of communication.

3. Power Supply Issues:

- Emergency: Battery voltage drops to critical levels.
- Resolution: Automated power management systems can trigger actions, such as reducing non-essential functions, adjusting power distribution, or initiating a return to a designated charging station.

4. Environmental Hazards:

- Emergency: The rover encounters extreme environmental conditions (e.g., high temperatures, radiation).
- Resolution: Rovers can be equipped with sensors to detect environmental hazards, and automated responses may include adjusting operational parameters, seeking shelter, or activating protective measures.

5. Sensor Failures:

- Emergency: Malfunction or failure of critical sensors.
- Resolution: Rovers often have redundancy in sensor systems. Automated diagnostics can identify the failed sensor and switch to a backup, ensuring continuous data collection and functionality.

6. Mechanical Failures:

- Emergency: Mechanical components, such as motors or actuators, experience a failure.
- Resolution: Automated fault detection systems can identify the failed component and, if possible, reroute operations to alternative mechanisms. In some cases, the rover may autonomously navigate to a safe location for repairs.

7. Navigation Issues:

- Emergency: Inability to navigate accurately or loss of position awareness.
- Resolution: Rovers can employ simultaneous localization and mapping (SLAM) algorithms, GPS-based navigation, or other techniques to recalibrate and re-establish accurate navigation.

8. Emergency Shutdown:

- Emergency: Any situation posing an immediate threat to safety or proper functioning.
- Resolution: Rovers often have emergency shutdown protocols triggered by predefined criteria. These can include stopping all movements, deactivating certain systems, or entering a safe mode until human intervention occurs.

HARDWARE IDENTIFICATION

No	Hardware details	Subsystem	category	Quantity needed	Justification for chosen type
1	Microcontroller board	Central Processing	Raspberry pi	1	Efficient processing power, suitable for real-time control
2	Camera	Vision System	Optical sensor	2	High-resolution imaging for accurate perception
3	Lithium-ion Battery	Power System	Li-ion	2	High energy density, lightweight, and rechargeable
4	Inertial Measurement Unit	Navigation System	9-axis IMU	1	Accurate tracking of orientation and motion
5	Wireless Communication	Communication	Cellexxa wireless intercom system	1	High-speed data transfer and remote control capabilities
6	LIDAR Sensor	Navigation System	Solid-State	1	360-degree mapping and obstacle detection
7	Stepper Motor	Arm Mechanism	NEMA 17	5	Good torque at low speeds, great for holding position, have a long life span.

8	DC gear motor	Roving Mechanism	Planetary DC gear motor	6	High torque, precise position feedback accurate and controlled robotic motion
9	Development board	Control mechanism	NodeMCU	2	To control rover arm and wheels.
10	Power distribution system	Deliver power to the various units	Bus	1	Voltage regulation, fault protection optimized electrical management
11	Charging unit	To charge the lithium ion batteries	12V charger	1	Efficient and safe recharging
12	Cooling system	To cool power system	12v Brushless 3 Inch DC Cooling Fan	1	Heat dissipation efficiency optimal operating temperature
13	Inertial measurement unit(IMU)	Measurement of orientation, acceleration angular velocity.	MPU9250 QFN24	1	9-degree of freedom compact design accurate measurement of orientation, acceleration angular velocity.
14	Weight sensor	Weight measurement	Xcluma 1kg Load Cell	1	Accurate measurement of weight of sample.
15	Ultra sonic sensor	Distance measurement	HCSR-04	1	Wide detection range, precise distance, obstacle avoidance.
16	RF transceiver	Transmission and receives data	NRF24L01	1	Long range communication capability high data transfer rates
17	Antenna system	Transmission of data	Probots NRF24L01	1	Directional capabilities design for communication, signal reception and transmission

18	Mechanical component and fasteners , Tools and equipment	Mechanical connection	----------	---------	Fasteners for construction, providing durability and reliability.
19	Safety gear	To handle emergency situation	-----------	---------	Protection during assembly and testing

SOFTWARE IDENTIFICATION

In order to operate the realized system, several software components are essential. These components are chosen to ensure efficient task execution and optimal performance of the hardware. The following software requirements are required for various computational tasks:

1. **Navigation Algorithm** The system will employ SLAM (Simultaneous Localization and Mapping) algorithm for autonomous navigation. This algorithm takes input from the on-board sensors, processes the data, and generates control commands for the actuators to navigate through the environment.

   The proposal uses ROS based SLAM implementation for Autonomous navigation using TurtleBot. The mobile rover will be capable of visually detecting and avoiding static obstacles using SLAM and reaching the desired location autonomously and performing the desired task of picking the sample tube. SLAM will be used for estimating the position of the robot by moving it along the unknown area, that is the provided arena. More the number of attempts of exploring the unknown area, the more will be the quality of the generated map. SLAM algorithm will be implemented using GMapping Tool. GMapping Tool requires odometry data (encoder data from the wheels) and laser data. Slam gmapping is used to create2-D occupancy grid map.

   The robot software development will be done in ROS (Robot Operating System). In ROS the process is shown in graph format and the processing happens in nodes. All the complex 3D simulations will be done in GAZEBO. GAZEBO has features like built in robot models, cloud simulation, dynamics simulation, advanced 3D graphics, command line tools and TCPIP transport. With the help of GAZEBO, we will be able to realize Inertia, Forces and Sensor Information.

   A Rapidly-exploring Random Tree (RRT) is a data structure and algorithm that is designed for efficiently searching high-dimensional spaces. RRTs are constructed incrementally in a way that quickly reduces the expected distance of a randomly-chosen point to the tree. We maybe be using the RRT algorithm for the robot to path plan to the endpoints/destination within the sensor's vicinity which in return makes the robot map new regions continuously using SLAM. Applying RRT to mobile robots in such a way enables us to create a self-exploring autonomous robot with no human interventions required. The nature of the algorithm tends to be biased towards unexplored regions which become very beneficial to the Martian environment exploring tasks.

Objectives include:

•Manually mapping the environment.

• To locate the rover in the generated map.

• Autonomously moving the rover.

2. **Image Processing Algorithm** [**Thresholding Algorithm**] - To analyse data from on board cameras and sensors, thresholding algorithm will be utilized. This algorithm will be responsible for tasks such as object recognition, obstacle detection, and other relevant image analysis. The rover will be recognizing objects and track them using the Open CV software running on a Raspberry Pi 5 with the web camera. It will be also equipped with an Ultrasonic sensor mounted on the servo to track its way in dark environments where camera wouldn't work. Signals received from Pi will be sent to the motor driver IC which drives DC motors mounted on the body.
The feature estimation should be based on geometric figures. In Image Analysis, certain geometric attributes of the object (here obstacles, craters) are to be measured such as Perimeter, Area, Radii, Corners, Roundness and Symmetry using specific mathematical formulas.
Colour features (RGB codes) will be incorporated such that the red dominant spectrum (since the target object is red in colour) should be identified and decisions will be made accordingly.

3. Fuzzy Logic

In the real arena, the rover may encounter a situation where it won't be able to determine whether the state is true or false, then fuzzy logic will provide flexibility for reasoning. In this way, we will be able to consider the inaccuracies and uncertainties of any situation that arises in the terrain. Fuzzy logic is a soft computing paradigm which enhances the reasoning ability of the autonomous rover.
Considering the example of the crater identification, if the diameter of the crater is strictly less than or equal to 100mm, the rover should traverse through it , however if its just 100.1mm, the rover will consider it as a false condition and may consider the crater as obstacle and traverse back. Hence, accuracy plays a vital role while specifying the conditions in the program instructions. Therefore, Fuzzy logic will be implemented since it allows for partial truths.

4. BFS Algorithm

The Breadth-First Search Algorithm will be also implemented to calculate the shortest distance from the starting point to the final destination. Its implemented using Queue Data Structure. It is an efficient algorithm for path planning.

HARDWARE AND SOFTWARE REALIZATION PLAN

HARDWARE REALIZATION PLAN

1. Chassis and mobility:

No.	Hardware details	Procurement source	Specification/realization plan	quantity	Unit cost(INR)	Estimated cost
1	Rover chassis	Structural fabrication	Aluminium alloy construction, free suspension	1	10000	10000
2	Dc gear motor with encoder	Market	High torque, precise position feedback accurate and controlled robotic motion	6	2000	12000
3	Motor drivers	Market	Capable of handling of high current, Bidirectional control, motor movements	2	1500	3000
4	Wheels and suspension system	Market	Stability, optimal ground clearances adaptability to uneven Terrains	1	5000	5000
	Subtotal chassis and mobility					30000

2. Power system:

No.	Hardware details	Procurement source	Specification/realization plan	quantity	Unit cost(INR)	Estimated cost
1	Lithium-ion battery(12V)	Market	High energy density, light weight design, long cycle life	2	8000	16000
2	Power distribution system	Electronic fabrication	Voltage regulation, fault protection optimized electrical management	1	3000	3000

3	Charging system	Market	Smart charging capability efficient and safe recharging	1	2000	2000
4	Cooling system	Market	Heat dissipation efficiency optimal operating temperature	1	500	500
	Subtotal power system					21500

3. Sensor and navigation:

No.	Hardware details	Procurement source	Specification/realization plan	quantity	Unit cost(INR)	Estimated cost
1	Inertial measurement unit(IMU)	Market	9-degree of freedom compact design accurate measurement of orientation, acceleration angular velocity	1	6000	6000
2	Weight sensor	Market	Accurate measurement of payload or applied force	1	4000	4000
3	Ultra sonic sensor	Market	Wide detection range, precise distance, obstacle avoidance	4	500	2000
4	Camera system	Market	High-definition resolution, low light sensitivity for imaging and versatile vision	1	7000	7000
	Subtotal sensor and navigation					19000

5. **Communication system:**

No.	Hardware details	Procurement source	Specification/realization plan	quantity	Unit cost(INR)	Estimated cost
1	RF transceiver	Market	Long range communication capability high data transfer rates	1	3500	3500
2	Antenna system	Market	Directional capabilities design for communication, signal reception and transmission	1	2000	2000

	Subtotal communication system					5500

6. **Computing unit:**

No.	Hardware details	Procurement source	Specification/realization plan	quantity	Unit cost(INR)	Estimated cost
1	Micro controller (raspberry pi)	Market	Quad-code processing, GPIO expansion, and multimedia capabilities.	1	7000	7000
2	Node MCU	Market	Wi-fi connectivity, ALU scripting and IOT application	2	500	1000
	Subtotal computing unit					8000

7. Mechanical design miscellaneous:

No.	Hardware details	Procurement source	Specification/realization plan	quantity	Unit cost(INR)	Estimated cost
1	Mechanical component and fasteners	Market	Fasteners for construction, providing durability and reliability	1	5000	5000
2	Tools and equipment	Metal fabrication	Assembly and maintenance, ensuring efficient and precise construction	1	3000	3000
3	Safety gear	Market	Protection during assembly and testing	1	2000	2000
4	contingency	Market	Unforeseen expenses, adjustment flexibility and adaptability in the specific budget	-		10000
	Subtotal miscellaneous					20000

SOFTWARE REALIZATION PLAN

1. Planning:

- Analyse competition requirements.
- Identify essential software functionalities.
- Define performance metrics and success criteria.
- Establish a project timeline for software development

2. Operating System Selection:

- Evaluate and select a suitable Linux-based operating system.
- Ensure compatibility with embedded systems and real-time operations.

3. Sensor Integration:

- Develop drivers for sensors (IMU, GPS, camera, ultrasonic).
- Implement location-based algorithms and image processing.
- Create interfaces for ultrasonic sensors to detect obstacles.

4. Control System:

- Design a PID control system for precise motor control.
- Implement algorithms for autonomous navigation.
- Integrate obstacle avoidance for safe rover movements.

5. Communication Protocol:

- Design a reliable bidirectional communication protocol.
- Implement data transfer mechanisms between rover and control station.
- Ensure data integrity and error handling in the communication protocol.

6. User Interface:

- Design an intuitive interface for mission planning and execution.
- Implement features for real-time monitoring and feedback.

7. Safety Systems:

- Develop fail-safe mechanisms for critical error detection.
- Implement emergency shutdown procedures.
- Integrate a watchdog system for continuous system health monitoring.

8. Testing and Debugging:

- Conduct unit testing for individual software components.
- Perform integration testing to ensure seamless interaction.
- Conduct field testing to identify and address performance issues.

9. Documentation:

- Prepare detailed documentation, including code comments and architecture diagrams.
- Create user manuals for rover software operation and troubleshooting.

10. Finalization:

- Review the entire software system for compliance with competition requirements.
- Address any remaining issues or improvements identified during testing.
- Ensure the software system is well-documented and ready for submission.

TEST PLAN

The successful deployment of the rover's sample pick-and-place mechanism is crucial for the mission's scientific objectives. This comprehensive test plan outlines the identification of relevant tests required for both subsystem and system levels. Each test is accompanied by a brief plan, ensuring a thorough evaluation of the mechanism's functionality and performance.

Identification of Required Tests

1. Subsystem Level Tests:

- **End-Effector Performance Test:**

- Objective: Evaluate the functionality of the end-effector, including its ability to grip and release various sample types.

- Plan: Perform tests with different sample materials, sizes, and shapes. Assess gripping force, stability during movement, and reliability.

- **Robotic Arm Range and Flexibility Test:**

- Objective: Verify the range and flexibility of the robotic arm, ensuring it can reach various locations on the rover.

- Plan: Execute movements to predefined positions. Assess the arm's reach, joint flexibility, and any limitations in movement

- **Control System Integration Test:**

- Objective: Validate the integration of the pick-and-place mechanism with the rover's overall control system.

- Plan: Execute commands for sample collection and placement. Verify communication between the subsystem and the rover's main control unit.

2. System Level Tests:

a. Autonomous Sample Collection Test:

- Objective: Assess the mechanism's ability to autonomously collect samples using pre-defined criteria.

- Plan: Implement a scenario where the rover identifies and collects samples based on visual or environmental cues.

b. Teleportation Test:

- Objective: Evaluate the effectiveness of teleportation for sample collection and placement.

- Plan: Allow operators to control the rover's pick-and-place mechanism remotely. Assess responsiveness, accuracy, and ease of operation.

c. Sample Handling and Stowage Test:

- Objective: Verify the mechanism's capability to handle and stow collected samples securely within the rover.

- Plan: Simulate the collection of multiple samples and assess the mechanism's ability to store them without damage during rover movement.

Test Plans for Identified Tests

1. End-Effector Performance Test

- Procedure:

- Securely mount various sample types on a test rig.

- Execute gripping and releasing commands using different gripping forces.

- Record observations on stability, grip strength, and any issues encountered.

- Repeat the test with variations in sample size, shape, and material.

- Acceptance Criteria:

- Successful grip and release of samples under varying conditions.
- Stable handling without damage to samples.

2. Robotic Arm Range and Flexibility Test

- Procedure:

1. Define target locations within the rover's workspace.
2. Execute robotic arm movements to reach each target.
3. Document the arm's ability to reach, articulate, and manoeuvre.
4. Identify any limitations or constraints in movement.

- Acceptance Criteria:

- Successful reach of all predefined positions.
- Smooth articulation without mechanical issues.

5. Control System Integration Test

- Procedure:

1. Send commands from the rover's main control unit to the pick-and-place mechanism.
2. Verify proper execution of commands and feedback.
3. Monitor communication logs for any errors or delays.

- Acceptance Criteria:

- Seamless integration with the rover's control system.
- Timely and accurate execution of commands.

6. Autonomous Sample Collection Test

- Procedure:

1. Define criteria for autonomous sample collection (e.g., colour, size).
2. Allow the rover to navigate and collect samples based on predefined criteria.
3. Evaluate the accuracy and efficiency of the autonomous collection.

- Acceptance Criteria:

- Successful identification and collection of samples based on criteria.

7. Teleportation Test

- Procedure:

- Provide operators with a remote control interface for the pick-and-place mechanism.
- Perform sample collection and placement under teleportation.
- Evaluate responsiveness, accuracy, and ease of operation.

- Acceptance Criteria:

- Precise control of the pick-and-place mechanism.
- Efficient sample manipulation under operator guidance.

8. Sample Handling and Stowage Test

- Procedure:

- Collect multiple samples using the pick-and-place mechanism.
- Simulate rover movement and assess sample stowage stability.
- Verify secure storage without damage to collected samples.

- Acceptance Criteria:

- Stable stowage of samples during simulated rover movement.
- No damage to samples during handling and storage.

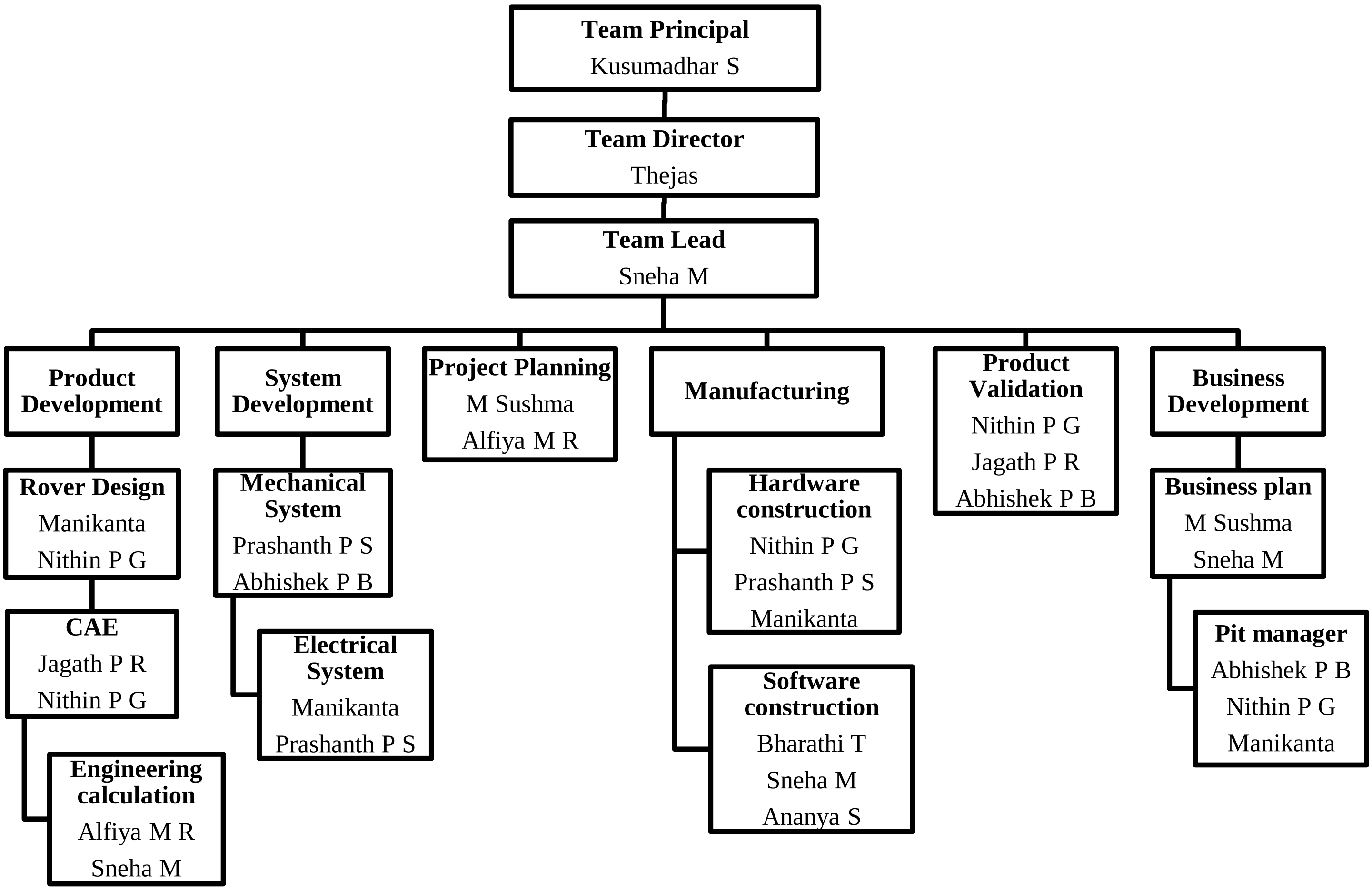
SYSTEM SPECIFICATIONS

Category	Requirement
Rover Overview	
Team Name	Adhvitiya
Functional Requirements	
Mobility	Ability to move in various terrains
Power Source	lithium ion battery unit
Communication	RF communication through transceiver
Navigation	Through camera and inertial measurement unit(IMU)
Imaging System	Cameras or sensors for capturing images
Data Transmission	Transmitting data back to the control centre

Non-functional Requirements	
Durability	Resistance to environmental conditions
Reliability	Consistent performance under various conditions
Autonomy	Ability to operate autonomously or with remote control
Hardware Requirements	
Chassis	Aluminium alloy lm*1m*0.8m
Wheels	Rough Terrain wheels
Motors	DC gear motors
Power System	Lithium ion battery unit
Sensors	Inertial measurement unit sensors Distance sensors Vision sensors Weighing sensors etc
Software Requirements	
Operating System	Linux (incl Raspberry Pi OS)
Control Algorithm	Node Microcontroller Unit
Communication Protocol	media access units
Testing and Quality Assurance	
Test Cases	End-Effector Performance Test Robotic Arm Range and Flexibility Test Control System Integration Test Autonomous Sample Collection Test Teleportation Test Sample Handling and Stowage Test
Testing Tools	Ansys software Hardware tools
Legal and Compliance	
Safety Standards	Kill switch Protection circuits
Cost Estimates	
Development Cost	Around 1.2 lakhs
Maintenance Cost	Around 10 thousand

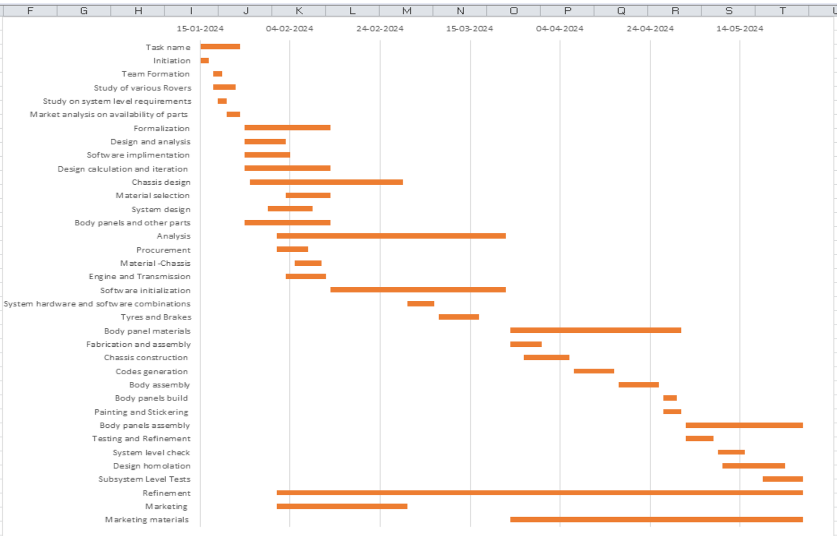
PROJECT MANAGEMENT

Resposibality among team members with a system break down stracture



Strategy for schedule management

	A	B	C	D
1	Task name	Start	Finish	Duration
2	**Initiation**	**15-01-2024**	**24-01-2024**	**9**
3	Team Formation	15-01-2024	17-01-2024	2
4	Study of various Rovers	18-01-2024	20-01-2024	2
5	Study on system level requirements	18-01-2024	23-01-2024	5
6	Market analysis on availability of parts	19-01-2024	21-01-2024	2
7	Formalization	21-01-2024	24-01-2024	3
8	**Design and analysis**	**25-01-2024**	**13-02-2024**	**19**
9	Software implimentation	25-01-2024	03-02-2024	9
10	Design calculation and iteration	25-01-2024	04-02-2024	10
11	Chassis design	25-01-2024	13-02-2024	19
12	Material selection	26-01-2024	29-02-2024	34
13	System design	03-02-2024	13-02-2024	10
14	Body panels and other parts	30-01-2024	09-02-2024	10
15	Analysis	25-01-2024	13-02-2024	19
16	**Procurement**	**01-02-2024**	**23-03-2024**	**51**
17	Material -Chassis	01-02-2024	08-02-2024	7
18	Engine and Transmission	05-02-2024	11-02-2024	6
19	Software initialization	03-02-2024	12-02-2024	9
20	System hardware and software combinations	13-02-2024	23-03-2024	39
21	Tyres and Brakes	01-03-2024	07-03-2024	6
22	Body panel materials	08-03-2024	17-03-2024	9
23	**Fabrication and assembly**	**24-03-2024**	**01-05-2024**	**38**
24	Chassis construction	24-03-2024	31-03-2024	7
25	Codes generation	27-03-2024	06-04-2024	10
26	Body assembly	07-04-2024	16-04-2024	9
27	Body panels build	17-04-2024	26-04-2024	9
28	Painting and Stickering	27-04-2024	30-04-2024	3
29	Body panels assembly	27-04-2024	01-05-2024	4
30	**Testing and Refinement**	**02-05-2024**	**28-05-2024**	**26**
31	System level check	02-05-2024	08-05-2024	6
32	Design homolation	09-05-2024	15-05-2024	6
33	Subsystem Level Tests	10-05-2024	24-05-2024	14
34	Refinement	19-05-2024	28-05-2024	9
35	**Marketing**	**01-02-2024**	**28-05-2024**	**117**
36	Marketing materials	01-02-2024	01-03-2024	29
37	Sponsorship approach	24-03-2024	28-05-2024	65



NOVELTY IN THE OVERALL PROPOSAL

To restate the importance of the novelty in the project and express the creativity of the opportunity to showcase innovative elements. This set the stage for the detail discussion of each unique aspects.

Originality in system design

Our rover system design deviates from the conventional architecture by implementing a simple autonomous cognitive frame works. This framework employees advance machines learning algorithms enabling the rover to learn and adapt to its environment dynamically. The proposed architecture enables the rover to make autonomous decision. The rover rigid body design and morphological adaptability allows the rover to adjust its physical form.

Enhanced mobility

The rover's mobility especially in challenging and unpredictable terrains. Enhanced mobility contributes to the rover's ability to navigate and explore diverse environmental condition it enhance mobility involves the incorporation of feature or mechanism that go beyond basic locomotion.

The enhanced mobility design features the mechanism that empowers the rover to move efficiently and effectively across a variety of terrains. This goes beyond the basic wheel and motor setup introducing innovation that improve the rover capability to transfers obstacles, adapt to uneven surfaces and navigate complex environment.

Hardware design

Our rover's hardware design introduces several innovative elements that distinguish it from conventional models, enhancing it overall capabilities and performance. The inclusion of quantum processing unit represents a ground breaking departure. This processing unit significantly boosts computational power, enabling faster data analysis and decision-making during exploration mission.

Our hardware design integrates energy harvesting modules that harness energy from the rover's environment such as solar panel with sun-tracking capabilities this features reduce dependence on external power source, increasing the rover's autonomy during the mission.

Our rover's hardware design introduces novel component and configurations that go beyond the standard features.

Software design

Rover's software design is characterized by innovative algorithms and architecture. At the core of our software design is autonomous cognitive framework. Our rover rather than relying on individual decision-making, our rover in cooperate swarm intelligence algorithms this approach enables multiple rover's to collaborate and make collective decisions, fostering more efficient exploration and adaptability in dynamic environments the rover's software features and immersive augmented reality interface for operators. This user-friendly interface allows real-time visualisation of data enhancing operator's situation awareness and facilitating more control over the rover.

Our rover's software design introduces novel algorithms that enhance its autonomy, adaptability and collaborations capabilities.

Image processing

Image processing methodology incorporates a novel algorithm that significantly enhances rigorous research and experimentation, out performs exiting method in accuracy and computational efficiency our system introduce sophisticated neural network architecture tailored for image analysis by optimizing that computational work flow leveraging parallel processing, our system can process images at an satisfying speed without compromising accuracy it addresses the existing challenges in the feel but also introduce settler solution that evaluate the stands of image analysis this innovation contribute significantly to the advancement of image processing technology and lay the foundation for future results and analysis.

CONCLUSION

In conclusion, the proposed construction of the rover stands as a pioneering initiative that promises to redefine exploration capabilities in various domains. The meticulous planning and design considerations showcased in this proposal underscore the project's feasibility and potential impact. The integration of advanced technologies within the rover, coupled with a robust power system and sophisticated computing unit, positions our construction project as a ground breaking endeavour in the field of autonomous exploration. The comprehensive subsystems, encompassing communication, mobility, and navigation units, harmoniously collaborate under the overarching guidance of the computing unit.

Furthermore, this proposal places a strong emphasis on safety mechanisms and risk mitigation, addressing potential challenges that may arise during rover deployment and operation. Our commitment to adhering to the highest standards of safety protocols reflects our dedication to ensuring the success and longevity of the mission.

In summary, the construction of this rover aligns with our commitment to innovation and exploration excellence. With your support, we are poised to embark on a journey that not only advances technological frontiers but also opens new avenues for scientific discovery and exploration. Together, let us pioneer the future of autonomous rovers and redefine the possibilities of exploration.