West Virginia University
Morgantown, West Virginia
United States of America

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Team Mountaineers: Preliminary Design Review

1. Team Structure

Leadership and Membership: West Virginia University's Team Mountaineers is composed of 9 subteams (Fig. 1). Subteam coordinators represent their subteam and organize assignments for team members. Dr. Yu Gu is the team's faculty advisor, and Logan Gold leads the team as the chief executive officer. Team Mountaineers is made up of 88 members, with 57 working on their senior design project and the remaining members being student volunteers. Team members are primarily Aerospace, Computer, Electrical, Mechanical, and Robotics engineering majors, as well as Biology and Computer Science majors. Members range from freshman to senior year, with 10% being returning members.

Outreach and Recruitment: Team Mountaineers is committed to growing the University Rover Challenge at West Virginia University, along with garnering interest in the general field of robotics. To achieve this goal, the team takes part in at least one outreach event per month, while also presenting at university-sponsored events to recruit new students.

2. Team Resources

Finances: Funding for Team Mountaineers is sourced through the Department of Mechanical, Materials, and Aerospace Engineering, the Lane Department of Computer Science and Electrical Engineering, grants, and private donations. The team is also actively pursuing sponsorships from industry partners. Purchased items must be approved by the team's chief technology officer, Izaak Whetsell. A purchase ledger is updated as items are requested to keep track of total expenditure as well as other pertinent financial information. Total anticipated income and expenses are tracked to ensure the team remains within budget (Fig. 2).

Facilities: Upon completing West Virginia University's mandatory lab safety training, team members gain 24/7 access to URC's open lab and office spaces. The team has access to the college's machine shop, along with additive and subtractive manufacturing, welding, and circuit board prototyping equipment. The team also uses an on-campus motion capture facility with an indoor rock garden to test the rover and practice for each mission before the competition.

3. Project Management Plan

Development Lifecycle Approach: The team uses a development lifecycle approach based on NASA's system design process. Subteams work collaboratively in parallel to allow for continuous integration and rapid development. The project management team supports integration and planning, ensuring Gantt Chart deadlines are met (Fig. 3). Team Mountaineers' previous rovers serve as benchmarks and testbeds, enabling early testing of subsystems. Internal competitions are held twice a year to practice each mission and improve the team's preparedness and understanding of competition requirements.

Systems Integration and Test Plan: As individual components are designed and fabricated, functionality is verified through simulations, prototypes, and testing on previous rovers. Components are then integrated into their respective subsystems as the development cycle progresses. Following fabrication, weekly testing and training sessions will be conducted using a mock lander, on-campus rock garden, and off-campus sites with geographic features similar to the MDRS. These sessions progress from simulated mission tasks to entire missions as system reliability and operator ability mature.

Communications: Each team member belongs to a minimum of two subteams, ensuring members are informed about multiple aspects of rover design. Subteams collaborate regularly through weekly full-team meetings and bi-weekly subteam meetings. Outside of meetings, Slack is used as the team's primary communication platform, Google Drive is used as a file-sharing platform for designs and documentation, GitHub is used for code sharing and task management, and CAD is developed and shared using Onshape.

4. Preliminary Technical Design

Similar to last year, the rover uses a split-body chassis design with a center rotating bearing to maintain ground contact on uneven terrain. To lower the rover's center of gravity and increase the overall stability, the rover will incorporate 20-inch wheel-legs with customized TPU treads (Fig. 4) , as opposed to the previous year's 24-inch wheel-legs A major change to this year's design is the integration of the manipulation and science components into a single payload, limiting component swaps, and ensuring readiness for any mission with minimal adjustments.

The rover continues to use a palletizer-style manipulator with a new quick-swappable wrist that supports mission-specific end effectors (Fig. 4). For the ES and Delivery missions, a refined 2-DOF wrist and gripper are used, while a new circular saw-scoop is used for the Science mission (Fig. 5). The arm also includes a horizontal linear rail for planar tasks and soil deposition, and a four-bar mechanism that places the primary shoulder motors at the joint to increase lifting capacity. To improve reliability, a linear actuator will replace the previously used solenoid for autonomous typing, and the manipulator will include force and position feedback for improved control.

The science payload has been redesigned from the previous competition to support these mechanical design updates, combining the surface/subsurface sample collection methods and revising the sample analysis techniques. It also maintains functionality for detecting extant life, extinct life, and analyzing the potential habitability of sample sites. Surface soil is now collected with a bi-directionally rotating scoop on the manipulator arm, which rotates in one direction for each sample site to reduce the chance of contamination (Fig. 5). The soil for each site is then dumped into a funnel, falls into a reservoir filled with solvents, and is agitated to create a solution. Peristaltic pumps move the solution into a rotating carousel of cuvettes, which are pre-loaded with the reactants for three new chemical experiments: resazurin, ninhydrin, and methylene blue. These experiments detect the presence of active metabolic processes, amines and amino acids, perchlorates, and similar indications of possible life. Experimental results are observed with a visual camera and UV-Vis spectrometer (Fig. 6). Subsurface samples are also collected with the scoop, deposited in separate funnels, and stored in a removable cache system. A gimbal camera is used to view sample sites and capture a panoramic photo of the MDRS field for use in the stratigraphic profile identification.

The rover is powered by two 40-volt batteries in parallel, with a custom power distribution PCB and e-stop to regulate voltage and current for device requirements. A custom payload PCB carries a Raspberry Pi Pico that interfaces with various sensors and actuators including two relays, servos, temperature sensor, humidity sensor, force sensors, and has room for expansion. It regulates its own power and can communicate with the rest of the system over both CAN (Controller Area Network) and USB. Overall communication between a LattePanda Sigma computer and other onboard electrical components such as radios, cameras, Pixhawk, autonomy LEDs, motors, and an NVIDIA Jetson are facilitated by three different communication protocols: CAN, Ethernet, and USB (Fig. 7). The NVIDIA Jetson will provide additional computation for processing computer vision models. The communications system facilitates control and video transmission between the rover and the base station using a 2.4 GHz system with frequency hopping. Auxiliary control signals will be transmitted through RF modems operating in the 5.8 GHz band for close-range communication.

The rover will operate using the ROS2 framework, with each subsystem running as a node that can exchange data through publishing or subscribing to topics (Fig. 8). A JavaScript Graphic User Interface (GUI) sends user commands, displays the rover status, and streams video from twelve onboard cameras. For the autonomy mission, the cameras also handle objects and ArUco marker detection using computer vision. This year's autonomy stack layers planners on top of a base point-to-point navigation system. Selectable planners include a global A* planner that generates a complete path from user-defined waypoints and a FALCO local planner that avoids obstacles through camera data. During the ES mission, the rover uses a camera to identify the keyboard using ArUco tags and a trained YOLOv12 model to recognize and box the keys. A closed-feedback loop provides joint velocities that incrementally adjust the manipulator into position before a linear actuator is extended to press the key.

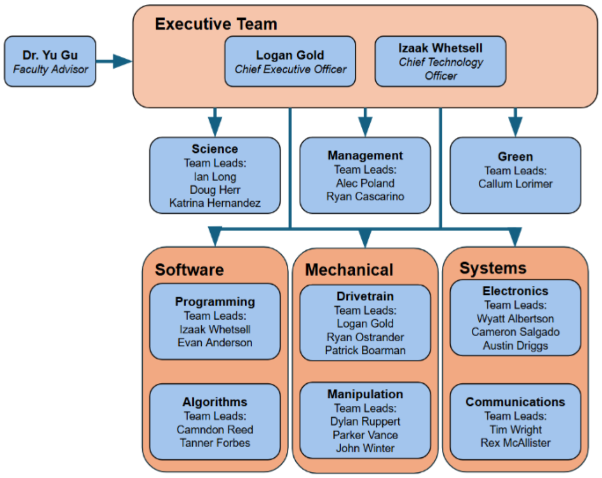

Figure 1. Team Structure.

Team Mountaineers: URC PDR Budget
As of Dec. 2, 2025

INCOME			
Actual Income to Date			
	WVU MAE Department		20,000
	WVU CSEE Department		20,000
Total Income Received to Date		$	**40,000**
Anticipated Income			
	NASA Space Grant Consortium		2,000
Total Additional Income Anticipated		$	**2,000**
	TOTAL INCOME	$	**42,000**
EXPENSES			
Project Expense Categories			
	Rover Drivetrain System		5,500
	Rover Manipulation System		3,300
	Electrical System		5,800
	Communication System		1,500
	Science System		2,800
	Administrative		4,000
	Facilities		4,000
	URC Rover Transportation		2,000
	URC Travel Expenses		12,000
	TOTAL EXPENSES	$	**40,900**
	FORECAST FUNDING SURPLUS (DEFICIT)	$	**1,100**

Figure 2. Current Expenses and Anticipated Budget.

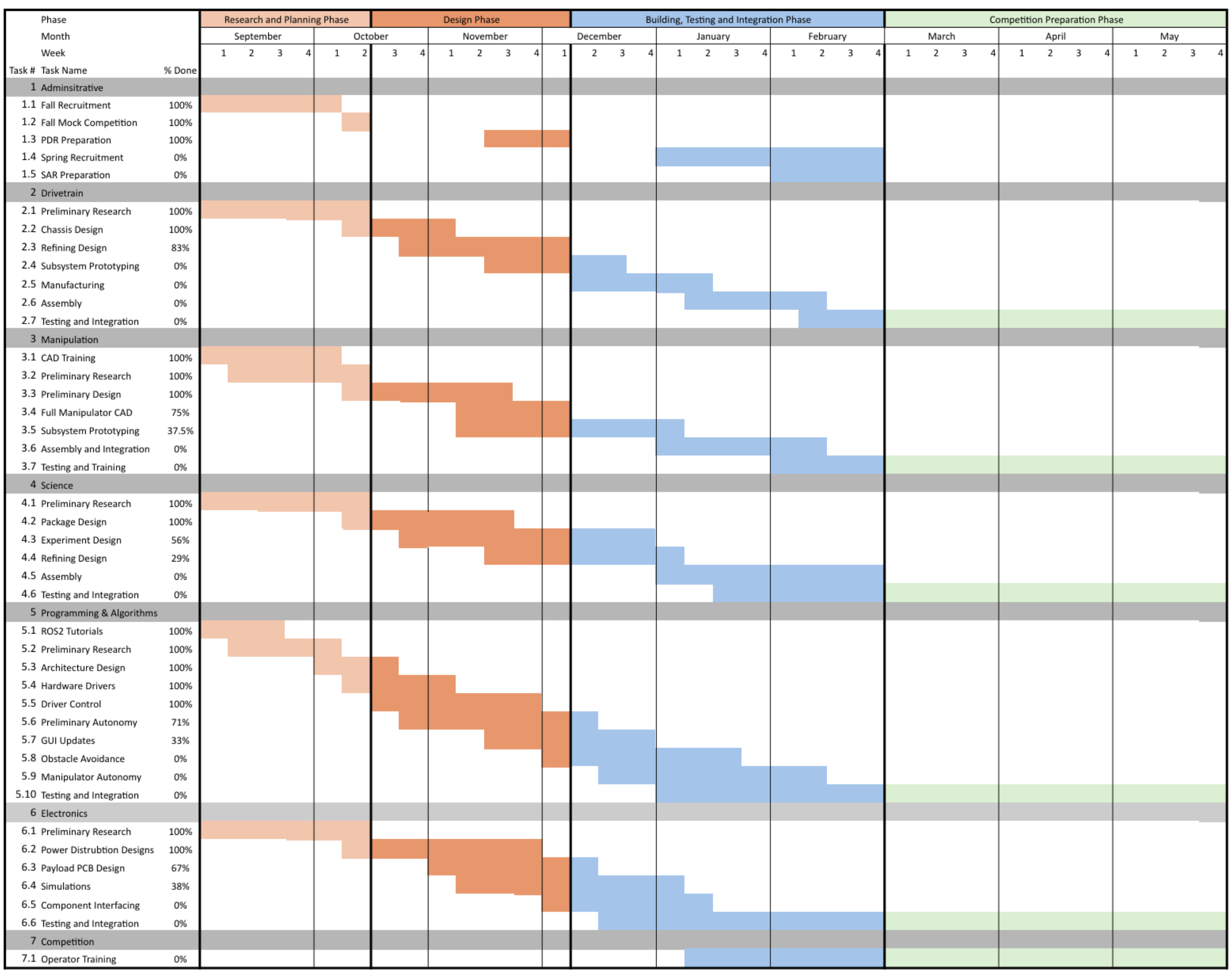

Figure 3. Subteam Gantt Chart.

Figure 4. Rover in Manipulation Configuration.

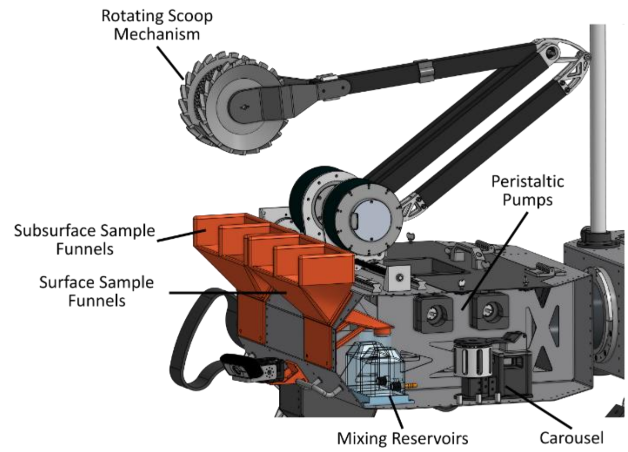

Figure 5. Sample Collection and Analysis System for the Science Payload.

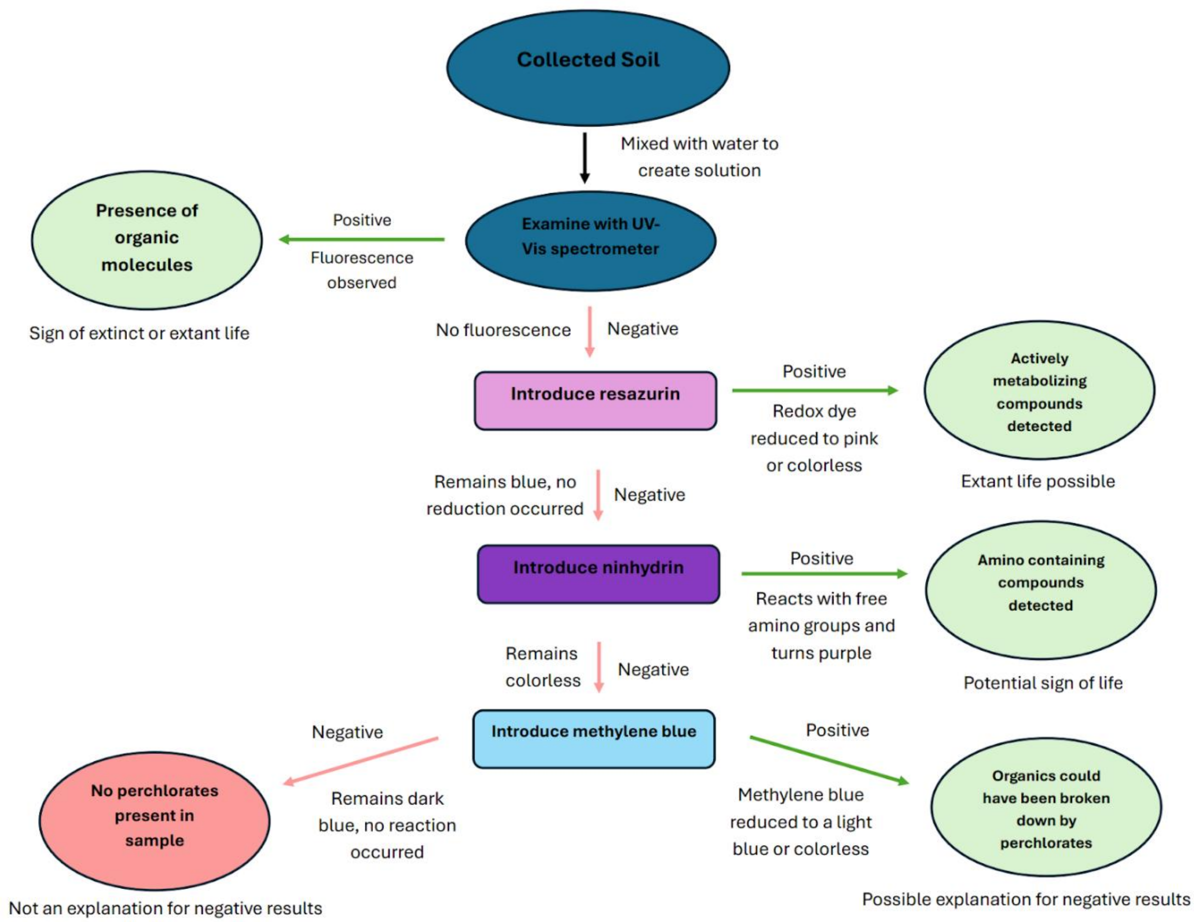

Figure 6. Soil Sample Analysis Flowchart for Science Payload.

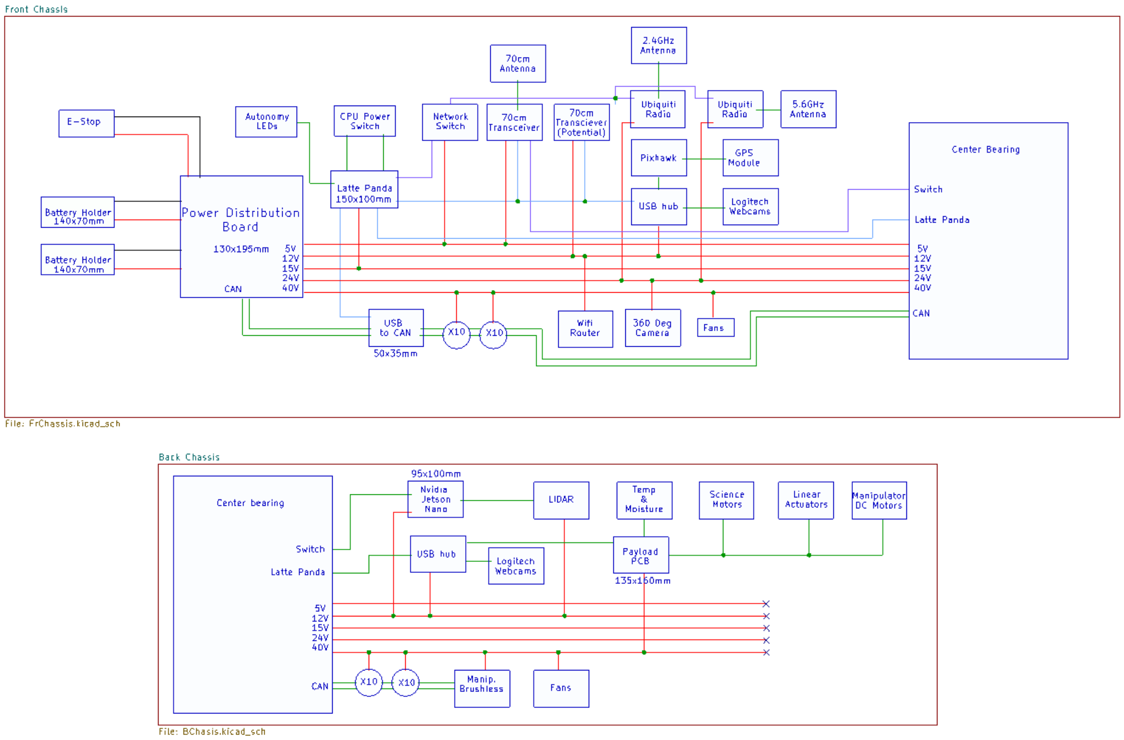

Figure 7. Rover Electronics Schematic

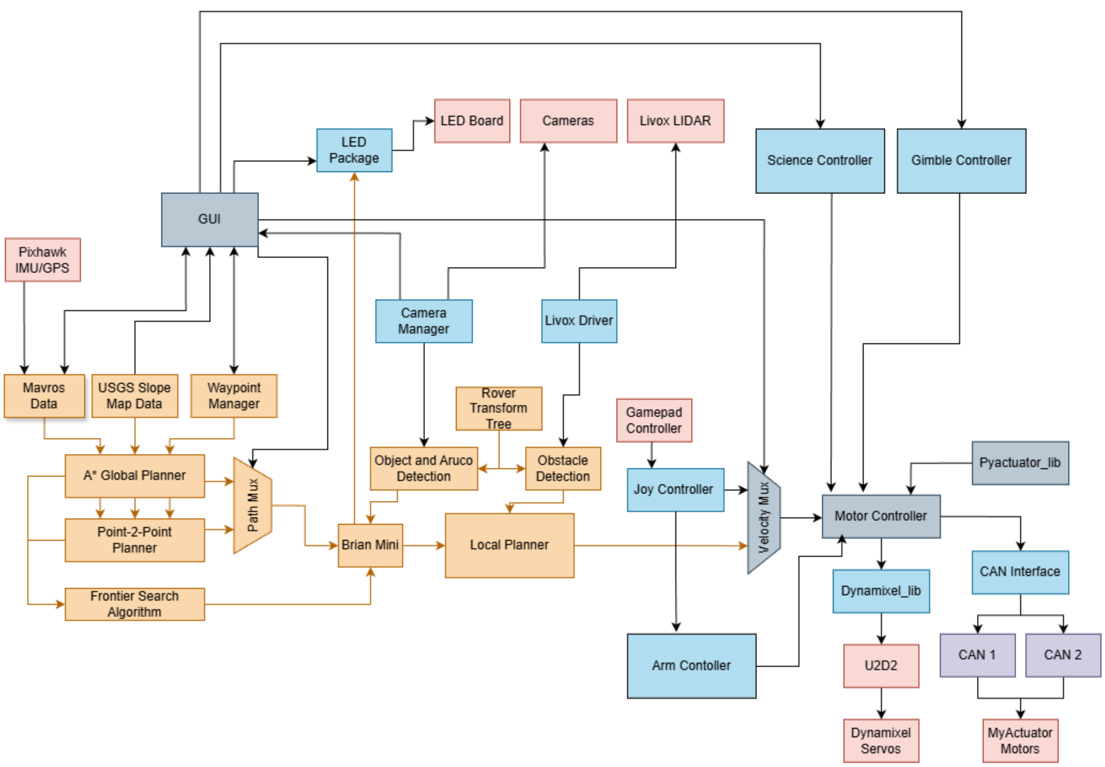

Figure 8. Software Flow Diagram.