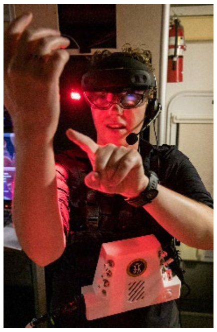
National Aeronautics and Space Administration

2025-2026
MISSION DESCRIPTION

NASA Spacesuit User Interface Technologies for Students

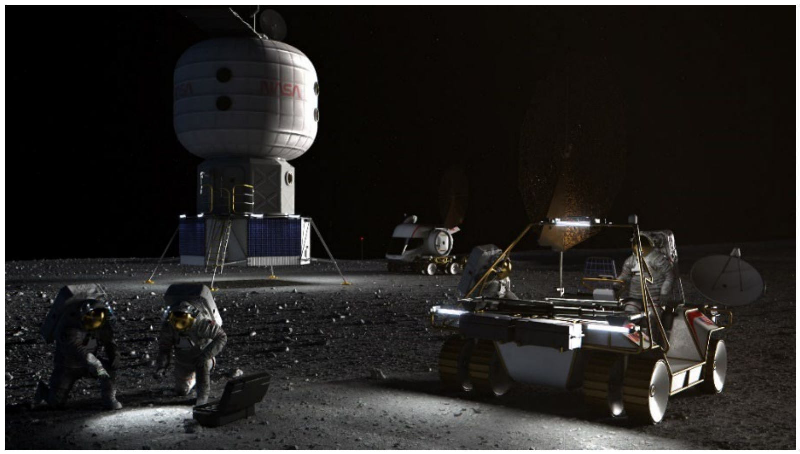
NASA STEM
Launching Tomorrow's Aerospace Workforce

Contents



1. Background

NASA SUITS (Spacesuit User Interface Technologies for Students) is a software design challenge in which college students from across the country help design solutions for future spaceflight needs. NASA is going back to the Moon for scientific discovery, economic benefits, and inspiration for the next generation of explorers: the Artemis Generation. This means engineers are actively developing technologies needed to ensure successful completion of science and exploration missions. NASA SUITS is a collaboration between the Extravehicular Activity and Human Surface Mobility Program (EHP) and the Office of STEM Engagement, currently entering its ninth year, with the goal of connecting students to authentic engineering challenges.



A sustained human presence on the lunar surface requires reimagining how spacewalks are conducted. NASA SUITS contributes to this challenge through displays, voice assistants, AI (artificial intelligence) integration, and interoperability between spacesuits and rovers.

In NASA SUITS, teams design crew autonomy enabling systems and UIs (user interfaces). Teams will submit a proposal for ***both*** spacesuit and PR (pressurized rover) systems, displays, and voice assistants. If selected, teams will be assigned one of the two assets to focus on. These teams will then be matched with other teams to cover both lunar assets. Teams may design for their choice of screen or device, however, any HMDs (head-mounted displays) for the spacesuit must be passthrough AR. The pressurized rover will be virtual and operating in a virtual environment integrating NASA’s [Digital Lunar Exploration Sites Unreal Simulation Tool] (DUST).

After submitting a proposal, top teams will be selected to develop a UI and background software, be mentored by NASA experts, and test and showcase their work to NASA engineers in a mock EVA (extravehicular activity) scenario at NASA’s Johnson Space Center in Houston in May 2026.

2. Mission Concept

NASA SUITS is creating a lunar EVA scenario for 2026. Teams are responsible for their UI, voice assistant, display device, and background software. The testing will take place at the JSC Rock Yard at night; therefore, teams will need to accommodate for lighting factors in the display systems, especially if an HMD is used. The rockyard consists of a pulverized granite base with scoria boulders ranging in size up to 1m as well as craters up to 2m deep and 20m in diameter.

The scenario takes place with each team assigned to either the pressurized rover or the spacesuit components and then paired with another team. Each team will have their own design objectives but may need to work together throughout the challenge to meet interoperability goals. Each team will also be connected to a telemetry stream specific to their assigned lunar asset.

2a. Pressurized Rover

The Pressurized Rover (PR) team will develop a display and control system for the rover operating in the virtual DUST environment. Autonomous systems should be used to navigate the rover from one location to another while conducting search and rescue patterns, path planning, object detection, and resource utilization factors. The use of AI to accomplish these goals is essential for a strong proposal.

2b. Spacesuit

The spacesuit team will need to deploy their solution for one EVA crew member. This can be a HMD, tablet, phone, or other device of your choosing. The EVA crewmembers will be referred to as EV. The EV will rely on both displays and a voice assistant to accomplish their goals.

2c. Artificial Intelligence Assistant (AIA)

NASA SUITS aims to act as a force multiplier for astronauts on the lunar surface. This is accomplished by increasing efficiency and lowering the cognitive load on the EVA crew member allowing them to focus their attention on tasks best accomplished by the human brain. Teams should use AI to accomplish this goal. This includes a voice assistant using normal language in an efficient way. For example, if the EVA crew member asks for oxygen levels the response should be concise and clear. “Primary O2 47%, Secondary 99%.” Rather than, “Your primary oxygen tank level is currently at 47% and your secondary oxygen tank level is currently at 99%. Do you currently have any other questions for me?”

AI will also be critical in finding safe, efficient routes for traverse by both the PR and EV. Route planning should account for consumable limits and be able to adjust as needed.

Keep in mind hallucinations can impact your goals, so you need to establish guardrails for mission-critical aspects of your design.

2c. Mission Tasks

Initial Scene

The scenario begins with an autonomous Lunar Terrain Vehicle (LTV) performing standard operations in a known location. An unknown error occurs, causing communications with the LTV to stop. We know the rover's last location and consumable status. Due to a software glitch, we suspect the LTV continued to operate autonomously until the power dropped enough to trigger an automatic sleep mode. The teams' job is to establish a search radius, map and execute a search pattern to locate the LTV, and navigate in range to allow a crew member to egress and make diagnosis and repairs safely.

Pressurized Rover Navigation

The Pressurized Rover (PR) team will demonstrate their UI and crew autonomy system as they navigate the rover from a starting location and perform a search pattern for the lost LTV. The team will know the LTVs last known location and its consumable limits to establish a search radius. The team will then establish a search pattern, based upon industry standards, taking terrain into account while locating the LTV safely and efficiently. This pattern should adapt and adjust as more details become clear from inputs such as LIDAR, or a beacon signal, which can be detected a short distance from the LTV. Keep in mind the PR will be operating in the DUST environment.

Evaluated PR features include autonomous best path planning, hazard avoidance, consumable resource usage, and estimates of remaining resources given the planned route. Additionally, teams should provide estimates of turn around points where the rover will need to return to base or risk depletion of limited resources. When provided with a point of interest, teams should use predictive modeling to provide a decision support system for the crew to optimize resource usage and reduce cognitive load.

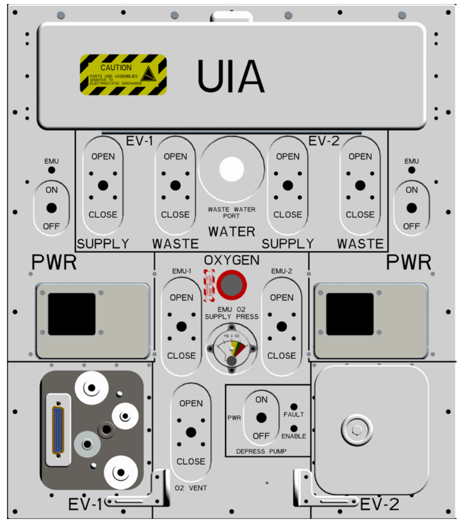
The PR will be broadcasting a simulated "wake-up call" for the LTV. When the LTV is in range, it will wake up and respond, reducing search range efforts to an area of less than 500m. PRs may include a "warmer/colder" feature to aid in tracking up to approximately 50m.

Upon arrival, the crewmembers will prepare for egress. The Umbilical Interface Assembly (UIA) will be part of the hatch in the PR.

Please reference the requirements section for more detailed PR system implementation requirements.

Egress

Egress occurs when the crew member, also known as the EV, exits the airlock to begin the EVA. Several steps must take place to ensure the crew member can safely egress.



The goal of this task is to demonstrate effective and efficient methods for completing the Umbilical Interface Assembly (UIA) procedures to initiate an EVA by preparing and checking the spacesuit's portable life support systems. The priority for the spacesuit system is the use of intuitive UIs, including display and voice. This is an opportunity to begin showcasing those abilities.

The EV will interface with tactile switches on the UIA in accordance with provided procedures. A sample of procedures is in Appendix A but is subject to change as we approach Test Week. Upon successful completion of the egress task, EV will move on to the navigation portion of the EVA.

Teams will decide the most effective method for communicating and accomplishing these procedures. This can be a text checklist, computer vision, voice commands, none of, or a combination of those listed. This is a prime opportunity to integrate AI. The UIA's switch state will be provided from the Telemetry Stream Server (TSS).

EV Navigation

The purpose of EV navigation is to ensure the crew member can traverse to locations safely and efficiently. The goal is to implement a software system to aid crew members as they navigate the lunar surface. This includes a system for detecting and navigating environmental hazards under lighting conditions like the lunar south pole and providing updates to the crew member as the situation changes. An animation of sample lighting conditions is available here. The system should provide real-time alerts and recommend immediate actions such as alternate routes.

Teams will design a navigation solution that is effective and non-obtrusive. This navigation solution needs to allow for flexibility in the EVA, as destinations can change. For the UI, teams shall design a 2D mini-map to aid navigation. Teams may also include a 3D map and computer vision destination waypoints and/or path indicators. Throughout the navigation, the LTV may provide status updates, which could affect navigation for the EV.

LTV Repair

Exit Recovery Mode (ERM)

Upon arrival at the malfunctioning LTV you will need to:

- Retrieve ERM procedures from AI assistant (AIA)
- Follow procedures to ERM
- *Wait for voice assistant/UI to announce ERM success*
- Proceed to the next task

System Diagnosis

- Command AIA to conduct system diagnosis when ready
- EV can conduct visual inspection as well to determine issues
- Wait for diagnosis completion and next steps from AIA
- AIA will provide procedures for correcting issues uncovered from diagnosis and will walk EV through procedures when ready

System Restart (Nav Correction)

- AIA will provide and guide EV through procedures for a physical restart of the rover nav system
- AIA will update when the restart is complete and will verify if position data is correct

Physical repair task

- When ready, AIA will provide and guide EV through physical instrument repair tasks
- Tasks may include:
    - Reconnecting a Loose Bus Connector
        - Power systems are limited due to disconnection
        - Must repair
    - Damaged Dust Sensor Replacement
        - Can repair later (omit if time is low)
        - If the team is low on time, AIA should suggest this repair be delayed

Final system checks & repair verification

- AIA will conduct a final system diagnosis to ensure the rover is stable and recovery is successful

Ingress

An EVA is not complete until the crewmember has arrived safely back inside their craft. Ingress is the process of returning to the airlock. Once the crewmember has completed all EVA tasks, they will begin the ingress portion of the EVA.

The EV will follow navigation cues and instructions to follow the best path for return to the PR. Once at the PR, the EV will conduct final procedures with the UIA.

Teams will decide the most effective method for navigating back to the PR. The UI shall provide a “breadcrumbs” feature for retracing a path. The ideal implementation would provide the shortest safe path back to the PR.

3. NASA Provided Systems and Equipment

3a. TSS

The Telemetry Stream Server (TSS) is a server that provides simulated telemetry values for the lunar assets. NASA will provide a Unity/Unreal plugin to assist in integrating the TSS with your device. Your device must be able to retrieve the following information from the TSS and display this information at any time:

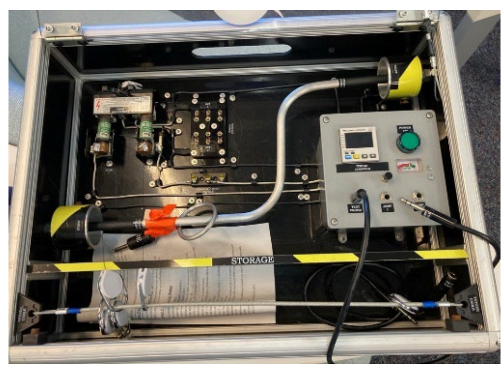
PR Telemetry	EV/Spacesuit Telemetry
• Pressurized Rover telemetry • LTV at 500m telemetry • UIA	• Spacesuit telemetry • Display Control Unit (DCU) • LTV at 50m • LTV Task Board

3b. UIA

The UIA features multiple switches teams will manipulate to match the desired configuration for egress. These switches feed into the telemetry stream via Booleans, allowing teams to receive real-time feedback on their state. Teams are encouraged to explore creative solutions to convey procedures and relevant telemetry such as computer vision and voice assistant to aid in completing the procedures.

3d. Lunar Terrain Vehicle

NASA will provide the LTV and framework for the LTV to move through the terrain of the test site. The team is responsible for receiving and displaying telemetry from the LTV.



The LTV also includes a task board. This board, shown in the photograph to the right, will include a few physical tasks. More details will be provided upon team selection.

3e. Display and Control Unit

The Display and Control Unit (DCU) features multiple switches, which allow the EV to interact with different systems of the space suit. These switches feed into the TSS, allowing teams to receive real-time feedback on their position. The DCU also allows the EV to handle any errors related to these systems. The version provided does not have an integrated display, rather your spacesuit display will handle this information via the TSS.

The systems controlled by the DCU include:

- Battery (Local/UMB)
- Oxygen (Pri/Sec)
- Comms (A/B)
- Fan (Pri/Sec)
- Pump (Open/Close)
- CO_2 (A/B)

NASA will provide a method for simulating the DCU location system to assist with your development.

4. Requirements

Please read and follow the requirements thoroughly. These requirements may evolve following team selection.

Note: In the requirements sections below:

Shall = required for minimally viable product

Should = requested features, but secondary priority

May = potential stretch goals for development

4a. Pressurized Rover Requirements

1. Pressurized Rover Control:
   a) Shall develop a system for controlling the rover in the virtual DUST environment.
2. Spacesuit Telemetry:
   a) The UI may display crew member biomedical data. This data shall be easily accessible.
   b) The UI shall display spacesuit system state data. This data shall be easily accessible.
3. LTV Telemetry:
   a) The UI shall display the LTV beacon data. This data shall be easily accessible.
4. Task Procedures:
   a) The UI shall display procedures for tasks. All procedures shall be easily accessible.
5. Map:
   a) The PR UI shall include a live 2D map for tracking surface assets.
   b) Spacesuit location:
      i) The map may track crew members' locations live for the duration of the EVA.
      ii) The map may draw the EV's projected and traversed path.
   c) LTV Search:
      i) The map shall show the potential travel radius of the lost LTV.
      ii) The map shall track the anticipated search pattern for the lost LTV.
      iii) The map shall adjust this track as new info is gained.
   d) Points of Interest:
      i) The map shall display points of interest.
      ii) The map shall allow the user to add and label points of interest (drop pins), and share with EV, and see EV added POIs.
   e) Caution and Warning:
      i) The UI shall feature a caution and warning system.
      ii) The caution and warning system shall alert PR when any telemetry enter off-nominal ranges and the AIA should recommend procedures to address warning.
   f) Display Mission Timers:
      i) The UI shall display the mission elapsed time. HH:MM:SS.
      ii) All mission timers shall adhere to standards and constraints provided to selected teams.
6. Autonomous Navigation System:
   a) Shall determine the best path.
   b) Shall detect and avoid obstacles.
   c) Shall receive updated destinations from telemetry stream (TSS).
   d) Shall provide a map showing all lunar assets.
   e) Shall track rover speed, angle, and heading.
7. Autonomous Resource utilization:

a) Shall track life support systems and their health.
b) Shall track rover resource use, such as power, and provide predictive analytics throughout the scenario.
c) Shall provide real-time updates as necessary through caution and warning system.
d) Shall use AIA to provide status updates using natural language. Including specific values.

4b. Spacesuit Display Requirements

1. EV Telemetry:
   a. The UI shall display EV's own suit and simulated biomedical data.
2. Map:
   a. The UI shall display a 2-dimensional map.
   b. The map shall display a planned search location and route for locating LTV efficiently.
   c. The map shall display the location of live assets, such other crew members.
   d. The UI may display 3D map of the environment.
3. Procedure List:
   a. The UI shall display correct procedures for each station of the EVA.
   b. The UI shall provide voice assistance using natural language.
4. Navigation:
   a. The UI shall implement a "breadcrumb" feature for navigational use.
      i. This feature will allow the user to backtrack to the PR.
   b. The UI should implement a best path navigation feature.
   c. The UI should offer navigation aids to points of interest.
   d. The UI shall provide predictive maximum range based upon spacesuit life support usage and limitations.
5. Drop Pins:
   a. The design shall allow the user the ability to drop a pin on the map at any point during the EVA.
6. Caution and Warning:
   a. The UI shall feature a caution and warning system.
   b. The caution and warning system shall alert the user if his/her spacesuit or biometric telemetry enter off nominal ranges.
   c. The UI shall use AI to recommend actions depending on the error.

4c. Peripheral Requirements

These requirements shall apply to the development of peripheral device:

1. Any external or additional device must be presented at the software design review (SDR) and approved by the NASA SUITS team.
2. The device should communicate with the team's device(s) outside of the TSS (i.e., Bluetooth).
3. Devices must not have holes or openings that would allow/cause the entrapment of fingers.
4. There shall be no sharp edges on the device.
5. Pinch points should be minimized and labeled.
6. Electrical design must meet the additional requirements.

Appendix A: Sample UIA Procedures

EVA Egress

Connect UIA to DCU and start Depress

UIA and DCU	1.	EV1 verify umbilical connection from UIA to DCU
UIA	2.	EV-1, EMU PWR – ON
DCU	3.	BATT – UMB
UIA	4.	DEPRESS PUMP PWR – ON

Prep O2 Tanks

UIA	1.	OXYGEN O2 VENT – OPEN
HMD	2.	Wait until both Primary and Secondary OXY tanks are < 10psi
UIA	3.	OXYGEN O2 VENT – CLOSE
BOTH DCU	4.	OXY – PRI
UIA	5.	OXYGEN EMU-1 – OPEN
HMD	6.	Wait until EV1 Primary O2 tank > 3000 psi
UIA	7.	OXYGEN EMU-1 – CLOSE
BOTH DCU	8.	OXY – SEC
UIA	9.	OXYGEN EMU-1 – OPEN
HMD	10.	Wait until EV1 Secondary O2 tank > 3000 psi
UIA	11.	OXYGEN EMU-1 – CLOSE
BOTH DCU	12.	OXY – PRI

END Depress, Check Switches and Disconnect

HMD	1.	Wait until SUIT Pressure, O2 Pressure = 4
UIA	2.	DEPRESS PUMP PWR – OFF
BOTH DCU	3.	BATT – LOCAL
UIA	4.	EV-1 EMU PWR - OFF
BOTH DCU	5.	Verify OXY – PRI
BOTH DCU	6.	Verify COMMS – A
BOTH DCU	7.	Verify FAN – PRI
BOTH DCU	8.	Verify PUMP – CLOSE
BOTH DCU	9.	Verify CO2 – A
UIA and DCU	10.	EV1 disconnect UIA and DCU umbilical