Team TerpVISIO
(Vision Interface for Space Immersive Operations)

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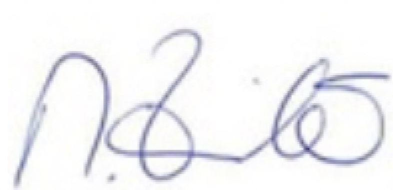


Faculty Advisor Signature Date

Technical Section

Abstract

This proposal showcases the Vision Interface for Space Immersive Operations (VISIO), an augmented reality (AR) information display system that aims to increase situational awareness and reduce cognitive workload during routine extravehicular activity (EVA) operations. We outline the system's major components, design considerations, overall architecture, and a more in-depth look at the interaction paradigms that were explicitly designed for the proposed EVA task. The VISIO system was developed to provide a seamless and intuitive interface for astronauts performing EVA tasks. The primary AR display gives astronauts a clear and unobstructed view of their work area while still allowing them to observe, interact with, and hide generated biometric and location telemetry data in their peripheral vision via voice and gaze interaction. Our caution and warning system will give them actionable steps to fix any space suit issue they may encounter. From this default display, they can access a variety of display phases specific to the task they are currently performing. During the egress phase, astronauts are able to review an animated sequence of the airlock procedure, as well as superimposed boolean values of each switch's current status allowing for more efficient outfitting and toggling of equipment. During the site navigation and return phase, the astronaut has access to both a 2D and 3D map of their environment with semantic data and the ability to configure way point drop settings which they can then use to backtrack to any location of interest. During the geology scanning phase, the astronaut is able to take the data provided by the spectrometer and store it in a virtual notebook, take pictures of the rock and take their own notes through voice commands. During the rover commanding phase, the astronaut is able to control the navigation and tasks of the rover through voice commands while being able to see the ROVER's perspective through a virtual camera. In

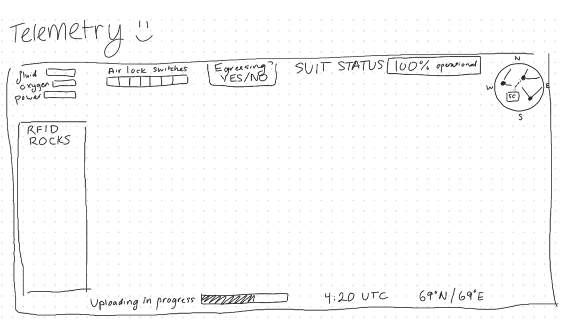
order to get feedback and keep improving our design, we intend to test it against a virtual, simulated lunar environment through a series of agile iterations.

Software and Hardware Design Description

Default EVA System State

The Microsoft Mixed Reality Toolkit, our primary resource for developing on the HoloLens 2, offers gaze-tracking and voice interactions as core features we will be utilizing. This Default EVA System State is the standard display the astronaut will see when they are not performing a certain task. As shown in the wireframe below in Figure 1, this view will simply display basic biometric information given by our telemetry stream, world longitude and latitude coordinates, and local coordinates concerning the landing site. To maintain the astronaut's situational awareness, we decided that unless the astronaut is directly looking at this information, the data would be passively displayed in their periphery as semi-transparent icons. This would allow the astronaut to easily glance at the display to check their status without actively thinking about it or taking their attention away from the task at hand. If the astronaut wishes to see a more detailed view of their location or biometric data, they can either gaze at the location for a longer period or use the voice commands "VISIO show me my location" & "VISIO show me my biometrics" to have the data overlay displayed more prominently in their field of view. They can then easily hide the data again by saying, "VISIO hide my biometrics" and "VISIO hide my location ."The voice interactions were designed to minimize the amount of time the astronaut has to take their attention away from the task and make the system as intuitive as possible.

Figure 1



For the more detailed bio-metric display view, the astronaut is not only able to see the full range of their vitals, including how close they are to an anomaly, but they will also have the ability to view their vitals over time through a graph that it is generated and displayed by storing previous biometrics data. For the more detailed location view, the astronaut will be able to see an AR world-in-miniature version of their surrounding lunar environment that they can manipulate to better understand their orientation and environment (Stoakley, Conway, Pausch, 1995). The HoloLens 2 headset contains a time-of-flight depth sensor constantly mapping the surrounding environment. The MRTK provides a mechanism to display a geometric mesh to create this miniature version of the physical world through the Spatial Awareness system, as depicted in figure 6. In the case of a space suit anomaly, our system will automatically open the caution and warning view, which will have a red blinking caution icon on the top right corner of the head-mounted display that corresponds with the current anomaly. The audio system will also repeatedly play a message warning the astronaut of the anomaly every 30 seconds. The astronaut will then be able to view the more detailed warning view by saying, "VISIO, show me an issue," or by looking at the warning icon for an extended period, albeit shorter than other data displays. In this view, astronauts see more detailed information about the anomaly and possible solutions. From here, they can acknowledge the warning by saying “VISIO acknowledge warning” or looking at the acknowledge button for an extended time. This will cause the system to stop repeatedly playing the audio message, and the caution icon will no longer blink, although it will still indicate an active warning until the issue is solved. As this is the “main menu” of the system, the astronaut will also be able to access the other display phases from here through voice commands, or if they wish to do so, enable corresponding phase icons that they can interact with through gaze.

Egress Phase

The egress phase is the first phase of this EVA mission and is responsible for preparing the astronaut for their time outside the airlock. The first display that the astronaut will see is an animated augmented reality 3D model of the UIA that will highlight each switch in the order that they need to be toggled as well as the corresponding boolean value of each switch (e.g., green for on, red for off) given by the telemetry stream. They can pause, rewind, fast-forward, and examine the animation in slow motion through voice commands. To give them a better perspective of the equipment, we will also allow them to manipulate the 3D model with their hands by scaling, rotating, and transforming. This will allow the astronaut to better understand the procedure and provide a quick reference at any point during the sequence. They can hide the animation at any time by saying "VISIO hide airlock animation" or by looking at the hide button for an extended time.

There will also be the option of just superimposing the boolean values of each switch over the physical switches within the airlock, which the astronaut can turn on or off. The astronaut will also see a visual "progress bar" in the display's top center, indicating how many switches still need to be toggled. Once all the switches have been toggled correctly, the progress bar will be filled, and the astronaut can proceed to the next phase.

Site/Return Navigation

During the site navigation phase, the astronaut will be able to navigate to the point of interest while still maintaining situational awareness of their surroundings and dropping "breadcrumbs" along the way, which they can then use to navigate back. This will be accomplished by having a 3D representation of their surroundings that they can manipulate with their hands as well as voice commands. The 3D representation will be generated by the HoloLens 2's time-of-flight depth sensor, which will constantly be mapping the surrounding environment. The MRTK provides a mechanism to display a geometric mesh to create this miniature version of the physical world through the Spatial Awareness system.

The 3D map will also have a "breadcrumb" trail superimposed on it, showing the path the astronaut has taken. These waypoints, by default, will start automatically dropping when the astronaut says, "VISIO drop bread crumbs every [time interval]." At any point, if the astronaut wishes to drop a waypoint manually, they may use the default command of "VISIO drop bread crumbs," and if they wish to specify the coordinates, they may say "VISIO drop bread crumbs at [coordinates].

If they wish to view the waypoints beyond the augmented reality map they created, they can use the command "VISIO show breadcrumbs," which will display the waypoints in a list format they can scroll through. And cause them to appear on the lunar surface. Each waypoint will appear as a solid-colored point on the lunar surface with a translucent beam that extrudes directly upward for several meters before fading out. The scale and size of each waypoint will shrink or grow based on proximity to the user, enabling the astronaut to gauge a sense of perspective and how far away different sites are. We want to ensure that the user can see exactly where each site is concerning them, even if they might be in a situation with poor visibility or if a terrestrial feature is occluding the site.

During the creation of each of these waypoints, the user can select one of a set number of colors to label and organize these points. Within the menu, the user can turn on and off each waypoint marker by color to prevent distraction and highlight a relationship between a specific set of points. Aside from choosing a color, the user will be asked to give the marker a custom title and a set of notes; both can be filled through speech recognition software. Users can also leave a voice memo if that is preferred. After the creation of the waypoints, the user will have the option to alter any attribute of a waypoint by accessing the menu.

While traversing through the environment, the astronaut can retrieve specific information relating to each waypoint by interacting with them virtually. By simply hovering a hand over a waypoint, the waypoint will display the waypoint's title and the current distance from the user; by selecting each waypoint, a more detailed window will open, displaying further information relating to the point, including an estimated time to travel to the point, user-generated notes, coordinates, and time of creation.

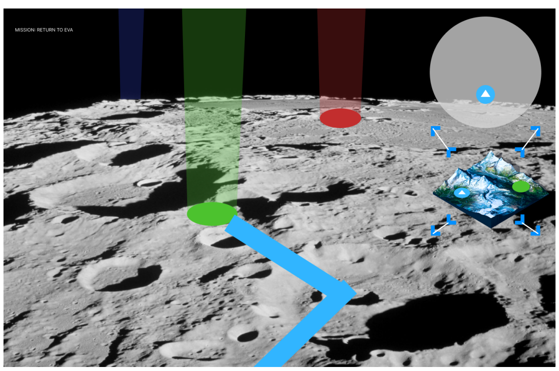
As mentioned previously, these waypoints will serve as the points that lie along the astronaut's return route, which will be continuously recalculated by our navigation system based on the user's preference. At any time during their return trip, the astronaut can edit their path by opening the detailed map menu. To change their current path, the astronaut can then select and drag waypoints into a preferred order from the currently ordered list. The default order will include all set waypoints that have not been revisited in an order that minimizes the time of travel from the user's position, through all the remaining waypoints, before finally arriving at the EVA. The astronaut also has the option to select and deselect waypoints individually or as a previously defined color group based on whether they want to visit those points on their trip. While editing their trip, the user can rerun the path optimization software to reorder all currently selected waypoints most optimally.

The terrain of the lunar surface is very uneven, with features consisting of mountains, valleys, craters, and maria (Earth's Moon Our Natural Satellite, 2022). Because of its unpredictability, traversing the Moon is risky, but to minimize this risk, our navigation system will optimize paths to achieve the fastest route while also avoiding any potentially dangerous obstacles. While on the lunar surface, the astronaut will see a route indicator extending from their person, directing them towards the next closest waypoint. Given the nature of the Moon's potential obstacles, this path will likely include bends and turns, which may not be obvious to the astronaut based on their perspective, field of view, or low-light visibility.

In order to help with understanding their terrain, our design will incorporate a 3D topological mini-model of the previously traversed lunar terrain, highlighting the user's position, all waypoints, and the current path of the astronaut. The model includes information regarding the terrain's altitude level indicated by a colored gradient. This mini-model will be hidden behind an icon to the top right of the user's view, which, when gazed at, will expand in front of the user, where they can transform the model by rotating and scaling it to better orient themselves and make notes of any upcoming terrain features.

Part of our methodology to produce a route between waypoints, as shown by figure 2 is to build this model, otherwise known as a digital elevation model (DEM), to consider the changes in surface elevation. This DEM will be built by using scanners on the exterior of the user's headset that will read LiDAR or "light detection and ranging" data (Fan & Atkinson, 2015). This is a form of terrestrial laser scanning (TLS) that would allow the astronaut to capture this data during their initial traversal of the terrain (Altuntas, 2022). These astronauts' scanners will emit pulsed laser beams at the Moon's surface and read their reflections as point-cloud data,

Figure 2



and our system can then recreate the previously traversed terrain as a digital topographical model. In order to potentially add a degree of realism to our model, we could use photogrammetry to capture the actual surface detail of the mini-model as the astronaut traverses through space, however with the low-lighting conditions, we may not be able to produce a high-definition texture. However, this may not be necessary because of the uniformity of the Moon's surface's color and texture.

As an extension to our mini-model representation of the Moon's terrain, we will also offer the astronaut a simplified "top-down" of their position, surrounding area, route, and waypoints. This map will be in the third person, with a user icon in the center indicating the user's position. As a default, the map will be oriented to always have the location of the next waypoint on the route directly in front of the user's icon. As mentioned earlier, the route will likely not be a straight line; thus, we include an arrow on the user's icon to signal the direction the astronaut is facing. Similar to other mapping services, we will allow the user to change orientation based on their preference, including the option for the perspective to point towards other waypoints, the EVA, and the Moon's north based on the selenographic coordinate system. The map will be overlaid with a colored gradient to indicate changes in surface altitude and a selenographic coordinate grid to help determine the precise location (Springer, 2012). This map will appear as a circular window and occupy the top-right corner of the user's headset display, with the option to display the minimap and the mini-model to be toggled within the menu (Sliwinski, 2013). The mini-model will be located underneath the map if both options are selected.

Geology

During the geological scanning phase the astronaut will be able to scan and take notes on radio frequency identified rocks with their spectrometer and a 3D representation of the rock's data superimposed on top of the physical rock. The data that is collected by the spectrometer will be displayed in a text format on the top left of the screen as an icon which the astronaut can open through gaze or voice interactions. The data will include: the rock's name, composition, and notes. The astronaut will be able to add their own notes by saying "VISIO add note: [note]". The notes will be time stamped and color coded based on the category. The categories

include: Natural Landmarks, Environmental Anomalies, and RFID rocks. The astronaut will also be able to view the notes that they have previously taken by saying "VISIO show notes". The notes will be displayed in a list format that they can scroll through or simply state which time-stamp they wish to show.

The notebook will be displayed as a mesh with virtual pages that the astronaut can flip through. The astronaut will be able to add, delete, and edit their notes through voice commands and hand gestures. The astronaut will also be able to take pictures of their current surroundings by saying "VISIO take picture". The pictures that the astronaut takes will be stored in the notebook as well as in the photo album which the astronaut will be able to access at any time by saying "VISIO show photo album". The photo album will be displayed in a list format that the astronaut can scroll through.

Rover

For the ROVER step of this challenge, the design evaluator must direct the autonomous rover to a location of interest where it will operate. The design evaluator will later recall the rover back to its starting position. Throughout this step, the rover and location of interest will be within the view of the design evaluator.

The head-mounted display will communicate with the rover via the telemetry stream. GPS coordinates of the intended location will be sent to the rover to indicate where it should navigate autonomously. The coordinates can change mid-route, updating the rover's path, and commands can also be sent directing the rover to start or stop its motion.

Although the design evaluator can see the location of interest, e.g., a pile of rocks to be analyzed, they are unlikely to know the exact coordinates, especially if the area has not been navigated or mapped before. Since the rover is autonomous, the goal of this system is to allow the user to direct the rover with minimal interaction while giving the user the control to monitor the rover and make adjustments as necessary. The general process is to first estimate the destination's coordinates by allowing the user to visually select the direction and distance of the destination relative to their location. After the rover starts its navigation, the user can adjust the destination as needed.

To select the destination initially, the user will first specify the direction of the destination relative to their location with the help of a holographic line perpendicular to the ground. This line will hover several feet above the ground and extend straight out from the user, decreasing in width as it gets farther away. When the selection process starts, the line will appear in the direction the user is currently looking. They can then adjust the direction via hand gestures (grab and hold to adjust the angle) or via voice commands, e.g., "30 degrees clockwise" relative to its current direction. The idea is that when the user places it correctly, it will appear to pass through the destination.

The user will specify a distance in the selected direction to complete the selection process. This can be done via a holographic slider button or voice commands, e.g., "30 meters". As the distance is adjusted, a marker will appear on the holographic line to help visualize the distance. Due to the limited range of the depth sensor on the HoloLens 2, it cannot be used to measure the distance unless the destination is within several meters of the user. Therefore, the location of the marker will have to be estimated and will be less accurate at farther distances.

Additionally, how well this step works partially depends on the design evaluator's ability to judge distances. Therefore, the system allows for additional direction after the rover starts moving.

With direction and distance selected, the x and z coordinates of the estimated destination can be calculated using GPS data from the VISION kit and sent to the rover.

After the selection process, the rover is ready to begin navigation. The user will direct the rover to start using the voice command: "Start rover." The holographic line will disappear, and a new holographic line will be drawn from the rover to the inputted destination using GPS data from the rover. The rover will autonomously drive to the destination, moving around any obstacles.

As the rover moves, the user can adjust the destination. This can be done in a process similar to before, but with the direction being relative to the rover instead of the user. They can again make adjustments using hand gestures and sliders or voice commands, e.g., "20 degrees clockwise" or "add 10 meters". At any point, the user can use the command "stop rover" to stop its motion.

Once the intended location is reached, the user can exit out of rover navigation using the UI menu or the command "exit rover."

At the start of the rover step, the coordinates of the rover given by the telemetry stream will be saved. The design evaluator can also manually save the location using the command "Save rover start." After completing the task at the location of interest, the design evaluator will recall the rover to its start location using the command "Recall rover." The saved coordinates from earlier will be sent to the rover via the telemetry to stream, and it will autonomously drive to that location.

In addition to the holograms, a minimap will also be displayed during the destination selection and rover navigation processes to aid the user in directing the rover. This will give a "top-down" view of the area and display the location of the user, rover, and selected destination, using arrows to indicate the rover's and user's directions. Additionally, lines will be displayed on the map, corresponding to the holographic lines. Since the lines on the minimap are in 2D, it might be easier to judge their lengths. This will use the same UI as the minimap used in the navigation step (circular window in the top-right corner); however, information about the terrain might be incomplete if the area hasn't been mapped.

Concept of Operations (CONOPS)

Assumptions

- *During the site navigation, we would be directed by the test conductor and not our system*
- *All the telemetry data that needs to be displayed was given to us*

Claim

We are designing a lightweight and intuitive user-interface that increases situational awareness and reduces cognitive workload during routine extravehicular activity (EVA) operations. We prioritize natural voice and gaze interactions, and indiscrete transparent icons to reduce screen clutterness.

Workflow

- *Egress*
    a. *The astronaut would enter the "egress phase" of the user interface by voice command or gaze interaction with icons*
    b. *This will cause an animated augmented reality 3D model of the UIA that will highlight each switch on the digital UIA in the order that they need to be toggled as well as the corresponding boolean value of each switch (e.g., green for on, red for off) given by the telemetry stream. Which they can pause, rewind, fast-forward, and examine the animation in slow motion through voice commands "VISIO [pause, fast-forward, rewind]. They can hide the animation at any time by saying "VISIO hide airlock animation" or by looking at the hide button for an extended time.*
    c. *If they move there hands towards the 3D model they are able to manipulate to transform and rotate the model with a one hand pinch and scale it with a two hand pinch*
    d. *There will also be the option through a voice command or icon gaze of just superimposing the boolean values of each switch over the physical switches within the airlock, which the astronaut can turn on or off.*
- *Geology*
    a. *The astronaut would enter the "geology phase" of the user interface by voice command or gaze interaction with icons*
    b. *The astronaut can gaze at a icon, that will open up a view of the data collected by the spectrometer*
    c. *The astronaut will be able to add their own notes by saying "VISIO add note: [note]". and if they ever want to see the virtual note book they can say "VISIO show [notes]*

d. They can interact with the virtual note book through hand or voice commands, flipping pages, editing notes and taking pictures to add to the notebook

- *Navigation*
    - *a. The astronaut would enter the "navigation phase" of the user interface by voice command or gaze interaction with icons*
    - *b. The astronaut would begin dropping bread crumbs every minute or so by saying "VISIO drop breadcrumbs every minute", they can view bread crumps dropped on their 3D map*
    - *c. If they astronaut wishes to see a more detailed view of the waypoints, they may state "VISIO show breadcrumbs" or use hand interaction, this will also show the crumbs superimposed on the lunar surface*
- *Rover*
    - *a. The astronaut would direct the rover to autonomously drive towards a desired location using a visual marker that can be adjusted with their hands or via voice commands.*
    - *b. The astronaut would say "start rover" to begin autonomous movement, then adjust the path as necessary.*
    - *c. The astronaut would say "stop rover" to halt the rover, then say "recall rover" to return the rover back to the base.*

Human-in-the-Loop (HITL) Testing

Conducting HITL testing on a system designed to be used on a lunar mission presents several challenges. For one, an astronaut using the system would be wearing a bulky, pressurized space suit, restricting his/her mobility. Along with a space suit comes a space helmet, which restricts one's field of view, particularly in the vertical direction. Lastly, the lunar environment itself presents several challenging conditions, from extreme lighting conditions to rough terrain and craters. Our team has arrived at three categories of HITL testing that attempt to account for different aspects of these challenges: on-campus testing using space suit simulators, off-campus analog field testing, and on-campus testing in a virtual reality testbed.

It is difficult for a user to visualize what an AR user interface might look like while they are on the Moon, with different surfaces, backgrounds, and lighting conditions. Simply testing it on a HoloLens in a classroom setting (or even outdoors) here on Earth won't necessarily provide a realistic view of how the astronaut may actually see the info. However, virtual reality "applications enable scientists and engineers to interpret and visualize science data in new ways and experience environments that are otherwise hard, impossible, or too costly to visit in person" (Memarsadeghi and Varshney, 2020). Thus, our virtual reality testbed subteam will design a realistic VR simulation of an astronaut on the Moon, in order to better replicate moonwalks and create situational training of a lunar mission. We will be utilizing NASA's Mixed Reality Exploration Toolkit (MRET) for creating a virtual environment of the Lunar South Pole that accounts for dynamic surface conditions (sunlight, geology, topography), and will be porting over the HoloLens UI into a VR format, which should be simple since the MRTK supports VR build targets. In the HITL tests, the user would be given a sample EVA to carry out, which may involve navigation and geological tasks.

The goal of all of our forms of HITL testing will be to evaluate the interface's effectiveness. Metrics for the interface's effectiveness will come from whether the user was able to successfully complete the task as well as survey feedback where participants give a score ranging from 1 to 10 on areas like ease of use, visual aesthetics, intrusiveness, and helpfulness. Additionally, for non-VR testing, we will also evaluate the interface's efficiency by measuring the time it takes to complete a mock mission with and without the help of our interface.
For testing taking place on-campus, we will be seeking volunteers from within the University of Maryland community. Members of this community would include undergraduate and graduate students as well as faculty and staff. With a relatively large population of over 40,000 individuals, we could obtain a diverse sample of volunteers. The expected age group of our volunteers would be between 18 to 24 for students and between 30 to 60 for professors. In general, this population may not be well-versed with space terminologies or missions, thus we hypothesize that if the interface is easy to understand and use for our testing group, it should be at least as easy for astronauts to understand, even if they don't have experience with an EVA.

Our team will enact a number of safety measures across all of our HITL tests. We will ensure compliance with all safety guidelines enacted by the University and our local health departments, such as indoor mask mandates. We will provide testers with a variety of PPE, including hand sanitizer, disposable gloves, disposable VR eye masks while using headsets, and disinfecting wipes for various surfaces (including those that are safe with electronics and VR headsets). Through the XR Club, our team will also have access to a Cleanbox CX2, which decontaminates XR headsets in one minute using a medical-grade UV treatment that kills 99.999% of viruses and bacteria. We will put headsets through this treatment before and after use.

Project Management

To ensure timely development for our project, we have devised a comprehensive plan that distributes tasks to our eight subteams along with scheduled checkpoints to ensure that progress is being made. The subteams and their responsibilities are listed below:

- System Integration: Merges all subteams' branches into one cohesive experience, general UI controls not handled by specific subteams
- Navigation: Calculating navigation path between points, displaying AR visualizations
- EVA System State: Connecting to telemetry stream and raising events
- Geology: 3D animated instructions for tools and scanning of artifacts
- Egress Procedure: Assisting the astronauts in performing a successful egress procedure
- Design: 2D/3D design, including graphic & UI design, 3D modeling/animation, VFX
- HCI/UX Research: All aspects of HITL planning and testing, results analysis
- Outreach: Social media, seek press coverage, organize outreach events, video editing

The target size for each subteam is 2-4 students, which we believe is a good size for giving each member tasks to perform while also distributing the workload to a manageable size. Our team will also make extensive use of the project planning software Trello (as seen in Figure 4). Many of our team members are already familiar with this software, both in their personal and academic projects. By using Trello, we will be able to seamlessly assign tasks and criteria to different subteams so that they always have a sense of what needs to be done, which will also assist us in performing our internal progress reviews. Lastly, we would host a monthly progress presentation, inviting our faculty advisor, NASA mentor, and support team. This will hold us accountable and provide practice for the software development reviews in April. Lastly, we have also prepared a rough Gantt chart for our development schedule for the upcoming year (as seen in Figure 3) that we will utilize to make sure we stay on track.

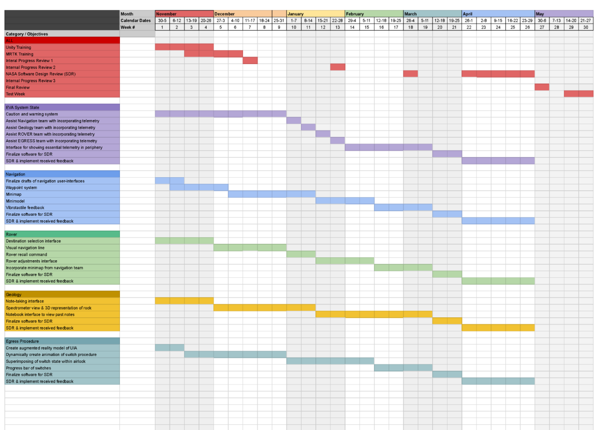


Figure 3 GANTT Chart for subteam objectives

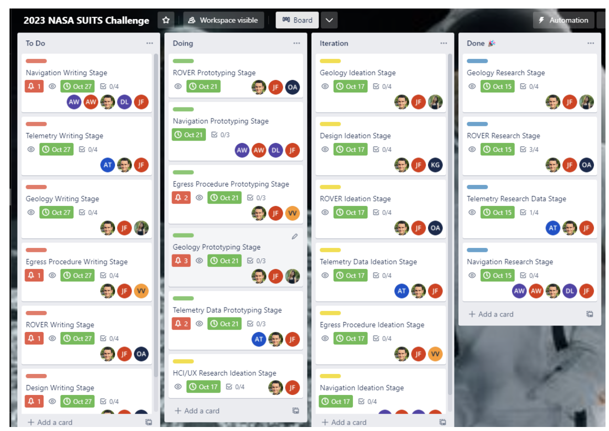


Figure 4 Trello Board for assigning tasks

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Outreach Section

This section outlines our plan to disseminate the results of our work to the greater DMV community, engaging a diverse group of attendees through each event. All who are intrigued by the interconnection of topics such as space exploration and mixed reality and the Artemis Mission as a whole.

Event Plan

- **Event/Entity:** XR Club at UMD
    - **About/Audience:** The XR Club aims to build an immersive ecosystem at the University of Maryland by providing **undergraduate and graduate students** with resources and opportunities to explore virtual, augmented, and mixed reality through hands-on tutorials, projects, hackathons.
    - **Target Date:** January 20th, 2023
    - **Activities**: Hosting a interactive workshop on Microsoft HoloLens 2 + Mixed Reality Toolkit Development while showcasing the features and tools we used when creating our design.
        - Number of Participants: 40+

            - Connection to mission: The XR Club is dedicated to providing students with resources to explore and build immersive experiences. As our project focuses on developing an augmented reality information display system for routine extravehicular activity (EVA) operations, we believe that it is essential to provide students with the opportunity to learn about and experience augmented reality technology and its potential applications.

- **Event/Entity**: Wide Angle Youth Media
    - **About/Audience:** Through media arts education, Wide Angle Youth Media cultivates and amplifies the voices of **underrepresented Baltimore youth** to engage audiences across generational, cultural, and social divides. They inspire creativity and instill confidence in young people, empowering them with skills to navigate school, career, and life.
    - **Target Date:** February 17th, 2023
    - **Activities**: This will be a hands-on lecture that complete showcases Team TerpVISIO complete design process when building this AR interface, from ideation to user testing. There will be an interactive component where participants will have the chance to put on a HoloLens 2 and experience the interface for themselves.
        - **Number of Participants:** 30 - 35
        - **Connection to mission:** We will show Baltimore youth that there is a future for them in the field of technology and computer science. We hope to inspire creativity and confidence in the participants, and show them that they have the ability to create amazing things with the media skills they learn.
- **Event/Entity:** Iribe Intiative for Inclusion and Diversity & Maryland Center for Women in Computing
    - **About/Audience:** The Iribe project for Inclusion and Diversity in Computing aims to empower people from **underrepresented K-12 groups** who are interested in computing by fostering a diverse and inclusive environment. Peer tutoring and CompSciConnect along with the Maryland Center for Women in Computing's K-12 Outreach program, are two of the initiatives it offers.
    - **Target Date:** 4 intearctive lessons inbetween March - May
    - **Activities**: These 4 interactive lessons will be a part of a larger computer science curriculum that students will be learning. The first lesson will be an introduction to computer science where students will learn about the different types of programming languages as well as their applications. The second lesson will be an introduction to the Unity game engine, which is the software that we used to create our augmented reality interface. In the third lesson, students will learn about the HoloLens 2 and the Mixed Reality Toolkit, which are the hardware and

software that we used to create our interface. Finally, in the fourth lesson, students will have the opportunity to put on a HoloLens 2 and experience the interface for themselves.

    - **Number of Participants:** 30
    - **Connection to mission:** As our project focuses on developing an augmented reality information display system for routine extravehicular activity (EVA) operations, we believe that it is essential to provide students with the opportunity to learn about and experience augmented reality technology and its potential applications.
  -

- **Event/Entity:** DCXR
  - **About/Audience:** DCXR is an inclusive community of **immersive designers, developers, and enthusiasts** from around the DMV, with over 2,200 members. They host various to network and explore the latest developments in the immersive industry.
  - **Target Date:** April 14th, 2023
  - **Activities**: This seminar will provide an overview of the work that our team did to develop an augmented reality information display system for routine extravehicular activity (EVA) operations. We will also showcase the features and tools that we used when creating our interface.
    - **Number of Participants:** 70+
    - **Connection to mission:** DCXR is an important entity in the DMV area because it provides a community for people who are interested in immersive technology to network and explore the latest developments in the industry. As our project focuses on developing an augmented reality information display system for routine extravehicular activity (EVA), we believe that it is important to share our work with the DMV community in order to get feedback and improve our design.

Press and Social Media Plan

We will develop a comprehensive and captivating social media and press plan that piques the interest of those who are intrigued by the interconnection of topics such as space exploration and mixed reality as well as showcase any progress we may make during the developmental process. While our social media and press content will be available for anyone who may be fascinated by this subject matter, they most resonate with individuals above middle school age due to the sheer amount of technical concepts involved in this challenge.

In an age of connection, social media is a powerful tool for engaging with a wider audience. Therefore, we are using a select number of social media platforms to reach our target community, such as Twitter, Instagram, Linkedin, Youtube, and Tik Tok. We will create a presence on Twitter which we will use to share general updates and day-to-day activities about our project. Leveraging this presence in conjunction with the other outreach methods will provide the project with a centralized area for announcing news and updates. On Instagram, we plan to post a "person of the week", in which we will give recognition to one team member who has contributed to the project in a significant way. We will use Linkedin to share major monthly updates on the project page. On Youtube, we will post monthly showcase videos of the various aspects of our project. Similarly, on Tiktok we will also engage with the platform's community through short videos that will be used to share weekly updates about our project.

In terms of press, we currently intend to have three major phases of updates. First, we will update our university's newspaper, The Diamondback, once we have been informed of our acceptance into the NASA SUITS program. This article will include information about who is on the team, why we were chosen, and a summary of our proposal and what we plan to do for our project. In this update, we willw provide information about all of the project's progress (basically, a formal write-up version of our two-week social media updates aggregated together), as well as some information about what we still need to accomplish and how the competition will work. Finally, after we finish our project and compete in the competition, we will implement our final major press strategy. This will include updates to The Diamondback on everything we were able to accomplish by the end of the project, as well as our accomplishments during the Virtual Test Week itself. The next press release will be a mid-project update written for The Diamondback, sometime in February. Finally, for the project's final press update, we would like to try and reach out to other local and larger newspapers (College Park Here and Now, Maryland News Center, Washington Post, and others) to possibly host articles about our work, outreach, and achievements. One of our goals in the outreach aspect of our project is to spread awareness about NASA Suits and we would do so by reaching as many people as possible.

Popular blogging VR/AR sites such as UploadVR and Road to VR aim to showcase fascinating uses and innovations in extended reality. Therefore, we will look into contacting them after we have completed and received our results to see if they would be interested in writing an article about our work and the innovations made in immersive technology in space exploration.

Administrative Section

<u>Institutional Letter of Endorsement</u>

UNIVERSITY OF MARYLAND

COLLEGE OF COMPUTER, MATHEMATICAL, AND NATURAL SCIENCES
Department of Computer Science

Matthias Zwicker
Professor and Chair
Department of Computer Science
8125 Paint Branch Drive
College Park, Maryland 20742
zwicker@umd.edu

October 24, 2022

Dear NASA SUITS Selection Committee,

On behalf of the University of Maryland, College Park, it is my pleasure to endorse Team TerpVisio, a team of students representing our institution who are submitting a proposal for the NASA SUITS challenge under the supervision of me, Professor Matthias Zwicker. The University of Maryland is aware of their intent to submit an application for this activity and would be happy to support the team should they be selected to move forward in this challenge.

Please feel free to contact my office at zwicker@umd.edu should you have any questions.

Sincerely,

Matthias Zwicker
Professor and Interim Chair, Department of Computer Science

Statement of Supervising Faculty

UNIVERSITY OF MARYLAND

COLLEGE OF COMPUTER, MATHEMATICAL, AND NATURAL SCIENCES
Department of Computer Science

Matthias Zwicker
Professor and Chair
Department of Computer Science
8125 Paint Branch Drive
College Park, Maryland 20742
zwicker@umd.edu

October 24, 2022

Dear NASA SUITS Selection Committee,

As the faculty advisor for an experiment entitled "TerpVisio" proposed by a team of higher education students from the University of Maryland College Park, I concur with the concepts and methods by which the students plan to conduct this project. I will ensure the student team members complete all project requirements and meet deadlines in a timely manner. I understand any default by this team concerning any project requirements (including submission of final report materials) could adversely affect selection opportunities of future teams from their institution.

Sincerely,

Matthias Zwicker
Professor and Interim Chair, Department of Computer Science

Statement of Rights of Use

As a team member for a proposal entitled "TerpVISIO" proposed by a team of higher education students from University of Maryland College Park, I will and hereby do grant the U.S. Government a royalty-free, nonexclusive and irrevocable license to use, reproduce, distribute (including distribution by transmission) to the public, perform publicly, prepare derivative works, and display publicly, any technical data contained in this proposal in whole or in part and in any manner for federal purposes and to have or permit others to do so for federal purposes only. Further, with respect to all computer software designated by NASA to be released as open source which is first produced or delivered under this proposal and subsequent collaboration, if selected, shall be delivered with unlimited and unrestricted rights so as to permit further distribution as open source. For purposes of defining the rights in such computer software, "computer software" shall include source codes, object codes, executables, ancillary files, and any and all documentation related to any computer program or similar set of instructions delivered in association with this collaboration. As a team member for a proposal entitled “TerpVISIO” proposed by a team of higher education students from University of Maryland College Park * University of Maryland Baltimore Campus institution(s), I will and hereby do grant the U.S. Government a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States Government any invention described or made part of this proposal throughout the world.

Jason Fotso-Puepi

Damian Figueroa Oliver Adkins [illegible]

Alexander Wang Amy Tran Vikaas Venkatesh

Daniel Lopez Kevin Gu Nhi Tran

Funding and Budget Statement

Our team, after building our thorough outline plan, has developed a budget that we think accounts for all the factors that we believe will be of cost to us in the development and testing of our project. The breakdown of these costs is outlined in the table below. The way we have split up our budget is into 2 prominent sections: Operating Costs and Miscellaneous/Other. For each of these sections, we have broken down the components that will be a part of each of them, indicated their costs, and aggregated these costs together for a section cost and then later a total cost. We are fortunate enough to already have access to various important hardware components as members of our school's XR Club. Through applying for funding via our Student Government Association, our club already has several pieces of hardware equipment such as the HoloLens 2. As such, we have indicated the cost of these already-owned items as $0 in the first section of our budget. We have also not included travel costs for conferences in our table, since those are not directly a part of the development or testing. Our SGA, the organization which has already helped us purchase many of our resources, is large and very likely will serve as a significant source of funding for our project - we plan on applying for more funds for our project from them, and anticipate we will be able to receive them. Additionally, if necessary, we will work with our Computer Science department to reach out to a few corporate sponsors who can help us in our search for funding. The Computer Science department at our school already has several prominent corporate partners, such as Leidos, Alion, and Lockheed Martin, some of which could be interested in our work. We can also search for local companies outside of these corporate partners and pitch our idea to them in hopes of receiving funds.

Items	**Net Costs**
Shipping Fees	*$125*
Poster printing	*$150*
Operating Cost	*$200*
Round Trip to Houston	*$7,500*
Hotel Cost	*$10,400*
Travel Total	*$17,900*
Miscellaneous/Other	*$150*
TOTAL	**$18,525**

Letters of Support

UMBC

AN HONORS UNIVERSITY IN MARYLAND

Department of Computer Science and Electrical Engineering
University of Maryland, Baltimore County
1000 Hilltop Circle
Baltimore, MD 21250

Phone: 410-455-8181
Fax: 410-455-3969
http://www.csee.umbc.edu

SUITS Program, NASA

October 20, 2022

Dear Colleagues:

Regarding Mr. Kevin Gu, an undergraduate student at UMBC, majoring in Computer Science. Kevin informs me that he intends to participate in the NASA Suits Challenge representing the University of Maryland. As far as I know, UMBC is not participating, and we approve of Kevin's participation as part of the team from our sister campus.

With my best wishes,

Charles K. Nicholas, Ph.D.
Professor and Graduate Program Director for Computer Science

IRIBE INITIATIVE FOR
INCLUSION & DIVERSITY
IN COMPUTING
MCWIC | MARYLAND CENTER FOR WOMEN IN COMPUTING

Iribe Initiative for Inclusion and Diversity
in Computing
1204 Iribe Center for Computer Science
and Engineering, University of Maryland-
College Park
cjavery@umd.edu | (301) 405-7615

October 27, 2022

NASA SUITS Selection Committee
Johnson Space Center
2101 E NASA Pkwy, Houston, TX 77058

To whom it may concern,

The Iribe Initiative for Inclusion and Diversity and the Maryland Center for Women in Computing in partnership with Terp SUITS will collaborate to produce an explorative interactive lesson that will engage underrepresented groups historically marginalized in computing from local middle and high schools in Maryland. This lesson will be offered at least 4 times during the spring and summer of 2023. Together representatives from Terp SUITS and our I4C teaching ambassadors, will help students define augmented reality by creating real-world experiences with AR technology. It is our collective goal to show students how augmented reality technologies can be applied to various scenarios and spark their interest to pursue degrees and careers in computer science and space exploration. We hope that you consider this proposal.

Sincerely,

CJAvery

Charlotte Avery

Outreach Coordinator

Washington, DC
DCXR.org
hello@capitol-interactive.com

NASA SUITS Selection Committee
Johnson Space Center
2101 E NASA Pkwy, Houston, TX 77058

To whom it may concern,

The DCXR community, in partnership with TerpVISIO will collaborate and produce an outreach event for our 2,200+ member group, as well as to the general public. It is our collective goal to show established professionals in the extended reality space the fascinating use cases of the technology in the space exploration industry. We hope that you consider this proposal.

Sincerely,

Joseph Cathey
DCXR Lead Organizer

NASA SUITS Selection:

We want to express our excitement and support for the development of the TerpVISIO team and their NASA SUITS proposal. As the XR Club at the University of Maryland, a student organization that aims to inspire students through access to cutting edge immersive technologies and educate students on the creation of their own extended reality application, this proposal is essential in showing the impact of this technology and the potential that it has to change our way of life. We are currently collaborating with the TerpVISIO team to create an event in early 2023, where they will be able to showcase their project to members of the club, promoting their work and inspiring students to get more involved in this exciting field. We look forward to more from this project in the near future and they are welcome to use our equipment to advance in their endeavour.

Best Regards,
XR Club at the University of Maryland

WIDE ANGLE YOUTH MEDIA

2601 North Howard St. Suite 160 Baltimore, MD 21218 www.wideanglemedia.org

November 1, 2022

To Whom It May Concern,

Wide Angle Youth Media in partnership with Team TerpVISIO will collaborate on an outreach event during which TerpVISIO will demonstrate their SUITS augmented reality interface and their overall design process from idea to product.

Through media arts education, Wide Angle Youth Media cultivates and amplifies the voices of Baltimore youth to engage audiences across generational, cultural, and social divides. Our programs inspire creativity and instill confidence in young people, empowering them with skills to navigate school, career, and life. Since 2000, Wide Angle Youth Media has worked with over 6,650 youth from across Baltimore City who have produced hundreds of digital media projects about their lives and communities.

Wide Angle Youth Media will promote the outreach event to our older youth community and encourage student attendance and event participation.

Sincerely,

Susan Malone
Executive Director
Wide Angle Youth Media
Susan@wideanglemedia.org
443-759-6700