National Aeronautics and Space Administration

SUITS Faculty Guidebook

2021-2022

Top 5 Reasons to Participate in NASA SUITS

Get Published

- Augmented reality is a rapidly developing research field with emerging applications in space exploration.

Authentic Real-time Project Management

- Guide a team of students from drawing board to full implementation of a software build.

Build Your Brand

- Former student participants report a considerable part of job interviews focus on their involvement in NASA SUITS. Participation in NASA SUITS stands out on student resumes.

Scalable

- Focus only on the base challenge or pursue stretch goals to develop additional capabilities and skills.

Project Based Learning

- NASA SUITS involves more than software. Teams develop authentic workforce and research skills with human-in-the-loop test designs, outreach, and more.

Watch Promo Video

What

NASA Spacesuit User Interface Technologies for Students (SUITS) is a software design challenge tasking undergraduate and graduate students from across the United States with developing spacesuit information displays within augmented reality environments. These designs assist astronauts in conducting extravehicular activities, also known as spacewalks, more effectively.

NASA SUITS tackles key aspects of NASA's Artemis missions, which will land the first woman and first person of color on the Moon and provides students the opportunity to contribute real solutions to problems NASA faces. Each proposed user interface display has potential to help astronauts on lunar explorations for the Artemis program.

Who

- Undergraduate, graduate, and post-graduate students are eligible to participate. All skill levels, from entry to expert, can contribute to the team.
- Computer science is critical to the challenge; however, engineering, human factors, marketing, and STEM education are also important for a balanced team. See the Skills section below.
- Onsite participants must be 16 or older and U.S. citizens or legal permanent residents.
- Eligible institutions include community colleges, military academies, technical colleges, and universities. Minority serving institutions are strongly encouraged to submit proposals. Partnerships between institutions are encouraged to build research capacity and collaboration.

Why

- NASA SUITS provides hands-on application of software design components.
- Offers students an opportunity to gain experience planning and conducting human-in-the-loop testing, which is a requirement for testing designs before the onsite experience at NASA's Johnson Space Center.
- Provides robust, real-world opportunities for capstone projects.
- Complements multiple computer science degree paths and coursework. See Appendices A and B.

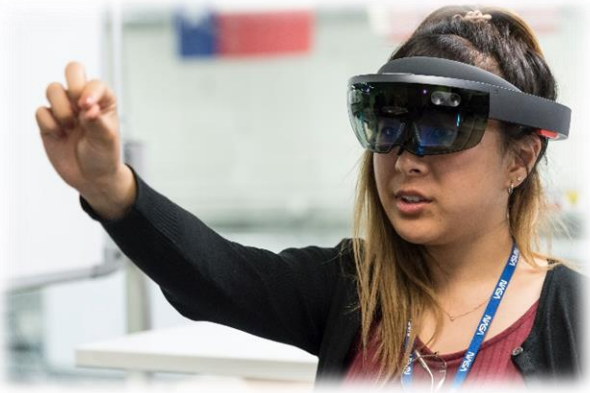
Builds research capacity and leads to publications. Multiple faculty and students presented at conferences and published in journals as a direct result of NASA SUITS involvement. See Appendix C-Published Works.

When

- **Proposal deadline:** October 28, 2022 in the NASA STEM Gateway.
- **Team selections:** Mid-November.
- **Full challenge details released:** Early January 2022
- **Software design reviews:** March 2022.
- **Test week at Johnson Space Center:** May 19-24, 2022.
- The most successful teams utilize the full year approach to development.

Where

- Teams conduct concept development and human-in-the-loop testing at their own institutions of higher learning.
- Selected teams participate in an online learning management experience from team selection to final reports.
- Onsite testing is at NASA Johnson Space Center in Houston, Texas.



How

- NASA SUITS offers a hardware loan program for institutions to borrow an augmented reality head-mounted device. Minority Serving Institutions receive hardware loan program priority.
- Participating institutions may purchase hardware directly through NASA SUITS partners.
- Many state space grant consortiums can assist with funding your NASA SUITS project via travel support, lodging, equipment purchases, etc.
- Seek out local industry partners for sponsorship, mentorship, and development support.
- Collaborate with other institutions to build capacity and shared funding.
- Research grants to support research activities and publication.

Team Skills

Skills students may learn, develop, and employ while creating a quality Software User Interface design.

Skills/Technologies:

- Software development
- Object orientation programming
- Augmented/Mixed/Virtual reality
- Computer vision
- Geology
- Path planning
- User interface (UI/UX)
- Artificial intelligence and machine learning
- Human in the loop testing
- Hardware design (for peripheral devices)
- Databases
- Web development
- Speech recognition
- Source control tools such as Git or SVN

Software/Hardware

- Azure
- Unity
- Hololens2
- Magic Leap
- Node.js
- Unreal
- RESTful

Languages

- C#
- C++
- JavaScript

Appendix A: Developed Courses

1) Texas A&M University created a research class for NASA SUITS Augmented Reality Development.
2) Boise State University developed a Vertically Integrated Projects class for NASA SUITS though the College of Innovation and Design. Dr. Steve Swanson is the lead instructor for the class. This class counts as a technical elective for students in the Games, Interactive Media, and Mobile Technology degree program. Dr. Swanson is working on designating it a computer science elective course.
3) University of Baltimore
    a. Designed a course focusing on open source software development. The university piloted the course in Spring 2020 as a Special Topics course. The course focuses on ARGOS (the university's solution for NASA SUITS 2019 challenge) as well as another project the university carried out in Spring 2019.
    b. Developed an Undergraduate Research Experience course (AITC 481), completely dedicated to a component of their NASA SUITS 2019-20 proposed solution.
        i. The product of the course is used as a model for a future course related to creating an ad-hoc IT infrastructure, focusing on networking, security, and wireless devices,
        ii. The technical aspects of the project are submitted for publication to an appropriate peer-reviewed journal or conference.
4) University of Colorado, Boulder offers independent study credit, up to 3 hours per semester, for participating in NASA SUITS. These credits can be earned through the Aerospace Engineering Sciences department or the Computer Science department. This is not a requirement, but it is an option.

Appendix B - Revised Courses

The University of Baltimore revised the following courses because of SUITS:

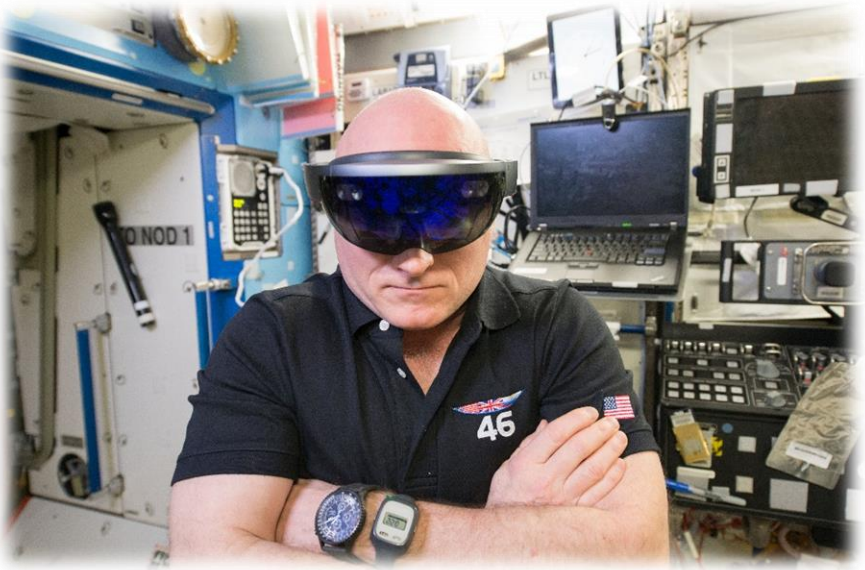
a. *AITC 351, Object-Oriented Programming*
   i. **Course Description:** Introduces abstract data types, as well as generic classes and methods, complexity, and algorithms. It also focuses on the design and implementation of object-oriented data structures. The course is based on an object-oriented programming language such as Java, C#, or C++. Proficiency in an object-oriented programming language is required.
   ii. **Course Revision:** Students implement a semester-long project aimed at creating an information management system associated with the scientific samples to be collected.

b. *AITC 356, Database Systems*
   i. **Course Description:** Introductory course to database design and implementation. Topics include modeling using Entity-Relationship (ER) diagrams, query formulation with Structured Query Language (SQL), database planning and design, normalization, creating, and maintaining a database administration. Basic concepts of the relational data model and SQL are discussed in detail. Students plan, design and test a relational database and associated application components. They also obtain hands-on experience using a current version of Microsoft SQL Server Database Management System or another system.
   ii. **Course Revision:** Students implement a group project aimed at creating an ER diagram and related database for storing scientific samples information, mission information, telemetry information, and any other, relevant data-centered aspect of the mission.

c. *AITC 457, Mobile Applications Programming*
   i. **Course Description:** Introduces students to mobile application programming and provides an understanding of the underlying wireless architecture and infrastructure in native environments. Discusses various aspects of mobile applications and design patterns, and students gain hands-on development experience with at least one mobile platform.
   ii. **Course Revision:** Students implement two group projects aimed at creating remote management and monitoring systems (to simulate an operator associated with IVA or MCC) that allow the user to view telemetry information as well as remotely manipulate the UI of the astronaut.

d. As a direct consequence of University of Baltimore involvement with NASA SUITS 2019, several undergraduate and graduate courses in human-computer interaction now discuss usability in augmented reality systems. The courses affect students in the following degree programs:
    i. B.S. in Applied Information Technology.
    ii. B.S. in Simulation and Game Design.
    iii. M.S. in Interaction Design and Information Architecture.
    iv. D.S. In Information and Interaction Design.

e. University of Colorado, Boulder revised one Extravehicular Activity course taught by Dr. Allison Anderson to include a portion of lecture time that discusses NASA SUITS activity and the role augmented reality may play in future EVA spacesuits.



Appendix C – Published Works

This is not an exhaustive list of works.

Ahsan, N., Andersen, M., Baldwin, P., Brown, J., Chapman-Weems, N., Estevez, C. H., Hyland, W., Leonard, B., Manlucu, J., Vandi, M., Yee, C., Walsh, G., & Vincenti, G. (2021). *An Augmented Reality Guidance and Operations System to Support the Artemis Program and Future EVAs*. https://ttu-ir.tdl.org/handle/2346/87081

Altmiller, L., Campbell, T., Chapman, T., Cohen, D., Garrison, J., Hill, G., Lambert, D., Leonard, B., Schuettke, K., Shirley, M., Thomas, O., & Trantham, A. (2019). ARSIS 2.0: Augmented Reality Space Informatics System. *2019 Undergraduate Research and Scholarship Conference*. https://scholarworks.boisestate.edu/under_conf_2019/95

Cardenas, I., Kim, J.-H., Kim, J., Jiang, L., Amoah, M., Benitez, M., & Kolacz, M. S. P. (2020, December 28). NASA Telesuit: Designing a Spacesuit Layer for Information Displays with Augmented Reality Environments. *Pivoting for the Pandemic*. Pivoting for the Pandemic. https://doi.org/10.31274/itaa.12174

Cardenas, I. S., Lenhoff, C., Park, M., Xu, T. Y., Lin, X., Paladugula, P. K., & Kim, J.-H. (2021). AARON: Assistive Augmented Reality Operations and Navigation System for NASA's Exploration Extravehicular Mobility Unit (xEMU). In M. Singh, D.-K. Kang, J.-H. Lee, U. S. Tiwary, D. Singh, & W.-Y. Chung (Eds.), *Intelligent Human Computer Interaction* (pp. 406–422). Springer International Publishing. https://doi.org/10.1007/978-3-030-68452-5_42

Cardenas, I. S., Powlison, K., & Jong-Hoon Kim. (2021). Reducing Cognitive Workload in Telepresence Lunar—Martian Environments Through Audiovisual Feedback in Augmented Reality. *ACM/IEEE International Conference on Human-Robot Interaction*, 463–466. https://doi.org/10.1145/3434074.3447214

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Hunt Estevez, C., Jones, J., Shrestha, S., & Vincenti, G. (2021). Serious Games in STEM: Online Collaborative Design of a Lunar Simulator. In G. Meiselwitz (Ed.), *Social Computing and Social Media: Applications in Marketing, Learning, and Health* (pp. 223–235). Springer International Publishing. https://doi.org/10.1007/978-3-030-77685-5_18

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Miller, L. S., Fornito, M. J., Flanagan, R., & Kobrick, R. L. (2021). Development of an Augmented Reality Interface to Aid Astronauts in Extravehicular Activities. *2021 IEEE Aerospace Conference (50100)*, 1–12. https://doi.org/10.1109/AERO50100.2021.9438430

Mitra, P. (2018). Human Systems Integration of an Extravehicular Activity Space Suit Augmented Reality Display System [M.S., Mississippi State University]. In *ProQuest Dissertations and Theses*. http://www.proquest.com/docview/2093609603/abstract/350552AF5FC54F5CPQ/1

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Samford, T. C. (n.d.). *Data Visulization in Augmented Reality* [M.S., University of Houston-Clear Lake]. Retrieved June 30, 2021, from http://www.proquest.com/docview/2355982532/abstract/6E28EB04420441BEPQ/1

Soto Medico, J. P., Gilbert-Wason, K.-H., Hyland, W., Manlucu, J., Martinez, O., Paliashchuk, L., Ra, E., & Vincenti, G. (2020). ARGOS: A Platform for Student Engagement. *Proceedings of the 21st Annual Conference on Information Technology Education*, 298. https://doi.org/10.1145/3368308.3415430

Thomas, O., Lambert, D., & Dayrit, B. (2020). Augmented Reality Space Informatics System. In C. Stephanidis, M. Antona, & S. Ntoa (Eds.), *HCI International 2020 – Late Breaking Posters* (pp. 221–228). Springer International Publishing. https://doi.org/10.1007/978-3-030-60703-6_28

Vincenti, G. (2019). Engaging IT Students through the NASA SUITS Design Challenge: An Experience Report. *Proceedings of the 20th Annual SIG Conference on Information Technology Education*, 22–27. https://doi.org/10.1145/3349266.3351400

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Vincenti, G., & Pecher, W. T. (2020). Merging Sustainability and Technology in the Classroom: An Experience Report. *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*, 448–453. https://doi.org/10.1145/3328778.3366899