

This paper describes objective technical results and analysis. Any subjective views or opinions that might be expressed in the paper do not necessarily represent the views of the U.S. Department of Energy or the United States Government.

SAND2019-4693C



# Human-Machine Teaming & Innovation Yield Mission Success

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

USGIF  
**geoint** 2019  
M P O S I U M

# Leveraging Augmented Reality to Enhance the Human-Machine Interface in Space Applications

---

**Nicholas P. Blazier**

R&D S&E Computer Science, Sandia National Laboratories

**Nadine E. Miner, PhD**

R&D S&E Computer Science, Sandia National Laboratories



# Overview



**Background**



**Motivation**



**Method 1: Data Visualization**

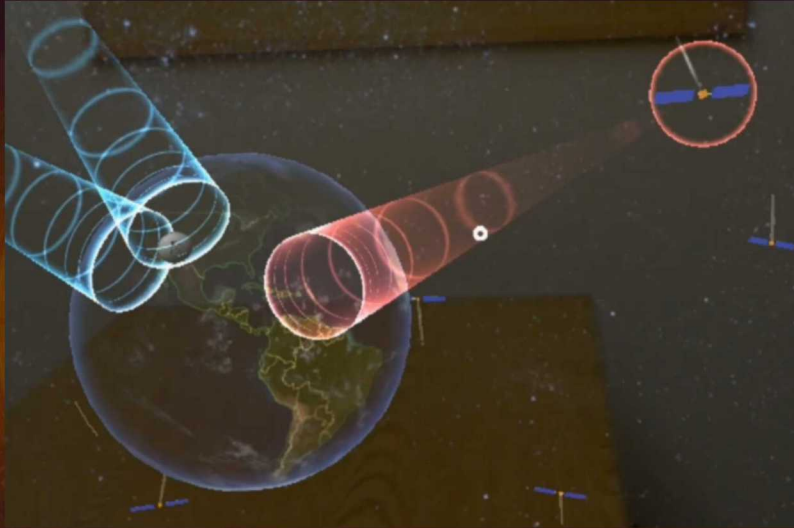


**Method 2: Design Exploration**



**Future**

# What is Augmented Reality?



- **Augmented Reality is an interactive experience where the real world is augmented by computer-generated graphics.**



BACKGROUND



MOTIVATION



METHOD 1



METHOD 2



IMPACT



FUTURE

USGIF  
**geoint** 2019  
SYMPOSIUM 9

# Augmented Reality to Virtual Reality Spectrum

**Actual Reality**

*Consensus reality*



Digital content on top of your real world

**Mixed Reality**



Digital Environments that shut out the real world

**Augmented Reality**

Mainstream with mobile apps, big-tech backing, untethered operations, wide range of content development



Digital content interacts with your real world

**Virtual Reality**

Dominated by gaming, headsets tethered, good for Big Data, some believe being eclipsed by AR



BACKGROUND



MOTIVATION



METHOD 1



METHOD 2



IMPACT



FUTURE

USGIF  
**geoint** 2019  
SYMPOSIUM

# Problem Space



## Data Visualization

Advancing algorithms calculate complex solutions to complex problems; results can be difficult for humans interpret



## Design

Significant gap between flat screen design and realization of full three-dimensional (3D) systems

**Augmented Reality immerses users in the problem space.  
Potential to provide early and intuitive data and design understanding.**



BACKGROUND



MOTIVATION



METHOD 1



METHOD 2



IMPACT



FUTURE

# Why Sandia?

Sandia has been a leading researcher in Augmented and Virtual reality technologies since the 1990s

Exploring methods for better data and design visualization

Sandia has wide range of space applications expertise

- High value in bringing together space competencies and AR to bridge the human-machine-information gap



BACKGROUND



MOTIVATION



METHOD 1



METHOD 2



IMPACT



FUTURE

USGIF  
**geoint**  
SYMPOSIUM 2019

# National Security Impact



Using technology in space applications to enhance the human-machine-information interface in the national security area

- Data visualization
- Design



Advanced algorithms can create complicated results. National security missions still require human attention.



Advancements in more intuitive displays may allow users to understand and act on information more expediently



BACKGROUND



MOTIVATION



METHOD 1



METHOD 2



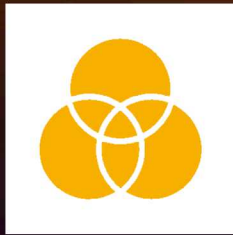
IMPACT



FUTURE

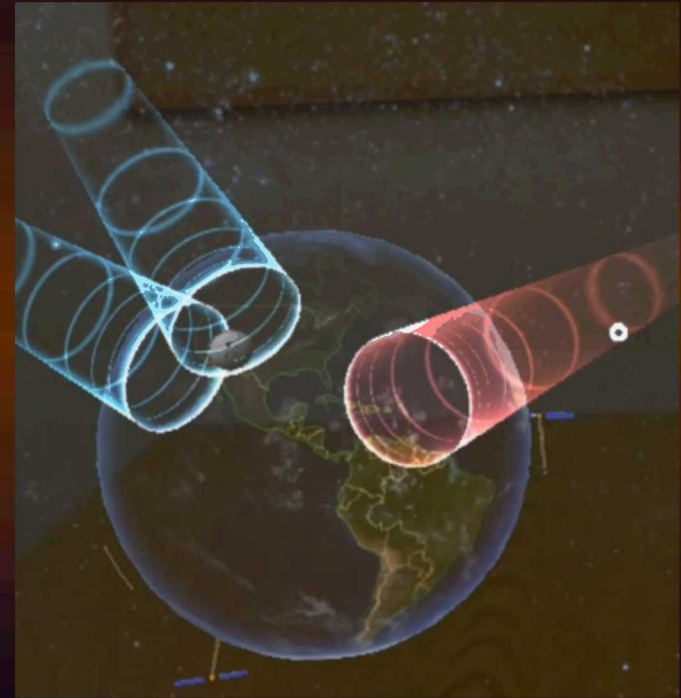
# METHOD 1:

## AR for Data Visualization In Space Applications



# Method 1: AR for Data Visualization

- Space simulation allows the user to interact with orbiting satellites in a 3-D environment using a Microsoft HoloLens
- Intuitive interactions: voice commands, audio feedback, and gesture recognition
- Users can visualize and interact with
  - Space and ground assets
  - Orbits
  - Fields of view
- Naturally 3-dimensional information, such as distance between orbit regimes, is more easily understood in 3-D displays



BACKGROUND



MOTIVATION



METHOD 1



METHOD 2



IMPACT



FUTURE

USGIF  
**geoint** 2019  
SYMPOSIUM

# Space Application Data Visualization Capabilities



- Visualize space-based detection of earth-based events
- Indicate communication between ground stations and in-range satellite platforms
- Visualize sensor field-of-views with cone projection from satellite platform to geo-locations
- Gain intuitive understanding of satellite platform orbits and sensor performance



BACKGROUND



MOTIVATION



METHOD 1



METHOD 2



IMPACT



FUTURE

# Impact of Method 1



Improve data understanding

- Easier to contextualize distances



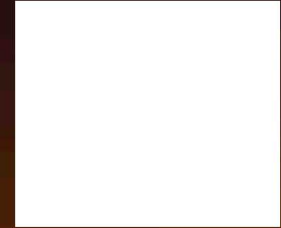
Intuitive interaction

- Can easily look more closely at a given event without losing entire context of the environment



Reduce displays

- Gaining a 3<sup>rd</sup> dimension can allow data that may have taken multiple displays to be condensed into one display



BACKGROUND



MOTIVATION



METHOD 1



METHOD 2



IMPACT

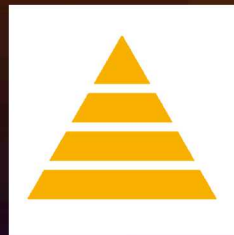


FUTURE


USGIF  
geoint  
SYMPOSIUM  
2019

# METHOD 2:

## AR For Design Exploration in Space Applications



# Method 2: Using AR to Speed Space Asset Design Cycles

 Sandia is developing a general-purpose AR Design Framework and streamlined workflow

- Allow engineers early design interaction in 3D
- Built-in mechanisms provide exploration not possible with flat screens
- Framework and AR environment provides intuitive human-machine interfaces: voice, audio feedback, gesture recognition



BACKGROUND



MOTIVATION



METHOD 1



**METHOD 2**



IMPACT

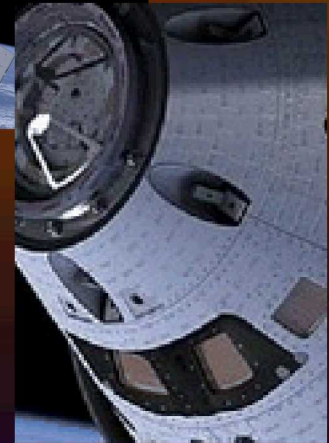


FUTURE

USGIF  
**geoint**  
SYMPOSIUM 2019

# Method 2: Augmented Reality Framework for Design Exploration

- Framework provides participants with design interaction mechanisms such as scale, explode, zoom, hide, and cutaway.
- Participants will interact with their designs via intuitive menu systems, gestures, voice commands, and receive audio and visual feedback



Voice commands:

- Scale Up/Down
- Zoom In/Out
- Explode View
- Select Object
- Hide Object
- Reset Scale
- Exit Application



BACKGROUND



MOTIVATION



METHOD 1



METHOD 2



IMPACT



FUTURE

USGIF  
**geoint** 2019  
SYMPOSIUM

# Impact of AR Design Framework

- 3-D design exploration provides immersive views not possible with flat screen displays
- Refined workflow, including model optimization and automated model export/import will allow rapid design exploration
- Reduce number of expensive prototypes required
- Promise of
  - ⚠ Reducing design errors by early detection
  - 🔄 Reducing design iterations
  - ★ Increasing design confidence
  - 📈 Ultimately → reducing costs



BACKGROUND



MOTIVATION



METHOD 1



METHOD 2



IMPACT



FUTURE

# Next Steps

## Data Visualization

- Develop intuitive data mapping paradigms
- Create enhancements allowing visualization of real time data

## Design Exploration

- Sync multiple devices together so users can explore and collaborate on designs
- Evaluate completed prototype framework by conducting cognitive studies

Exploring additional applications across Sandia's program



BACKGROUND



MOTIVATION



METHOD 1



METHOD 2



IMPACT



FUTURE



**Nicholas P. Blazier**  
npblazi@sandia.gov

**Nadine E. Miner, PhD**  
neminer@sandia.gov

**Visit us in booth 362**