Panel on Artificial Intelligence for Scientific Discovery

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Space Science Endeavors

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USRA/Space Policy Institute
Artificial Intelligence for Space and Aeronautics

Examples of ANI Usage in Space Science Today

- Autonomous Spacecraft Navigation
  - Landing Terrain Relative Navigation on Perci
  - Navigate around obstacles and schedule download of data from rovers
- Satellite data processing
  - Example: 18-year-old developed an AI algorithm that identified 1.5 million new variable objects, including supernovae and supermassive black holes, from NASA's NEOWISE mission data
  - Future: onboard spacecraft processing – bring back the needed data
- Spacecraft Operations
  - Health and Monitoring through anomaly detection
- Experimental usages: Brings up ethical usages
  - Research Proposal Evaluation, Scientific Paper Peer review
  - Meeting summaries from recorded discussions would then be posted
  - Image generation of figures and videos

Basic Ethical Principles

Fair. AI systems must mitigate discrimination and bias, preventing covert manipulation.

Explainable and Transparent. Solutions must clearly state if, when, and how an AI system is involved. AI solutions must protect intellectual property.

Accountable. Developers must be accountable for the systems they create and consider potential misuse and take steps to mitigate negative impact.

Secure and Safe. AI systems must respect privacy and do no harm. Humans must monitor and guide machine learning processes.

Human-Centric and Societally Beneficial. AI systems must obey human legal systems and must provide benefits to society.

Scientifically and Technically Robust. AI systems must adhere to the scientific method and be robustly tested in implementation, well-documented, and peer reviewed in the scientific community.

Ethical Use of AI

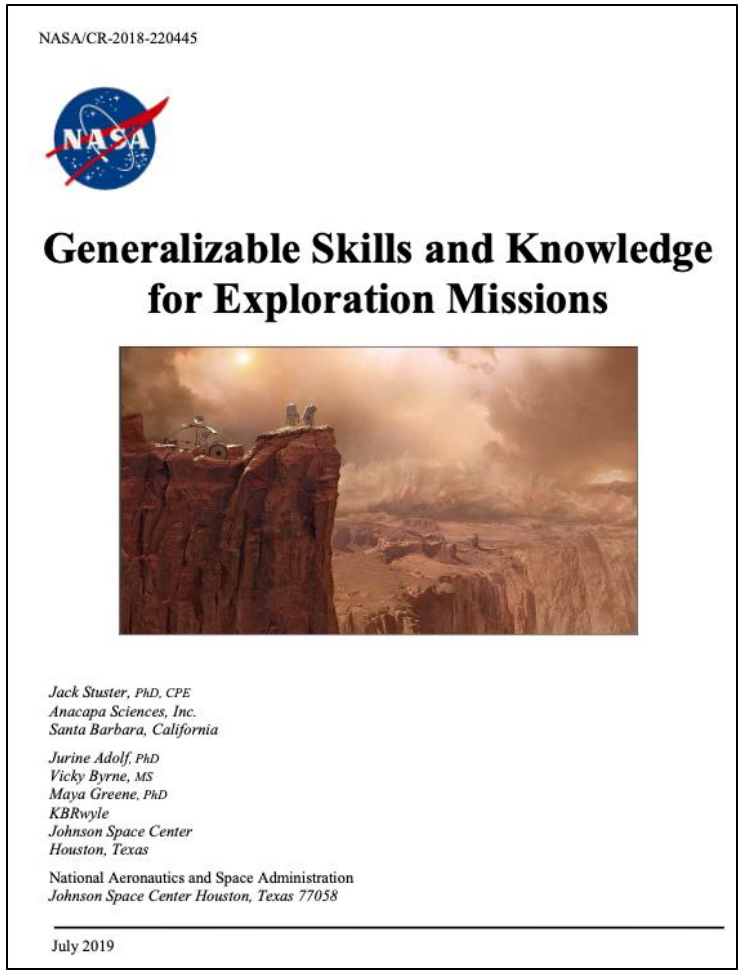
- *NASA Framework for the Ethical Use of AI* (TM-20210012886)
  - Ethical AI Advisory Group to provide consultation when problems arise
  - Adjust and refine the ethical AI policy
  - Create a registry for AI capabilities, and monitor, encourage, and enforce its use
  - Focus on longer-term *Artificial General Intelligence* and *Artificial Super Intelligence* aspects
  - Create guidelines for data handling, data fairness, data protection, and data monitoring
  - Create a NASA AI “how to” handbook
- Science societies call for a multidisciplinary examination of its scientific, sociological, and cognitive impacts

AI & the Future: Human Exploration on Mars

Robotic Assistance

Astronaut Tasks by Mission Phases to Mars

1. Launch – Into to Low Earth Orbit (60 tasks)
2. TMI – Transfer to Mars Injection (19 tasks)
3. CM – Cruse to Mars (206 tasks)*
4. MOI – Mars Orbit Insertion (10 tasks)
5. MO – Mars Orbit (13 tasks)
6. MSD – Mars Surface Decent (29 tasks)
7. MSO – Mars Surface Operations (484 tasks)*
8. MSA - Mars Surface Ascent (29 tasks)
9. TEI – Trans-Earth Injection (10 tasks)
10. CE - Cruise to Earth (204 tasks)*
11. EA - Earth Approach (26 tasks)
12. ESD - Earth Surface Descent (35 tasks)



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Generalizable Skills and Knowledge for Exploration Missions

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Jurine Adolf, PhD
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* Significant activity by all/most of the crew

Expected Crew Specialties/Roles for Long Stay

1. Leader
2. Pilot/Navigator – HIL not completely automated
3. Physician
4. Electrician
5. Mechanic
6. Equipment Operator
7. Computer Specialist

<u>All Cross-Trained</u>

1. Medical triage

<u>Scientist Roles</u>

1. Botanist – Growing food
2. Astrobiologist – Looking for Life
3. Planetary Geologist
4. Astrophysicist

Approach: Develop cross-training and/or personnel-selection strategies to achieve a crew size of 6 astronauts

Humans versus Robots

Unique to Human:

- People management and psychology issues
- Concept of operation – Conops – Humans in the Loop
- Onsite trouble shooting
- Brain-storming – managed by humans
  - Allowing Robot/AI to contribute as a team member

Unique to Robots (robotic systems with AI):

- Manual repetitive, dangerous, high-load bearing tasks
- Analysis of databases to create information (including health)

Results:

- Hybrid missions – humans and robots working together
- Brings up the new task of *monitoring* the Robot

Six Member Mars Crew With Robot