

Data Science White Paper

Artificial Intelligent System for Human Health Support

Air Force/Space Force



Machine Learning

Mosaic data scientists collaborate with customers, digging deep into the data to inform design and deployment of custom ML tools that make a difference.



Artificial Intelligence

Mosaic integrates powerful AI tools into clients' existing technology stack to solve complex business challenges



Business Analytics

Mosaic helps corporations of all shapes and sizes take advantage of their data, transforming their decision-making processes.

1. IDENTIFICATION AND SIGNIFICANCE OF THE PROBLEM

As the [Space Force](https://www.spaceforce.mil/)¹ expands its capabilities, the potential for operations to be conducted in isolation, confinement, and extreme condition (ICE) environments away from Earth and monitoring capabilities, increases. Having an autonomous artificial intelligence (AI) system that can monitor individuals via facial mood recognition, vocal tonality analysis, proximity to one another, performance, biosensors, surveys, and more, and predict conflict before it is problematic could improve a unit's cohesion and performance in missions both in space and in isolated environments on Earth.

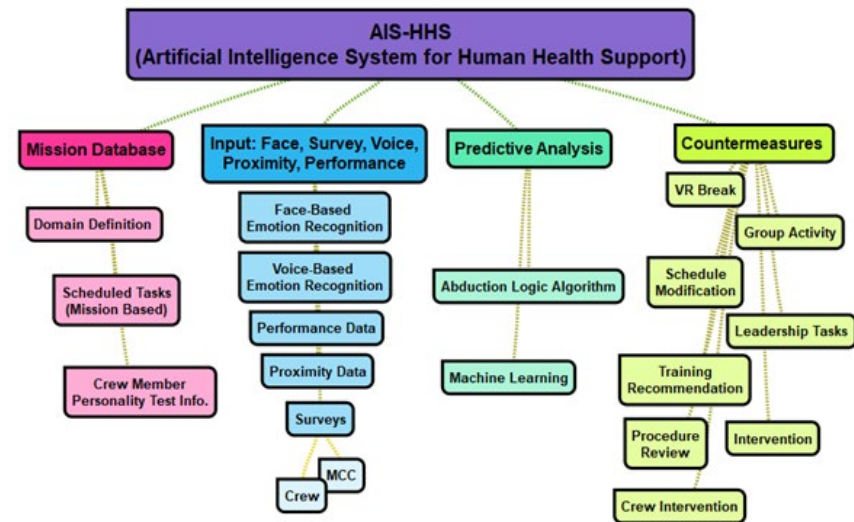
The goal of this autonomous AI system is to interpret, track, predict, and recommend countermeasures to the mental effects that can come from ICE environments, on-site, in real-time, and provide the support essential to maintaining interpersonal relationships of crew members. Note that ICE environments are expected during long-duration space missions but also exist on Earth, e.g., during winter stays in Antarctica research stations or prolonged deployments at sea. No such product currently exists, but as long-duration crewed space missions become more prevalent, the need for such a system will be critical. By developing it today and using it on current missions, the system will be finetuned and poised for use on long-duration spaceflights. Building and testing such a system today is critical.

1. <https://www.spaceforce.mil/>

Mosaic and teammate, Aptima Inc., have extensive experience with machine learning (ML) and AI systems produced for government solutions.

Mosaic is planning to identify Air Force and Space Force customers. Mosaic proposes to build the Artificial Intelligence System for Human Health Support (AIS-HHS) (figure 1) ingesting data using mature Aptima technologies and analyzed with proven data science techniques to support our customer's needs.

Figure 1. High-level diagram of the proposed AIS-HHS system. It includes information about the mission and the crew; algorithms to interpret facial expressions, voice intonations, and other data; countermeasures to minimize or deter negative crew interactions; and predictive and prescriptive analytics to suggest interventions.



PHASE I TECHNICAL OBJECTIVES

The Phase I effort has several technical objectives. They are:

1. Determine Air Force and Space Force needs. While we are certain that countermeasures for antagonistic crew behavior will certainly be needed by the Space Force, we will begin by gathering information pertaining to the need for this tool, its best fit within the Space Force organization, and any additional technologies that either the Air Force or Space Force has identified that could be used by this system. As described in more detail below, the proposed Principal Investigator, Mounir Alafrangy, recorded detailed observations during his 45-day confinement in the NASA HERA HAB with the intention to improve the current system and introduce early-detection capabilities of the type we are proposing here.
2. Create an initial design of the proposed AIS-HHS system. We have sketched out an initial design shown in Figure 1, but this high-level system will be revised given input from various interested parties in the Space Force and Air Force.
3. Test the design against the Space Force needs. After determining the needs and developing an initial design, the next objective is to ensure that the design satisfies the needs of the Space Force. We propose to achieve this objective by developing a prototype system.
4. Refine Prototype and Design given Space Force Feedback. After using the prototype and validating it against Space Force needs, we will modify and finalize the design of the system for a Phase II implementation.

PRINCIPLE INVESTIGATOR

Mr. Mounir Alafrangy

Space Exploration Lead, Senior Analyst, Aerospace Engineer

Mosaic Data Science

ABSTRACT

Mounir Alafrangy knows a bit about isolation and being quarantined. In October 2019, the George Washington University, MS Mechanical and Aerospace Engineering, 2018, alumnus successfully completed a 45-day confined space mission at NASA's Johnson Space Center in Houston, Texas. During his analog mission to the Martian moon of Phobos, he participated in activities similar to those performed on the International Space Station such as simulated cargo transfers with the Canadarm, virtual EVAs, Lunar Landing Control, Spaceship Maintenance, and sample evaluation.



Mr. Alafrangy was one of four crew members, known as analog astronauts, who were selected from a large pool of applicants to be part of the Human Exploration Research Analog (HERA) Mission XX. While they simulated a landing on Phobos, the crew stayed inside of the HERA habitat in Houston for the duration of the mission. HERA is a ground-based analog used by NASA's Human Research Program (HRP) to study the effects of isolation and confinement on humans. The research being done there will help NASA better understand the hazards of human spaceflight as it prepares to send astronauts to the Moon and on to Mars and bring them safely home.



For 45 days, Mr. Alafrangy experienced the impact of being in confinement, first-hand. With a diverse cultural upbringing, growing up on 4 continents (Africa, Asia, Europe, and North America) and hearing 4 languages being spoken among family members, his cultural knowledge equipped him with a macro lens. This enabled him to see situations from many perspectives and assisted his interest in researching scientific methods for enabling positive human behavior during conflict in isolation. During the confinement, Mr. Alafrangy immediately began identifying behavioral changes and possible missed opportunities for improving the crew's experience with one another.

While completing his Master's in Mechanical and Aerospace Engineering at GWU, Mr. Alafrangy's research focused on creating mechanisms that will mitigate the physiological risks associated with long duration space travel and improve human health on deep space missions. Mr. Alafrangy will discuss his HERA experience and how it is influencing his current research with the use of AI in deep space exploration.



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