# HUMAN CENTERED AI IN SPACE

Réka Szabó | Supervisor: Dr. Ferenc Horvai

## Monitoring Astronaut Well-Being

Scalable, non-invasive, and continuous monitoring is crucial for assessing astronaut mental health in space. Speech and facial analysis offer real-time insights into emotional and cognitive states, ensuring well-being in extreme environments.

Studies[1,2,3] at the Concordia research station—an analog for space missions—showed machine learning can predict depression severity through speech. Using Support Vector Regression, parameters like rhythm, pitch, and intensity assessed depression with over 75% accuracy, proving effective across languages.

Integrating AI-driven speech and facial monitoring into astronaut health protocols enables early detection and intervention. This technology is vital for maintaining crew well-being on long missions, including Mars and deep-space exploration.

## Humans vs. AI: Who should make the decision?

Space demands autonomous decision-making due to communication delays or even complete unreachability. AI processes data with high accuracy, while humans handle ambiguity better. In spacecraft anomaly detection, thousands of alerts—mostly false positives—appear daily, requiring decisions on AI vs. human intervention. Figure 1 shows the link between prediction success and confidence score. Augmented intelligence blends AI efficiency with human judgment, but biases like automation bias reduce effectiveness. Forced-display systems risk over-reliance, while optional ones preserve autonomy. Trust in AI hinges on confidence score presentation, as uncertain recommendations are often dismissed.

Better decisions come from knowing who to ask[4,5,6].

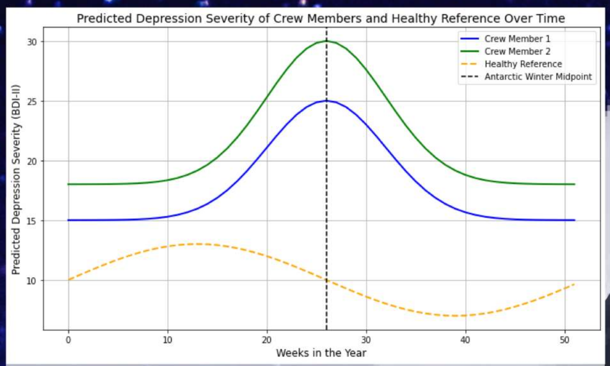



Figure 2: Predicted depression severity over time for two crew members, peaking in the middle of the Antarctic winter, compared to a healthy reference. Data were collected weekly from speech samples (voice diaries and reading tasks) at the Concordia Research Station.

**As we design AI systems for space exploration, it's crucial to understand how different fields of application are deeply intertwined in shaping ethical standards. Decisions like whether to override an astronaut's judgment in a crisis, such as a module shutdown or emergency landing, require careful ethicalconsideration.**

**In situations where an astronaut's mental health is compromised, can they be trusted to make life-critical decisions, or should AI step in?**

**Similarly, AI systems used in exoskeletons must be designed to enhance astronauts' physical capabilities while respecting their autonomy. How can we ensure that these systems do not unintentionally harm the astronaut while optimizing their performance?**

**By addressing these challenges, we can develop human-centered, ethical AI systems.**

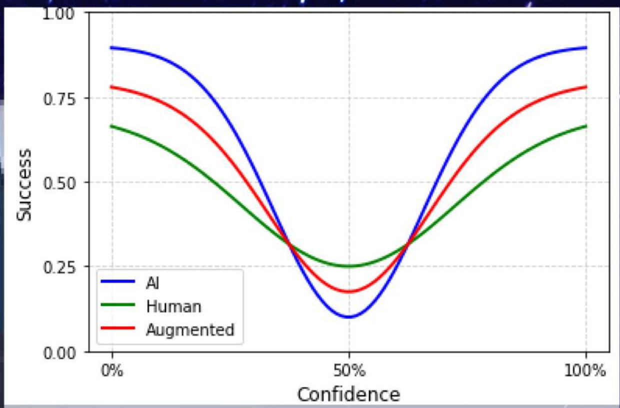
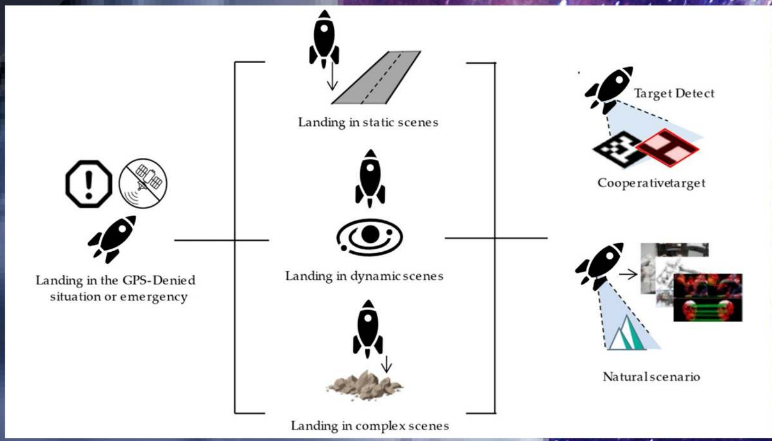



Figure 1: The X-axis shows confidence scores from 0% (false positive) to 100% (real alert), while the Y-axis measures prediction success.

The AI curve (blue) achieves high accuracy at extreme confidence levels but struggles with ambiguity. In the mid-range, where uncertainty is highest, humans outperform AI.




## Exoskeleton: Enhancing Human Capabilities and Recovery in Space

AI-powered exoskeletons enhance astronauts' physical capabilities, aiding in demanding tasks like spacewalks. By boosting strength and endurance, they help execute critical operations efficiently, reducing fatigue and optimizing mission success.

On long-duration missions or distant planets with limited medical access, AI-driven exoskeletons support recovery and health management. In case of injury, AI assists in immediate recovery, helping astronauts regain mobility and continue their missions with minimal downtime[8].

## Autonomous Landing: AI for Real-Time Navigation and Decision-Making

AI is crucial for autonomous landings on celestial bodies, especially when there is no connection with the mission control centre.

During descent, AI analyzes sensor data and adjusts the trajectory, ensuring the safest landing within set boundaries.

For example, during NASA's Perseverance Rover landing on Mars in 2021, Terrain-Relative Navigation, an AI-powered system, autonomously selected the landing site. It made real-time decisions to avoid hazards like rocks and cliffs, ensuring a safe touchdown within the designated region[7].


1. Kiss, G., Tulics, M. G., Sztahó, D., Esposito, A., & Vicsi, K. (Year). Language-independent depression detection by speech. In Recent Advances in Nonlinear Speech Processing (Vol. 48, pp. 103–114). Springer. https://doi.org/10.1007/978-3-319-28109-4_11
2. Kiss, G., & Vicsi, K. (2014, October). Physiological and cognitive status monitoring based on speech parameters. Lecture Notes in Computer Science. https://doi.org/10.1007/978-3-319-11397-5_9
3. Ehmann, B., Altbäcker, A., & Balázs, L. (2018). Emotionality in Antarctic Winteroverers: Content analysis of diaries. Journal of Environmental Psychology, 60, 112–115. https://doi.org/10.1016/j.jenvp.2018.09.003
4. West, J., & Bhattacharya, M. (2016). Intelligent financial fraud detection: A review. Computers & Security, 57, 47–66. https://doi.org/10.1016/j.cose.2015.11.001
5. Dietvorst, B. J., Simmons, J. P., & Massey, C. (2015). Algorithm aversion: Avoiding algorithms after errors. Journal of Experimental Psychology: General, 144(1), 114–126. https://doi.org/10.1037/xge0000033
6. Logg, J. M., Minson, J. A., & Moore, D. A. (2019). Algorithm appreciation: Preference for algorithmic over human judgment. Organizational Behavior and Human Decision Processes, 151, 90–103. https://doi.org/10.1016/j.obhdp.2018.12.004
7. Miele, A., & Pandya, R. (2021). NASA's Perseverance Rover and Terrain-Relative Navigation for Autonomous Landing. Aerospace, 8(6), 155. https://doi.org/10.3390/aerospace8060155
8. Vitiello, N., & Cempini, M. (2016). Wearable robotic exoskeletons for rehabilitation: From research to practice. Biomedical Engineering Letters, 6(2), 109-120. https://doi.org/10.1007/s13534-016-0007-3