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AI-POWERED AUTONOMY SUITE FOR INTELLIGENT DECISION-MAKING IN CHALLENGING ENVIRONMENTS THROUGH HETEROGENEOUS AUTONOMOUS SYSTEMS

Abstract

Autonomous robotic systems may encounter adverse scenarios, such as exploration through extreme and unforeseen environments leading to structural degradation, subsystem failures like sensors and actuator malfunctioning, experiencing unexpected disturbances etc., which might limit the durability and scope of consistent operation. Thus, making space robotic systems resilient to failure is a significant challenge for practical deployments.

We introduce Extreme Terrain Autonomy (ETA) - a Hardware-agnostic AI-powered Resilient Autonomy Suite for gathering actionable insights in challenging environments, leading to a reduced and efficient Observe, Orient, Decide and Act (OODA) loop.

Essentially, we are building an orchestration software specifically designed to address uncertainty in various elements of the mission, including sensing, environment, motion, system health, and communication, among others for making them completely self-sustainable.

Our system is resilient as it demonstrates (i) robustness, i.e. the ability to withstand or overcome adverse conditions or rigorous testing, (ii) redundancy, i.e. the ability to overcome any sub-systems failures by either replacing the faulty part or by adapting this component with its reduced functionality, and lastly (iii) resourcefulness, i.e. the system adapts to the changes in the surroundings as well as to the dynamic mission needs to some extent.

The overarching goal is to formulate a comprehensive product for the efficient exploration of extreme environments, considering the intricate spatio-temporal configurations and potential obstacles inherent to such environments. We intend to develop a multi-robot system that is sensor-hardware-agnostic driven by AI in the backend with three distinct objectives:

Exploration - Efficiently and thoroughly traverse the terrain with heterogeneous sensory suite to comprehensively map its spatial layout and identify potential hazards or obstructions. Localization Mapping - Accurately determine the robot's position within the environment, enabling precise navigation and obstacle avoidance. Generate a detailed and accurate 3D map of the region, including the location and characteristics of accessible areas, obstacles, and structural elements. Data Analytics - Provide an easily operable software interface for situational awareness and actionable insights for end-users in real-time along with a digital twin for further analysis.

We intend to discuss about how ETA's autonomy architecture translates the mission specifications into single- or multi-robot behaviours. Once we are able to commercialise our technology, the integration of ETA in Lunar exploration missions will lead to:

- Improved Situational Awareness - Enhanced Decision-Making Speed - Optimized Resource Allocation - Increased Mission Success - Reduced Human Error