15th Reinventing Space Conference (RISpace 2017)

Autonomous Micro-Rovers for Future Planetary Exploration and Terrestrial Sensing

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Abstract

Autonomous Robotic vehicles represent a key and fast-moving technology area in space exploration and exploitation. We aim to to make future operations on other planets more affordable, reliable, and responsive by developing better and more useful mobile robots that can be deployed on other planets, and expediting this process by applying similar technologies to robotic applications on Earth. These robots must be responsive, energy efficient, lightweight for transport, and mechanically robust.

To accomplish these goals, we have developed the Aria micro-rover platform based on micro-rover concepts for low-cost Mars surface and subsurface exploration and inspired by the recent resurgence of interest in planetary exploration. The Aria is designed using a novel methodology for probabilistic autonomy programming that makes use of Bayesian networks for highly reliable sensor fusion, planning, and behaviour control. Autonomy and AI are accomplished by inference-based reasoning into stored probabilistic data, and includes probabiliistic learning and self-programming.

A fully distributed electronic component architecture with fault tolerance increases modularity and adaptability. Reliability is maximized and cost of deployment is minimized by modularly re-using common hardware and components. Also, the mechanical structure uses a lightweight and flexible actuated space frame to increase resiliency and allow full-body movements. The use of flexible structures allows the rover to transform and re-configure itself to a limited extent in the field.

The physical design is driven by the need for light weight, simplicity and reconfigurability, with a minimalist mechanical structure and a flexible software design model to facilitate additions and multiple use cases. To lower cost of construction and transport, mass is minimized through the use of thin structural members and wire members in tension to create resilience without adding additional material.

The Aria platform is unique in its aim to be constructed using as much automation as possible during manufacture. The chassis makes use of a jointed frame that can be assembled using additive manufacturing methods. The electronics are common modules that are attached and connected during the manufacturing process using a common bus architecture and later programmed for component-specific duties. The mission responsiveness of the platform is very high due to the ability to re-use and re-configure modules as needed for mission changes. This also opens the possibility for rovers to be mass-produced and deployed autonomously, or even assembled on another planet by partially using local materials to save transport of mass.

In addition to the ability to be deployed as a planetary rover for scientific or resource management use, the Aria rover is targeted at terrestrial applications by using similar but non space qualified electronics to lower cost and increase availability. The primary applications targeted are 1) agricultural field monitoring and intervention, 2) environmental sensing and research uses, and 3) surveillance and disaster response.

The Aria rover platform represents a new paradigm in deploying mobile robots to perform remote missions on Earth and other planets. Prototypes are currently being tested, and the technologies refined to produce more reliable, responsive, and flexible configurations for the applications of the future.

Abstract Submittal Please submit abstracts for RISpace 2017 of up to **500 words** to Stuart Eves, papers@rispace.org.