Field Testing of Rimless Wheel Micro Rovers in Space Analogue Environments

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ABSTRACT

This contribution presents the development and field testing in a variety of space analogue environments of different Rimless Wheel (RW) Micro Rovers. Originally designed for search and rescue and surveillance applications, the *Asguard* rover demonstrated remarkable mobility capabilities, including stair climbing, water traversal, and high-speed locomotion over rough terrain[4]. Building upon this platform, successive iterations introduced autonomous navigation features[6, 9], ultimately leading to the *Coyote* series, tailored for planetary exploration missions. The most recent version, Coyote 3, integrates a standardized electromechanical interface and a robotic arm, expanding its scientific and operational capabilities [11].

The RW locomotion system is a hybrid approach combining advantages of both wheeled and legged mobility. This design aims to achieve a balance between the terrain adaptability of legged systems and the energy efficiency and control simplicity of wheeled systems. Despite its demonstrated effectiveness in obstacle negotiation and climbing, the dynamic behavior of RW systems, particularly in 3D and under impact conditions, remains an active area of research, with open questions concerning multi-wheel interactions and complex terrain response [5, 1].

Field validation has been a cornerstone of this development effort. During the Utah analogue campaign, Coyote 3 served as a shuttle rover, transporting payloads between SherpaTT, BaseCamps, and a simulated lander [12]. In Tenerife, Asguard v4 was deployed for semi-autonomous lava tube exploration, testing SLAM, predictive simulation, and autonomous navigation [2]. Adapted versions have also participated in underwater and surface analogue missions, focusing on semi-autonomous crew support operations [8].

Repeated deployments at the ROBEX Volcano Summer School allowed both Asguard and Coyote platforms to demonstrate remote control operations, data capture for episodic memory development, and autonomous navigation in steep and rugged environments [3]. In one campaign, Coyote 3 used its arm to collect hyperspectral data and successfully navigated a crater slope traverse composed of loose and consolidated rocks, as shown in the Figure.

As part of the COROB-X campaign, Coyote 3 collaborated with the larger SherpaTT rover in a multi-robot mission to access and explore a lava tube [13]. The mission involved using ground-penetrating radar for subsurface analysis, descending into the tube via rappelling, and performing remote operations to demonstrate the rover's ability to navigate and operate in such a challenging environment.

The most recent field test in Teide National Park evaluated technologies for autonomous resource identification. Novel modules tested included a gait controller [7], a tip-over prevention system [10], and a rock identification algorithm.

This abstract will present the key technologies developed and tested across these campaigns, discuss their performance and limitations, and provide an outlook on future development directions for RW-based space rovers.

Keywords: Field Testing, Locomotion, Control, Autonomous Navigation, Environment Representation.

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