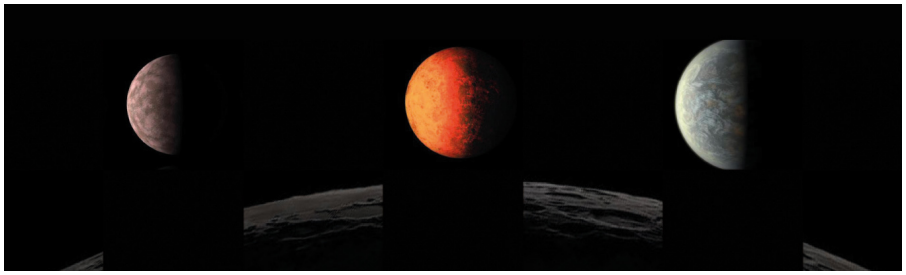

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A swarm of mini-rovers supported by UAV as a Mars exploration concept - positioning aspects

Friday 24 October 2025 12:00 (15 minutes)

The paper presents the progress made on the concept of a swarm of rovers assisted by a drone for mapping the surface of Mars. The concept we presented a year ago is still being developed and improved. This year's work focused on implementing and integrating a drone built specifically for our project and positioning aspects.

Positioning for Mars exploration is particularly challenging without Global Navigation Satellite System (GNSS) signals and reliable magnetic field data. This work investigates two complementary approaches to positioning in GNSS-denied environments: photogrammetric methods using a drone and radio-based distance estimation.

The first concept is based on the autonomous positioning of rovers using tagged control points placed on the rovers. This concept involves using photogrammetric data collected from the drone, processing it using Structure from Motion (SfM) algorithms, detecting coded markers, and determining the position of the rovers in a local reference frame.

The second approach, based on Wi-Fi and Bluetooth positioning, owing to their widespread availability and low cost, offers practical alternatives for distance estimation and localization based on Received Signal Strength Indicator (RSSI). The radio-based positioning approach evaluates a linear regression model, derived from the log-distance path loss formula, and a feedforward neural network for mapping RSSI values to distance, accounting for noise and signal variability. The resulting distance estimates are applied to trilateration techniques within a multi-robot system framework.

Combining UAV-supported photogrammetric positioning with radio-based techniques enables a more robust and resilient navigation system. While photogrammetry provides high-precision mapping and localization, radio-based methods add redundancy and extend reliability under harsh conditions. This hybrid approach enhances the autonomy of rover swarms, paving the way for future exploration missions on Mars.

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