

## **A Zupt-Based Method for Astronaut Navigation on Planetary Surface and Performance Evaluation under Different Locomotion Patterns**

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### **ABSTRACT:**

Astronaut navigation system is critical for ensuring an astronaut's safety and efficiency while exploring on the planetary surface in manned planetary missions. Accurate position information helps the astronaut find the scientific target more quickly and return to re-entry module safely. Planetary surface environment not only limits the adoption of sensors (such as GPS) that are commonly used on earth, but also causes spatial disorientation due to lack of familiar reference for vision cues of distance and size. Therefore, it is much more difficult for astronaut navigation compared with pedestrian navigation on earth. As Inertial Measurement Unit (IMU) can realize autonomous navigation without GPS signals and has the advantages of high data frequency, free of external influence, positioning stably within a short time, it is suitable for navigation and positioning on planetary surfaces. By integrating measurements from IMU, position and attitude information can be obtained at a high frequency. However, this dead reckoning method suffers from severe drift and is bound to accumulate with time and cannot be practically used for navigation application. In the field of pedestrian navigation, Zero Velocity Update (ZUPT) is a common used method for restraining error accumulation of IMU by correcting error drift using the constraint that the instantaneous velocity turns zero when walking or driving stops. In this research, we evaluate the positioning accuracy for astronaut navigation with ZUPT under different locomotion patterns and study the feasibility of ZUPT correction for long term navigation. A low-accuracy IMU is rigidly attached on the foot in our experiment. After initial alignment, position drift correction is made with ZUPT by supposing the walking velocity becomes zero when static state is automatically detected. Experiments are carried out on terrains of different slopes and hardness under different locomotion patterns, such as walking, jogging, hopping, along different paths. Preliminary results show that the positioning accuracy reached 0.6%-2.1% when walking along a straight line with different distances, and 1%-2% when walking along a rectangle path, demonstrating the potential of ZUPT for long term astronaut navigation.

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