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A WEARABLE 3D MEASUREMENT SYSTEM FOR ASTRONAUT EXPLORATION ON LUNAR SURFACE

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ABSTRACT:

Accurate wearable 3D measurement system for astronaut exploration is becoming an important topic in manned mission on the lunar surface as the unfamiliar environment can influence human's perception on distance, position and orientation. Since no familiar objects can be utilized as reference to give the brain any vision cues, it is difficult for astronaut to estimate distance and size of a surface feature. As the size, weight and power of on-suit sensors is strictly limited, a practicable wearable 3D measurement system is greatly anticipated for astronaut while exploring the lunar surface. In this paper, we propose a wearable 3D measurement system by integration of a monocular camera with a laser distance meter (LDM). This system provides the astronaut with accurate measurements including the object's distance, orientation, size, distance between two objects and even the slope of the terrain. The core measurement pipeline is achieved through an integrated procedure that fuses monocular image sequence with synchronized distance measurements seamlessly through image feature detection and matching, motion estimation, and laser pointer projection on image frames. A remarkable advantage of this combined measurement scheme is that an enhanced monocular visual odometry (VO) model is automatically incorporated when the astronaut stops and rotates the head to makes observations. While traditional monocular VO can only recover orientation information from images sequence without absolute scale; this new VO obtains absolute scale directly from LDM's distance measurements. This proposed integration architecture is examined using a live dataset collected in a simulated lunar surface environment while performing a series of measurement tasks. Experimental results demonstrate the feasibility and effectiveness of this wearable measurement system for lunar surface exploration.

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