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ULYSSES – SDG : SYNTHETIC DATA GENERATION FRAMEWORK FOR LUNAR SURFACE OPERATIONS

Abstract

This paper introduces a framework tailored specifically for the Lunar surface operations use case, aiming to address the challenges inherent in visual robotic methods crucial for space exploration. With the increasing accessibility of AI and machine learning models, there is a growing demand for tools capable of generating large volumes of training data suitable for robotic surface operations, including methods visual navigation, monocular depth perception, visual obstacle detection, and hazard avoidance. In order to meet this demand, we propose a tool that leverages the capabilities of powerful game engine technology, specifically Unreal Engine 5, in conjunction with digital elevation models to produce photorealistic training data. Our approach is designed with a primary focus on Lunar surface operations, acknowledging the unique environmental conditions and challenges posed by extraterrestrial exploration.

Furthermore, the implementation of this framework explores methods for verifying the generated data, analyzing its Sim-to-Real predictability, and evaluating its usability in machine learning-based models commonly that could be employed in future Lunar surface operation missions, such as depth perception and hazard detection. A central objective of this endeavor is the development of a user-friendly toolset for generating synthetic Lunar surface imagery that is easily expandable and upgradable through future research and toolset integration.

By tailoring our approach specifically to the Lunar surface operations use case, we aim to contribute to the advancement of visual robotic methods towards exploration, ultimately facilitating safer and more efficient exploration and navigation on the Lunar surface. The framework is part of the overall sandbox simulation environment ULYSSES (a universal physics-based planetary surfaces exploration simulator) being developed at Tartu Observatory of the University of Tartu.