Comparison of SLAM algorithms on virtual test bed URSSA for space applications

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Abstract— **Robots are critical enablers for space exploration as they help offset safety risks associated with a human astronaut, aid in precursor missions prior to manned missions, provide critical on-mission and post-hoc support. However, designing robotic systems to navigate, map and localize itself in hostile and unknown extraterrestrial worlds remains open challenge. The prime reason for this being the testing the semi-autonomous agents for robust performance in such environments. In this paper, we address this issue by using Unity-ROS Simulator for Space Applications(URSSA) for compare performance of three popular Visual Intertial Odometry (VIO) Simultaneous Localization And Mapping (SLAM) algorithms on lunar surface. The test architecture, agent modelling, rationale for test cases and generation of ground truth data is discussed. Paper concludes with results from simulations comparing the algorithms and discusses on failure reasons and potential directions for improving algorithms for better applicability such environments. We believe such a comparative study can give vital pointers for future research directions and help accelerate development of specific algorithms for SLAM in extra terrestrial environments.**

I. INTRODUCTION

The last decade has seen major space faring nations chart out focussed plans for deep space exploration starting with the moon. The Artemis I, Chang'e-4 mission and Chandrayaan-2 are some of the ongoing and completed precursor missions to put human explorers on lunar surface. These missions have robotic systems onboard to do remote investigation,survey and data collection of the lunar surface. The follow-up missions to all of these missions have a increasing component of robotic systems of which ground based mobility systems are central. Wheeled rovers are the most commonly used platform for planetary surface mobility. To date, they have been used for surface exploration, mapping and scientific investigation. However, future missions call for advanced mission operations including periodic monitoring of geo-spatially distributed scientific assets, remote assembly and In-Situ Resource Utilization(ISRU) tasks. The first of these call for advanced navigation, mapping and localization capabilities and the ISRU tasks require advanced manipulation and dexterity capabilities.

Through this paper, we aim to address the problem of designing robust test beds to robustly test and design Visual Intertial Odometry (VIO) Simultaneous Localization And Mapping (SLAM) algorithms specific to extra-terrestrial environment. This paper specifically discusses a case-study of using in-house developed Unity-ROS Simulator for Space Applications(URSSA) to test and compare perdormance of these algorithms in a virtual lunar environment.

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A. Simulator model

B. Test System model

C. Test-Case generation

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TABLE I
AN EXAMPLE OF A TABLE

One	Two
Three	Four

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Fig. 1. Inductance of oscillation winding on amorphous magnetic core versus DC bias magnetic field

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A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

APPENDIX

Appendixes should appear before the acknowledgment.

ACKNOWLEDGMENT

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References are important to the reader; therefore, each citation must be complete and correct. If at all possible, references should be commonly available publications.

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