Open-source AI Assistant for Cooperative Multi-agent Systems for Lunar Prospecting Missions. Z. M. Kakish¹, F. R. Lera², D. Bischel³, A. Mosquera⁴, R. Boumghar⁵, S. Kaczmarek⁶, T. Sebrook⁷, P. Metzger⁸, J. L. Galache⁹, ¹Arizona State University (zahi.kakish@asu.edu), ²University of León (ffjrodl@unileon.es), ³University of California Santa Cruz (dbischel@ucsc.edu), ⁴Aten Engineering (ana@atenengineering.com; jl@atenengineering.com), ⁵European Space Agency (redouane.boumghar@esa.int), ⁶Imperial College London (s.kaczmarek17@imperial.ac.uk), ⁷Oxford University (timothy.seabrook@cs.ox.ac.uk), ⁸University of Central Florida (Philip.Metzger@ucf.edu).

Introduction: In recent years, we have seen a major turning point in the development of Space exploration capabilities. Government Space agencies are achieving great milestones in this NewSpace race by mixing and assisting commercial ventures. All these advances, and humanity’s inherent hunger for adventure and exploration, are pushing forward the development of the space sector in an exponential way, helping envision a near future with settlements on the Moon and Mars. For this dream to come true, and establishing permanent presence in space, in-situ exploration, identification, and prospecting of space resources is paramount to sustain human activities. Mining water, for example, will be essential for life-support systems, and can, additionally, be split and used as rocket propellant. If carbon is found in water-ice, as it’s believed to exist, it can be transformed into plastics that can be used to protect against radiation, and other minerals can be targeted with the goal of construction.

Just a few months ago, two missions successfully reached their final destinations after their many year long pursuits: JAXA’s first pair of hopping robots called MASCOT [1] on a nearby asteroid, Ryugu, and NASA/JPL’s Mars lander InSight [2]. In the case of the MASCOT robots, mission planning for non-terrestrial surfaces is critical to a mission’s success [3]. Future public and private mission’s would seek to expand rover and other robotic platforms for exploration and scientific research, but numerous issues persist.

At present, robots missions are expected to do a wide variety of tasks ranging from exploring, prospecting, and research. These tasks are made evermore difficult by communication interference, interactions with human operators in the loop, and harshness and unpredictability of the environment, just to mention a few. These challenges can be significantly reduced by multi-robot operations, which can improve the mission efficacy and lower the risks by autonomously coordinating the agents. Despite there being many advances in the field, there are still numerous challenges to reduce the complexities associated to the coordination of multi-robot systems and mission planning strategies, which motivates further research.

During work at the NASA Frontier Development Lab [4] (an AI accelerator geared towards space applications), the authors have put forward a stepping stone towards that goal in the form of MARMOT, or Multi-Agent Resource Mission Operations Tools. MARMOT is an extensible, open-source tool that allows users to expand the current functionality of mission planning systems for extra-terrestrial operation. The first iteration of the tool provides heterogeneous multi-agent global planning optimization of environments for different tasks and goals. Future iterations of the work will allow extensibility into other areas of machine intelligence and robotics, and further enhance the goals both public and private space operations.


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