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UTILIZING EARTH ANALOGUES FOR ADAPTIVE PLANETARY SCIENCE ROBOTICS

Abstract

Machine learning and deep learning algorithms have a major role to play in the future of planetary science robotics, however scarcity of training data is a major hurdle to both further research and wide adoption of these algorithms. The coming decades will see planetary science robots explore new frontiers in our Solar System. The NASA Dragonfly mission bound for Titan and ESA's ExoMars rover are set to launch in the next decade, and proposed missions like the Mars Science Helicopter, Europa lander, and robotic missions to Enceladus and Venus, are seeking to address the science goals laid out in the US National Research Council's Planetary Decadal Survey, and ESA's Science Programme Voyage 2050. Yet despite these ambitious goals, robotic exploration paradigms remain largely unchanged, relying heavily on time-consuming feedback loops of downlinking data to human operators, planning, and uplinking sets of actions. In this paper, we argue that achieving these ambitious missions necessitates a shift in this paradigm, that adaptive autonomous decision making, reliant on classical machine learning (ML) and deep learning (DL), will be a vital step in the future of planetary science robotics. ML and DL algorithms rely on an abundance of suitable training data on which to train and test these algorithms to guarantee performance off-Earth. Unfortunately, the lack of availability and access to suitable planetary science datasets, geared specifically towards robotic development, has hindered development and adoption of these approaches in the planetary robotics context. In this paper we explore the use of Earth analogue geological sites as a means of bridging this data gap. We present data collected at field sites in Svalbard as analogues for Mars. Four field sites were selected based on their geologic features that mirror known Martian terrain (a permafrost feature, alluvial fans, and dry riverbeds). We discuss the site selection, data collection, and data processing techniques used in preparing suitable training data. Emphasis is placed on the use of largely low-cost, commercially available hardware and software in the data collection and data processing steps, with the goal to lower access of gathering and utilizing these types of datasets for researchers. A discussion of the lessons learned from fieldwork is also presented. We present preliminary results of utilising this data in an adaptive robotic path planning algorithm to seek out sites of geological interest that mirror autonomous missions that could be carried out on Mars.