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THE AUTONOMOUS SOIL ASSESSMENT SYSTEM TO ENABLE SAFER PLANETARY ROVER NAVIGATION

Abstract

The ability of a planetary exploration rover to safely traverse a given terrain greatly depends on the terrain's physical characteristics and the rover-terrain interaction properties [Chhaniyara et al., 2012; Ding et al., 2011; Gonzalez et al., 2014; Iagnemma and Dubowsky, 2004; Papadakis, 2013]. While some "terrain induced hazards" or "non-geometric hazards" can be avoided by painstakingly designing a safe route through terrain that has been carefully analyzed by a human expert, other hazards can only be detected using on-board perception techniques. The goal of the Autonomous Soil Assessment System (ASAS) is to enable a rover to accurately estimate the physical properties of the terrain ahead of it and assess the risk of traversing it. This is done by employing machine learning to 'learn' a relationship between some observed properties of the terrain ahead of the rover that are determined from a stereo camera, such as slope and terrain type (sand, bedrock, etc.), and measurements of how the rover behaves once it drives over that terrain. In an operational phase, the risk of a terrain is then assessed by using the current observations of this terrain and the previously learned relationship, to estimate what the rover's behavior will be when it drives over the terrain. In the future, ASAS can inform the rover's navigation strategy to obtain a safe traverse route [Angelova et al., 2007; Helmick et al., 2009] or modify the system's control actions to increase mobility [Coyle et al., 2010].

ASAS is being developed by Mission Control Space Services Inc. under contract with the Canadian Space Agency. By June 2017, the TRL is expected to reach TRL4. Ongoing RD is supported through collaboration with Ontario Drive Gear (ODG) through the provision of a rover, Concordia University's Dr. Chris Skonieczny, and external consultant Dr. Karl Iagnemma of MIT.

This paper will summarize the RD activities conducted to date and outline the next steps in ASAS development prior to ASAS deployment on a Lunar, or Martian, exploration mission.