Investigating Rover Operations as Part of an Experimental Demonstration of Rover-CubeSat Collaboration

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Recent years have seen the growing interest in nano and pico satellites in the space industry and academic research as well. The low launch costs, short development time, availability of off-the-shelf electronic components are the driving factors behind the use of such satellite platforms in space missions. These low-cost platforms can be used to validate new space technologies and to perform scientific research related to the Earth, its atmosphere and its climate. Our interest lies in the use of a cubesat (typically cross-sectional area 100 cm^2, length 10-30 cm and mass 1-4 kg) to do autonomous operations using the limited onboard computational capability. More specifically, the study focuses on the development of an experimental test-bed for WSU's first cubesat and mining rover. There has been a burgeoning interest in the space industry to mine the Moon, asteroids and potentially other celestial bodies, and our key motivation is to investigate the use of cubesats as part of such missions. To this end, we first present a few mission scenarios demonstrating the potential use of cubesats in future lunar and asteroid mining operations. A cubesat could be used to monitor the celestial body surface and send terrain-mapping data to rover to optimize its path based on global information. Second, we present an overview of the experimental set-up comprising the rover and the cubesat. The rover is based on four (100mm diameter) wheel drive, battery-operated (12V Ni-MH 1800mAh), 4 dc motors (120 rpm, 17W) attached with four wheels and capable of executing forward, backward, rotating and sliding movements. Finally, we investigate various aspects of collaboration between a resource-limited cubesat and the mining rover. We assume that a set of instructions are already available from the cubesat for the rover to execute. In our lab experiment a handheld computer, which is considered as a mission control center, sends a series of commands to the microcontroller board of cubesat through serial communication via a transceiver. The rover executes a series of movements based on these instructions. We also allow for communication delays between the cubesat and the rover. The developed experimental setup will pave the way for conducting future experiments related to dynamics and control of cubesat/rover combination or even a team of cubesats and rovers. The developed setup is also a step towards enabling WSU's participation in NASA's lunar mining robotics competition in the future.