Design and implementation of the Heavy Onboard Platform for Lunar ISRU and Terrain Excavation (HOPLITE) to enable payload development and field testing for lunar and mars applications. P. van Susante, E. Cobb, A. Goddu, H. McGillivray, C. Miller, E. VanHorn, Planetary Surface Technology Development Lab, Michigan Technological University. (Contact: pjvansus@mtu.edu)

Introduction: The Heavy Onboard Platform for Lunar ISRU and Terrain Excavation (HOPLITE) is a modular robotic system built at Michigan Technological University (MTU) that enables the field testing of ISRU technologies. Many payloads are currently being designed and implemented for lunar applications and there is a need for accurate, reliable, and safe mobility of these payloads during field testing. Using a large sensor array, fine tuned control, and autonomy, HOPLITE is designed to provide a solution to this need.

Payloads: HOPLITE can incorporate a diverse range of payloads from excavators to surveying equipment weighing up to 200 kg. Mechanical, electrical, and software infrastructure was built to enable easy integration. All edges of the frame incorporate an exposed 20 mm T-slot to create a modular mounting system for payloads. To provide data and power to payloads, pass-throughs allow access directly into the rover's electronics cabinet. Payload software is compartmentalized as a ROS node and abstracted into a software library that can communicate and issue commands to necessary subsystems onboard HOPLITE. The current payload configuration is for the Planetary Surface Technology Development Lab (PSTDL) 2021 Lunar Surface Technology Research (LuSTR) grant. HOPLITE currently provides its services to a ground-penetrating radar (GPR) and will also include a percussive hot cone penetrometer (PHCP) onboard in later tests in order to field test characterization of the spatial distribution of ice within the lunar subsurface in addition to profiling the geotechnical properties of regolith.

Data Collection: To support the development of various payloads, HOPLITE uses its sensors to generate data about its own orientation, movement, electronic power system, and vision system. Onboard is a 9 degree of freedom (DoF) inertial measurement unit (IMU) in addition to a high-accuracy global navigation satellite system (GNSS). Due to its modular design, additional sensors necessary for a specific test can easily be attached and integrated into HOPLITE. The rover uses two 160 degrees field of view (FOV) cameras on the front and back and supports various cameras for payload observation with differing FOVs and resolutions. Data streams collected from all onboard sensors are consolidated into a central database onboard HOPLITE. This allows engineers to query all system telemetry at any given time throughout the duration of a test.

Ground Control: HOPLITE is controlled via a custom open-source ground control software designed by a team at the PSTDL. Extensions can be developed for all subsystems and payloads. The ground control software provides pre-defined extensions including an integrated terminal, vision capture, sensor streaming, and more to provide system control and monitoring of HOPLITE and its payloads.

Autonomy: Testing different ISRU and excavation payloads on a rover requires reliable and consistent operation. Collection passes with a GPR must be straight, and separated with enough distance, and cone penetrometer tests must be done at specific locations, spaced sufficiently apart. To this end, HOPLITE uses an autonomous system using its cameras, IMU, and GNSS to perform testing. This system is built from low-level commands, which can be chained into operations and actions. With these commands accurate, repetitive control is provided by allowing the operator to outline the behavior of the system without needing to actively direct it. The operator can dictate the rover's orientation, location, and operation of payloads directly or with a command sequence. This ensures the safe and effective operation of HOPLITE and its payloads.

FIG 1. HOPLITE driving at the Stamp Sands field testing location in Houghton, MI.