Laurentian University's Entry in NASA's 2nd Annual Lunabotics Mining Competition

Greg Lakanen[1,2]

[1]*Laurentian University, 935 Ramsey Lake Road, Sudbury, Ontario*
[2]*Northern Centre for Advanced Technology Inc, 1545 Maley Drive, Sudbury, Ontario*

Telephone: (705)521-8324 ext. 263, Fax: (705) 521-1040, glakanen@norcat.org

Abstract:

A team of 4th year Laurentian University engineering students designed and built the winning entry in NASA's 2nd Annual Lunabotics Mining Competition. The Lunabotics Mining Competition is an annual event held to promote science, technology, engineering and technology (STEM) as well as create a competitive environment through which innovative ideas and solutions for excavating lunar regolith can be developed. The competition requires teams to build a teleoperated robot (called a Lunabot) capable of excavating, transporting and dumping the maximum amount of lunar simulant in a limited time period. The competition rules imposed strict size, weight and bandwidth limitations. The robotic excavator, shown in Figure 1, was designed and built by eight 4th year mechanical engineering students at Laurentian University. The team worked in collaboration with NORCAT and EVC in testing the excavator in lunar simulant. The team was divided into two groups; one responsible for the design and build of the chassis and one responsible for design and implementation of the control system. The members of the chassis design team were: Samuel Carrière, Patrick Chartrand, Stéphane Chiasson, and Myles Chisholm and the members of the control system design team were: Drew Dewit, Greg Lakanen, Jeffrey Pagnutti and Jean-Sebastien Sonier.

The design was heavily influenced by heavy machinery and machinery used in industry with some consideration given to past lunabotics entries. The innovative design aspects borrowed from industry included a unibody (monocoque) construction (no supplemental frame for the hopper), a 4-wheel steering system which enables the use of "crab-walking" (diagonal translation) and the inclusion of a live-bottom hopper. An "all-conveyer" concept was adopted. The front implement (excavator) is a bucket ladder design which dumps into the live-bottom hopper, which subsequently feeds the rear unloader (conveyer belt with attached paddles to lift material). All three sub-systems work on conveyer principles and utilize the same motor-gearbox combinations (3 for the excavator and 2 for each the live-bottom and rear unloader).

The Laurentian team was also the winner of the Arizona Communications Efficiency Award for using the least amount of data bandwidth during their run (normalized by the amount of simulant excavated and dumped). The control system consists of a laptop onboard the excavator communicating with a laptop running in the master control center (MCC). The operator telerobotically controls the excavator with an XBOX 360 controller interfaced with the MCC laptop. The robotic excavator has three onboard cameras which are interfaced with the onboard laptop and subsequently monitored on the MCC laptop. In order to conserve bandwidth the video feeds were compressed and flattened to a binary string before being passed across the

network. Although there are three cameras running onboard the robotic excavator at any given time, the operator can only stream one camera at a time and has the option to not stream any in order to conserve data. In order to maximize excavator potential ‘sub-routines’ (autonomous digging and unloading) were created. The excavating sub-routine consisted of having the excavator start digging and lowering to a preset (user specified) depth, which once reached enables the robotic excavator to begin moving forward. The whole process is activated by pressing one single button, and reduces the demand on the operator to try and control all those parameters.

During the competition the Laurentian lunabot moved a record setting total of 237.4 kg during its winning 15 minute competition run. The excavator also moved a record 89 kg in one collection-dumping cycle. The results from the competition run prove that the Laurentian design is capable of excavating, hauling and unloading a significant amount of regolith as per competition conditions. Areas of improvement for the physical design include reevaluating the floatation and traction aspects of the excavator to operate more efficiently in the lunar simulant. Reducing the overloaded conditions of power transmission components such as steering servos and gearboxes as well as calculating the reliability and life cycle of these components would improve the design. Improvements to the control system could be made by determining the root cause and mitigating the control system issue, which caused the more than two minute period of “down-time” resulting in the necessity to reboot the onboard computer.

Figure 1: Laurentian’s Lunabot