



The Mining Systems Laboratory at Queen's University works with this autonomous loader. The passenger is in place for safety.

SUCCESS STORY

Autonomous Mining Becomes Reality with Queen's University Retrofit Vehicles.

Queen's University, one of Canada's top-ranked post-secondary institutes, is renowned for the Robert M. Buchan Department of Mining. Dr. Joshua Marshall is the Assistant Professor and figurehead in the Mining Systems Laboratory (MSL) at Queen's and focuses his research on the development and application of advanced methods for the perception, modeling, and control of mining equipment. Dr. Marshall and his team are fostering new methods for low-cost, high-output, safe, and environmentally responsible mining systems.

Before Clearpath Robotics

The MSL set out to develop new and innovative projects around the automation of load-haul-dump (LHD) processes in the harsh and unstructured environments of mining operations. In order to field test their concept algorithms and prototype designs for robotic excavation, materials transport, and for the coordination of robotic machines, they needed a set of experimental platforms; to procure actual mining equipment would be too costly to purchase and maintain. Conversely, the use of laboratory-scale

vehicles would not suffice for credible mining research. The team quickly realized that building vehicles from the ground up or modifying commercial equipment in-house was not an option due to the scope and complexity of the project. "To create our own piece of equipment would have taken upwards of three years and run us over budget - this was not an option for our team," explained Marshall.

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The team required pilot-scale autonomous mining equipment that met industry standards; "Developing applied control algorithms for autonomous mining is a huge challenge because testing in a live environment is near impossible," said Marshall. Recognizing the need for a custom robotics project, Dr. Marshall turned to Clearpath Robotics for a solution.



“The nature of this project was highly customized. There are not too many companies in the world who could do what we wanted ...with the experience that Clearpath has in the area of autonomous robotic vehicles.”

The Clearpath Advantage

Dr. Marshall reached out to Clearpath Robotics to conceptualize, design and build specialized autonomous mining vehicles for his unique lab. Clearpath’s multi-disciplinary team worked with Marshall to align technical requirements with operating constraints and project timelines. The winning concept called for complete autonomous system retrofits of a stock Kubota Wheel Loader and Kubota Utility Vehicle.

“The vehicles provide a perfect balance between simulation and near-realistic field experiments ...for real-world results.”

Both vehicles were custom-outfitted with drive-by-wire controls, a range of navigation and perception sensors and cutting edge autonomy software built on the Robot Operating System (ROS) - ideal for autonomous mining machines research in harsh and realistic environments.

Position feedback, pressure sensors and hydraulic valve controls were also added to the Wheel Loader to allow for intelligent loading. Using these sensors, “the trajectory force is calculated to determine how much pressure to apply when lifting rock rubble; the machine feels its way through the pile.”

“The nature of this project was highly customized. There are not too many companies in the world who could do what we wanted, in the price range we needed, with the experience that Clearpath has in the area of autonomous robotic vehicles,” said Marshall.

Results

Marshall’s autonomous mining vehicles were built to exact specifications, on budget, on time, and enabled their research to be brought to market faster than expected; “The vehicles provide a perfect balance between simulation and near-realistic field experiments, which allowed us to yield accurate real-world results,” said Marshall.

The MSL team has completed successful field work in Ontario, Canada mines and proved their robotic vehicles’ functionality in challenging environments. Marshall concluded, “Clearpath’s team was efficient and effective - the turnaround time of

getting our research to the field, and proven, was faster than we’ve ever done before.”

“Clearpath has been incredibly attentive to supporting us throughout our research to ensure we are successful.”

Since the successful field tests, the team has started working with Atlas Copco, one of the world’s largest mining equipment manufacturers. The Company has plans to apply this research and autonomous technology on their industry-leading mining vehicles.

The Mining Systems Laboratory at Queen’s University plans to continue using Clearpath Robotics services for future research and development mining projects. Dr. Marshall added, “Clearpath has been incredibly attentive to supporting us throughout our research to ensure we are successful.”



The MSL successfully completed field testing in Ontario mines.



The standard tractor was retrofit into an autonomous loader.

About Clearpath Robotics

Clearpath Robotics, a global leader in unmanned vehicle robotics for research and development, is dedicated to automating the world’s duller, dirtier, and deadliest jobs. The Company serves robotics leaders in over 30 countries worldwide in academic, corporate, industrial, and military environments. Visit us at www.clearpathrobotics.com to learn more or call us at 1-800-301-3863 to speak with an applications engineer.