

GROUP 04

AUTOMATION IN MINING



AUTOMATION IN MINING

MISSION

The group aims to develop and transfer technology to the mining industry in the following areas: automation, robotics, sensorization, sensors and data networks, pattern recognition and image processing. Thus, the group aims to support the development of the next generation of mining systems through design and construction of equipment and smart systems, environment-friendly to increase competitiveness of the mining sector, reduce production costs, environmental impact, and improve safety and health in the workplace.

TEAM

Principal researchers:

- Martin Adams, PhD.
- Claudio Pérez, PhD.
- Javier Ruiz del Solar, PhD.
- Manuel Duarte, PhD.

Associate researchers:

- Pablo Estévez, PhD.
- Marcos Orchard, PhD.
- Mauricio Correa, PhD.
- Isao Parra, PhD.
- Paul Vallejos, PhD.
- Freddy Milla, PhD.
- Mauricio Mascaró, Eng.

- Jacob Saravia, Eng.
- Carlos Tampier, Eng.

Postdoctorate researchers:

- Francisco Galdames, PhD.
- Patricio Loncomilla, PhD.
- Norelys Águila, PhD.

23 PhD. students

7 MSc. Students

FIELDS OF EXPERTISE:

- Teleoperation and automation of vehicles and mobile mining machinery.
- Fault diagnosis and predictive maintenance of equipment.
- Technology for mapping and 3D modelling of tunnels, slopes in pits, machinery and mining environments in general.
- Collaborative systems for safe and efficient human-machine interaction.
- Advanced techniques of pattern recognition and image analysis

- Rock types classification via 2D and 3D imaging and determination of granulometry.
- Electrical generation technology, based on clean and renewable energies.
- Advanced control systems and computer intelligence to improve the energy efficiency of different stages of the mining process.

FIELDS OF APPLICATION

- Automation of vehicles and mobile mining machinery.
- Development of assisted driving systems.
- Application of UAV technology in exploration, inspection and 3D modelling.
- Development of sensors systems and real-time decision making for underground and open pit mines.
- Systems for determination of lithologic composition for improvement of exploitation processes.
- Estimation of minerals granulometry.
- Detection of defects in machinery (fault diagnosis) or products (quality control).
- Accident prevention by monitoring the interaction between machinery and workers.
- People-oriented security systems through biometric identification and people count.
- Heating systems for mining solutions in bioleaching and electro-obtaining processes.
- Optimize mining power systems in terms of their continuity and quality of service.
- Optimum fleet management of trucks, water pumping systems, air conditioning and mineral flotation.

OPPORTUNITIES FOR COLLABORATION WITH THE MINING INDUSTRY

- Technologies for autonomous tele-operated or assisted driving of vehicles in harsh environments.
- Analysis of semi-autonomous LHD systems technologies.
- Aerial platforms for 3D modelling.
- Sensors technologies for vehicle operation in low-visibility environments.
- Development of an autonomous loading system for LHD.

PROJECTS

1. MODELLING AND CONTROL OF THE INTEGRATED ENERGY CONSUMPTION IN MINING-METALLURGIC PROCESSES

Fundamentals

The way that the mining companies have to reduce operating costs corresponds to the optimization of both, processes and energy consumption. There are multiple processes with innumerable variables, which are not known with certainty. For this reason, the optimization of mining processes is a complex task, however a solution that arises naturally, is the use of specialized mathematical tools of the control systems.

Goals

The general objective of the project is the use of advanced control strategies to optimize the performance of all mining-metallurgical processes in terms of achieving planned production levels with minimal energy expenditure. In this area, the optimization control strategies that we use are very important in the mining area, because they allow the incorporation of restrictions in the synthesis or implementation of the controller. The specific objectives include the predictive control of the following systems: Mining electrical power systems (this implies optimizing in terms of continuity and quality of service). Mining water recirculation systems, (this implies control inventory, minimizing energy). Flotation systems (this implies minimize energy, stabilize production), Underground mining climate control systems (minimize energy) and Mining truck routing system (this implies optimizing fuel consumption and duty cycle).

Finally, we also bet on a new advanced strategy called fractional control for a SAG mill with promising results of energy efficiency.

Results

- Global reduction of energy consumption in a mining system.
- Reduction of voltage oscillations, frequency and power of a MEPS and improvement of the MEPS' recovery time after failures and contingencies.
- Reduction of the energy consumption of each one of the main individual operations of the mining-metallurgic process, by using predictive models and advanced control strategies.

Team

- Manuel Duarte, PhD.
- Leandro Voisin, PhD.
- Norelys Águila, PhD.
- Freddy Milla, PhD.
- Williams Calderón, PhD.
- Rodrigo Palma, PhD.
- Álvaro Valencia, PhD.
- Aldo Tamburrino, PhD.
- Aquiles Sepúlveda, PhD.



2. DEVELOPMENT OF AN AUTONOMOUS NAVIGATION SYSTEM FOR LHD IN MEDIUM-SIZED MINING

Fundamentals

Automation is a key factor in enabling an increase in safety and work life quality in mining, which is closely related to higher productivity and lower operational costs.

Costs and complexity of the currently available semi-autonomous LHD systems are custom-made for massive mining operations and do not adjust to the needs of medium-sized mining.

To bring the benefits in safety and productivity of semi-autonomous LHD systems to the medium-sized industry, it is necessary to develop a custom-made system, considering the needs and characteristics of such operations.

Goals

The project aims to develop an automation system for LHD. As part of this concept, the operator's station should be located in a safe zone outside the mine, from where the machines can be controlled remotely.

Results

- An autonomous navigation system, jointly developed with the LHD manufacturer GHH with the following characteristics:
 - The system will be remotely operated from a safe location.
 - The system will autonomously navigate in stopping-type mines, with a robust obstacle detection system.
 - The productivity of the system will be equal or superior to manual operation and/or line-of-sight teleoperation.
- An industrial validation of the system in a sub-level stopping mine is planned for March-September 2017.

Team

- Paul Vallejos, PhD.
- Javier Ruiz del Solar, PhD.
- Isao Parra, PhD.
- Mauricio Correa, PhD.
- Mauricio Mascaró, Eng.
- Carlos Tampier, Eng.