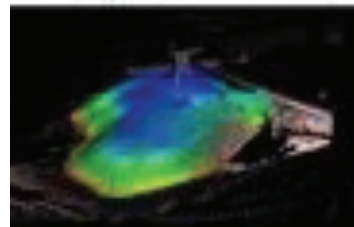
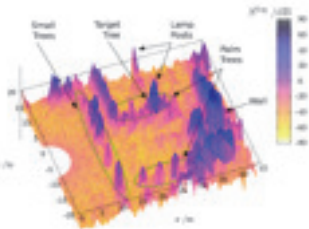


Robotics and Automation

Our goal is to transfer recent research and development results in Robotics, Automation, Sensor Technologies, Pattern Recognition, and Sensor and Data Networks to the mining industry

Sensing solutions for mining

- ✓ Robot Perception in challenging environments
- ✓ Battery management systems
- ✓ Sensorization of underground mines (Muzo, Colombia)
- ✓ RFID-based Tracking of drillhole samples



Resources

- ✓ 3 Faculty researchers
- ✓ 3 Full time researchers
- ✓ 4 Postdocs
- ✓ 9 PhD students
- ✓ 2 MSc students
- ✓ 6 research labs: Robotics, Field Robotics, Computer Vision, Automation, Control Systems, Mechatronics



Vehicle and mining machinery automation

- ✓ Vehicle tele-operation & automation
- ✓ Unmanned air platforms
- ✓ Haptic control for a rockbreaker
- ✓ Study of LHD automation technologies in CODELCO



Predictive Maintenance

Diploma on Robotics and Automation

Industrial Sponsors

- Codelco, IM2, Nissan Marubeni, ClearPath Robotics, Komatsu, El Soldado, Jacobs Univ, Entel

Achievements since 2009

- ✓ ISI Publications: 28
- ✓ Grants: USD\$1.200.000
- ✓ Graduates: 7 PhDs, 5 MSc, 16 Eng.
- ✓ Tele-operation of a commercial vehicle
- ✓ Design and construction of an UAV platform and 2 x-copters.
- ✓ Sensing systems validated in Chile and Colombia



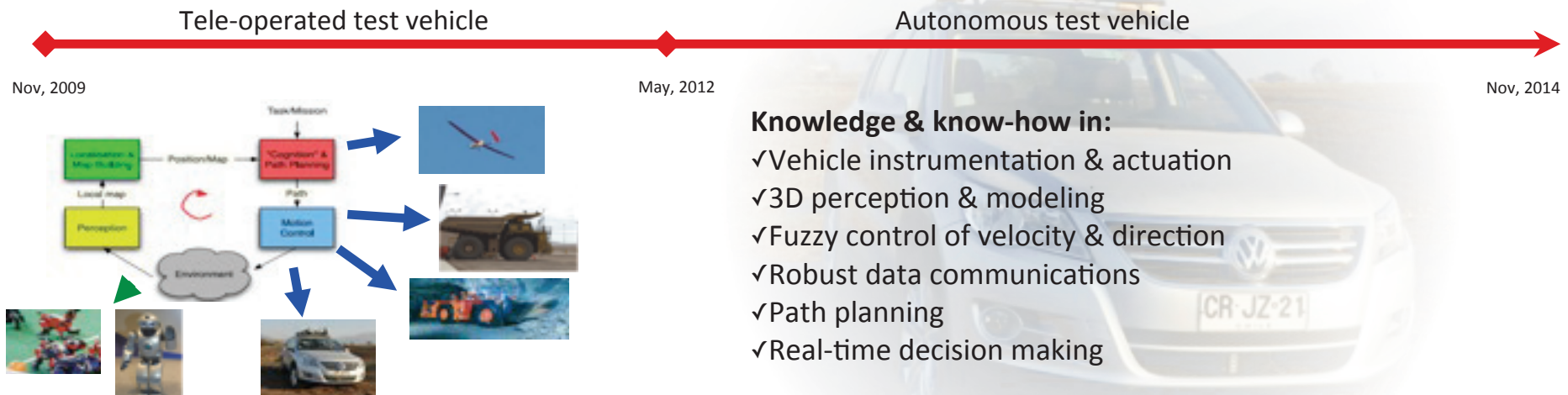


Projects/Proposals

- ✓ Study of LHD automation technologies in CODELCO (in execution)
- ✓ Haptic interfaces for rock breakers in Codelco (under evaluation)
- ✓ Tele-operation of hovercraft for inspection of tailing dams (under preparation with Aerodeslizadores Chile)
- ✓ Automated inspection of vibrating screens with Ludovici for Cluster Program of Codelco (proposal rejected in 2012)

Achievements

- ✓ 5 engineering thesis
- ✓ 3 PhD thesis under execution





History

- ✓Development/sensoring of UAV platforms – together with G8 / restricted applications in mining
- ✓Development of x-rotor platforms

Applications of x-rotors

- ✓Stock Pile volume measurement
- ✓Leach pile modeling and monitoring
- ✓3D mapping & inspection in tunnels
- ✓Rock Cavity and big machines (Mills, Crushers) mapping
- ✓Open Pit mapping & inspection
- ✓Atmospheric measurements

Projects/Proposals

- ✓Thermal inspection of irrigation flow in heap leach piles in El Soldado mine (in execution)
- ✓Postdoc project on 3D mapping of tunnels (in execution)
- ✓High interest of Komatsu on application in open pit operations
- ✓Fondef-Idea proposal on 3D mapping of tunnels (in preparation)
- ✓G8 interest on glacier inspection
- ✓G1 interest on open pit 3D visualization

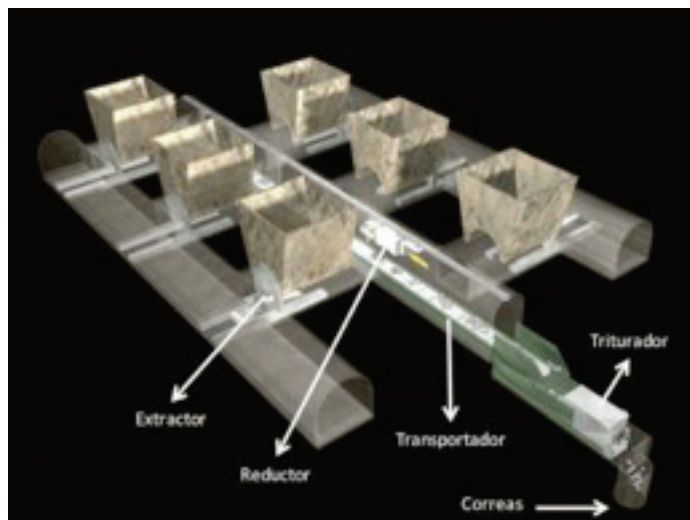
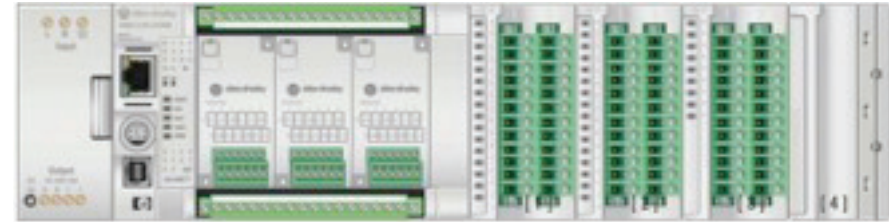
Achievements

- ✓2 patent applications (VID-UCH analysis)
- ✓Accepted paper in Hydroprocess 2013



Projects/Proposals

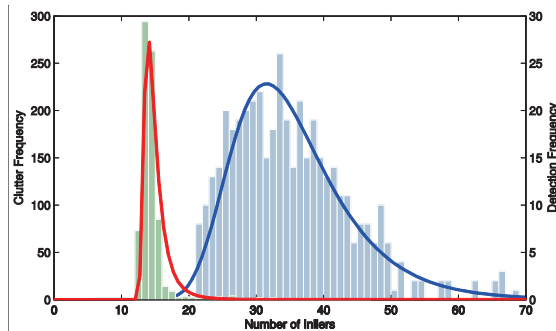
- ✓ Automation of a scaled version of a continuous mining operation for Codelco (G4; under execution)
- ✓ PLC sensing in floatation applications for Candelaria and for L2 project (G9; finished)
- ✓ Infrastructure for video, communications and tracking for Muzo underground mine (finished)
- ✓ RFID based tracking of drill cores with Entel for Codelco Norte (under evaluation)
- ✓ Survey of available technologies for person detection in mining applications for El Teniente mine (G4; finished)
- ✓ Volume estimation of stock piles for El Teniente Mine (proposal rejected in 2012)





Sensing solutions for mining

- ✓ MMW Radar processing
- ✓ Improving detection – Scan Integration
- ✓ Laser based feature extraction
- ✓ Visual based probs. detection/false alarm
- ✓ Multi-object filtering for improved detection & mapping.
- ✓ To address volumetric & surface profile estimation.



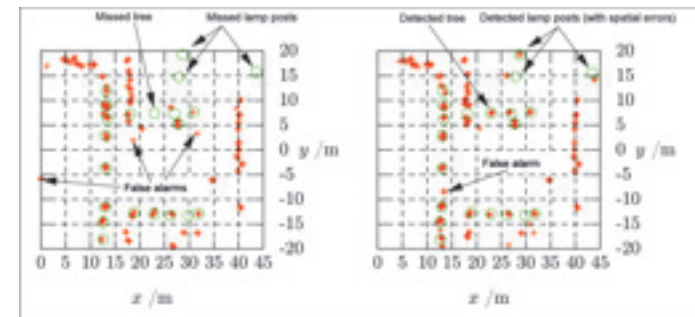
Robotic & Sensing Equipment

- ✓ Scanning MMW radar,
- ✓ Scanning laser range finder,
- ✓ 2 robotic platforms + access to autonomous VW,
- ✓ vision, gyro and compass sensors,
- ✓ Computational resources.

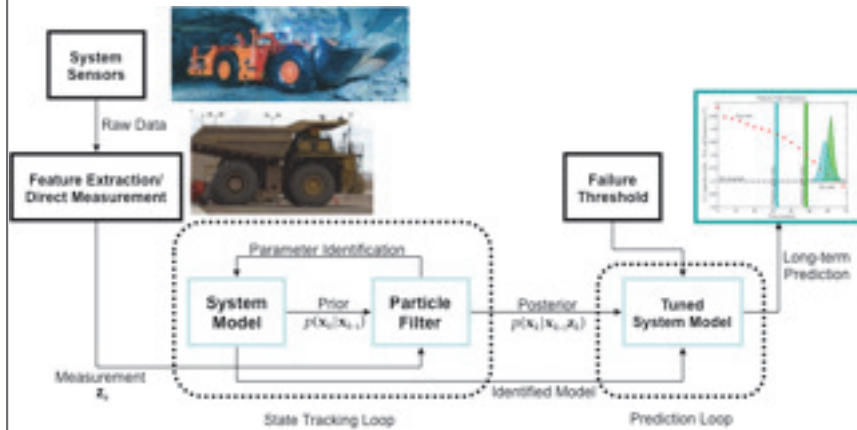


Projects/Proposals

- ✓ ClearPath Robotics project (started Jan. 2013)
- ✓ Conicyt - DAAD Jacobs Univ, Bremen (to start April 2013)
- ✓ Corfo L1 proposal (under evaluation)
- ✓ Fondecyt project 1110579 (started Jan 2012)
- ✓ Postdoc Project – vision based detection (started Nov. 2012)



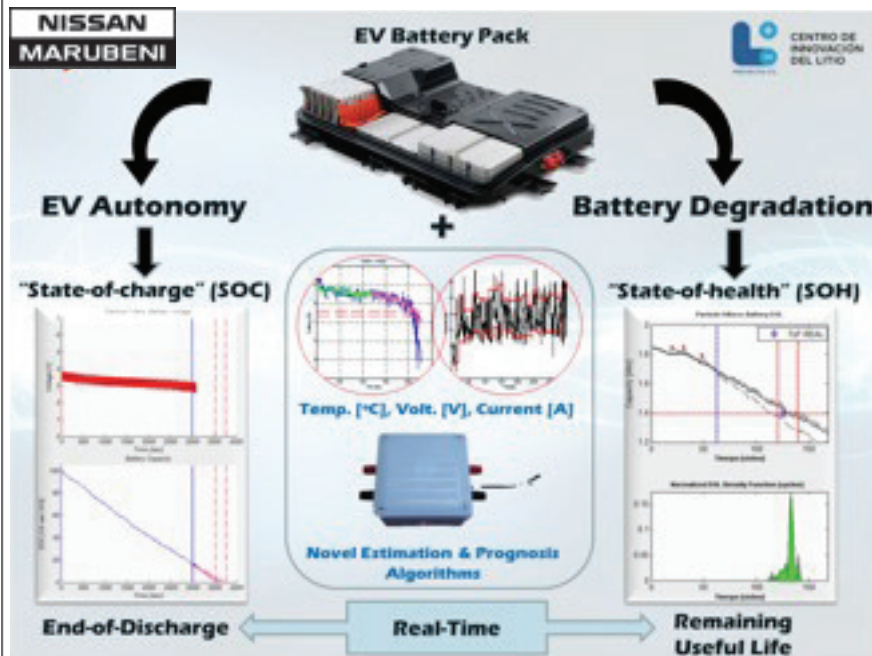
Predictive Maintenance and Condition Monitoring



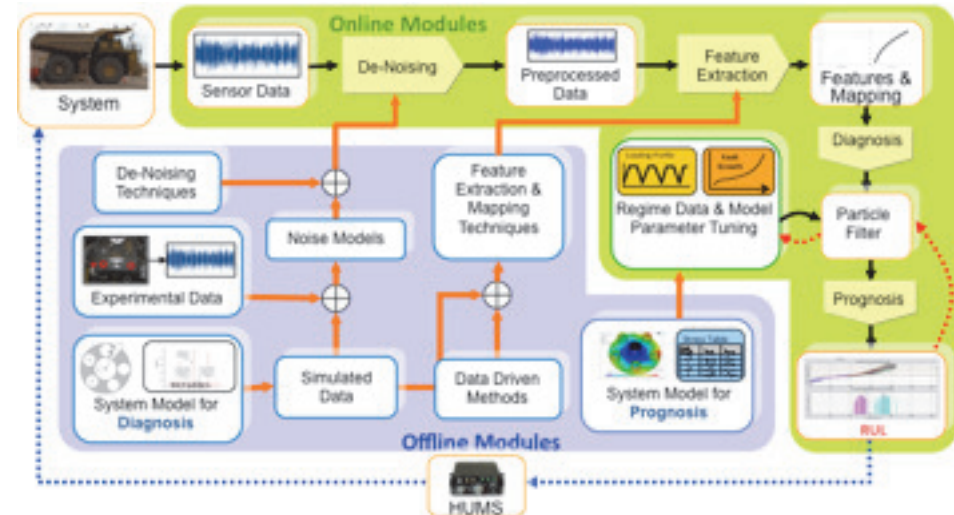
Expected Benefits:

- ✓ To monitor the condition of equipment/machinery.
- ✓ To ensure operational continuity.
- ✓ To reduce maintenance costs (optimize preemptive maintenance strategies and minimize the need of corrective maintenance).
- ✓ To build databases and knowledge associated with the behavior of the machinery.
- ✓ To develop internal policies for the acquisition of machinery.
- ✓ Applications to conveyor belts, ore crushers, SAG mills, electric motors, gearboxes, bearings, and mobile equipment (trucks, LHDs, impact hammers)

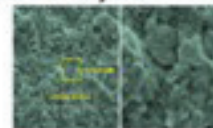
SOHC L1/L2 Projects (CIL & Nissan-Marubeni)



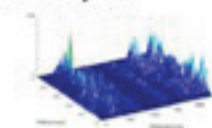
Intelligent Systems: CSIRO-Chile & G4 AMTC



• Lubricant analysis



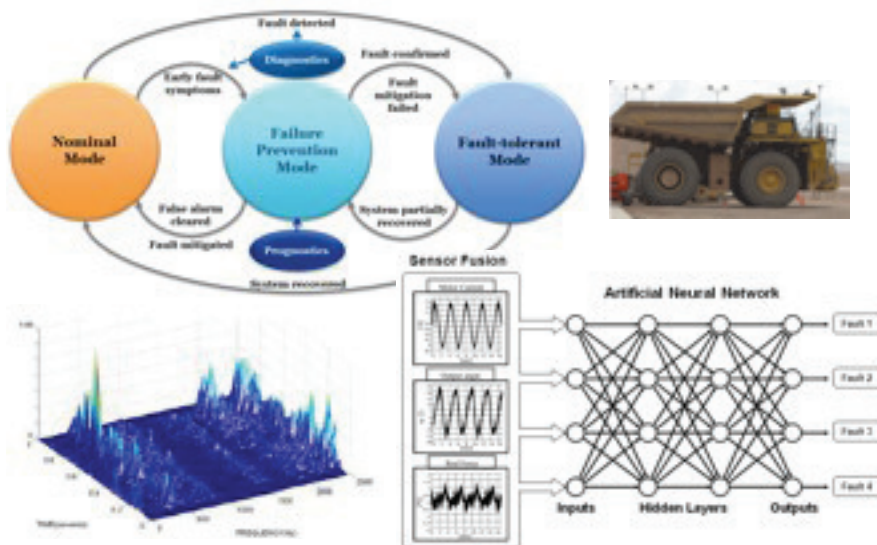
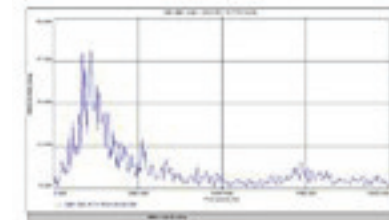
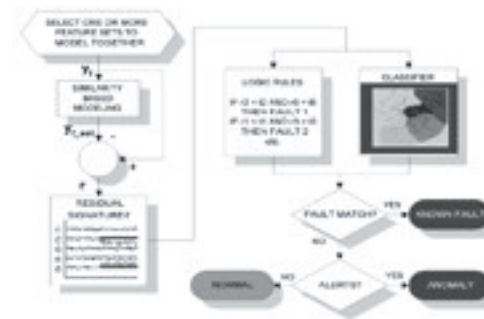
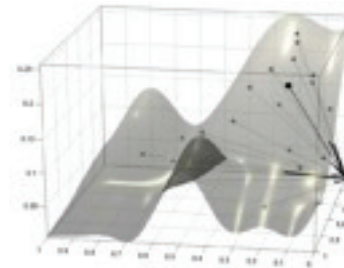
• Vibration analysis



• Thermography



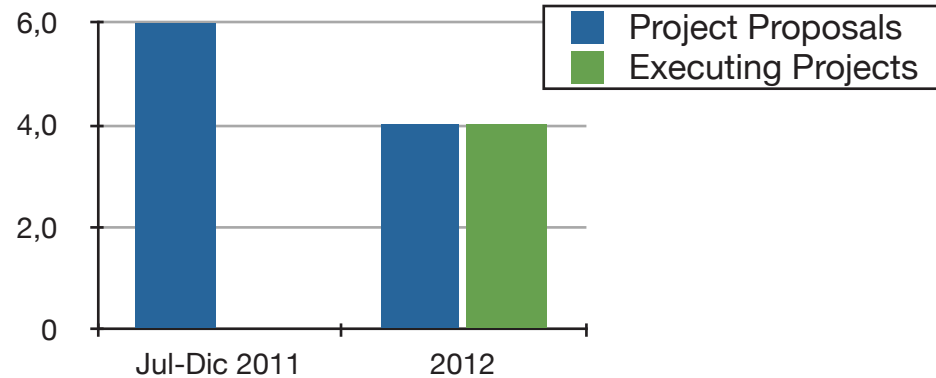
- ✓ Survey conducted among participants of CODELCO's 6 SAT (6^{to} Seminario de Acercamiento Tecnológico), June 2012, Calama, Chile.
- ✓ Total number of answered surveys: 29
 - ✓ 22 surveyed people (76%) provided contact information (optional).
 - ✓ 18 respondents (62%) declared a strong interest in a diploma on the proposed topic.
 - ✓ 10 respondents (34%) declared that they were personally interested, although such activities were not a priority in their companies.
 - ✓ 76% declared that they could attend if the Diploma was lectured at Santiago.



Structure:

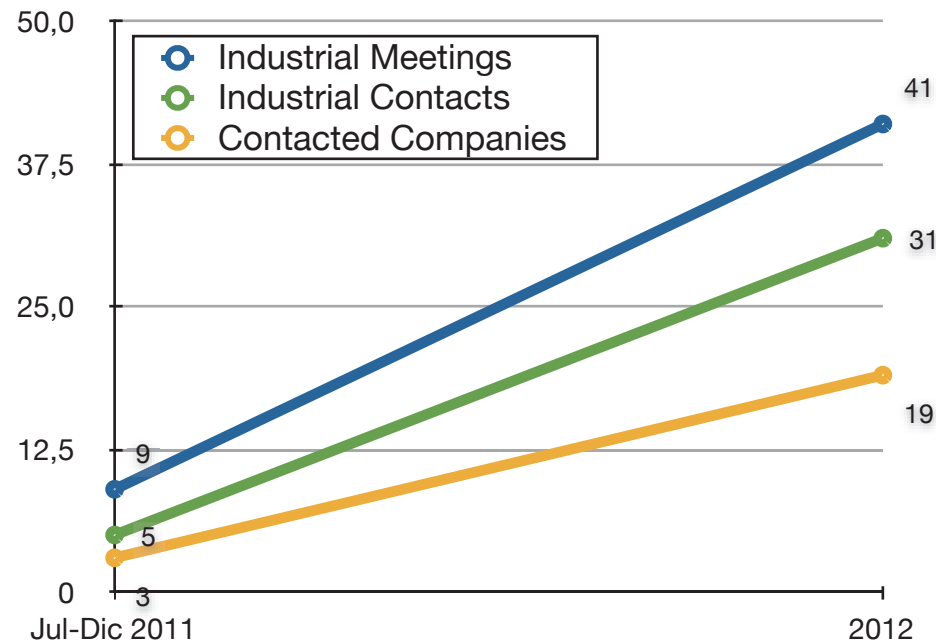
- ✓ Vehicle and mobile machinery instrumentation
- ✓ Sensing systems
- ✓ Principles on communications
- ✓ Image processing
- ✓ Fault detection, failure prognosis, and predictive maintenance
- ✓ Tele-operation and haptic interfaces in mining
- ✓ Mining automation and mobile robotics

Industrial Projects



	Jul-Dic 2011	2012	Jan 2013
Industrial Meetings	9	41	17
Industrial Contacts	5	31	8
Contacted Companies	3	19	4
Project Proposals	6	4	2
Executing Projects	0	4	4
Number of months	6	12	1

Industrial Relationship



Industrial Partners

- ✓Codelco
- ✓IM2
- ✓Nissan Marubeni
- ✓ClearPath Robotics
- ✓Komatsu
- ✓El Soldado
- ✓Jacobs Univ, Bremen
- ✓Entel

Internal Collaboration

- ✓Group 4: Collaboration in 3 Projects
- ✓Group 9: Collaboration in 2 Project
- ✓Group 8: Collaboration in 1+1 Project
- ✓Group 1: Interest in Collaboration

Questions?



jueves, 11 de abril de 13