Mining in the Future: Autonomous Robotics for Safer Mines

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Mining in the Future

- Safer mines with reduced hazard to which personnel are exposed
- Improved production and efficiency
- Gain access to new resources
- Many industry leaders are investing in automation in both underground and opencast mining
  - Rio Tinto/ACFR
  - Anglo American 2030 mine
  - Sandvik
  - Atlas Copco
  - Komatsu
  - CMU
Field Robotics

- Robotic systems for “real-world” environments

- Operating in environments:
  - Dynamic, unknown and unstructured
  - People may be present

- In contrast to controlled environments (e.g. Factories/Assembly Lines), these environments are much more challenging

- MIAS focuses on field robotics
Advantages of Autonomous Robots

- There are several advantages to using autonomous robots
  - Operate in extreme/inaccessible environments
  - Do not suffer from fatigue and the associated errors
  - Not bored by repetitive tasks
  - Require less support infrastructure
  - Advanced sensors
Degree of Autonomy

• Teleoperation

• Semi-autonomous

• Autonomous
The Mobile Intelligent Autonomous Systems (MIAS) was formed as an Emerging Research Area (ERA) in 2007.

- CSIR did not have existing capability
- Was deemed to be an important future capability

First 5 years focussed on capability building – now moving into commercial ventures

Focus is on intelligence and sensors for field robotics applications
Autonomous Rover

- A GPS-guided autonomous platform

- Autonomously navigate along known paths with collision avoidance

- Applications of this technology include:
  - Security patrols
  - Transportation of cargo
  - Mining
Mine Safety Platform

• Joint project with CSIR Centre for Mining Innovation and Material Science and Manufacturing

• Focuses on performing pre-entry safety inspections in deep mines
Problem Statement

- South Africa’s hard rock mining is one of the most dangerous types of mining.

- Many fatalities happen post-blast and before stabilizing the roof.
Challenges

• Unknown and unstructured environment

• GPS deprived

• No landmarks and few distinguishing features

• Hostile environment, i.e. dark, humid, high temperatures

• Challenging to traverse
Operation Phases

- Simultaneous exploration and mapping
  - Local scans
  - Exploration frontier planning
  - Path planning
  - Platform motion control
  - Global map generation
- Sampling user-defined points on the hanging wall
- Generate a hazard map of the entire hanging wall
System Modules

- Exploration
- Localization
- Manipulation
Current System
Conclusions

- Field robotics can help increase the safety in mining operations

- Tele-operated, semi-autonomous and autonomous robots can be utilized to reduce the hazard to which personnel are exposed

- Robots can be beneficial in operation in extreme/inaccessible environments, i.e. no fatigue, less error, repetitive tasks, less support infrastructure, advanced sensors

- Autonomous Rover Project outcome can be adopted for automating haul trucks in opencast mines

- Mine Safety Platform is a joint project with CMI and MSM targeting the task of post-blast inspection in deep hard rock mines
Thank you