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

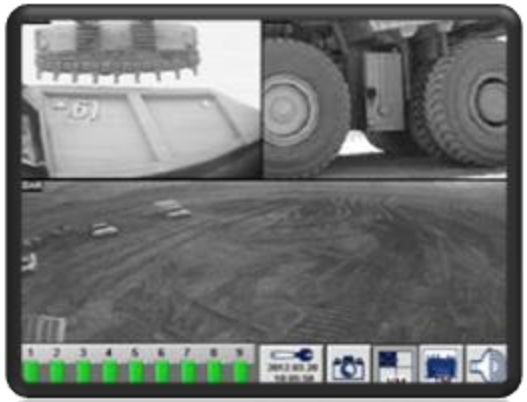
Advantages of Autonomous Robots

- 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

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Mobile Intelligent Autonomous Systems Group

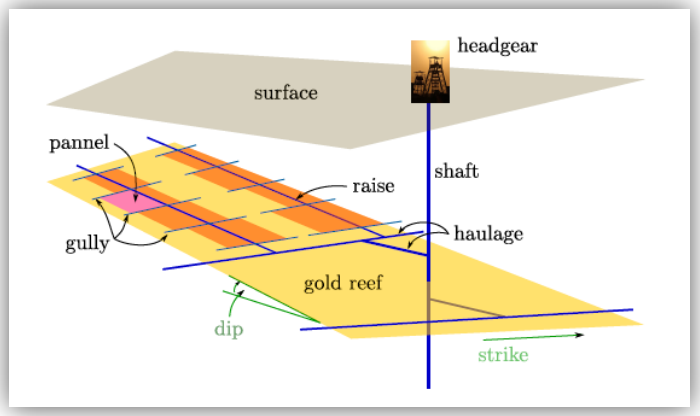
- The Mobile Intelligent Autonomous Systems (MIAS) was formed as an Emerging Research Area (ERA) in 2007.
  - CSIR did not have existing capability
  - Was deemed to be an important future capability
- First 5 years focussed on capability building – now moving into commercial ventures
- Focus is on intelligence and sensors for field robotics applications

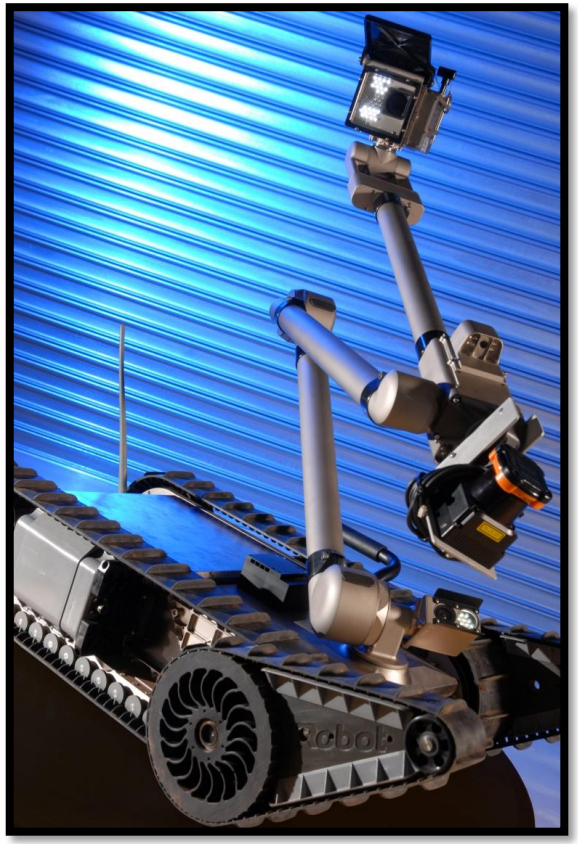
Autonomous Rover

- 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

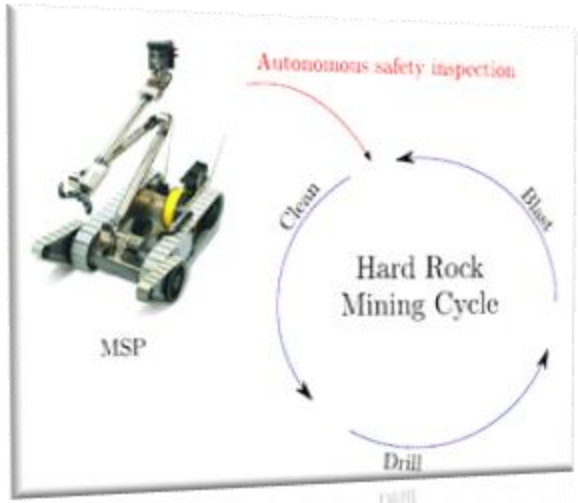
- Joint project with CSIR Centre for Mining Innovation and Material Science and Manufacturing
- Focuses on performing pre-entry safety inspections in deep mines





Problem Statement

- South Africa's hard rock mining is one the most dangerous types of mining
- Many fatalities happen post-blast and before stabilizing the roof

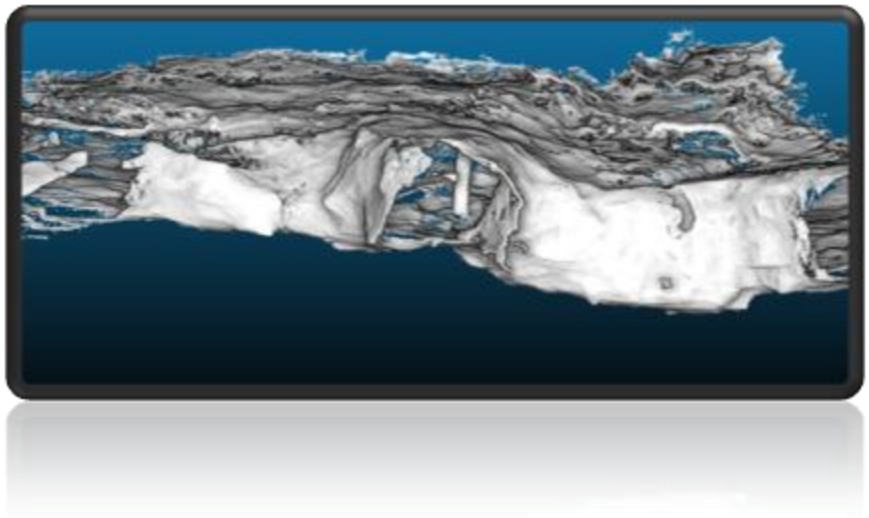


Challenges

- 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

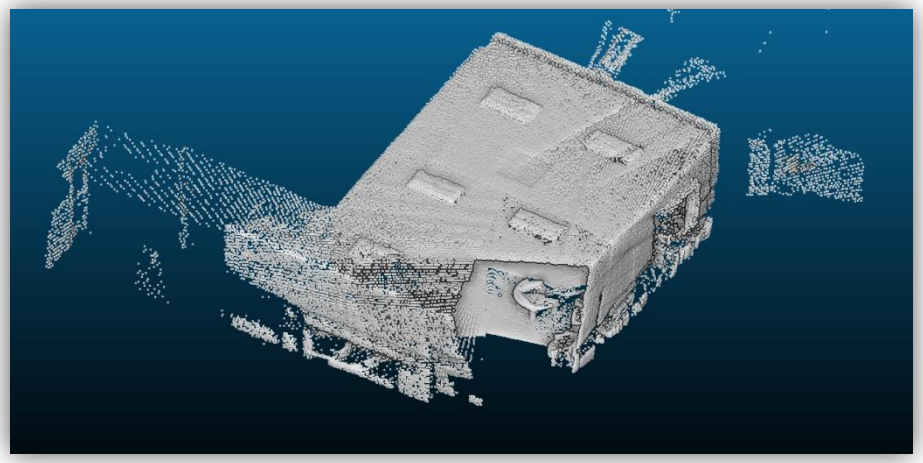
- Simultaneous exploration and mapping
  - Local scans
  - Exploration frontier planning
  - Path planning
  - Platform motion control
  - Global map generation



- Sampling user-defined points on the hanging wall
- Generate a hazard map of the entire hanging wall

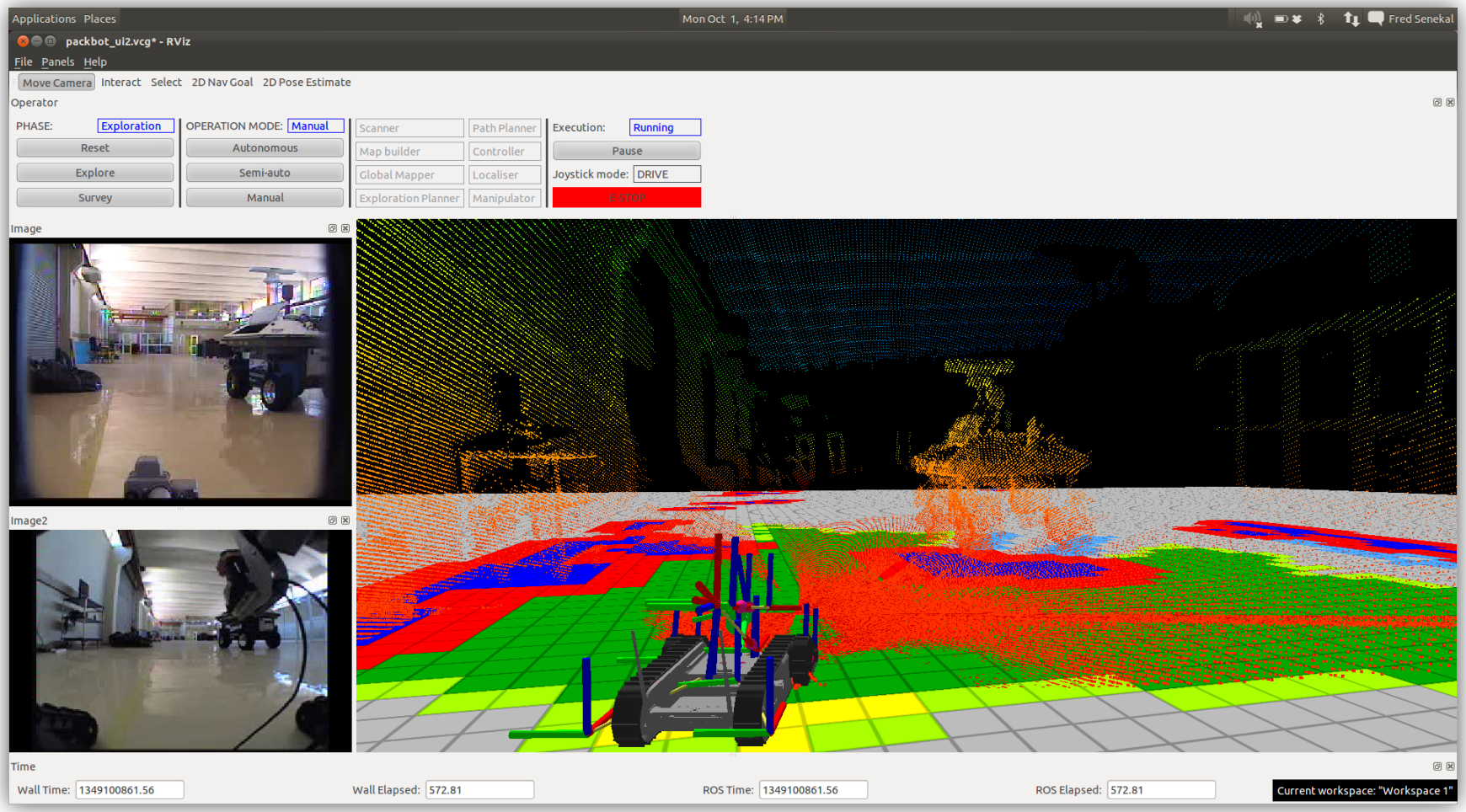
System Modules

- 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

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