AngloAmerican

Compact Radar System for RockMass Movement Monitoring in Underground Narrow Stope

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Contents

Objective

Open pit showed success by introducing radar technology to prevent fatalities and damage to equipment from uncontrolled slope failures. Anglo American, in partnership and collaboration with Geobotica, researched and developed remote sensing radar technology for underground mines called NanoRadar.

Goal

- Sustain zero rock fall fatality performance
- Develop rock movement radar tool
- Early warnings to workers
- Recording geotechnical data in real time

Solutions

- Fit for purpose (Robust, Waterproof, Compact, Durable, Reliable tool and Portable design)
- Alarm trigger (alerts employees to rock movement)
- User friendly and Simple deployment
- Accurate and precise measurements
- Data recording and integration capabilities
- Continuous real-time monitoring
- Monitor larger area
- Long battery life

Technology Development

Underground NanoRadar

MIMO

Multiple-Input Multiple-Output (MIMO) radar.

Variant of Synthetic Aperture (customization)

High resolution imaging

Spatial coverage

Accuracy

Detect small-scale rockmass movement

No moving parts

Reduces physical size and power requirements

NanoRadar Development

2 Years development (9 rounds of prototypes)

Sense Movement and Orientation

20 m detection range

Buttonless

Customizing scanning cycle time

Short- and Long-term recording functionality

Tri-pod deployment

Filtering Non-Rock Movements (RockDetect Algorithm)

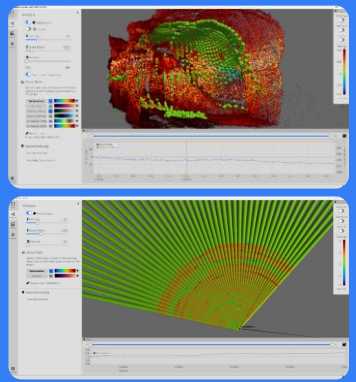
Software

Data visualisation tool

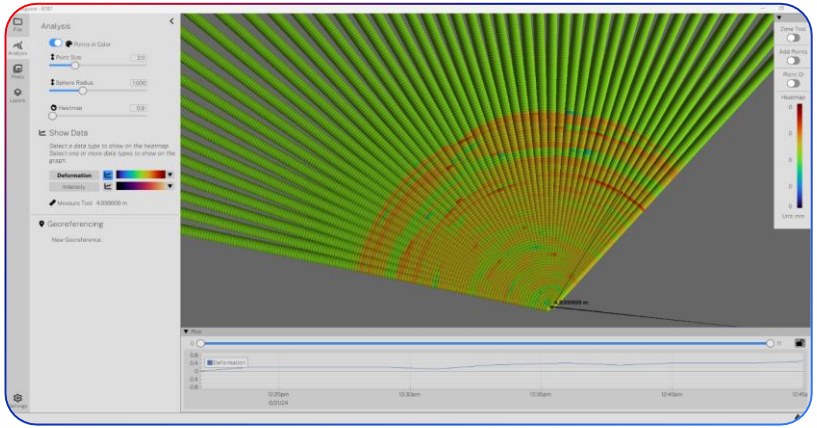
Analyse deformation

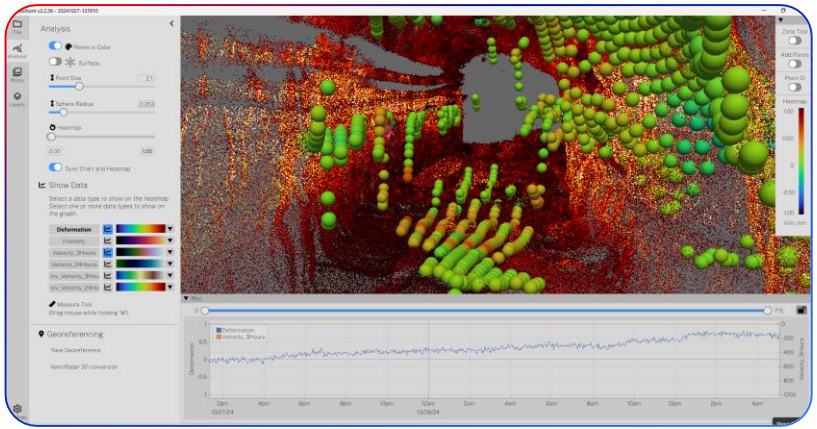
Post- alarms analysis

2D or 3D (PointCloud) map integration



UG Proof of Concept





Piloting

Short-term (8 hours)

Environment

- Productive Operational Narrow Reef Stope
- Slope angle 15º to 30º
- Working Height of 1.4 to 1.5 m

Application

Adoption Key Points

- Draft operation procedures and training documents
- Crew engagement sessions prior piloting
- Fully training on the crew
- Time spent initially with the crew in workplace
- Ongoing support was provided by a dedicated member of the Geotechnical team

Ongoing process

- Units brought to surface to charge and download data every 10 to 14 days. (Overnight charging)
- Member of Geotechnical team visit workplace and record status of units and crew feedback

Duration

- 6 Months

Outcome

- Crew was acceptable of technology
- Robust and fit for purpose
- Success of a rock dislodged and triggered alarm (Protocol was followed on alarm trigger)

Piloting

Long-term (> 24 hours)

Environment

- 3.0 m x 4.0 m Tunnel
- Flat Surface
- Area was closed off due to rockmass instability

Application

- NanoRadar was placed approximately 5.0 m from rock movement area
- Rope was attached to unit to retrieve incase no access was possible

Duration

- Continues scanning for 8 days

Outcome

- Rockmass movement was recorded successful indicating positive and negative direction of movement (this behaviour was proven to be correct)

Proposed Integration into Mining Operation

Underground Team member collect and return unit/s at lamp room

Daily or when Low Battery

Charging and Data Transfer

While on charge, real-time data transfer to a cloud-based server.

Deployment

Issued as integrated tool with production or according to geotechnical risk assessment and critical monitoring zones.

Monitoring Modes

a.Short-Term Monitoring: Immediate hazard detection for underground personnel, used for one shift, and returned for charging post-shift.

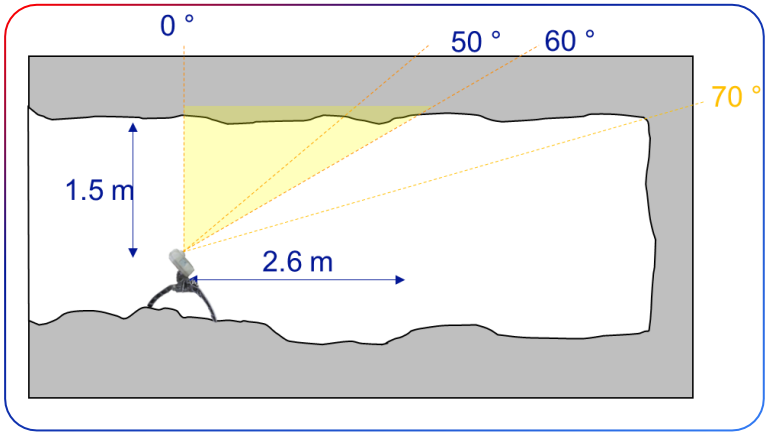
b.Long-Term Monitoring: Continuous observation of rock mass deformation and velocity for up to 7 days, followed by recharging.

Data Analysis

Uploaded data is processed on the cloud for geotechnical review using Geopoint software, enabling proactive risk management.

Learnings

- **Accuracy limitation results in reduced coverage range**
  - 60º in all direction
- **Vibration of rockdrill machines drilling in hangingwall caused no recording of NanoRadar**
  - Deployment method was changed from pole to floor stand deployment method
- **Wireless charging unit was not lasting for the environment**
  - Changed to safe plug in type of charging
- **Stable network is required**
  - Lost of data occurred but safe option was build to keep data



Other Applications

Surface NanoRadar

- **Utilized for surface applications**
  - Hardware upgraded
    - Detection range from 20 m to 80 m
    - Monitor surface slopes from greater distances
  - Recording of any surface slope area
    - Effectively record rock falls or slope movement
  - Self-sustainable
    - Solar battery station
    - Mobility and remote operation
    - Built-in network capabilities
    - Real time monitoring from any place
  - Addition to the surface mine monitoring strategy

Conclusion

- **Passed comprehensive multiple stages of testing**
  - Underground narrow stope real-mining conditions demonstrated its functionality, reliability, effectiveness, performance, and robustness
  - Accurately detecting rock movement and providing early warnings
    - Post analysis could be done through GeoPoint software
  - Long-term testing confirmed its accuracy
    - Analysis could be done through GeoPoint software
    - Visualization and interpretation through point cloud data overlay
  - Achieving Technology Readiness Level 9
    - Ready for full commercial deployment

Conclusion

- **Key Advances of the NanoRadar:**
  - Real-time Movement Recording & Rock mass Behaviour Analysis
    - Recording of rock movement over time until dislodgement from a safe distance
    - Study and understanding of rock mass behaviour
  - Enhanced Safety
    - Providing early warnings of potential rockfalls
    - Monitoring done from safe positions
- **Versatile tool**
  - Capabilities were extended to surface applications
  - Offering reusability

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Thank you