The primary objective of mine safety monitoring is the swift identification and proactive management of safety concerns and potential disaster risks within mining operations. This goal is pursued to enable the timely implementation of appropriate measures to prevent and respond effectively to any accidents that may arise. This comprehensive approach hinges on using diverse technical methodologies to collect, analyze, and continuously monitor data derived from the mining environment.

Precision Surveillance:

HD-SAR300

Radar Monitoring Solution at Wuhai Longchang Coal Mine

Project Background

The Wuhai Longchang Coal Mine Area, situated in the northern part of the Dili Bangwusu mining area of the Zhuozishan Coalfield under Haibowan District, Wuhai City, is a significant employer in the region. The mine uses open-pit mining methods, covering an area of 0.9478 square kilometers. The mining depth ranges from 1300 to 1040 meters, with an annual production capacity of 450,000 tons. The mining project commenced in February 1993, and its capacity was increased to the current level in 2010 after several technical upgrades. It has been recognized as a 'Green Mine of Inner Mongolia Autonomous Region' and a 'Second-Level Safety Production Standardized Mine.' The mine's employment of over 70 staff is a testament to our commitment to the local community, primarily producing coking coal sold to local washing coal companies.

Pain Points Analysis

During the long-term monitoring project for this mine, we encountered and successfully addressed several challenges:

- **Complex Terrain**: The intricate terrain of the mining area posed significant challenges to traditional GNSS monitoring.
- **Environmental Interference**: The terrain constraints and harsh natural conditions affected the stability and accuracy of the equipment.

Coal Mine Overview FIG1

However, after conducting field investigations, we found that InSAR radar is well-suited for such scenarios. Following on-site surveys, we chose suitable and stable points for installation and established radar observation houses to safeguard the radar equipment. These observation houses are equipped with air conditioning to regulate the working temperature. Additionally, the portability of the HD-SAR300 radar made the installation process more straightforward, with each unit weighing only 15 kg. We ensured the radar's long-term stable operation in the complex terrain through careful point selection and device protection measures.

Implementation Program

For the monitoring project at Luotuoshan Coal Mine, we utilized the HD-SAR300 radar. Here are its features and potential applications:

- **Maximum Monitoring Distance:** 5 km
- **Maximum Monitoring Angle Range:** 360°
- **Deformation Monitoring Accuracy:** Sub-millimeter level
- **Protection Level:** IP65
- **Radar Host Dimensions:** Length 147.5 cm, Width 35 cm, Height 33.5 cm, Weight not exceeding 15 kg
- **Resolution:** 0.25 m (R) * 5 mrad (A) @ 1 km
- **Data Playback Software:** Radar is equipped with data playback software that can automatically replay echo signal waveforms and view calibration signals
- **Built-in GNSS Function:** Enables differential positioning
- **Automatic Orientation Function**
- **Integrated Camera Monitoring Function:** Integrated into the radar system, allowing scene images to be captured through the system interface.

The features of the HD-SAR300 radar make it suitable for monitoring the complex terrain of the mine, providing high-precision, all-around multi-angle monitoring.

HD-SAR300 FIG2

Workflow

The application of the HD-SAR300 radar in the mining monitoring project demonstrated its unique advantages. Despite the complex terrain posing significant challenges, the simple installation process of the radar and the establishment of observation houses ensured the radar's protection and stable operation in harsh environments. Slope radar is a precision instrument, and the complex working environment requires measures to extend its service life.

Radar Observation Room (internal) FIG3

Radar Observation Room (external) FIG4

The HD-SAR300 is a rotating radar capable of 360° all-around monitoring. The rotating motion of the mechanical arm requires protective measures to prevent dust and moisture from affecting the instrument's accuracy and damaging the motor and transmission shaft. The design of the observation house not only protects the radar equipment, reduces maintenance costs, and extends the radar's service life.

Additionally, technicians successfully connected the HD-SAR300 to the "Hi-IMS" platform, completing the automatic data collection, analysis, and warning tasks.

Result

The HD-SAR300 radar system is a complete monitoring solution that can collect, transmit, calculate, and analyze vital operational data of critical areas of the mine slope in real time. The system captures absolute displacement data of the hill and scans it into point cloud maps through radar waves, visualized in the Hi-IMS software. Stable and potential collapse areas are distinguished by color, allowing for real-time slope safety assessment.

Software Platform FIG5

The system can provide real-time predictions and warnings by organizing and analyzing monitoring data. Additionally, the Hi-IMS platform can intuitively display each monitoring data set's historical progress and current status, providing a simple, straightforward, and efficient tool for mine safety management personnel. In emergencies, the system sends graded notifications to relevant management and supervisory personnel through various channels, such as sound alarms, monitoring screen prompts, SMS, and email.

Project Summary

The HD-SAR300 radar has proven invaluable in mining monitoring. Its ability to perform high-precision, all-around monitoring in complex terrains ensures the safety and stability of mining operations. The radar's integration with the Hi-IMS platform allows for automatic data collection, analysis, and warning, providing real-time assessments and predictions of slope stability.

The radar's portability and ease of installation, combined with protective measures such as observation houses, ensure long-term stable operation even in harsh environments. This makes the HD-SAR300 an ideal choice for monitoring projects in challenging conditions, offering a reliable and efficient solution for ensuring the safety and stability of mining areas.

In conclusion, the HD-SAR300 radar from Hi-Target is not just a comprehensive and reliable monitoring solution, but also a safety net for complex monitoring environments. Its high-precision data and real-time assessments ensure the safety and stability of mining operations, making it a must-have for any mining monitoring project.