RAT-SAFE: Robotic Solution for Rat-Hole Mining

Making coal extraction safe, standards-driven, and sustainable through robotics

The Problem: Fatalities & Hazards

Rescue operations at mining accident site

Recent Fatalities

2018 Meghalaya: 15 miners trapped, presumed dead
2021 Meghalaya: 6 miners killed in collapse
Many unreported yearly deaths

Risk Factors

- Unstable soil
- No ventilation
- Waterlogging
- Toxic gases (CH_4, CO, H_2S)

Rescue team with inflatable boat during mining rescue

Proposed Solution (RAT-SAFE)

RAT-SAFE

Robotic Arm Technology for SAFE & Fair Extraction

Bandicoot robot used across India

Sewer-cleaning robotic systems

Crawler Bots

- Remote sensing of depth
- Soil stability analysis
- Coal type detection
- Gas monitoring

Robotic Arms

- Drilling operations
- Coal extraction
- No human entry required
- Precision control

Existing Systems Reference

- Bandicoot robot replaces manual scavenging
- Sewer-cleaning robotic arms deployed in cities
- Proven technologies adaptable for mining

Technical Workflow & Components

Workflow

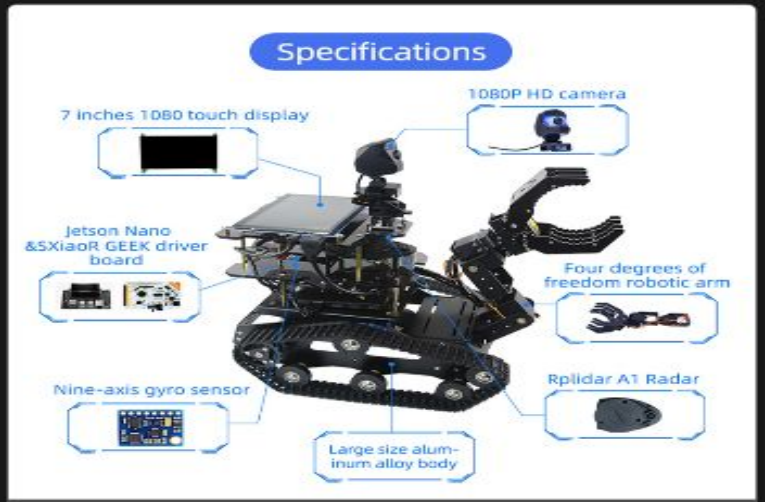
Survey
Deploy crawler → Map tunnel (LiDAR/radar) → Gas readouts → Depth measurement

Assess
Stability (GPR + penetrometer) → Coal detection (thermal, visual, NIR)

Act
Drop stabilizers → Position arm → Core drill/sample → Clear debris

Extract/Assist
Collect coal → Move debris → Place markers → Set hoses

Recover
Retract system → Winch back → Auto-store data for reports



Crawler robot with LiDAR radar and robotic arm for mining applications

Crawler (Survey & Navigation)

Tracked vehicle · LiDAR/radar · IMU sensors · Gas detection · Soil stability

Robotic Arm (Drilling & Extraction)

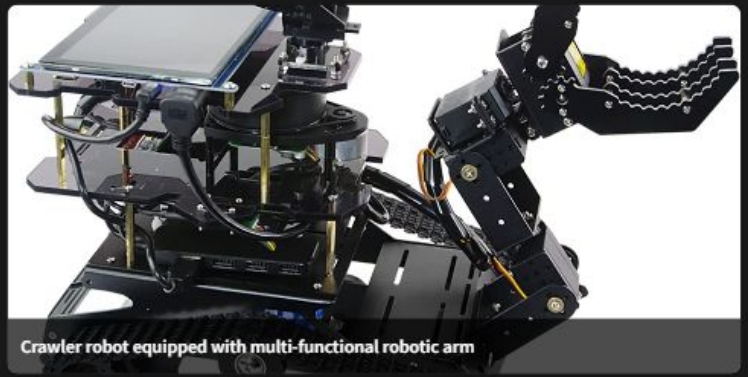
4-5 DOF · Carbon-fiber · Core drill · Gripper · Dust suppression

Control & Safety

Tele-op · Assisted autonomy · Safety interlocks · Auto-retract · BIS compliance

Robotic Arm Technology

Robotic arm performing precision drilling in mining operations



Crawler robot equipped with multi-functional robotic arm

Advanced Design

- 4-5 DOF
- Carbon-fiber
- IP68 Sealed
- Dust-resistant

Multi-Tool System

- Core Drill
- 2-Finger Gripper
- Scoop
- Gas Probe

Operational Features

- Torque Stabilizers
- Water Mist Suppression
- Remote Control
- Safety Locks

Human-Free Operation

Enables safe drilling and extraction without human entry

Implementation & Standards

Durable Design

- Carbon Fiber
- Polycarbonate
- IP68 Sealed
- Heat Resistant

Standards Compliance

- BIS Aligned
- Explosion Proof
- Safety Interlocks
- Emergency Protocols

Training & Jobs

- Local Upskilling
- Robot Operators
- Safety Techs
- Maintenance

Partnerships & Community

- Government
- NGOs
- Academia
- Insurers
- Community Model

कोल इण्डिया
Coal India

मानकः पथप्रदर्शकः
Bureau of Indian Standards

Business Model - B2G Focus

B2G Engagement Process

1. **Safety Needs Assessment** with government agencies
2. **Solution Customization** for specific mining regions
3. **Pilot Implementation** with performance metrics
4. **Scale & Deploy** across mining districts

Procurement Model

- Safety tech tenders
- **Bulk purchasing** agreements
- Multi-year contracts

Partnerships

- **Joint ventures** with state entities
- Revenue sharing models
- Technology transfer

Revenue Streams

- Equipment Sales
- Maintenance
- Training
- Data Analytics
- Upgrades

Cost Savings

- **Reduced rescue** operations
- Lower healthcare costs
- Increased productivity

Scalability to Other Industries

- Construction
- Manufacturing
- Sewer Maintenance
- Nuclear
- Disaster Response
- Oil & Gas

Impact & Conclusion


Precision Robotic Drilling System


Automated Tunneling Technology

Safety

- Human-free danger zones
- Reduced fatalities
- Real-time hazard monitoring

Efficiency

- Precision extraction
- Enhanced stability
- Continuous operation

Economy

- Preserved income sources
- Skilled jobs creation
- Lower rescue costs

Scalability

- Based on existing systems
- Modular design
- Industry transferable

> "Same coal, new method: robots go in, people don't."