
中科慧拓
WAYTOUS
2023
WAYTOUS
Addressing Climate Change Proactively:
The Application of Intelligent Vehicles and
Artificial Intelligence in Mining
WE THE FUTURE
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2023-09-15

Background of mining development in China

Huge size

The Number of mines	58K
Large mines	4,324

Meaning

The Proportion of GDP	~7%
The Coal production in 2022 hits a new peak	4.56B T 8%↑

Policy

- ✓ Ensuring coal supply and energy security are two major political tasks. Equipment upgrading and intelligent development are two major means to expand supply.
- ✓ The primary goal is to transform mechanized operations into digitized, automated, and intelligent processes, with safety as the core foundation.

Difficulties in transportation

High losses due to accidents

Fatal-Accident from 2018 to 2022

~2.3K

Labor shortage

The proportion of post-90s employees

< 5%

Operation modes

Inefficient scheduling | Traditional technology | Extensive management

Insufficient information & low efficiency

Intelligence is the only way for the high-quality development of mines

The 4IR is coming

The technology of 5G、AI、Big Data, etc. have been widely used in the industry

The industrial innovation is now being triggered

1、The number of intelligent mining faces increased from 494 to 1019, with a year-on-year growth of 42%.

2、The number of unmanned mines increased from 242 to 572, with production capacity increasing from 850M Tons to 1.936B.

3、The number of types of underground mining robots increased from 19 to 31.

By the year 2023, the development of intelligent mines is still in its infancy.

2020-First Year

The national policy provided a clear plan for the development of intelligent mines for the first time.

2021-Short Term

71 demonstration coal mines with intelligent construction have completed preliminary acceptance.

2025-Mid-Term

The large-scale coal mines and coal mines with severe disasters will be mostly intelligent.

2035-Long Term

Comprehensive intelligence will be achieved in all aspects. The workforce will be reduced by more than 80%.

Insights into sustainability of AI for mining operations

Waste recycling

AI can help to build modeling of mineral waste generation and improve decision making on waste recycling and reduction.

Autonomous transportation

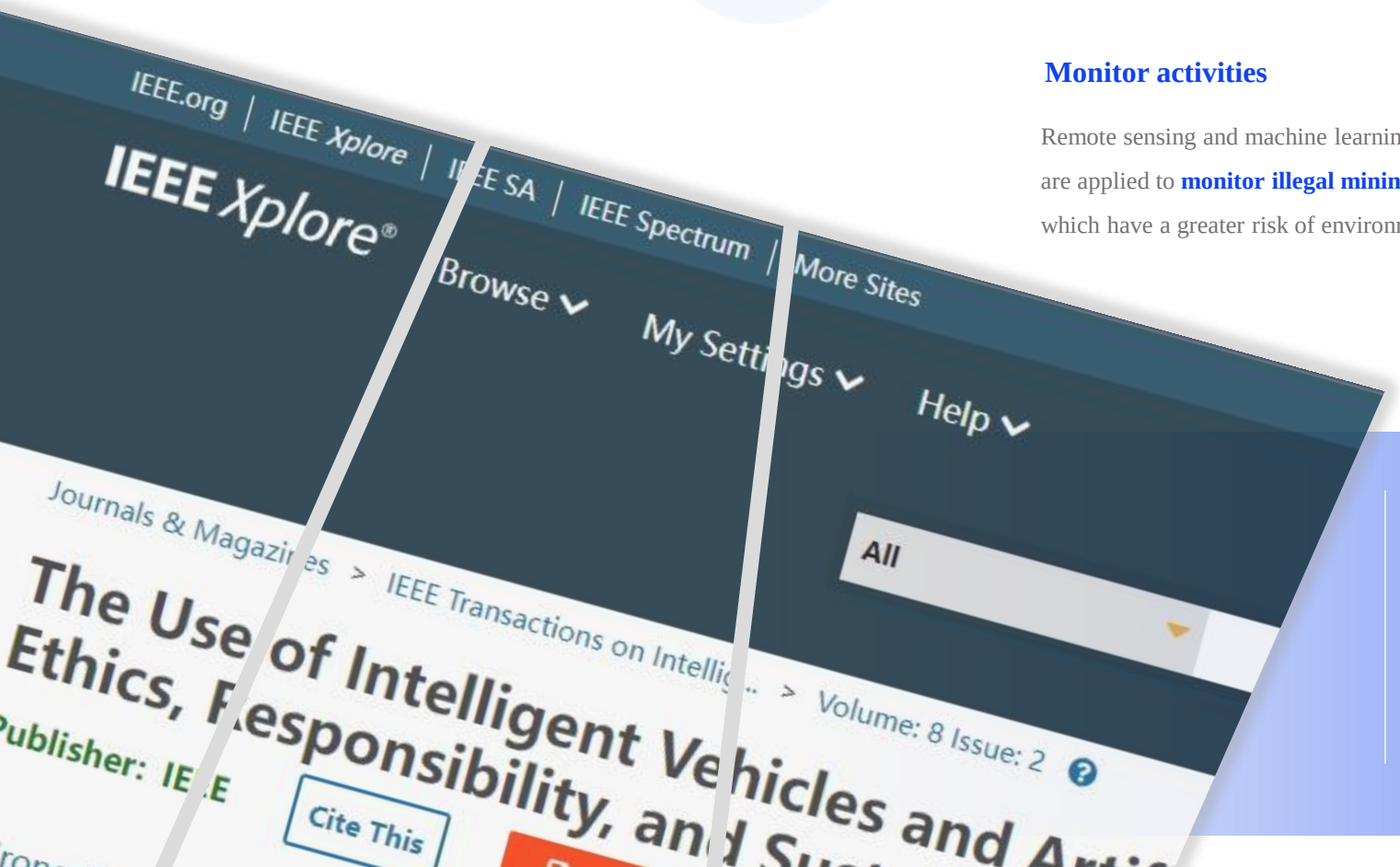
AI technology can support the development of low carbon systems and thus reduce energy consumption during mining operations such as mining transportation. **Mining autonomous transportation** enabled by self-driving technology can contribute to fuel consumption reduction thanks to the more efficient route and smooth control offered.

Monitor activities

Remote sensing and machine learning technologies are applied to **monitor illegal mining activities**, which have a greater risk of environmental pollution.

Assess environmental risks

AI models have been used to assess environmental risks to nearby ecosystems of **blast-induced dust emissions**, making decisions on distance range and time interval of mine blasting to minimize disruption to the nearby community.



《The Use of Intelligent Vehicles and Artificial Intelligence in Mining Operations: Ethics, Responsibility, and **Sustainability**》

S Ge, Y Xie, K Liu, Z Ding, E Hu, L Chen, FY Wang
IEEE Transactions on Intelligent Vehicles, 2023

WAYTOUS utilizes autonomous transportation to empower the high-quality development in the mining industry

Core Technology： CPSS-Based Parallel Intelligence

Parallel Intelligence

Intelligent technologies are tested on virtual and real mines to guide vehicles to complete various scenario-based tasks in real-world through single-vehicle operation, multi-vehicle collaborative systems, and vehicle-road collaborative systems.

Real-Virtual Interaction

The parallel mining system utilizes machine learning algorithms to complete virtual operations and guide real vehicles. The remote monitoring center supervises the state of the whole mines and provides remote control functions.

Collaborative Operation

The entire system ensures resource scheduling and guarantees the efficient running through the collaborative work of various subsystems.

Applications

Zhunge'er Coal Mines Project, China Energy Group

- 36 vehicles
- Maximum speed 40km/h
- Unmanned capacity 461,400 m³/ Month
- The average monthly transportation volume of manual driving is 450,000 m³/ month

Baorixile Coal Mine Project, China Energy Group

- 38 vehicles
- Maximum speed 40km/h
- It has been over 24 months since the first safety supervisor disembarked from the vehicle, marking the longest duration in China.

Yimin Coal Mine Project, China Huaneng Group

- 8 NHL Trucks in operation
- Maximum speed 35km/h
- Achieved 93% efficiency of manned vehicles

Heshangqiao Iron Mine, China Baowu Steel Group

- Fully unmanned

Hualian Zinc-Indium-Tin Mine, Yunnan Tin Group

- Fully unmanned

The first pure electric, digitized, and environmentally friendly smart mine in the domestic cement industry

Jidong Cement Mine, Yangquan, Shanxi

It is the first demonstration project in the domestic cement industry to achieve a pure electric, digitized, and environmentally friendly smart mine. With the integration of 5G technology and intelligent mining, this project replaces 12 fuel-powered mining trucks with 8 fully electric unmanned wide-body vehicles, ensuring safe and efficient production in open-pit mining operations.

- ✓ Addresses the challenge of unmanned driving positioning in crushing stations with no or weak GNSS environment
- ✓ Updates the complex geologic HD map in real-time
- ✓ Establishes the first collaborative intelligent unloading system
- ✓ Reaches an average operating efficiency of **90%**
- ✓ Saves monthly **＞￥30000**

Huarun Cement Mine:
Dual improvement in cost reduction and carbon emission reduction

Huarun has replaced all 9 manual mining trucks with 5 fully electric mining trucks and has implemented unmanned driving technology on these electric vehicles. This enables the entire logistics process of loading, transportation, and unloading to be operated autonomously.

Huarun Cement Mine, Bai'se, Guangxi

- ✓ A comprehensive intelligent solution based on a 5G private network
- ✓ The first fully unmanned mining project completed in China.
- ✓ Accurate navigation and positioning achieved in complex environments with no or weak GNSS signals.
- ✓ Precise coordination operation between excavators and mining trucks realized.

83% ↓
Annual operating costs

68% ↓
Annual CO_2 emissions

Technological Innovation Facilitates the “Belt and Road”: China's Autonomous Driving Technology Implemented in Thailand's Mining Area

Mines profile

- Cement Mine(Khao Wong Mining)
- Yearly output: 9 Million Tons, large production
- Total operation equipment 24+ unit, 7*24

Khao Wong mine

The first 5G+ autonomous driving smart green mine project in Thailand

Thailand's first 5G+ autonomous driving smart green mine project is located in SCG Salaburi mining area, with a total investment of 10 million US dollars. Relying on the comprehensive application of 5G, artificial intelligence, autonomous driving, cloud computing, new energy power batteries and other cutting-edge technologies, the mining area will be built into a green, intelligent, efficient and safe new mine. It has become a leading model of mines in Thailand and even Southeast Asia.

The Technology Service supported by WAYTOUS

CarMo- The New Energy & Intelligent Platform

中国矿业大学（北京） CHINA UNIVERSITY OF MINING AND TECHNOLOGY-BEIJING
中国科学院自动化研究所 Institute of Automation,Chinese Academy of Sciences
中科慧拓 WAYTOUS

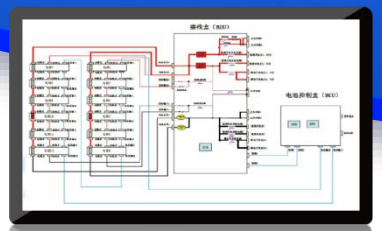
Forward-design 24-hour electric autonomous truck

Full perception | **Multi-scenarios control mode** | **GNSS** | **High-performance platform** | **Digital management**

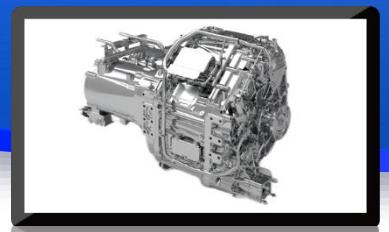
- Battery （kwh）： 525
- Climbing： 35%
- Power（kw）： 450
- Speed（km/h）： 40
- Dimension（mm）： 8980×3550×3420
- Carrying（kg）： 60000
- Turning Mode：Electro-hydraulic steering
- Charge Mode：Dual fast charge

CarMo- Forward-design for Autonomous Driving

- Convergent design **towards complete autonomous driving**
- Feature adding and system upgrading **uninterruptedly,** and it **continues to optimize** over time



- high-capacity battery enables long-distance driving and heavy-duty climbing
- precise energy control strategy maximizes performance and extends the life of the power unit



- capability of intelligent shifting gears in motion
- torque compensation strategy to avoid shifting shocks and power interruptions

- intelligent electro-hydraulic steering system supports steering following, stable steering at a low speed, and achieving accurate steering control within 0.3°

- full vehicle wire control technology and safety control strategy make the vehicle safety and reliable

CarMo- More economical, more efficient, safer and smarter

	Manual Fuel-base Truck	CarMo
Cost	>800K	0
Consumption (¥/km)	16.16	5.20
Safe	Difficult to eliminate hidden dangers	300%
Green	1 truck ≈ 655 vehicles	-1200 tons CO2 emissions per truck per year
Intelligence	Traditional transportation tools	Suitable for unmanned systems
Efficiency	–	Loading volume 5%↑ Tire consumption 8%↓ Scheduling efficiency 15%↑

Compared to traditional manned fuel mining trucks

The whole energy cost saves

67.8%

Technological Innovation and Sustainable Development

P-A-R

In Aug. 2022, WAYTOUS, in collaboration with the Chinese Automation Society, established the Smart Mine Professional Committee and held the first academic forum, the Smart Mine Innovation and Development Forum.

In Jun. 2023, WAYTOUS deeply participated in the "Key Technologies and Application Demonstration of Large-scale Open-pit Mine Robotized Autonomous Transport and Transportation System" held by the intelligent robotics project, the National Key R&D Program.

Talent Cultivation

In 2023, WAYTOUS and China University of Mining and Technology (Beijing) established a collaborative base of smart mines that integrates production, academia, and research. The goal is to cultivate a group of researchers and engineers with strategic vision and outstanding capabilities in the field of mining, promote technological innovation and industrial development, and push the development of intelligent mining into a new era.

Standards

In Jun. 2023, the National Mine Safety Administration officially released the "Intelligent mine data fusion and sharing standard". WAYTOUS played a significant role in the development of 11 standards, contributing to the standardization of intelligent mines in the country. Up to now, WAYTOUS has taken the lead or participated in the formulation of more than 50 standards.

Future Intelligent Mining

Mining Robotics supported by Control and Management Platform

Hybrid Enhance Parallel Intelligence

Autonomous Mode
Under normal circumstances
All equipments running without human

Parallel Mode
Under special circumstances
Mixed operation of manual intervention and unmanned mode

Emergency Mode
In an emergency
Emergency response team handled it manually

Core Capability

System
Fully Autonomous with
high Stability, high Safety, high Efficiency

Platform
Intelligent Command and Control
+ Strong Data Capability

Vehicles
new Unmanned Transportation Terminals for AHS

Building a Modern Harmonious Human Society with Nature