

Smart mining

Extracting the power of AI

In Chinese mythology, the colored stones used by the mother Goddess Nüwa to mend the sky were drawn from Shanxi's extremely rich coal reserves. One-third of the province's underground area contains coal, which generates over half of its revenue and provides 1 in 20 local jobs for Shanxi's 37 million people. While the coal industry is a pillar of economic development, it's unequivocally dangerous for those on the frontlines.

By Xue Hua, Linda Xu



“Our primary goal is to achieve zero coal mine deaths. We hope to achieve this in every coal mine across the country.”

However, technology is helping to smarten up safety in coal production, with accidents in Shanxi declining sharply since 2010 thanks to more stringent requirements and an officially sanctioned action plan that focuses on mechanization, automation, and intelligent mining. By 2020, the plan aims to have fully implemented intelligent control systems and cut the headcount needed on workfaces in key mines by 50 percent. By 2030, centrally controlled, fully unmanned workfaces are expected to be in operation. The plan identifies 38 types of mining robots in the following five categories: tunneling, coal mining, transportation, security control, and rescue.

According to Cai Jianjun, the Chief Engineer of Shanxi Administration of Coal Mine Safety, “Our primary goal is to achieve zero coal mine deaths. We hope to achieve this in every coal mine across the country.” China’s 5,800 coal mines supply power stations with more than half of the annual 3.68 billion tons of raw coal produced nationally, generating 7.1 trillion kWh of electricity.

Given the scale of the coal mining industry, creating a smart, efficient, safe, and clean operating model is obviously important. Improvements have already been made in Shanxi mines when it comes to the environment. Today, coal is transported through natural wooded surroundings in closed belt corridors directly to coal washing plants, so that no coal spills onto the ground. While coal mining areas are situated in shaded forests and the environment is cleaner than ever, the safety problem persists.

Why mines are unsafe

Jingying Shuzhi GM Zhao Cunhui summarizes the three major factors causing unsafe coal production as, “The unsafe behavior of people, the unsafe conditions of things, and unsafe factors of management.”

Hazards can appear at any time in underground mine workspaces, with Zhao citing examples like missing face guards on shearers and faults with mobile or hydraulic supports. Moreover, production machinery relies on the human eye



to determine operating status, which leads to a start-stop work flow and is prone to human error.

People are in fact the biggest overall hazard. According to Zhao, poor worker discipline and a lack of overt supervision tends to make the following violations commonplace: riding belts, running after monkey cars (chair lifts), carrying unregulated items, smoking, and not wearing helmets. He also mentions risks that occur due to weak links in the chain of command, including favoritism, fraud, and negligence. Water leaks, he says, are a common result of negligence when drilling locations aren't correctly conveyed.

A third major issue is the bottlenecks caused by a lack of automation, which creates monitoring blind spots. At the same time, the lack of smart perceptual AI makes it difficult to determine whether a workspace is safe, identify worker violations, or analyze the status of machinery. As today's young people tend to be reluctant to work in the mines – not least because of the safety issues – labor shortages are also on the rise.

“AI excels at repetitive work, freeing people from traditional labor,” says Zhao. “But for safe production in coal mines, AI is desperately needed to expand the scope of automation and the depth of smart capabilities.”

Intelligence means safety

Powered by big data and AI, Huawei's Mine Brain solution can boost safety in coal mines by optimizing workplace and supervisory efficiency. It can replace humans in hazardous environments and take on tedious and repetitive tasks. For example, Mine Brain's computer vision capabilities can monitor scraper conveyors, reducing the number of people needed and increasing efficiency.

According to Zhao, “A coal mine in Inner Mongolia with an annual output of 21.7 million tons requires 900 people. At the moment, 10 scraper machines are operated simultaneously for underground digging.” One person is needed per shift to perform specialist start-stop operations for each machine, he says, meaning that 10 people are required per shift and 30 for three shifts. Replacing those 30



“Mine Brain helps us identify whether the pump house inspection is on time, improve people management, provide on-site prompts, and generate inspection reports.

– Zhao Cunhui, General Manager, Jingying Shuzhi

workers with equipment could save 6 million yuan (around US\$837,160) a year based on an annual cost of 200,000 yuan per worker. Zhao believes that, “Efficient enterprises are founded on progressive concepts – in this case the willingness to spend millions of yuan to install equipment rather than spending 10,000 yuan to hire one person.”

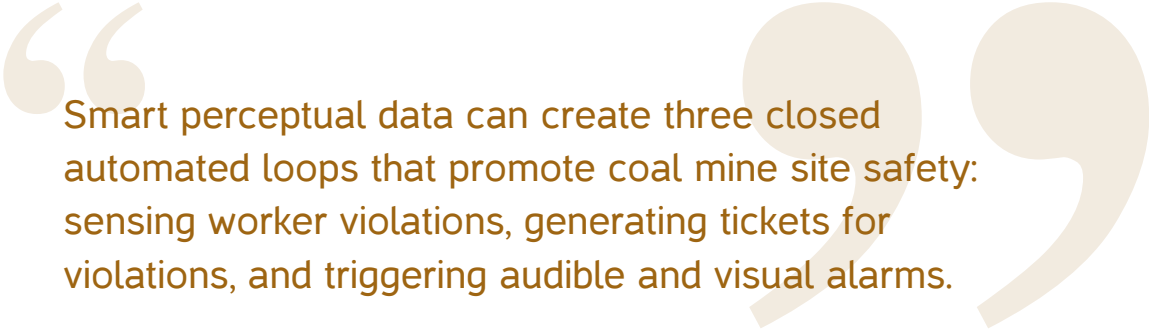
Mine Brain’s computer vision capabilities can report unsafe behavior to the onsite monitoring system, which can then issue warnings. The solution can also protect people by identifying changes in the state of workplace objects and environment. Computer vision can identify unsafe scenarios like people working in front of shearers or missing hydraulic support guard plates, and issue warnings through the broadcast system. The system can then generate software records, making these types of incidents part of future safety assessments.

Mine Brain makes project quality management and production process management no longer dependent on humans. Managers aren’t needed

onsite for tasks like supervision, inspection, and acceptance testing for exploration or water bore drilling identification. Instead, the operator receives acceptance test results and alerts about any operating errors.

“Computer vision means that safety management doesn’t have to rely on humans. By identifying conditions like belt no-loads, coal piling on belts, and belt deviation, remote alerts or messages can be issued to the belt control system for coordinated shutdown,” says Zhao. “Mine Brain helps us identify whether the pump house inspection is on time, improve people management, provide on-site prompts, and generate inspection reports. It can also identify the absence of management in the dispatch room and generate software records and reports for daily assessment.”

He believes that smart perceptual data can create three closed automated loops that promote coal mine site safety: sensing worker violations, generating tickets for violations, and triggering audible and visual alarms.



Smart perceptual data can create three closed automated loops that promote coal mine site safety: sensing worker violations, generating tickets for violations, and triggering audible and visual alarms.

Smart collaboration, smart results

Mine Brain is the product of collaboration between Huawei, Jingying Shuzhi, and the China Coal Research Institute. A strong example of Huawei's Platform+AI+Ecosystem strategy for the coal industry, it features Huawei's FusionCube, intelligent edge application, and smart cameras, while Huawei Cloud and Enterprise Intelligence platform provide powerful basic computing power and management support. Jingying Shuzhi's strength in algorithms delivers an AI model for Mine Brain that includes early warning algorithms and expert models.

Already installed in mines across the country, including in Shanxi, Inner Mongolia, and Anhui, Mine Brain has been applied to tasks like water prospecting and gas extraction, and has shifted acceptance testing methods from underground to above ground. It also provides remote intelligent

diagnosis and warning alarms for operations and construction compliance, building a solid safety foundation.

As well as protecting workers, Mine Brain can reduce personnel requirements by 10 percent while increasing actual production hours by 10 percent, thanks to identification and early warning alarms for problems that interrupt production. Freeing up coal mine management personnel allows them to focus on optimizing processes rather than managing people. "Even in a mine with an annual output of a million tons," says Zhao, "Mine Brain can mean a bottom-line gain of 30 million yuan."

Powered by data and AI, smart coal mines need to continue to expand perceptual sensing capabilities beyond vision and sound to include touch, taste, and smell based on existing IoT technologies, paving the way towards truly smart robots. Cai Jianjun, Chief Engineer of Shanxi Administration of Coal Mine Safety, hopes that Huawei continues to invest in AI applications for coal mining to help achieve the zero-death goal. 