

This publication is an English version of Tierra Plus publication for the Japanese domestic customers by Hitachi Construction Machinery headquarters

[Construction Machinery] × [ICT Solutions] 3

MICT Is Creating Smart Safety

MICT* Is Creating Smart Safety

*MICT = Mining ICT



Global-scale resource development companies are looking at machinery manufacturers in a new light

The Hitachi Construction Machinery Group plans to debut unique new safe operation support solutions next spring that help reduce the dangers posed to the operators of human-operated dump trucks.

Aerial Angle is a 360 degree perimeter display device with added alert functions. The Fleet Awareness V2X safety support system uses vehicle-to-vehicle communications ("V2X").

In 2006 a new global organization, the Earth Moving Equipment Safety Round Table ("EMESRT") was established. It was organized by global resource development companies such as Rio Tinto, Anglo American, and Vale, and is composed of mining machinery manufacturers such as Hitachi Construction Machinery and manufacturers of communications systems and other peripheral devices. EMESRT's aim is to improve mining safety.

According to Koji Fujita, director of the Mining ICT Development Center, one of the round table's members, "Impact reduction systems were being deployed in passenger vehicles, and we decided to work on creating an environment for installing safety support technologies like these in mining sites as well."

Safety measures have always been the highest priority in mining companies. Safety problems threaten peoples' very lives. According to past studies by EMESRT, approximately 35% of fatal accidents at mining sites were caused by collisions between vehicles such as mining machinery and service vehicles. In order to address this situation, there are moves around the world to establish appropriate legal and regulatory systems. Fatal and serious worksite accidents change the lives of victims, family members, and colleagues. Operation shutdowns, financial penalties, and governmental improvement orders also have an impact on business.

In order to eliminate fatal accidents, mining companies are introducing various programs to perform thorough risk management, as well as continuously reviewing and improving the contents of these programs. In recent years, safety levels have been even further raised. For example, in order to further strengthen its exist-



Vehicle self-driving technology is making steady advances. Hitachi Construction Machinery is developing an Autonomous Haulage System (AHS) for mining dump trucks, aiming for a commercial launch in fiscal year 2019. At the same time, it is collaborating with the Hitachi Group to develop advanced safe operation support technologies which can be deployed in existing human-operated dump trucks. If the company is aiming to achieve autonomous haulage, why is it working to improve safety for human-operated dump trucks? What impact will the Hitachi Construction Machinery Group's next-generation safe operation support technologies have on the mining and civil construction markets?

Author/ Satoru Sato Photographer/(personnel) Shinya Kojima

ing safety systems, such as management standards and action guidelines, in 2015 Rio Tinto began implementing a new “Critical Risk Management” system. It focuses on identifying all of the work which could result in serious accidents such as fatal accidents (critical risks) and verifying that appropriate countermeasures to those risks are in place to help prevent accidents. In 2016 alone, it finished verifying that appropriate safety countermeasures for over 800,000 tasks.

The company’s injury rates are at record lows, but, explains Joanne Farrell, Group Executive for Health, Safety & Environment at Rio Tinto, “In order to ensure that every employee goes home safe every day, it is essential to pay close attention to every task, every time, in every shift. Eliminating fatalities and managing process safety and catastrophic risks continue to be our priority areas of focus.”

What these mining companies expect from mining machinery manufacturers are common safety specifications for mining machinery, shared by all manufacturers. This is what is behind EMES-RT’s discussions regarding the unification of communications protocols. At Rio Tinto, “The autonomous haulage system, for example, can be a fantastic solution for safety but also has the potential to seriously injure someone if not designed, developed and operated properly.”

Aerial Angle and Fleet Awareness V2X are safety support technologies developed in response to these conditions and needs. Yoshinori Furuno, Strategy Department Chief in the Customer Solutions Business Promotion Division, has been involved for many years in the development of comprehensive systems which use mining machinery. According to Furuno, “AHS is our flagship system. However, looking at marketability, I don’t necessarily think that all customers will be rushing to introduce it at once.” This is because, at present, AHS requires a closed environment, in which there are no competitor products or human-operated vehicle operation areas.

“For the typical mining site,” Furuno continues, “there is an extremely high need for safe operation support solutions for human-operated dump trucks.”

There is an especially high need for systems which promote vehicle and obstacle collision avoidance. The Aerial Angle and Fleet Awareness V2X systems are perfect matches for these needs.

“The ultimate objective will be auto-



Customer Solutions
Business Promotion Division
Strategy Department Chief,

Furuno Yoshinori

“Going forward, what will be important won’t be individual machines, but providing customers with solutions optimized for their entire operations”

nomous haulage dump trucks, but, as a manufacturer, I believe our role is to rapidly spin out polished, cutting edge technologies and to deliver them to customers. The Aerial Angle and Fleet Awareness V2X technologies are just that.”

Monitor displays and buzzers that help operators avoid danger

The current version of Aerial Angle displays the area around the vehicle on a single monitor, making it easy for operators to confirm the situation around them. Next spring, a new evolution of the system will be launched, adding functions for detecting moving objects and obstacles and warning the operator. Two modes will provide support for even greater safety by informing operators of dangers both visually and aurally. In “Stationary Mode”, the system will display the area around the vehicle when it

is stopped, and operators will be alerted of moving objects by displaying them on the monitor and sounding a buzzer. In “Forward Mode”, the system will detect objects in front of the vehicle while driving and alert operators of objects which are too near the vehicle by displaying them on the monitor and sounding a buzzer.

Aerial Angle development manager and AHS development project lead engineer, Yoichi Kowatari says, “Initially, we planned to focus on Stationary Mode, increasing the precision with which obstacles and hazards around stopped vehicles would be detected, ensuring that they would all be displayed accurately. However, there is a great deal of need among mining companies for devices which can prevent frontal collisions while driving, so we moved up our technology roadmap and developed Forward Mode for detecting objects in front

of vehicles while they are moving.”

Stationary Mode uses cameras installed on the front, back, left, and right of vehicles to detect moving objects such as other vehicles in the surrounding area while the operator’s vehicle is stopped or accelerating from a stopped position. These moving objects are displayed and flagged on a monitor in the driver’s cabin, and a buzzer is sounded, helping eliminate blind spots and prevent collisions due to inattention when pulling out from a stop. Initially, Aerial Angle was unable to completely eliminate the seams when using the images from the four cameras to create a composite bird’s eye view, but the development team succeeded in overcoming this problem, producing even greater visibility and almost completely eliminating blind spots.

In Forward Mode, the system uses millimeter band radar, which is relatively unaffected by rain, snowfall, or dust, to

scan the area in front of the moving vehicle and identify other vehicles. When the operator’s vehicle comes near another vehicle, a buzzer sounds and an alert is displayed on the monitor, helping the operator take evasive action and contributing to the prevention of head-on collisions due to inattentive or careless driving.

This technology is also used in passenger vehicles, but the environments of mining sites are quite different. The driving surfaces are unpaved and there are no center lines. The conditions that apply to massive three-story tall dump trucks also differ tremendously from those of ordinary passenger vehicles. It’s not enough to look at just approach distance. Instead, the system must take a comprehensive view that encompasses various factors and optimally time the issuing of alerts. That timing differs

depending on the vehicle’s driving conditions.

“If, for example,” explains Kowatari, “a vehicle is driving at 2km/h and an alarm is sounded 5m in front of an obstacle, the vehicle can be stopped in time. If, on the other hand, a vehicle is fully loaded and moving at 30km/h, that alarm would need to be issued much earlier.”

This was made possible by the control system, which uses an algorithm developed by Hitachi Construction Machinery for mining dump trucks.

The millimeter band radar acquires information about other vehicles in front of the operator’s vehicle. This information is used together with machine-side data such as the vehicle’s speed, the weight of its cargo, the slope of the road surface, and the steering angle to make a

holistic decision, determining collision timing and alerting the operator using a buzzer and alert displayed on the monitor. "The calculations involved are quite complex, and are the culmination of the many years of experience we have accumulated in mining work sites," Kowatari says, beaming with pride.

The monitor display design also reflects Hitachi Construction Machinery's dedication to safety support, evident from the initial stages of Aerial Angle development. The larger the screen the greater the alert visibility, but if the screen is too large it can impede forward visibility. This is why the system uses a 7 inch monitor, which is large enough to offer sufficient alert visibility without interfering with forward visibility. The monitor is installed at the same height as the mirrors, making it possible for operators to check both the mirrors and the monitor just by moving their line of sight from side to side.

"Even if the monitor displays the entire area around the vehicle, the operator needs to directly check using the mirrors. Unlike an ordinary passenger vehicle, operators also need to see the tires' angles. That's why it's best to use the same heights, allowing everything to be checked just by looking to the side," says Kowatari.

The screen display modes include a dual display mode showing both the camera video viewing mode and a bird's eye view. There are six different viewing modes, further improving operator convenience.

Dramatically reducing IT infrastructure investment while introducing the latest safety support technologies

The other safety support system, Fleet Awareness V2X, uses positioning information shared between vehicles. It was developed by Wenco International Mining Systems Ltd. (Canada), a Hitachi Construction Machinery Group company that developed the Fleet Management System ("FMS") mining operation control system, using Hitachi, Ltd. technologies.

It offers the existing FMS's "PitNav" functionality, which uses GPS information to display positioning information and operation routes for mine site equipment on a monitor, and embeds the V2X technology developed by Hitachi, Ltd. This uses wireless communications to directly share positioning information



between vehicles, displaying it on a map shown on the monitor. When other dump trucks and mining machinery come nearby, appropriate alerts are displayed and a buzzer is sounded.

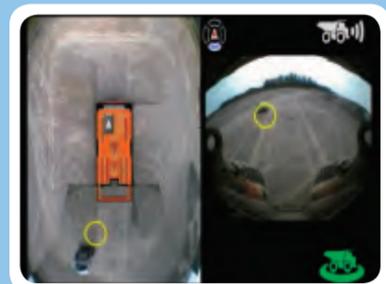
This system makes it possible for both vehicles to detect that they are approaching each other while still far away, and make it possible to avoid collisions when visibility conditions are poor, such as at intersections or road forks which are not level, while driving at night, and the like. The communications between the vehicles are performed directly, eliminating dependence on difficult to install IT infrastructure such as Wi-Fi, and making it possible to significantly improve safety support functionality at little cost. It is an attractive technology for small and medium-sized mining sites, which account for

the largest share of customer work sites. Furuno says, "Just like automobile manufacturers take on F1 and rally races, as a manufacturer, we consider it one of our fundamental missions to create new, cutting-edge technologies such as AHS. That doesn't mean that we're trying to direct customers, though. Our role is to carefully identify the problems our customers face and to provide customers with optimal solutions tailored to their work environments, business scale, and work sites. This doesn't just apply to the mining industry. We will also roll our safety solution technologies to customers in the construction and civil engineering industry, the environment industry, and the forestry industry, meeting our customers' expectations and providing carefully tailored reliable solutions."

Multiple safety support technologies are combined to prevent collisions between vehicles. Aerial Angle's Stationary Mode is used to detect and issue alerts regarding moving objects around stationary vehicles and vehicles pulling out from a stop. Forward Mode is used to detect and issue alerts regarding other vehicles in front when driving. V2X is used for medium-range distances of roughly 10 meters to several hundred meters, helping avoid collisions and accidents by providing alerts even when visibility conditions are poor. Overall mine operation is managed by vehicle allocation managers using an FMS mining operation control system.



Aerial Angle Stationary Mode



A bird's eye view of the area around the vehicle is displayed when stopped or pulling out from a stop. Moving objects near the vehicle are detected using camera video analysis. These are displayed and flagged on the monitor, and the operator is alerted with a buzzer.

Forward Mode



Forward-facing millimeter band radar is used to scan the area in front of the vehicle. When operator's dump truck approaches another vehicle, the operator is alerted by displaying it on the monitor and sounding a buzzer. Based on information from the radar, data such as approach distance and relative speed are used to provide two levels of alerts, depending on proximity.

Fleet Awareness V2X



The system combines "PitNav," a function offered by Wenco International Mining Systems' mining operation control system, with V2X technologies developed by Hitachi, Ltd. Positioning information for vehicles at medium range distances of roughly 10 meters to several hundred meters, are assessed in real-time. When other dump trucks or mining machinery approach, appropriate alerts are issued. This assists with preventing collisions when visibility conditions are poor, such as at non-level intersections or while driving at night.