Industry 4.0 Solutions for Mobile Machines

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INTRODUCTION

The industrial world is moving steadily towards industry 4.0 and embracing the technologies that will define this era – a move which in effect means more connectedness between machines and the harnessing of data analysis to enhance operational efficiencies.

While there is a lot of literature on the topic of industry 4.0 – or the fourth industrial revolution – papers have tended to focus on the general implications for industries and their fixed equipment. However, it is also prudent to examine the implications this new era will have for automated and mobile machines.

In regards to mobile equipment – particularly in high-risk work environments such as mines or quarries – safety is a prime concern. With the help of proper controllers and sensors, machines can offer an extra set of eyes to operators and reduce hazards for individuals working onsite.

In addition to offering more visual tools for obstacle detection and collision avoidance, the right sensors also provide better insight into the machines, facilitating better fleet management and predictive maintenance. From applications as simple as locating the whereabouts of each vehicle in the fleet or measuring the remaining fuel in the tank, to collecting complex data from equipment and analysing data in real time for performance optimisation, mobile machines need to be industry 4.0-ready as much as the fixed equipment.

But while a lot of the sensors and controllers used with mobile equipment have more or less similar functions as those used with fixed industrial equipment, they need to be designed with the specific applications in mind in order to withstand the rugged environments that they are exposed to.

ifm has developed the ecomatmobile series control system, which includes a range of components and systems to meet the special requirements of mobile applications.

This paper discusses some examples from ifm's customers where mobile machine operators across different industries are using industry 4.0 technologies to reduce operational risks, optimise operations and improve the life of their equipment.

SAFETY FIRST WITH COLLISION AVOIDANCE

At any site where mobile machines and vehicles are moving around, personnel safety is the primary concern. A major risk, particularly in busy sites such as in the construction and mining industry, comes from vehicle collision.

According to Safe Work Australia, which collects information on all work-related injury fatalities in Australia, as much as 31 per cent of all worker-related fatalities in Australia in 2018 were due to a vehicle collision – making it the biggest cause of fatality across all sectors.[1]

To avoid vehicle collision, reliable sensors need to be installed in strategic locations on the vehicle body and the information from these sensors should be effectively communicated to the driver.

Once a signal is produced by sensors, controllers need to respond quickly and reliably and provide the signal to actuators. In addition, a graphical visualisation module ensures the indication of system messages and simple display instruments so the operator can be alarmed immediately.

Aditya Kunder, mobile industry sales manager with ifm Australia, says what distinguishes ifm's mobile machine systems is their robustness under harsh environments.

All products in the ifm ecomatmobile series, including controllers, Input/Output (I/O) modules, sensors and cameras, have been designed to withstand extreme conditions such as heat, cold, moisture, dust and vibration to offer maximum reliability in any harsh environment. The ifm 3D sensors for mobile machines meet the IP67 and IP69K requirements. The sensors can tolerate an ambient temperature range of -40 to 85 °C, which makes them suitable for use in a wide range of applications.

"When we are talking about applications such as a truck operating on a mining site, we are dealing with high temperature variations, as well as shock and vibration. While previously the same systems traditionally used for fixed machinery were implemented on mobile machines, these systems cannot withstand the extreme conditions that mobile machines are exposed to," says Kunder.

A key component for collision avoidance in the ecomatmobile series is the O3M photoelectric 3D sensor, which measures the distance between the sensor and the nearest surface point by point using the time-of-flight principle.

The unit illuminates the scene with an external infrared

1. https://www.safeworkaustralia.gov.au/

light source and calculates the distance by means of the light reflected from the surface.

The O3M can be used on mine and quarry sites to detect any object that the sensor is programmed to detect.

For example, Kunder says, one quarry site uses the ifm O3M sensors on their moving machines to detect the reflective vests worn by the personnel.

"Quarry sites are often very dusty environments and it's difficult for the driver to see individuals, particularly when reversing the vehicle. The ifm 3D sensor detects the reflection from the individuals' vests and sounds an alarm for the operator to stop," says Kunder.

To further enhance the safety of the personnel, ifm also offers programmable interface panels for operators that facilitate effective communication with the operator. Thanks to the high protection rating of the housing, the display modules are suited for outside panel and surface mounting as well as for cabin installation in construction machines, agricultural machinery or municipal vehicles.

The ifm display panels are available in many sizes, from 5-inch and 7-inch-sized square displays to ergonomically-designed 12-inch wide rectangular display with both landscape and portrait orientation capability. This enables the screens to be easily mounted even in small control cabins without blocking the driver's view.

While traditional displays used buzzers to alert the operators of imminent risks, the latest ifm display offers audio outputs that can covey clear messages to the operator. This is particularly useful on noisy sites where it can be difficult for the operator to distinguish between the different ambient noises.

Moreover, the display systems have the ability to push the collected data directly to the cloud for immediate and realtime access to information.

PREDICTIVE MAINTENANCE & FLEET MANAGEMENT

Predictive maintenance is another area where industry 4.0 technologies can help increase the uptime with mobile machines and avoid unnecessary delays.

ifm offers powerful, freely programmable controllers with a large number of inputs and outputs that can process data from any diesel engine using the J1939 protocol. This allows vehicle operators to collect data directly from the engine to monitor the vehicle's performance before something goes wrong.

Over the past 10 years, more than 500 mobile equipment OEMs worldwide have applied ifm controllers, HMIs and I/Os on their vehicles to increase uptime and reduce installation costs.

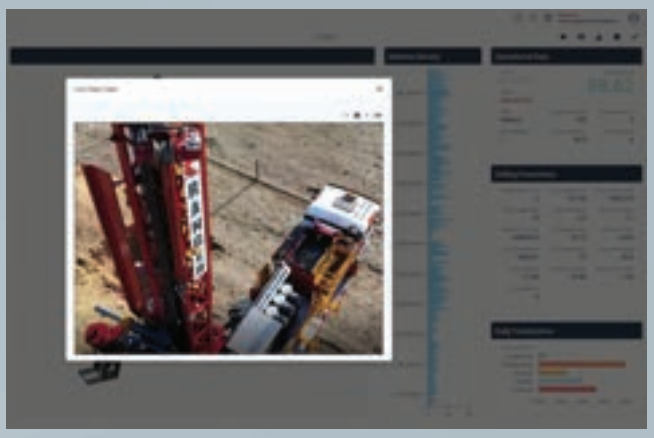
Predictive maintenance is especially critical in mining and quarrying operations that take place in remote areas. If there's an issue with one piece of equipment, technicians need to drive or fly to the remote site to fix the problem, causing considerable loss in downtime.

Kunder uses an example to demonstrate how predictive maintenance with ifm sensors is helping equipment owners with better fleet management.

"One ifm client uses specific vehicles to move drill rigs and other mining equipment from one site to another. The owners wanted to keep track of the whereabouts of their vehicles as well as to make sure the engines were performing well. This allowed the fleet managers to detect any faults with their machines and to dispatch a mechanic to assist urgently in case of a breakdown.

"The parameters the vehicle owners had in mind were: tracking the location of the vehicles with GPS, monitoring any errors on the system, the speed at which the vehicles were travelling as well as the overall distances travelled.

"By monitoring the frequency of errors as well as gathering detailed data from the vehicles, this customer has been able to avoid unnecessary downtime and manage their fleet efficiently. It has also helped them gain deeper insight into the best maintenance practices to avoid breakdowns," Kunder adds.



CASE STUDY

How Cortex Implement Predictive Maintenance into Exploratory Drilling

Cortex Intelligent Systems is an Australian company engaged in automated exploratory drilling. The company uses ifm CR711S controllers and a suite of ifm sensors including proximity switchers, coders and inclinometers to collect and collate information from drill rigs. The data is then fed into Cortex's software program, SYNAPSE, where real-time analysis of mineral samples down-hole allows operators to auto-adjust core processes.

In a drilling operation in extremely remote regions of Western Australia, there was an operation failure due to a hole collapsing. The Cortex SYNAPSE unit was able to explicitly prove that the drilling operator had performed the correct actions and that the ground conditions were the direct cause. This saved the drilling company over $20,000 in lost drilling pile and bits.

In another incident, an engine failure and resulting fire was blamed on faulty or ill maintained rig systems by the engine manufacturer. The data from the SYNAPSE units was able to directly provide the engine performance logs to show a progressive system degradation over a period of seven days and the direct indication of a fuel injection systems failure, again saving the drilling company the full cost of a replacement engine, valued at $160,000.

Cortex founder and managing director, Chris Hold, says collecting such reliable information from the drill rigs would not have been possible without help from the ifm control systems.

"Exploratory drilling is one of the harshest environments you can get on the planet. Electronic equipment in such applications need to withstand extreme heat, high-pressured water, fluctuating power and other such issues," Hold says.

"One of the prime reasons that Cortex works so closely with ifm is the robustness of their equipment under difficult working conditions. We've been around the industry for a while and we know that apart from ifm, there are no other products in the market strong enough to do the job."

CONCLUSION

In all of the above examples from mining and agriculture industries, as well as in construction, transport and waste management sectors, components from ifm's ecomatmobile series are helping operators get the best life out of their equipment.

By monitoring the performance of each component in real-time, plant managers can avoid unnecessary down-time for repair. They can also ensure maximum fuel efficiency by monitoring the performance of the engine. The main advantage, however, is an enhanced level of safety with reliable components that can transfer messages to the operator effectively and promptly.

Sensors and controllers that were traditionally used with immovable equipment are not suitable for use on mobile machines, as they were not designed to withstand the harsh environments that these machines are exposed to. To ensure maximum reliability, ifm has a range of control systems that are designed for use in harsh conditions.

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