FATIGUE MONITORING

About two thirds of traffic accidents in surface mines are due to driver fatigue or microsleeps, according to industry statistics for open-pit mining. In response, **Hexagon Mining**'s safety solution, **SAFEmine**, developed FatigueMonitor, a state-of-the-art solution that combines data from fatigue detection and collision avoidance to minimize accidents involving mining vehicles.

FatigueMonitor is mining's first multi-technology fatigue detection system for monitoring driver alertness. Already mines in Colombia, Australia, and South Africa have turned to SAFEmine FatigueMonitor. The fatigue monitoring system enhances SAFEmine's impressive suite of traffic safety solutions and is integrated with the SAFEmine Collision Avoidance System (CAS). The SAFEmine CAS warns with audio and visual alarms of possible collisions with obstacles, such as other vehicles, and it supports the operator by improving traffic awareness, especially in blind spots around the vehicle. Today, SAFEmine CAS protects more than 20,000 vehicles in over 45 mines worldwide and has become the global standard. The system is proven to significantly reduce mining accidents and save millions of dollars by minimizing the risk of business disruption and maintenance costs (http://hex.ag/NjPv1). The Maintenance Superintendent at Premier Coal Mine, Western Australia, states: "Premier had more than a 53% reduction in metal-to-metal contacts within the year following SAFEmine full implementation."

To combat fatigue, SAFEmine developed FatigueMonitor for surface mining. The system combines operator-specific physiological and traffic related data – both real-time and historical – to predict imminent vehicle collisions, thus improving mine safety and efficiency. The FatigueMonitor is based on a three-pillar approach for increased reliability. Multiple inputs are analyzed: the computer vision technology for detecting apparent signs of sleepiness, body clock models are used to predict the operator's individual sleep pressures, and CAS technology provides the added value for analysis and reporting (indicators such as the speed and location of vehicle can be depicted).

Firstly, the appearance of the operator is analyzed by a computer vision system. Are the eyes open or closed? Is the operator looking on the road? Did the head drop, because he/she has fallen asleep? Answering these questions gives us the indication for actual driver attention. Perclos technology is one of the tools to assess these signs of drowsiness in real-time. Secondly, to incorporate predictive alarming, individual body clocks are incorporated. The human body follows an internal clock which drives our sleep/awake cycles, also known as circadian rhythm. This can be felt when travelling across time zones (jetlag) or changing between night and day shifts. The body does not adjust instantaneously; it takes time, during which we may experience increased sleep pressure. The body and its level of attentiveness are influenced by many factors: sun light/darkness, working hours, hours of sleep, and more. While human bodies and minds are highly individual, there is little difference in physiology. Based on these commonalties, SAFEmine's body clock model predicts the fatigue pressure for each operator based on shift plans, time on duty, and night/day operation, etc. The model computes the current fatigue risk for the operator and displays it on the in-cabin display as: LOW – MEDIUM – HIGH. This fatigue risk level is adapted to the body clock model and actual state of the operator, as seen by the operator's appearance.

Thirdly, collision avoidance combined with fatigue monitoring (CAS Fusion) is powerful. The danger of fatigue-related incidents is imminent when surrounding traffic is present.

FatigueMonitor addresses both fatigue and traffic related issues.

In the haul truck cabin, the complete safety hardware integrates two safety concepts into one system. For the operator, this means he/she needs to merely glance at a single spot in the cabin for the system to reveal all safety-related matters, both on fatigue risk as well as surrounding traffic risks. System reliability is increased, and the operator interface is greatly simplified and standardized. Safety management both in-cabin as well as in the control room is clear and concise and speaks the same language, reducing misinterpretation. No need for operators to wear additional equipment, such as glasses or caps.

The image above shows the in-cabin FatigueMonitor system: the left display shows the fatigue risk level, while on the right side, the LED display with traffic indicators from the CAS system is integrated.

In the control room, a web-based application under the name of FatigueSupervisor, presents fatigue-related data for the supervisor. Dispatchers and supervisors in the control room are provided with real-time data from all vehicles equipped with the FatigueMonitor. The left part of the web-interface displays an interactive map showing the location of all vehicles with vehicle icons that are color-coded according to their risk levels: To the right, the overview of all operators on duty with corresponding fatigue risk levels and status of the data connectivity (ie. WiFi). When the mine-management team is alerted that an operator is experiencing early stages of fatigue, it can dynamically manage and reassign operators to maximize levels of safety and efficiency within mining operations.

As part of Hexagon Mining's integrated life-of-mine solution, SAFEmine is proven technology that can be trusted to protect both people and equipment.

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