Collision Avoidance System Technology for Surface Mine Operations

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Introduction

Vehicle-to-vehicle collisions remain one of the highest causes of accidents on surface mine sites worldwide. For instance, in the United States, there have been 58 fatalities and many more serious safety incidences attributed to mine vehicle interactions since 1987.

Numerous studies have determined that the root cause of many mine site collisions is poor visibility or blind spots associated with large mining equipment. Figure 1 clearly illustrates the limited visibility around a typical haul truck.

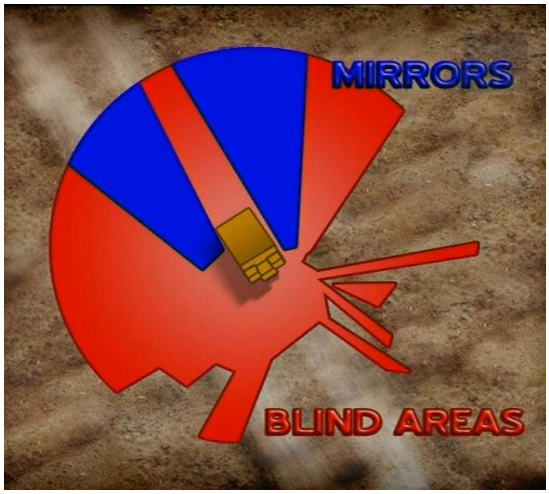

Figure 1 - Red zones indicate blind areas with assistance of rear view mirrors.

Figure 2 demonstrates, in practice, the hazards that confront mine equipment operators on a daily basis. With even large mobile equipment hidden in blind spots around a haul truck, it is easy to understand the causes of mine site collisions.

Figure 2 - Large mine equipment has significant blind spots which contribute to vehicle to vehicle collisions.

Blind spot hazards are well known, with most mines employing numerous devices and procedures to combat collisions. These may include flashing lights, buggy whips, back-up alarms, horn signals, two-way radio communications and site driving procedures among others. Unfortunately, none of these controls have so far provided a comprehensive solution and collisions resulting in fatalities, serious injury and equipment damage continue to be common place.

There are now a number of commercially available systems using a wide range of sensing technologies that provide a more efficient means to alert equipment operators of potential collisions and the proximity of at-risk objects. These systems have proved to be successful in preventing collisions when used in conjunction with appropriate site safety and operating procedures and when implemented in a thoughtful and site specific manor.

The key to a successful Collision Avoidance System (CAS) implementation is a site specific Risk Assessment, which determines the key site hazards associated with mobile equipment interactions. The Risk Assessment and resulting Risk Management Plan will make choosing the appropriate technology much easier as it should contain a list of CAS features that are required on site.

Collision Avoidance System Features and Technologies

A comprehensive list of desired CAS features has been identified through various academic and industry studies. These features include;

- *Blind spot elimination* through the use of video cameras
- *Automated object detection* through the use of proximity detection with visual and audible alarms
- *Positive identification* of objects in proximity through the use of vehicle IDs
- *Redundancy* to provide a failsafe system
- *Integrated* vision and proximity detection.
- *Two-way alarming* for both the primary vehicle and the vehicle at risk
- *Standalone system* that is not reliant on existing infrastructure such as WLAN or GPS
- *Configurable* proximity alarms
- *Elimination of nuisance* or false alarms
- *Audit trail* data logging
- *Interface* to third-party systems (e.g. Fleet Management Systems) for alarm reporting and system health monitoring.
- *Reliable operation*
- *Ease of Maintenance* through the use of 'plug-&-play' technology.

One of the primary design philosophies of a CAS system should be to ensure the system is completely independent of any other third party technology interaction or infrastructure. This ensures that the manufacturer and the final users of the system are in full control of its functionality and reliability. For instance, users of the system can be confident that the system's reliability is not dependant on the vagaries of satellite positions and limited visibility of the sky common to open pit mine operations nor is it dependent on the upkeep of WLAN or other radio infrastructure that suffers as the mine develops and outgrows the original radio coverage plan.

Another key design criterion should be the elimination of false or nuisance alarms. A positive alarming technology in conjunction with system flexibility will allow site management to configure alarms for specific site based risk scenarios. Positive alarming provides confidence to equipment operators that when an alarm is raised there is a real hazard to be acknowledged. The benefit of this feature is that operators who use the system become less complacent in their reaction to proximity alarms.

A number of sensing technologies are available for proximity detection; they include infrared, ultra-sound, Radio Frequency tagging (RFID) and radar to name the most common. RFID tagging is the only technology that is both independent of external infrastructure as well as provides positive alarming and a means for fully programmable alarm configuration.

In all other cases, the technologies are not suitable for implementation in surface mining operations because they do not provide a basis for positive identification of at-risk objects and have a propensity to generate numerous false alarms. For example, in the case of commonly used radar systems, equipment operators are provided with warnings for all detected objects, which may include road signs, large rocks and berms amongst other objects.

By nature, large mining equipment operates in proximity to other equipment (e.g. the case of a front-end loader loading a haul truck). Without the use of a technology that provides for positive and configurable alarms there is a real danger that operators will become immune to the alarms and therefore reduce the efficiency of the collision avoidance system.

Advanced Mining Technologies CAS/CAM-RF

Advanced Mining Technologies (AMT) has developed the world's leading CAS technology with input from the Australian Commonwealth Scientific Industry Research Organization (CSIRO) and a number of major mining houses. The AMT CAS was designed from the ground up to be a surface mining collision avoidance system and is now in operation successfully at 27 mine sites around the world. The system has had all of the desired features incorporated into its original functional requirements specification.

The AMT CAS uses a combination of cameras and Radio Frequency ID (RFID) proximity sensing to alert operators of potential vehicle interactions. For heavy mobile mining equipment, the system provides full 360° object detection that is continually identifying potential high-risk scenarios in all directions. When a programmed risk scenario is detected, the camera view switches to the direction of the vehicle at-risk and provides an early visual and audible warning of the pending danger to the operator in a way that can be quickly and easily understood. The unique two-way alarming feature provides operators of other vehicles a visual and audible warning to take appropriate defensive action, if required.

To provide maximum flexibility, the AMT CAS supports programmable "risk zones" for a wide range of mobile mining equipment, including: trucks, dozers, graders, loaders, scrapers, drills, draglines, shovels, medium-size vehicles and light vehicles. Other fixed equipment and assets, such as, lighting plants, pit pumps and stockpile pillars, can be protected with a stationary transceiver alerting drivers of heavy mobile equipment when they are within the programmed no-go zone surrounding the object.

The high reliability of the AMT CAS is due to the self-contained design. The system operates over a peer-to-peer radio frequency communication link providing fast response time (~150 ms) for signaling of proximity data out to a range of 150 metres surrounding each vehicle. The system does not depend on any external infrastructure, such as, WiFi, telemetry repeater networks, mesh-WLAN systems or a GPS satellite network for operation as a safety device.

Conclusion

Proven technology now exists that provides heavy mobile equipment operators with reliable proximity detection tools which can prevent mine equipment collisions.

Selecting and implementing the correct technology based on a site specific Risk Management Plan is the key to ensuring that maximum benefits are achieved from the use of a collision avoidance system. The selection of an inappropriate technology could see the system benefits compromised by equipment operators who disregard the system because of its poor reliability or high number of false hazard alarms.

The AMT CAS-CAM/RF® System is a proven safety aid, which provides the drivers of Heavy Vehicles and Light Vehicles with additional information to make informed decisions in order to reduce the incidence or risk of collisions. This is achieved by the use of parallel technology that enables visibility of equipment blind spots with a robust video system and with 100% positive automated alarms. The use of RFID tagging allows for the configuration of specific site based risk scenarios.