PRESENT STAGE AND TENDENCIES IN THE MANAGEMENT AND MONITORING MODERNIZATION SYSTEMS OF EXTRACTION

Grecea Dănuţ, *Eng. PhD Student University of Petroşani*
Nan Marin-Silviu, *Eng. PhD Prof. University of Petroşani*

ABSTRACT: This paper addresses the problem of accuracy and real-time transmission of information on the work environment and mining equipments is essential for safety, productivity and automation equipment. In these circumstances the use of sensors and cameras in management and monitoring processes, for scanning and displaying contours of land and to locate people and equipments with high accuracy are needed for increasing security and safety in the tough conditions of the mining industry. Improvement targets that include remote control, semi-automation or full automation can only be reached if the machine "sees and feels" like the operator did when he was operating the machine. His senses need to be replaced by sensors communicating appropriate information to the remote operator command center or directly to the control system. Environmental conditions like dust, fog, rain or darkness can compromise both visibility and perception with cameras thus limiting their use only in the management processes. Important indirect information like shocks and vibration are not available through cameras, so must be used in addition to several types of sensors so that the transmitted information to be precise and complete.

KEY WORDS: mining, management, security, machine, operator, sensors

1. GENERAL CONSIDERATIONS

Because global demand for natural resources is continuously increasing, the need for increased resource production grow similarly.

Coal is a highly competitive energy source given that most European countries are forced to have recourse to imports to meet energy needs. The coolest part of the coal extracted (85%) is used to produce electricity in power plants.

Obtaining a competitive price of electricity from coal is dependent on the performance of the technology adopted. In the mining and other industries competition is the factor that determines the desire for change. The cost pressure and the desire for change are the engine deploying modern techniques.

All these depend on the speed with which collect information necessary to make informed decisions to increase productivity and reducing costs.

Using information technology in production processes is a today reality. There is no doubt that it can obtain increased productivity while reducing costs through intelligent application of information technology. Such innovative solutions are already available:

- Optimization of material flows by tracking them;
- Use of quality management systems in coal deposits;
- Making maintenance works of automation systems and remote operator;
- Use of telediagnosis for preventive maintenance.

2. PRESENT STAGE AND TENDENCIES

The mining industry has recognized this trend early. Many careers, particularly in Germany, have become fully integrated and therefore able to extract coal in terms of optimized cost.

Ensuring the competitiveness of a company implies integrative processes with information technology that allows connection between technological classic processes and the ultimate standard technique.

Rotor excavator is the first in a chain of integrated tools which ensures continuous exploitation of the lignite layers. Proper functioning of this complex equipment correlated with other complex machinery of a chain considerable distance stretched ensures the overall process efficiency by using new equipment and automation concepts.

The control cabin of such a machine, Figure 1, appears more complex by the addition of the process computer monitors.

In fact the use of computers to process allows a command cabin ergonomics and a more efficient machine operations.

Using on a machine such complex computing process is a direct consequence of the desire to simplify the system to ensure a high reliability.

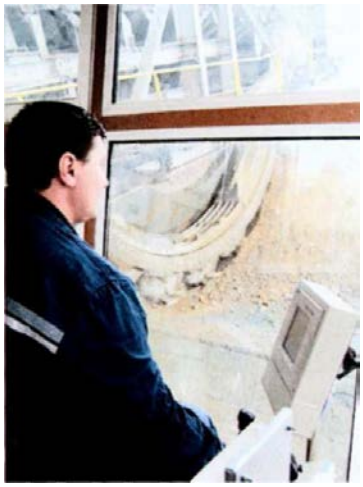

Fig. 1. The control cabin modernization

A modern excavator must have a high degree of automation and ensure automatic execution of several functions:

- Automatic cycle operation, programmed;
- Limiting the angle of rotation;
- Control the cutting depth, the thickness and height;
- Control slopes / surface flatness vehicular on the excavator;
- Control performance;
- Automatically positioning a belt on the excavator on the front belt;
- Optimize startup and shutdown of the conveyor belt excavator:
- Switching conveyors;
- Speed control bands, rock excavation and transport;
- The automatic transmission of specific values to the upper levels of automation;
- Diagnosis systems that equip the machine.

All those functions are accessible to the operator by means of computer screens multifunctional Figure 2.

Fig.2. Tracking screens and input process parameters

A particularly interesting trend is the use of global positioning satellite system (GPS) to work daily extraction of lignite. It is known that the mining to date stretches on a considerable area.

At Soc. Rheinbraun AG from Germany was introduced SATAMA system that allows real-time tracking of the position of equipment involved in the excavation and deposition the tailings, and each machine is equipped with a GPS receiver. [2]

By this receiver, connected to a computer network of equipment and career can be determined in real time. position of the machine.

Through intersection of this position with three dimensional model of career mapping can be updated in real time and with minimum cost mapping profile career. More than that, GPS is a simple and effective way to determine the quantities excavated so tracking production.

Technological data are presented as hierarchical computer screens. Moving from one screen to another, changing references, starting and stopping some machines are made by mouse click. The messages and alarms are managed unitary by a dedicated system.

Dispatch, Figure 2 contains several workstations, Each of them dedicated to a particular machine or group of machines.

The system allows each workstation can serve any group of machines, apart from workstation screens, parameters or real-time video images can be viewed on large diagonally screens placed on the wall of the room.

An example is automating Jaenschwalde career where ABB Open-Pit Mining company, installed in several stages a Central Control System for the Lausitzer Braunkohle AG (LAUBAG) lignite company at the Jaenschwalde mine. This is a control system, Figure 3, which covers all machinery and mining conveyor lines, which consists in monitoring of all processes resulting from the coal exploitation.

Fig. 3. The control station of the Jaenschwalde mine

An information management system monitors and records all operations, the data being collected by LAUBAG the network control centers well as a diagnostic system that provides information for the maintenance the exploitation process and maintenance of equipment. All processes and videos images can be displayed on monitors and the control station. can also be displayed on the central panel, measuring 4x1.5 meters.

The 3D control systems can improve the safety, accuracy and capacity dislocation of the rotor excavators mining exploitations. The control 3D solution is well suited to application in control of rotor excavators. In mines from Australia are five such excavators equipped with 3D control technology, Figure 4.

Fig. 4. Overview of mining exploitations

On the excavator structure is installed two receiver's GNSS type, Figure 5. First GNSS antenna is installed in the central pivoting point. It provides the reference position of the excavator in the mining exploitations and as well deposit position towards.

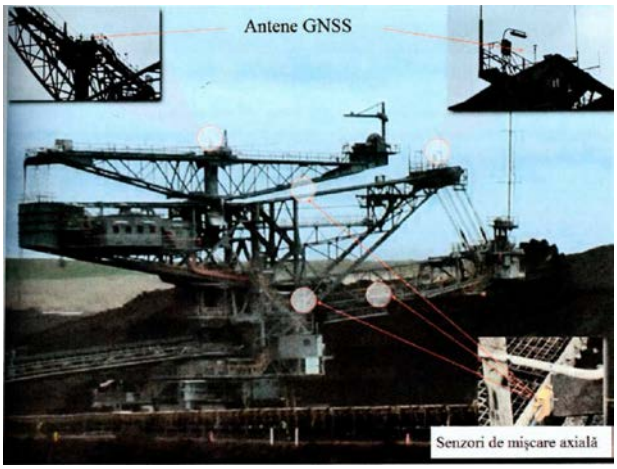

Fig. 5 The location of system components

The second GNSS antenna is positioned such as to monitor position of the to pivoting arm. Also, the two GNSS antennas provide coordinated direction. Motion sensors on direction are installed at strategic points for monitoring all joints.

In operator's cab displays all the information from the process to facilitate management by the operator. Information from the sensors are transmitted to a computer running software 3D driving. The software calculates in real time information about position, position of the cutting-loading system, production and distance from other excavators.

All information from each excavators are transmitted over a wireless network to the control center, the received data is stored in real time database to be analyzed in detail later. The software is able to create reports and data playback respectively can transmit data to the excavators using same radio network.

By installing a 3D control system get more benefits. The most important advantage is safety in operation in the sense that the advancement evolution of extraction complex (mainly the excavator with rotor) should not be quantified by measurements in situ, making this automatically. Cutting accuracy is also enhanced with an error of ± 50 mm, Figure 6.

Productivity increased because of long time uninterrupted operation as well of the possibility calculating the volume of coal exploited in real time. This is a key factor in producing the required amount of coal, based on demand fluctuation of energy from thermoelectric plants.

The advantage of this technology is mainly reducing the cost of coal per ton of coal exploited. Mining exploitation are continuously looking for solutions and new technologies that make the most efficient methods and equipment existing without losing investments already made.

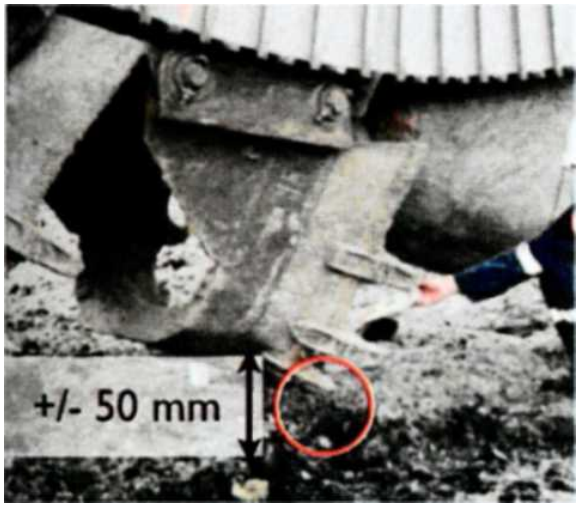

Fig. 6 The accuracy of the measuring system

Using image analysis programs helps to increase maintenance and equipment reliability. The use of video surveillance cameras are mounted on the excavator structure performing real-time measurements that can be used by the machine operator or by the automated system driving.

A visual sensor together with the software of analysis and processing and allow use of the sensor configuration in order to achieve accurate measurements, the detection of the position, distance, wear, and presence or absence of the defective parts of the machine, the sensor providing the flexibility to adjust a number of inspection unlimited.

In studies performed to show that it can use images captured by DVT vision sensor 554, Figure 7, and processed using image analysis software Intellect, setting wear, damage or missing teeth excavator. [1]

Fig. 7. DVT 554 Vision Sensor

The location of the camera is very important because it requires high contrast images captured for analysis. An optimal position may be just above the cutting wheel, figure 8, the excavator because it provides good illumination, protection from damage and a slight possibility of connecting the network cable to transmit data to the central system controller or control.

Fig.8. The location of the video camera

Using the wide range of image analysis tools can check the status of cutting teeth, their state of wear or lack thereof. For each tooth were assigned two instruments, figure 9:

- Along the position line (1)
- Measurement of the area (2)

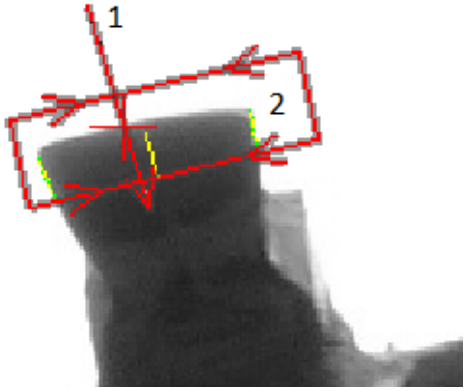

Fig. 9. Teeth mesurement tools

Through the Intellect software tools is measured the cutting edge and the location of the absolute position of an element or if it changes between two inspections.

Detection and monitoring technologies are increasingly important for the mining industry. Technologies that are able to perceive the environment can be used to automate processes and increase operational safety, offering reduced costs and ensure that certain processes are performed repeatedly with the same accuracy.

Improvement objectives include monitoring and remote control can be achieved only if the machine sees and feels just like human operator. His senses must be replaced by sensors that communicate appropriate information to control center in real time.

Exclusive use of cameras in the automation is difficult because disturbances such as dust, fog, rain and darkness considerably reduces the accuracy of distance estimate contours and indirect information machine operation.

In these circumstances it is necessary to use a smart sensor system formed from radar sensors, visual sensors, infrared sensors, proximity sensors, so as the information submitted is accurate and complete.

In general intelligent sensor systems must meet the following criteria:

- Data quality must meet operational needs and must respond to the request;
- The quality and quantity of data to be reliable and are not influenced by environmental conditions;
- Data must be provided in real time;

Laser scanning is an imaging method that has experienced a quick development since mid-1990. Laser scanner uses laser light to measure distances from sensor to object systematically. As shown in Figure 10, a beam of

laser pulses is sent from an infrared laser light source and the light refracted from the surface of the object is captured by a receiver. Distance relationship (1) to the object based on the time required to be received beam emitted by the sensor.

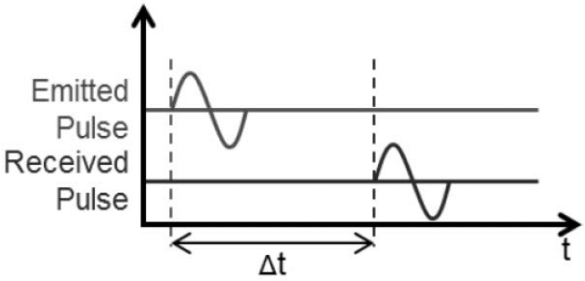

Fig. 10. The operating principle

$$d = \frac{c\Delta t}{2} \quad (1)$$

where:

d - distance to the object;

c - the speed of the beam.

Infrared cameras are a relatively new technology. Similar to laser scanners performed detection is with infrared light modular.

In contrast to laser scanners that scan sequential 2D or 3D scene measurements, infrared cameras in 3D scene using a matrix of pixels.

Another way to scan an area is using radar sensors. Radar is an acronym for "Radio Detection And Ranging".

A pulsed radar emits electromagnetic energy in a specific frequency antenna, figure 11, thus obtaining the distance to the target object.

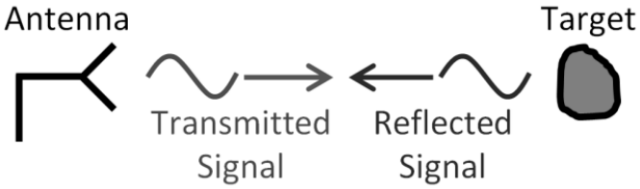

Fig.11. RADAR Principle

Because the equipment used in extractive industry have significant size figure 12, the danger of collision is high. Using intelligent sensor systems this can be reduced or eliminated creating the alarm signals in this case, figure 13.

So moving from one area to another depending on the proximity of the machine to another machine or personal alarm intensity to differ.

Central control system can receive information at any time to stop the machine avoiding creation of accidents.

Is configured three areas:

- Caution areas- warn people and equipment in the vicinity;

- Warning areas - acoustic and visual warning about the potential danger of collision ;

- Critical areas - initiate emergency braking

Fig.12. Mining combine

Fig.13. Warning distance in case of collision

3. CONCLUSION

Automation technology offers a reduction of labor costs and ensure that some of processes are repeatedly made with the same precision, resulting in reduced wear and defects. With the use of precise detection devices, automation functions can perform tasks in surface profiling, positioning and collision avoidance. Specific applications are numerous in the mining area.

More than that, the key objective of mining development is to increase the safety of miners with reducing the number of fatal and non-fatal accidents. With the implementation of automation functions, mining machine operators could be removed from hazardous environments. Therefore, the machine requires a set of perception sensors that are robust enough to work in such difficult environments.

The future mining machines have the potential to be safe for their operators to get higher productivity, at the same time, by incorporating a large amount of sensors. Positioning sensors are particularly interesting in this context that precise geometric sensor environment these machines can be positioned more accurately, precisely cut and operate more safely, especially if they are able to detect personal near them. As mentioned in the introduction, some manufacturers already use sensors to enable operator assistance functionality and automation on their cars. However, the cost of the solutions is currently still high, so that they are not widely used. But both mining machines and systems are becoming more sophisticated sensors and sensing technologies are developing, it can be expected that the costs for intelligent mining machine operator assistance or automation functionalities will decrease leading to use greater thereof. Also, new features will be developed that will allow a greater degree of assistance and automation in comparison to current state of the art solutions.

Regarding sensor technologies, we can say that most sensor technologies are not developed specifically for mining applications. Therefore, the performance of existing sensors for new applications and new environments sensors and mining applications must be well evaluated. The requirements are very specific application. This means that for different applications different sensor technologies are likely to be applied or, if necessary, to be used together to combine their strong points.

The large number of industrial examples and references showing the latest technology maturity 2D / 3D radar scan profile and high volume precision. The mining industry has focused on the extraction of material and are usually in remote locations, experts from the mining companies are probably unable to find optimal solutions. Thus, providing technology products, such as sensors for the mining industry could create confusion on the client and comes with the risk of not "choose correct", and their integration risk increases. Unlike the "product approach" profile firms sensors not only sell, but offers full solutions. These solutions are always based on a primary audit and includes site visits, drawings, photographs, interviews, etc. For this reason solutions identify real problems and propose a customized solution for solving.

Based on this solid foundation, specialized companies offers its clients in many cases, to assume the risk of implementation, providing hardware and customized software depending on the situation encountered. Based on these considerations is offered solutions adapted to each operation as shown in Figure 14 Figure below illustrates key solutions, such as Indurad that can be combined in any customized package.

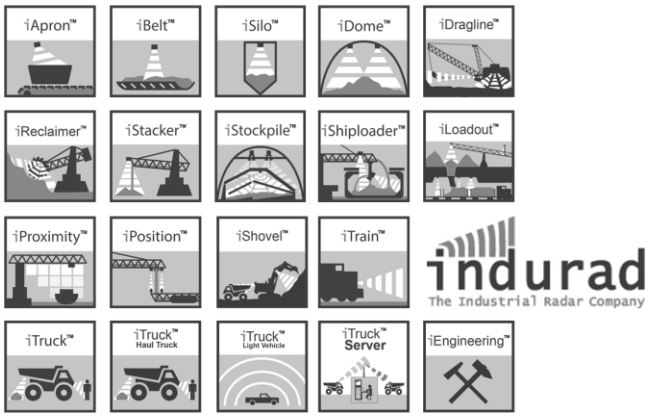

Fig.14. Indurad turnkey solutions for mining activity

4. REFERENCES

[1] Dandea, L.D., Nan M.S., *Research regarding the use of image analysis software for improving the control of bucket wheel excavators*, Universitaria SIMPRO 2012, Petrosani, 2012.

[**2] Dandea, L.D**., *Modernizarea sistemelor de comanda a excavatoarelor cu rotor utilizate in exploatarile la zi*, Teza de doctorat, Petrosani, 2014

[3] Nan, M.S., Ridzi, T.I., Dandea, D.L., *Theory of transport systems*, Universitas Publishers House, Petrosani, 2012

[4] Nan, M.S., *Excavation process parameters of the bucket wheel excavators*, Universitas Publishers House, Petrosani, 2007

[5] * * * , *Intellect software help*.

[6] * * * http://www.indurad.com/