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ScienceDirect

Procedia Computer Science 120 (2017) 411–416

Procedia Computer Science

www.elsevier.com/locate/procedia

9th International Conference on Theory and Application of Soft Computing, Computing with Words and Perception, ICSCCW 2017, 24-25 August 2017, Budapest, Hungary

# Soft computing models in an intellectual open-pit mines transport control system

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**Abstract**

This article focuses on the development of control mechanisms of open pit mine robotized transport system. Method for the state of the technological roads identification with the use of fuzzy inference mechanisms is discussed.
The structure of the control system is presented. The possibilities of the use of telemetry data for a wide range of important technological problems, which, anyway, are reduced to problems of interpretation of the data, object identification, forecasting of parameters and the interaction of robotic agents control are discussed. The examples of the formal setting of some of these problems which based on the soft computing are presented. Considered in detail the problem of identification of the open pit mine roadway. The procedure for organizing and conducting dump truck onboard experiments is described. The features of the main control parameters are analyzed. The mechanism of using the telemetry data processing in common with fuzzy inference tools is presented. The main stages of the experiment telemetry data processing are described.


Peer-review under responsibility of the scientific committee of the 9th International Conference on Theory and application of Soft Computing, Computing with Words and Perception.

*Keywords:* open pit mine; mining and transport system robotized objects; identification and evaluation of the mining road state; telemetry data; fuzzy inference; learning mechanisms

Nowadays, creation of pilotless technologies for developing quarries and various mineral and ore deposits is a worldwide trend. The most important part of this technology is transporting mineral and ore mass via robotized or completely autonomous mining transportation. Many leading companies such as Komatsu (Japan), Caterpillar

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1877-0509 
Peer-review under responsibility of the scientific committee of the 9th International Conference on Theory and application of Soft Computing, Computing with Words and Perception.
10.1016/j.procs.2017.11.257

(USA), Euclid-Hitachi (Japan), that produce machinery and transport solutions for mining industry and conduct active research in heavy trucks and excavators for open pit mining (Klebanov, 2015; Temkin, Klebanov, 2014).

One of the more perspective directions of research is developing effective intellectual control systems, based on technical possibilities of robotized machinery and modern methods of data manipulation. A simplified scheme of a mining technological complex is represented in Figure 1. The main elements maintaining the mining-transport complex (MTC) are:

- on board computing system, installed inside quarry tippers, that maintain multifunctional control (collecting, computing an transferring navigational and diagnostics data to the operations center) and remote control of the MTC;
- GLONASS\GPS navigation complex, that are installed on every single mobile unit and allow it's positioning with up to 1 – 1,5m precision, as well as various sensors that monitor unit's condition;
- software complex that allows for centralized remote control;
- wireless data transmission systems: Ultra Short wave connections, tracking systems, mobile connection systems, as well as broadband connections and wireless data transmission systems, such as Wi-Fi, WiMAX and MESH systems that supply reliable radio coverage and high speed transfer, sufficient for real time video feedback and any diagnostic information (Brown, C., 2012; Temkin, Klebanov, 2014).

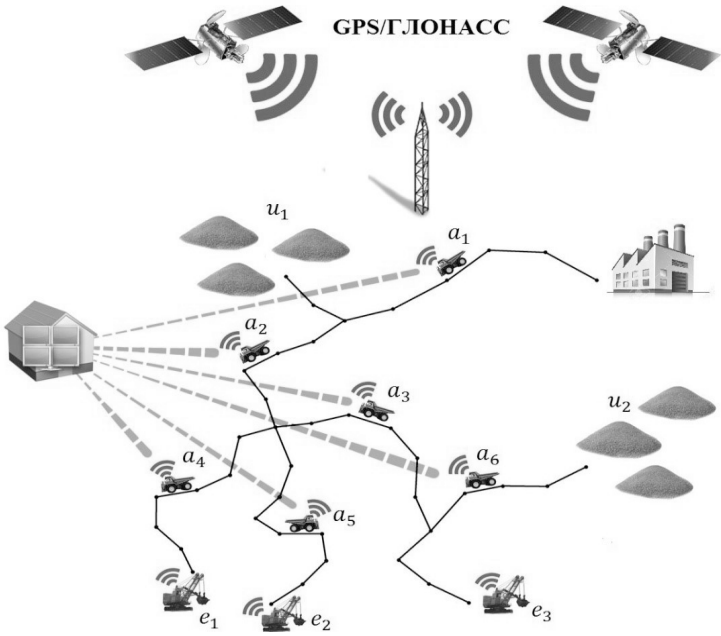


Fig. 1. Simplified MTC scheme

The concept of intellectual MTC control system is based on step by step expansion of system's capabilities in context of robotized machinery integration (prioritizing heavy trucks and excavators) and usage of modern technologies of data analyzing and processing (geological, operating, technological, sensor and expert data). In such a case many of the traditional MTC automated control systems objectives are non-relevant any more, others are modified. These steps, characterizing system's capabilities are sorted by control reactions speed and increasing autonomousity of technological machinery and "pilotlessness" level of the control process:

- centralized supervisor control, based on operative planning models and mining-transport machinery;
- supervisor control based on sensory data of partially robotized MTC units;