

Cooperative Robot Application in a Never Explored or an Abandoned Sub-Surface Mine

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Abstract : Autonomous mobile robots deployed to explore or operate in a never explored or an abandoned sub-surface mine requires extreme effectiveness in coordination and communication. In a bid to transmit information from the depth of the mine to the external surface in real-time and amidst diverse physical, chemical and virtual impediments, the concept of unified cooperative robots is seen to be a proficient approach. This paper presents an effective [human → robot → task] coordination framework for effective exploration of an abandoned underground mine. The problem addressed in this research is basically the development of a globalized optimization model premised on time series differentiation and geometrical configurations for effective positioning of the two classes of robots in the cooperation namely the outermost stationary master (OSM) robots and the innermost dynamic task (IDT) robots for effective bi-directional signal transmission. In addition, the synchronization of a vision system and wireless communication system for both categories of robots, fiber optics system for the OSM robots in cases of highly sloppy or vertical mine channels and an autonomous battery recharging capability for the IDT robots further enhanced the proposed concept. The OSM robots are the master robots which are positioned at strategic locations starting from the mine open surface down to its base using a fiber-optic cable or a wireless communication medium all subject to the identified mine geometrical configuration. The OSM robots are usually stationary and function by coordinating the transmission of signals from the IDT robots at the base of the mine to the surface and in a reverse order based on human decisions at the surface control station. The proposed scheme also presents an optimized number of robots required to form the cooperation in a bid to reduce overall operational cost and system complexity.

Keywords : sub-surface mine, wireless communication, outermost stationary master robots, inner-most dynamic robots, fiber optic

Conference Title : ICMRA 2018 : International Conference on Mechatronics, Robotics and Automation

Conference Location : San Francisco, United States

Conference Dates : June 06-07, 2018