Accepted Manuscript

Application of wireless sensor network for environmental monitoring in underground coal mines: A systematic review

Lalatendu Muduli, Devi Prasad Mishra, Prasanta K. Jana

PII: S1084-8045(17)30436-8

DOI: 10.1016/j.jnca.2017.12.022

Reference: YJNCA 2042

To appear in: *Journal of Network and Computer Applications*

Received Date: 13 September 2017

Revised Date: 3 December 2017

Accepted Date: 28 December 2017

Please cite this article as: Muduli, L., Mishra, D.P., Jana, P.K., Application of wireless sensor network for environmental monitoring in underground coal mines: A systematic review, *Journal of Network and Computer Applications* (2018), doi: 10.1016/j.jnca.2017.12.022.

Application of Wireless Sensor Network for Environmental Monitoring in Underground Coal Mines: A Systematic Review

Lalatendu Muduli[a,*], Devi Prasad Mishra[b], Prasanta K. Jana[a,c]

[a]*Department of Computer Science & Engineering, Indian Institute of Technology (ISM) Dhanbad, India*
[b]*Department of Mining Engineering, Indian Institute of Technology (ISM) Dhanbad, India*
[c]*IEEE Senior Member*

Abstract

The production, productivity and safety of underground coal mines are greatly affected by the environmental conditions of the mines. Hence, continuous monitoring of the complex and hazardous mine environment is essential for ensuring safe coal production. Now-a-days, wireless sensor network (WSN) technique is widely used for monitoring of workplace environment and other aspects in underground coal mines. This paper presents a systematic literature review on the state-of-the-art researches on application of WSN in underground coal mines and to identify the gray areas needing more attention for wide application of WSN technique. Advanced search is conducted on various digital libraries for extracting relevant studies for the review. The search strategy identified 762 studies, among which, 52 relevant studies are selected for thorough review. Application of WSN for monitoring of environmental parameters and other aspects in underground coal mines, such as mine gases, temperature and humidity, dust, fire, roof fall, etc. are discussed. Moreover, the need for further research for effective utilization of WSN technique and application of new advanced techniques for efficient monitoring of underground coal mines are explored in this paper.

Keywords: Wireless Sensor Network, underground coal mine, mine environment, monitoring, mine safety

1. Introduction

The production, productivity and safety of underground coal mines are mainly dependent on the environmental condition of the mines. Airflow, temperature, humidity, dust and gases are the primary factors that influence the environmental condition of underground coal mines. Coal mining operations are inherently associated with the generation of various poisonous and inflammable gases, such as hydrogen sulfide (H_2S), carbon dioxide (CO_2), sulfur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO), methane (CH_4), *etc*. The other major hazards associated with underground coal mining are mine fires and explosions, which are mainly caused due to spontaneous combustion of coal and ignition of firedamp (methane-air mixture) and coal dust, respectively.

The near surface coal seams are getting exhausted rapidly and in order to extract the deep seated coal deposits, the underground mining activities are moving towards the deeper horizons of the earth. As a consequence, the environmental condition of the mines lying at greater depths worsen due to poor ventilation and generation of large amount of heat, humidity, poisonous and explosive gases and dust. Moreover, the high level of mechanization adopted in mines to meet increasing coal production demand deteriorate the environmental condition of the mines. Hence, continuous monitoring of the complex and hazardous coal mine environment is indeed an essential need for ensuring safe and healthy working environment for the miners. The monitoring of underground coal mine environment is widely done using different monitoring devices including data loggers [1]. However, it does not provide high spatial and temporal resolutions as the system works offline. In order to alleviate this problem, on-line monitoring was adopted in advanced countries in order to keep a track of the environmental condition of the underground coal mines. However, these system used wire communication and suffers from many shortcomings, viz. damaging of communication cables, high fault rate, inconvenient system maintenance, *etc*. Therefore, on-line monitoring of underground coal mines using wireless sensor network (WSN) [2, 3, 4, 5, 6] has become the common practice. As a result, wireless underground sensor network (WUSN) [7] has emerged as an essential technology for continuous monitoring of the workplace environments in underground coal mines. It can be realized by deploying sensor nodes in appropriate locations of underground coal mines to collect environmental data and to detect the occurrences of possible hazards like fires, explosions and roof failures in mines [8].

Keeping the above view, we in this paper perform a systematic literature review (SLR) [9, 10, 11] with an objective to identify the current interdisciplinary researches conducted on the application of WSNs for monitoring the environmental parameters and other aspects of underground coal mines. The procedure for conducting the systematic review is presented in Section 2. The review results are provided in Section 3. The detailed review and analysis, their implications for further research and limitations are discussed in Section 4. Finally, the paper is summarized with conclusions and some useful remarks in Section 5.

*Corresponding Author: Telephone Number: +91-7061466727
Email address: lalatendu.bapi123@gmail.com (Lalatendu Muduli)