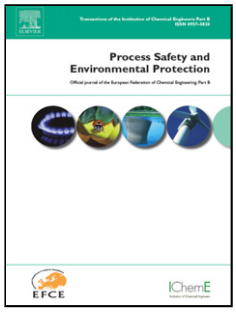

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Wireless Sensor Network based Fire Monitoring in Underground Coal Mines: A Fuzzy Logic Approach

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Abstract

Mine fire is one of the major hazards in underground coal mines. Continuous monitoring of underground coal mines for early detection of fires is very much important from the mines safety point of view. In recent years, wireless sensor network (WSN) has gained enormous attention for monitoring of underground coal mines. In this technique, the sensor nodes are deployed in coal mines for collecting various environmental data, such as temperature, relative humidity, concentrations of different gases, etc. and send these data to a base station (sink) directly connected to ground monitoring centre. Since the monitoring data are uncertain and imprecise in nature, it is important to interpret and analyze the data for taking measures for preventing fire hazard. In this paper, we propose a WSN-based fire monitoring system for underground coal mines using fuzzy logic approach for enhancing the reliability in decision-making process to alleviate the mine fire hazard. Mamdani fuzzy inference system is used as fuzzy model for taking real-time decision on monitoring data. The system is extensively simulated using Fuzzy Logic Toolbox in MATLAB. The simulation results revealed that the proposed system is more reliable and responsive to fire hazard as compared to the offline monitoring system used in underground coal mines.

Keywords: Fuzzy logic, Underground coal mines, Wireless Sensor Network, Mine environment, Mine fire monitoring

1. Introduction

1.1. Background

Underground coal mines are inherently associated with various hazards, such as mine fires, explosions, inundation, roof fall, *etc* [1]. Among all, mine fires constitute the major hazard involving loss of human lives and coal resources. Spontaneous combustion of coal, electrical sparking and arcing, open flame, frictional spark from drilling and cutting operations, mine explosion, blasting, welding, *etc.* are the prime causes of mine fires. However, spontaneous combustion of coal accounts for 75-90% of coal mine fires and happens to be the most important contributor of fires in coal mines across the world [1]. Mine fires due to

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