Chapter 30
Performance Comparison of Different Intelligent Techniques Applied on Detecting Proportion of Different Component in Manhole Gas Mixture

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ABSTRACT

This chapter deals with the comparison of performances of different intelligent techniques for detecting proportion of different component gases present in manhole gas mixture. Toxic gases found in manhole gas mixture are Hydrogen Sulfide (H_2S), Ammonia (NH_3), Methane (CH_4), Carbon Dioxide (CO_2), Nitrogen Oxide (NO_x), Carbon Monoxide (CO), etcetera. Detection of these toxic gases is essential since these gases influence human health even due to very short exposure. This study is centered on design issues of an intelligent sensory system for detecting proportion of different components in manhole gas mixture and comparison of different intelligent techniques applied for this. The investigation encompasses linear regression based statistical technique, backpropagation algorithm, neuro genetic techniques (using genetic algorithm to train neural network), and neuro swarm techniques (using particle swarm optimization algorithm to train neural network).

INTRODUCTION

The present chapter provides a comparative study on different intelligent techniques in relation to the design issues of an intelligent sensory system for detecting proportion of different components in a manhole gas mixture. Through the chapter we discuss several issues regarding the development of such intelligent sensory system. At first we discuss about the manhole gas mixture and the component gases found in manhole gas mixture. Then we define gas concentration measuring

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methodologies and try to put some knowledge regarding the safety limits of the gas components found in such a mixture. Subsequently we provide an idea on the developed gas detection system for detecting proportion of different component gases present in a manhole gas mixture. We also present a concise talk on the different modules of gas detection system. The modules are input module, intelligent system module and output module. A gas sensor array is containing semiconductor based gas sensors, which is used for the sensing component gases in a manhole gas mixture. Gas sensor array is used to prepare data samples for experimentation. Data sample formation mechanism is elaborately discussed in data collection process and data pre-processing mechanisms section. Multiple gases and multiple sensors arouse a cross-sensitivity issue, which is briefly discussed in this chapter. We try to provide solution to multiple gas detection not withstanding cross-sensitivity problem using different intelligent techniques and comparing their performances such that we can decide to opt any one among them for good hardware realization. The intelligent techniques applied on detecting components in manhole gas mixture are Linear Regression Based Statistical Techniques, Classical Backpropagation Neural Network Technique, Neuro Genetic Technique and Neuro Swarm Technique. In the performance comparison section we elaborately compare all those techniques and discuss their strengths and weaknesses. The objective of this chapter is to provide a solution to manhole gas detection issues and also to unravel the pros & cons of the intelligent techniques applied on a real life scenario.

BACKGROUND

We referred few papers reported in the literature on gas recognition and gas detection system. The referred papers are illustrating applications related either to the development of gas recognition system or to the development of an E-Nose (Electronic Nose) mechanism. We discuss these papers briefly to present a picture that how much and what development and research has been taken place in the past decades. We also provide a list of these papers in brief.

1. In (Ping & Jeng-Shong, 2002) the authors are demonstrating development of a system to detect mixture of organic molecules. The Backpropagation Neural Network (BPN) is used to distinguish the species in the mixture organic molecules and multivariate linear regression analysis (MLR) is used to compute the concentration of the species. Amine, carboxylic acid, alcohol and aromatic molecules can easily be distinguished by this system with backpropagation neural network. Furthermore, the concentrations of the organic compounds were determined with an error of about 10 percent by multivariate linear regression analysis.
2. In (Won, et al., 2010) the authors propose a real-time monitoring and estimation technique for managing facilities that store hazardous materials. It relies on Gaussian dispersion model, optical sensor and neural networks (back-propagation) for the detection and analysis of hazardous (gas) releases.
3. In (Shyam, 2010) the author is presenting a concept of developing an electronic nose system to implement backpropagation algorithm of the artificial neural network for odour identification of different tea samples. Chemical vapour identification is to build an array of sensors, where each sensor in the array is designed to respond to a specific chemical. The artificial neural network is trained for chemical vapour recognition; operation consists of propagating the sensor data through the network to generate the output. Since the feed forward calculations are simply a series of vector-matrix multiplication, unknown chemical can be rapidly identified in the field.