Advanced Science and Technology Letters
Vol.63 (NGCIT 2014), pp.248-253
http://dx.doi.org/10.14257/astl.2014.63.55

Developing Dispersion System with Detecting Autonomic Leak Location

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Abstract. It is more important to realize safety management, medium-large accident prevention and risk prediction of industry facilities can generate enormous physical and human damage because most energy plant may use noxious materials. An atmospheric dispersion system has been used for release accident of noxious material since the accident may show different of dispersion range and velocity according to various conditions. However, those systems have been used in design step of industry, and are difficult to deal with release accident quickly. This paper aims to develop real-time intelligent atmospheric dispersion system that can deal with leak accident quickly by enhancing distinct characteristics and efficiency if energy plant, and select leak time and area using intelligent algorithm as accident prevention type.

Keywords: noxious material, dispersion system, intelligent algorithm,

1 Introduction

As massive industrial complexes continue to increase, safety management about industrial facilities become more important for preventing accident. Accident of industrials can generate fatal human and material damage, because most industrials use make noxious materials or combustible materials in any shape or form. Especially, a leakage of noxious chemicals in various accident types industry is able to cause employee as well as a private person serious damage by means of atmospheric dispersion. Atmospheric dispersion of noxious materials should be different dispersion velocity and range depending on various leakage factors such as material, storage, atmospheric status. Therefore, we need atmospheric dispersion system which can estimate the correct air leak range [1, 4].

The existing atmospheric dispersion system uses generally for safety evaluation simulation in the design phase of industry structures. The universal commercial systems have not provided the proper atmospheric dispersion model for adapting a plant environment. Also, the system, which is based on simulation data, is unable to respond immediately against leakage accident. Although some system adopted real-time weather data and user-oriented simulation input data in order to monitor domestic whole area, it has not supported insufficiently process and reaction owing to system degradation and lack of expert knowledge [2, 3].

ISSN: 2287-1233 ASTL
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This paper aims to design and develop real-time atmospheric dispersion system that can calculate immediately dispersion range when leak of noxious chemicals happen for reinforcing efficiency and distinctiveness, and find methodology from accident correspondence to accident prevention using intelligent decidable algorithm toward leak point, time, and so on. The atmospheric dispersion range is presented in accordance with concentration criteria of EPRG (Emergency Response Planning Guideline) using Gaussian model and SLAB model. The intelligent model can recommend automatically risky leak point and time prior accident of gas leak using neural network model and Bayesian reasoning. Ultimately, this paper might propose and develop intelligent real-time atmospheric dispersion system that mounts the proposed our range method and intelligent model in order to minimize dispersion damage.

2 Related Works

The diagnosis methods of pipeline leaks and leaking area can be classified as biological, hardware, and software technique depending on the agent of performance [5]. The biological method means to check the pipe leaks using skilled human resource or sense organs of animal. The hardware method uses sensor or measuring equipment; the software technique is the way applied by IT technology. The diverse diagnosis methods are classified as signal processing method, model estimation method, knowledge based method [6].

The signal processing method uses signal or data of diagnosis factors to check the leaks. In this category, there are volume balance, pressure point analysis (PPA), and negative pressure wave [7-9]. Signal processing method has high accuracy in finding leaks and leaking area. However, the technique has only small range to check and takes relatively more time and efforts to calculate results [7-11]. On current days, the research is being carried out to overcome the limitation of the existing diagnosis methods. The research is concerned to design reference model by model estimation method, to use knowledge-based method, artificial neural network, and expert system for diagnosing leaks and leaking area. The followings are brief introductions of diverse researches on leak diagnosis.

[10,11] is focused on the diagnosis of the leaking spots and ranges through artificial neural network model using pipeline field data. The model enables to self-learning on the diagnosis of the leaks. The advantages of the research are quick outcome and relatively high accuracy.

3 Intelligent Real-time Atmospheric Dispersion System

A control system must exist for very large-scale industrials such as energy plants control system for supervising all the parts of plants. In general, these systems have maintained safety supervision by controlling risk facilities, monitoring facility status and interconnecting emergency response system. In order to improve conventional atmospheric dispersion system, this paper proposes real-time intelligent system that

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can minimize user's interference and process efficiently emergency response with control system such as Fig. 1.

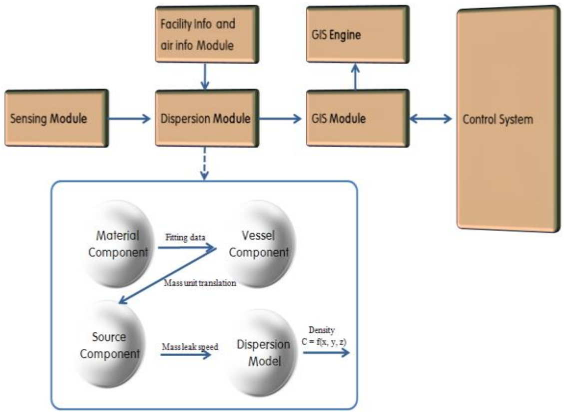

Fig. 1. Design of real-time atmospheric dispersion system

The sensing module collects risk data (pressure, temperature, etc.) in real risk facilities. The collected data are transferred to dispersion model or stored database. The facility and air information module manage the pre-stored facility information such as size, diameter, etc., and the reliable air information such as wind direction and wind velocity for storing to database or transferring to dispersion model. The dispersion model is made up material component, vessel component, source component, and dispersion model. This module differentiate our system from conventional atmospheric dispersion system by eliminating use of virtual accident scenario because of adopting real-time collected data only. Furthermore, our dispersion module drive worst case per facility except user selecting phase on various leak scenarios such as hole size, leak height, and so on. The GIS module and engine present the density contour of leak on GIS map in real time, and interconnect a control system of energy plant.

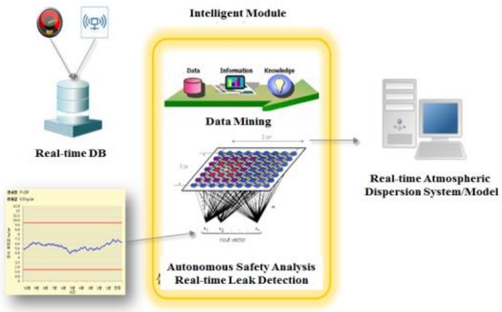

Fig. 2. Design of intelligent module for atmospheric dispersion system

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Fig. 2 explains the concept of intelligent module in our real time atmospheric dispersion system. The intelligent module is designed by data mining method using the continually collected data. Our intelligent module uses neural network as core module in order to detect whether noxious materials are leaked potentially in pipeline or not. Especially, the model on neural network estimates autonomically leak possibility by corrosion of pipeline. Therefore, the intelligent module can calculate atmospheric dispersion range that is provided by autonomous recommendation of leak point according to decision of our neural network model.

This research would suggest the autonomous recommendation method that can decide leak possibility in industrials, and recommend leak time and sector by deriving abnormal data using normal data. The proposed intelligent method is divided into a construction of intelligent model and decision of leak sector. Our intelligent model has been learning model of neural network to the target facility. A neural network algorithm is composed up weight connection between units with graphic feature and mathematical method, and is suitable for our industrial domain because of existing strength such as generalization, applicability and fault durability.

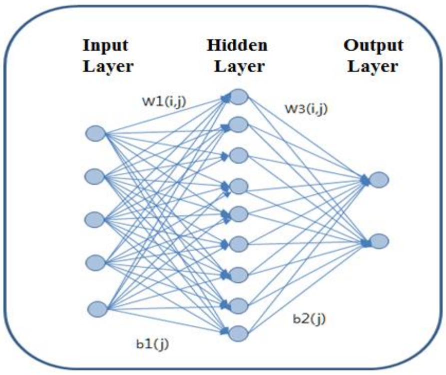

Fig. 3. The learning model of neural network

Our neural network model is classified by input layer, hidden layer and output layer such as Fig. 3. The input layer takes sensing data (pressure, temperature, vibration, gas leak, pipeline identifier, time, etc.) with normalization using minimum and maximum value. The hidden layer uses tangent sigmoid function as activate function. The output layer shows pipeline identifier and status as a result, and uses a linear activated function. The learning of neural network model is performed in momentum back-propagation algorithm.

The recommendation of leak sector uses residuals between the estimated result of neural network and the real result. In order to select final leak sector, this research use a trend of residuals as input and Bayesian inference algorithm for decision. Bayesian inference method can decide leak time because it provides probability to possibility of some accident by deriving posterior probability that is calculated by likelihood of sufficiency and likelihood of necessity.

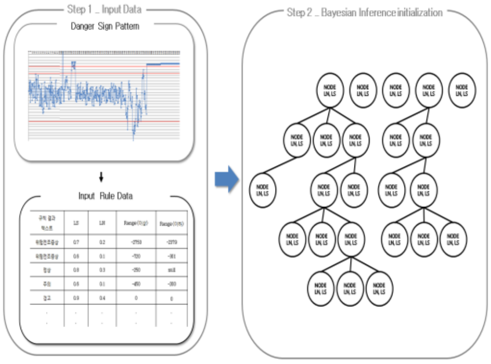

Fig. 4. Initialization of Bayesian Inference

For deciding leak time, our procedure is classify into normal, warning, risk sign, and risk by deriving pattern to trend of residuals, makes rules by selecting likelihood of sufficiency and likelihood of necessity per pattern, and then performs inferences by creating Bayesian tree such as Fig. 4. An inferred result is able to decide leak time by suggesting each probability to normal, warning, risk sign, risk to target facility. The recommendation of leak sector can propose possible leak sector and leak time that based on logical zone of target facility by each inferred result.

For example, logical structures of pipeline are divided by zone, sector and point. The zone is decided by connection between pipelines, and includes several sectors of identical size. The sector lays out a logical basis for detecting efficiently leak location. All sectors should consist of more than two points, and can take different number point according to circumstances. The point means measuring location with sensor equipment. The time uses each probability to normal, warning, risk sign, and risk of the possible leak logical structure. In some cases, the real-time intelligent atmospheric dispersion system may improve effectiveness using combination between possibilities such as risk probability and risk sign probability.

4 Conclusions and Future works

This paper designed and developed real-time atmospheric dispersion system that can calculate immediately dispersion range when leak of noxious chemicals happen for reinforcing efficiency and distinctiveness, and find methodology from accident correspondence to accident prevention using intelligent decidable algorithm toward leak point, time, and so on. The atmospheric dispersion range is presented in accordance with concentration criteria of EPRG (Emergency Response Planning Guideline) using Gaussian model and SLAB model. The intelligent model can recommend automatically risky leak point and time prior accident of gas leak using neural network model and Bayesian reasoning. Ultimately, this paper suggested intelligent real-time atmospheric dispersion system that uses the proposed our range method and intelligent model in order to minimize dispersion damage and overcome the conventional atmospheric dispersion system with simulation data.

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Furthermore, this paper proposed method for finding logical leak zone and time using intelligent algorithm. So, we make firstly intelligent model, and perform secondly autonomous selection of leak source. The intelligent model adopted neural network model with including input layer, hidden layer, and output layer. The autonomous recommendation system analyzes residuals by means of comparing result between the estimated data and real data, decides the leak possibility to target facility using Bayesian inference, and then provides each probability to normal, warning, risk sign, and risk of the possible leak logical structure. In future works, we are to stabilize the intelligent module in the fixed component of real-time atmospheric dispersion system.

Acknowledgments. This work was supported by Energy Efficiency & Resource Core Technology Program of the Korea Institute of Energy Technology Evaluation and Planning (KETEP) granted financial resource from the Ministry of Trade, Industry & Energy, Republic of Korea (No. 20132010500040).

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