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A Design of Risk Analysis System Based on Zone in Real-Time Environment

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Abstract. Energy industry facilities can cause fatal damage for internal industry employee as well as external general people because handling various kinds of gas and harmful substance might be spread to large scale severe accident by fire, explosion, and toxic gas leakage. In order to prevent these accidents, qualification by damage effect on structure and human is tried by using quantitative risk assessment, but it is difficult to process instantly exceptional cases and requires knowledge of expert. This paper aims to minimize exceptional cases and knowledge of expert, and present risk with human perceptible. So, we designed zone-based system that can compute risk of zone in real-time that point suing database and incremental model.

Keywords: quantitative risk analysis, dynamic scenario, accident prevention

1 Introduction

Safety management and accident prevention method are considered method as every energy industries have theirs own inherent risks owing to operate various kinds of gas and noxious material. The more pieces of equipment and facilities become generally obsolete in process of time, the more a possibility of accident is increased. If thus a possibility of accident is realized, large scale severe accident spread can spread. Furthermore, those accidents are able to damage industry employee as well as external person [8].

Most studies have focused on scenario except real-time and real data. Although a few similar studies using real-time data exist, they are not a composite risk analysis but a simple accident correspondence. Therefore A method, which can classified damage effect by deriving a potential risk, should be required. One of more specific method for classification of damage is quantitative risk analysis that can classify the damage effect of person and structure on severe accident through frequency analysis and consequence analysis about target process and facility [6, 9. 10].

As far as we know, a risk signal must be sensed beforehand trouble in order to fulfill safety management and accident prevention The general procedure of quantitative risk analysis may be summarized in confirmation of risk factor,

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establishment of accident scenario, frequency and consequence analysis, a method of reducing risk [7]. In other words, the quantitative risk analysis is suitable for preparing a countermeasure by creating various simulation cases due to confirm risk with previously set scenario and prescribed range. However, the analysis is problems for detecting risk before accident, because it may require expert knowledge for creating scenario, and does not take immediate reaction by means of several unexpected occurrences.

This paper aims to present zone-based risk by dynamic scenario with real environment and data. This method is suitable for personal recognition environment because of minimizing expert knowledge and unexpected situation. Furthermore, our research design a detailed class diagram using incremental method, construct database and calculation model, and then propose zone-based risk analysis system. Our zone-based risk analysis system can creates dynamic scenario by means of calculating model on risk of zone in real-time environment.

2 Related Works

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 [1].

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 [2-4]. 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 [3-5]. 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.

[5,6] 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 Design of Zone-based Risk Analysis System

Zone-based risk analysis system can get risk grade on zone-based area in real-time through means of assessing dynamically risk relation between complex facilities in zone.

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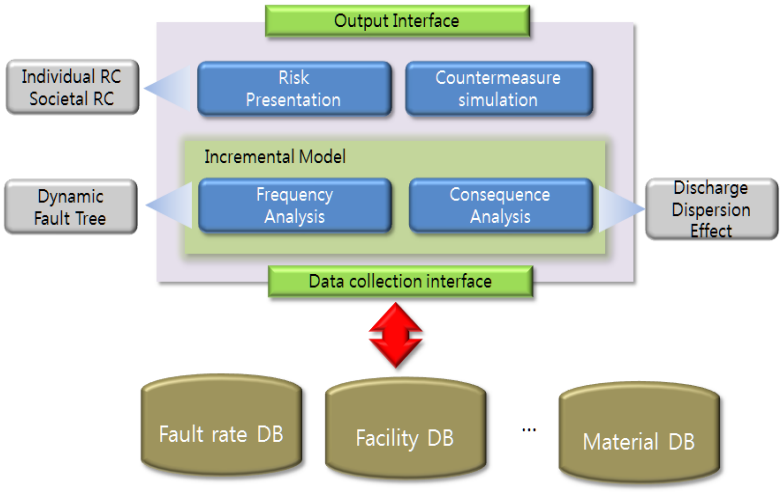

Fig. 1. Abstract architecture of zone-based risk analysis system

Fig. 3 shows overall architecture. The consequence analysis model would be designed as calculable model to degree of dispersion, explosion and fire when leak occur by reason of trouble of target facility such as crack. The frequency analysis is a method that is able to calculate accident occurrence probability, and adopt fault tree analysis and estimation tree analysis model for increase correctness. The fault tree analysis is able to schematize the synthesis trouble of failure that might cause accidents. The estimation tree analysis can present transition rate about trouble and failure. The risk presentation is designed for displaying individual risk and societal risk.

The design of zone-based risk analysis system constructs database as various data storage, and then designs class that realize zone-based risk analysis using those database. The table in designed database shows Table 1.

Table 1. Font sizes of headings. Table captions should always be positioned *above* the tables.

Table name	description
SensorData	Sensor data be attached on facility
Men	Employee information
Plants	Plant information
Equipment	Equipment information
Pipes	Pipe information
PipeLeakPoints	Leak point information in pipe
Nodes	Hierarchical structure information among plant, facility, pipe, etc.
NodeTypes	Type information of node
Materials	Material information
FTAs	Fault tree analysis information
AlarmLogs	Log information about alarm
NodeGroups	Information about node group

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RiskDistribution	Risk distribution information
RiskDistributionResults	Analysis result inforation

The detailed explain about major table are followings

- Plants: It manages uniform information related plant that is most significant object in system. The object includes map image, image area(coordinate), population information.
- Nodes: It is common object in database without inherent concept and overlap. The nodes are created as field in order to distinguish factor type, relation and name of hierarchal. Furthermore, real objects like as equipment and pipe should refer id of the Nodes table as 1:1 relationship.
- Equipment: It is table for explaining the operated devices, and has 1:N relationship to Plants table. This table must include status and result information such as sensor value, materials, etc. because of reflecting real-time information.
- FTAs: This table includes various accident scenario and has 1:N relationship to Equipment table. Sometimes, this table support optional information field because use can define and calculate.

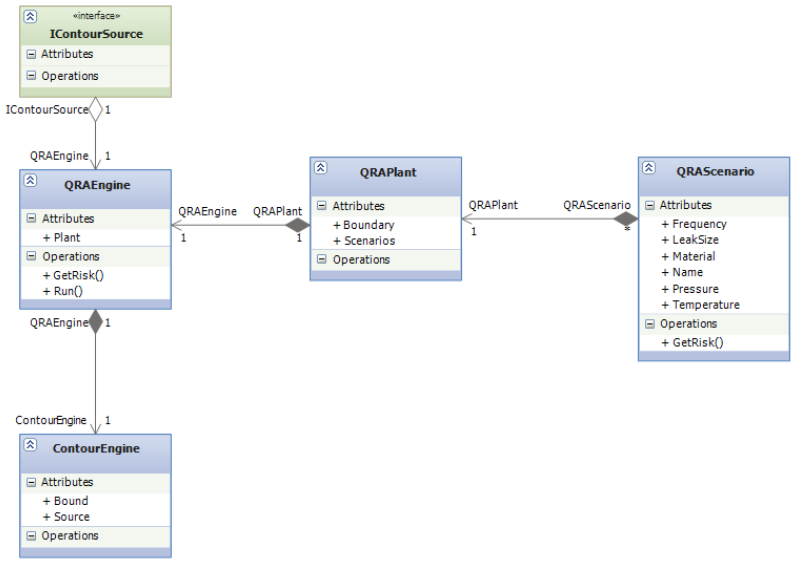

Fig. 2. Class diagram of analysis system

Fig. 2 shows the class diagram for designing zone-based risk analysis system. The design of all classes is irrelevant to database in order to guarantee independency of their function. This design method can enhance the portability and the reusability. The portability can adapt easily for system in various environment. The reusability can afford to minimize system resource and load. Our essential classes are followings;

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- QRAEgine: This class is most significant class in system, and includes all related risk analysis information in order to carry out zone-based risk analysis in application. The QRAEngine class is made up a constructor and two methods. The Constructor creates all requisite objects for analyzing risk inner class, and initializes them from database using utility function. The Run method creates related all objects of risk analysis from the designated plant id, and return current zone-based risk grade. The GetRisk method return values of X coordinate and Y coordinate as location of risk point.
- QRAResult: This class is comprised of matrix and zone property that are array and data structure. These properties must be required for presenting the result of risk analysis with return type in Run method of QRAEngine.
- QRAPlant: This class is realizing zone and component of zone toward target of risk analysis, and has two properties. The Bound property is logical field of plant. The Scale property has scale information of map
- QRAScenario: This class includes everything about the related risk analysis, and uses for merging Equipment information into FTA information. The class return values such as volume, temperature, pressure, leak size, location through properties and methods.

4 Conclusions and Future works

Safety management and accident prevention method are considered method as every energy industries have their own inherent risks owing to operate various kinds of gas and noxious material. The more pieces of equipment and facilities become generally obsolete in process of time, the more a possibility of accident is increased. If thus a possibility of accident is realized, large scale severe accident spread can spread. Furthermore, those accidents are able to damage industry employee as well as external person. In order to prevent these accidents, it is quantitative risk analysis that can classify the damage effect of person and structure on severe accident through frequency analysis and consequence analysis about target process and facility. However, the analysis is problems for detecting risk before accident, because it may require expert knowledge for creating scenario, and does not take immediate reaction by means of several unexpected occurrences. As far as we know, a risk signal must be sensed beforehand trouble in order to fulfill safety management and accident prevention.

This paper aims to design zone-based risk analysis system in order to present risk per zone area by dynamic scenario with real environment and data. This method is suitable for personal recognition environment because it can minimize expert knowledge and unexpected situation, and collect data in real-time in very large energy facility environment. Furthermore, our research design a detailed class diagram using incremental method, construct database and calculation model, and then propose zone-based risk analysis system.

In our paper, we design independently all classes in order to store necessary information into database and perform program. This design method can enhance the

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portability that can adapt easily for system in various environments, and the reusability that minimizes system resource and load. The database are made up fourteen tables and has 1:1 or 1:N, M:N relationship among tables. Especially, The Plants table is information of the most significant object and has relationship among various tables. The FTAs table store not data but scenario, unlike other tables. Classes are comprised of five lower level classes, and the class is activated as instance. The QRAEnigne class is the top class in order to analyze zone-based risk, and connects all necessary information for executing application program of risk analysis.

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