An Ontology-Based Cognitive Model for Faults Diagnosis of Hazardous Chemical Storage Devices

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ABSTRACT

Due to high temperature, high pressure, high corrosion, and many other factors, the hazardous chemical device is facing more severe security challenges than other industries. Now, the monitoring methods have been very mature, which play a basic monitoring role, not a predictive fault diagnosis. In this article, the hazardous chemical device’s status data will be collected from the existing industrial monitoring network, the real-time data will be preprocessed and then stored in a database, and the data will be imported to the real-time data into the ontology cognitive model; the data will be performed by big data processing and automatic reasoning so that real-time status of hazardous chemical device and the warning of security risks predict are easily obtained at any time. The model is proposed to solve the problem of knowledge representation and reasoning of the hazardous chemical device based on ontology. The model is analyzed and implemented in Protégé software.

KEYWORDS

Big Data, Cognitive, Fault Diagnosis, Hazardous Chemical, Model, Ontology

1. INTRODUCTION

Chemical industry is an important pillar industry of China’s economy. Large-scale hazardous chemical storage device is great significance to chemical process production. Due to high temperature, high pressure, high corrosion and many other factors, hazardous chemical storage device is facing more severe security challenges than other industries. For example, on August 5, 2009, 246 people have been injured in Chifeng City, Shanxi Province, caused by an ammonia leak. Tianjin port “8.12” Ruihai Company’s explosion of hazardous goods warehouses caused 165 dead and economic losses of 6.866 billion RMB [Husein, 2017; Chen, 2012]. Such safety accidents are numerous and occur every year. Therefore, it is great significance to monitor the faults of critical hazardous chemical storage device and analyze online data.

At present, various data collection methods for the hazardous chemical device in China have been studied very well [Wang, 2015; Xiao, 2011], and various required data and parameters can be collected; the industrial control network has been performed by international standards. The device

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such as: DSP, FPGA controller have been effect applied for collect liquid level, pressure, flow, ETC [Rajpathak 2016; Zhao 2015]. Wireless communication device (ZIGBEE, GPRS, Bluetooth, etc.) have been always used [Hosny, 2015; Komal, 2017; Zhou, 2017]. These factors are transferred to the control center, which perform a real-time monitoring and management [Yang, 2011; Zhang, 2015; Zhou 2017; Peng, 2016; Feng, 2013].

Base on the above research the basic guarantee method have been provided for the hazardous chemical storage device [Duan, 2016; Li, 2015], which play a basic monitoring role, not a predictive fault diagnosis. In this paper, the ontology is introduced into the safety monitoring of hazardous chemical storage device. It can identify various safety hazards of chemical device early and timely, and significantly improve the regulatory protection capabilities of the device. Using this method it is certain that can hazardous chemical storage system will be high-efficiency, safety, reliability, and low-cost.

2. ONTOLOGY

Ontology [Wiki] (introduced in 1606) is the philosophical study of the nature of being, becoming, existence, or reality, as well as the basic categories of being and their relations. Traditionally listed as a part of the major branch of philosophy known as metaphysics, ontology often deals with questions concerning what entities exist or may be said to exist and how such entities may be grouped, related within a hierarchy, and subdivided according to similarities and differences. A very simple definition of ontology is that it is the examination of what is meant by ‘being’.

In modern terms, [Bessedik, 2018; Ahlam, 2016; Mallak, 2015] the formal study of reality itself is in the domain of the physical sciences, while the study of personal “reality” is left to psychology. The idea of ontology comes from a time before people could make these distinctions and yet were beginning to investigate the bigger questions (“first principle”) within the emerging context of secular thought, without religious forms and ideas.

The Resource Description Framework (RDF) [Dibowski, 2017; Pardo, 2016; Schneider, 2016] is a family of World Wide Web Consortium (W3C) specifications originally designed as a metadata data model. It has come to be used as a general method for conceptual description or modeling of information that is implemented in web resources, using a variety of syntax notations and data serialization formats. It is also used in knowledge management applications. The RDF data model is similar to classical conceptual modeling approaches (such as entity–relationship or class diagrams). It is based on the idea of making statements about resources (in particular web resources) in expressions of the form subject–predicate–object, known as triples [Song, 2016; Dibowski, 2016; SAMIRMI, 2015; Lin, 2014]. The subject denotes the resource, and the predicate denotes traits or aspects of the resource, and expresses a relationship between the subject and the object.

3. BIG DATA

Big data [Wiki] is data sets that are so voluminous and complex that traditional data-processing application software are inadequate to deal with them. Big data challenges [Wang, 2014; Wang, 2018; Wang, 2017, Jin 2018] include capturing data, data storage, data analysis, search, sharing, transfer, visualization, querying, updating, information privacy and data source. There are five concepts associated with big data: volume, variety, velocity and, the recently added, veracity and value.

The term has been in use since the 1990s, with some giving credit to John Mashey for coinage or at least making it popular [Feng, 2013]. Big data usually includes data sets with sizes beyond the ability of commonly used software tools to capture, curate, manage, and process data within a tolerable elapsed time. Big data philosophy encompasses unstructured, semi-structured and structured data, however the main focus is on unstructured data. Big data “size” [Alshura, 2018; Feng, 2018; Yang, 2018] is a constantly moving target, as of 2012 ranging from a few dozen terabytes to many petabytes.