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Overview of digital risk prevention and control technology for natural gas pipeline geological disasters

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Abstract

The long-distance natural gas pipeline spans a wide area, the environment is complex, the probability of natural disasters is high, and there are many types. Therefore, the safe operation of pipelines has always been the focus of the government and enterprises. However, natural disasters have the characteristics of poor correlation and strong uncertainty, so it is difficult for natural gas companies to achieve accurate positioning and efficient prevention and control of natural disaster accident early warning. The use of big data technology can timely collect natural gas pipeline environmental data and backup storage of engineering information in the pipeline natural disaster prevention and early warning work, effectively realize the digital and information transformation of natural gas pipeline safety management and control, and greatly reduce the natural disasters caused by natural disasters to natural gas pipelines. It provides theoretical support for the safety prevention and control of natural gas pipeline accidents.

Keywords

Risk management and control; natural disasters; natural gas pipelines; digital management.

1. Introduction

Long-distance pipelines span a wide area, have complex environments, and are prone to natural disasters and have many types. Therefore, the safe operation of pipelines has always been the focus of government and enterprises. In recent years, the maturity of big data technology has been applied to all walks of life. Many pipeline companies also use big data technology to identify the surrounding environment of pipelines, predict the impact of natural disasters on pipelines, and do disaster prevention work in advance.

2. Characteristics of natural disaster pipeline accident

(1) Natural disaster data has the characteristics of multi-source heterogeneity. Geological objects are distributed in different spatial units, and the spatial units have different spatial scales. Different measurement methods will result in different results [1].

(2) Natural disaster data is highly temporal and spatial. There are obvious space-time and regional.

(3) Natural disasters also have the characteristics of large capacity. Due to the large amount of geological measurement data and the advancement of measurement methods, the data is huge.

(4) Geological data also has the characteristics of low value density. The amount of these data is large, but the correlation and economy are poor, and engineers need to mine the internal connection of the data;

(5) The natural disaster data is also uncertain, and the weather changes rapidly, which is a great obstacle for engineers to find the characteristics and laws of disasters.

3. The development of natural disaster accident data

The application of big data in the prevention of natural disasters can achieve functions such as data visualization and early warning of disaster consequences [2].

3.1. Data Visualization

Big data technology can visualize complex samples and mathematical logic, enabling engineers to understand the data intuitively and clearly, so that engineers can dig deeper into the logic behind the data [3]. For example, the visual interface of big data can display rainfall, soil quality, pipeline quality, etc. at the same time, allowing researchers to explore the relationship behind it, so as to find a new idea for prevention and early warning.

3.2. Comprehensive data

In the era of small data, the samples we draw are often small in number, large in randomness, insensitive to singularities, and have little effect on the early warning of natural disasters [4]. However, in the era of big data, we can achieve a rule: "sample = total". For example, Google can infer the imminent epidemic of a foreign flu based on hundreds of millions of searches. Putting this reasoning on natural disaster early warning, when the sample data is large enough, we can infer how much rainfall will cause damage to buried pipelines, and we can also infer what causes will increase pipeline risks. When the strength of the pipe is not enough to face the coming bad weather, the pipeline company can make a plan in advance to strengthen the safety protection and reduce the impact of the disaster.

4. Natural gas pipeline safety identification technology based on big data

The construction of big data application system requires three parts, data collection, data storage and data mining.

4.1. Collection of engineering information

Data collection mainly focuses on the collection of some key information and the collection of information on the natural environment. Such as pipe size, material, coordinates, local geographic conditions and weather information, etc. Some internal information of pipelines needs to be collected by sensors, such as the operation of buried pipelines, whether there is deviation, whether there is leakage, etc. [5].

Due to the widespread application of GIS technology, the work intensity of data collection has been greatly reduced. GIS technology, also known as geographic information system, is a very efficient and convenient spatial information system. The system can process acquisition, storage, management, calculation, analysis, display and description. The collected information is mainly expressed in the form of digital data in the GIS system, and the storage method is mainly raster (grid) and vector. The GIS system visualizes the collected geographic information according to its own database and processing software, and can also access other software [6]. For example, gvSIG is a JAVA-based desktop geographic information system and a powerful tool for developing geographic information systems. Engineers can develop their own software systems based on open source software.

4.2. Storage management of project data

The monitoring and early warning of natural disasters in pipelines requires massive data support. Therefore, it is necessary to establish a database for data storage and integration [7]. The database establishment is generally carried out by using the Hadoop system, and

professional personnel are required for maintenance in the later stage [8]. In addition to database construction, database storage is also required. Due to the large amount of data in the database, centralized storage is powerless for the storage and processing of the database. Today, enterprises often choose distributed storage, the purpose is to reduce the pressure on the network. The key technologies required are metadata management, system elastic expansion technology, optimization technology within the storage layer, and storage optimization technology for applications and loads. Huawei has made great progress in distributed storage technology. Huawei has been involved in storage technology research since 2002, and has continuously improved its independent research and development capabilities and core competitiveness for more than ten years. As of the end of 2018, their storage products have served more than 150 countries around the world. of more than 9,000 customers. After solving the storage problem, the key technology of big data can be solved, and then through the efficient computer, the running calculation can be carried out. In addition to Huawei, domestic companies with relatively mature big data technology include Baidu, Tencent, and Alibaba. Take Alibaba Cloud, a big data company under Alibaba as an example, which independently developed a computer engine, MaxCompute, in the early years. As a result, the computing power of Alibaba Cloud's Feitian big data platform has been qualitatively improved. According to data, the Feitian big data platform can now be expanded to 100,000 computing clusters, ranking first in the world. Due to the development of these Internet companies, pipeline companies do not need to spend a lot of money to build and maintain databases, but choose to cooperate with big data companies to build pipeline security databases with the help of big data companies' platforms.

4.3. Engineering data mining analysis

Data mining refers to finding clues behind the data through specific algorithms in a huge database. The steps of the data mining process model mainly include defining the problem, establishing the data mining library, analyzing the data, preparing the data, establishing the model, evaluating the model and implementing. However, the core of data mining lies in the algorithm. At present, the more common algorithms are neural network method, decision tree method, genetic algorithm, rough set method, fuzzy set method, association rule method and so on. Using data mining, we can use the database to evaluate the current pipeline operation status and the pipeline bearing capacity and damage degree under disaster weather, so as to ensure the safe operation of the pipeline.

5. Conclusion

Big data technology can timely collect natural gas pipeline environmental data and engineering information backup storage and data information mining in pipeline natural disaster prevention and early warning work. Data exchange between pipeline companies at all levels greatly enriches pipeline databases and reduces duplication of information collection. improve work efficiency, effectively realize the digital and informatization transformation of natural gas pipeline safety management and control, and effectively prevent the impact of natural disasters on natural gas pipelines. Discovery, early warning, and early treatment can ensure the safe operation of natural gas pipelines.

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