Research on multi-source heterogeneous data fusion system based on device object model

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Abstract. The effective fusion of data from multi-source heterogeneous automation subsystems in coal mines is a current industry problem. Problems such as inconsistent equipment models and inconvenient collection and configuration need to be solved urgently. Analyze the main electromechanical equipment and attribute information of the mine, establish a unified equipment object model, and develop equipment sensor monitoring data configuration systems for multiple protocols such as PLC, OPC, and TCP. It has functions such as online visualization configuration of equipment object attribute information, autonomous selection of collection protocols, and adaptive configuration of distributed parsing services. According to the on-site application table, the system has improved the efficiency of data fusion collection, reduced the difficulty of operation and maintenance, and accelerated the progress of intelligent mine construction, which has certain reference value.

1 Introduction

Coal is one of the country's important energy supplies and basic chemical raw materials, and is an important guarantee for national economic security[1]. With the continuous advancement of intelligent mine construction, various types of sensor equipment and automation subsystems in coal mines are constantly being put into operation, and coal mine data is showing an explosive growth trend, which has brought more and more difficulties to data collection, storage, analysis and utilization[2].

Therefore, it is necessary to study a new data collection and fusion platform to achieve effective fusion of heterogeneous system data used by various manufacturers, different technical architectures and different business management departments, and provide strong data support for the comprehensive management and control of intelligent mines and big data classification services.

2 Analysis of the current status of data fusion

At present, subsystems with IoT sensor devices are mostly used for underground environment, mechanical equipment operating conditions, personnel and vehicle underground distribution and other information[3]. Each subsystem transmits this data to the

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data analysis platform for analysis and processing. Real-time monitoring and analysis of these data can timely discover potential equipment failures and safety hazards, so as to take corresponding measures to prevent them before they occur.

Currently, most data acquisition systems can only perform simple data collection and storage, lack intelligent data analysis and processing capabilities, and are unable to efficiently analyze and utilize massive amounts of data[4].

Data mapping is the process of converting raw data collected by sensors into meaningful information. This process involves multiple steps such as data cleaning, conversion and standardization[5].

In short, coal mine sensor data collection and analysis is a very important part of the coal mine safety monitoring system[6]. Through reasonable data mapping, the collected data can be ensured to be accurate and reliable, providing a strong guarantee for the safe production and operation of coal mines.

3 System architecture design

The system establishes a standard coal mine equipment object model, and realizes the real-time collection and fusion of sensor data such as liquid level, pressure, temperature, and gas in each subsystem through a unified data interaction protocol and data interaction address. The collected data is cleaned, managed, and stored in categories through data analysis and data storage modules. The system architecture design is shown in the figure 1.

3.1 Data collection management

Establish different data collection interaction specifications for different subsystems, agree on the equipment model composition and monitoring point attribute information, and then enter or import the equipment model relationship and attribute information into the system to realize online management of information.

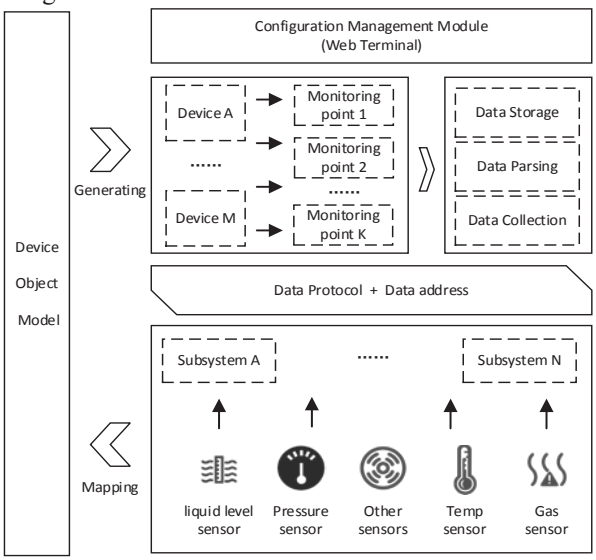

Fig. 1. Multi-source heterogeneous data fusion system architecture.

Managers operate and maintain through a graphical human-computer interaction interface, manage collection-analysis tasks and data source information in groups from multiple dimensions such as subsystems, equipment, and monitoring points, build a

mapping relationship between data sources and data object models, and implement multi-level mapping management and management configuration between scenarios, subsystems, equipment, sensors, and monitoring points to ensure data accuracy, usability, and configurability.

3.2 Data object model configuration management

In order to ensure efficient, stable and accurate data collection and analysis, we need to have an in-depth understanding of the relevant configuration items and set them reasonably. The configuration management module consists of data source configuration, collection task configuration and data mapping management.

3.2.1 Subsystem data source configuration.

The data source is the existing automation subsystems of the coal mine, which is the starting point of data collection. The correctness of its configuration is directly related to the subsequent collection efficiency and data quality. Its configuration content mainly consists of collection protocol, geological information, collection nodes and other extended information.

The module can use a variety of different communication protocols such as Modbus, PCL, OPC, TCP, etc. to adapt to various types of automation subsystems. The module collects address information to configure the source system IP address and port number. For some systems or protocols with higher security levels, you also need to provide a username and password for the connection.

3.2.2 Collection task configuration

According to the characteristics of the data source or business system, the module creates corresponding data collection and analysis tasks. Generally, the same data source in a subsystem corresponds to an access collection task.

Selecting the corresponding data parsing protocol according to the subsystem data acquisition protocol is an important basis for ensuring effective data integration. In a distributed system, the module needs to allocate different parsing service nodes to different data sources or business systems to achieve load balancing and efficient data processing.

In addition to the above basic configurations, you also need to configure some extended properties, including business data topics, collection polling cycles, etc. These properties can help us better control the behavior of data collection and parsing to meet different business needs.

Through reasonable configuration, we can ensure the efficiency, stability and accuracy of data collection and analysis, thus providing a solid foundation for subsequent data analysis and application. On this basis, we can continuously optimize and adjust to ensure the integrity, accuracy and practicality of data access.

3.2.3 Device model and source data mapping

Since coal mine automation systems are manufactured by different manufacturers, have different protocols or different development technologies, the data access of each subsystem cannot be effectively unified. For example, for the main ventilation monitoring system of a coal mine, some manufacturers use the PLC protocol to provide the data source,

while some manufacturers use the OPC protocol to provide the data source. In addition, the properties of the main ventilation fan equipment of different manufacturers are somewhat different.

Based on the subsystem and sensor device information contained in the original data, the corresponding data object model instances are matched, the device instances are mapped and generated, and the device instances are managed based on the location information of the sensor area. Grouping can also be used to make the relationship tree clearer.

3.3 Configuration push and update

During the configuration process, all operation configuration information is saved in the cache table. When the configuration task is completed or updated, after the user reviews and submits it, the configuration information is transferred to the formal table, and the distribution operation is performed and synchronously pushed to the collection and analysis server for processing. To ensure the consistency and integrity of the data, the system also adopts a version management strategy to facilitate the rollback management of information.

4 Conclusion

The successful application of the data fusion collection configuration visualization management system based on the equipment object model on site can realize the configurable collection of data from different equipment systems, different technical protocols and sensor measurement points, improve the data collection efficiency, shorten the project implementation cycle, further accelerate the construction of intelligent mines, and has a certain value for promotion and use.

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