Research on the Integration Technology of Power Engineering Design Materials Based on Fuzzy Retrieval

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Abstract. In order to cooperate with State Grid Corporation in its goal of building an ubiquitous power Internet of Things, build a modern smart supply chain, improve equipment procurement quality, supply timeliness and smart operation capabilities, according to the current grid company’s material data diversification, reporting data is easy to miss, and inventory is no longer available. Taking advantage of the status quo, the thesis launched an intelligent design material reporting system, which uses data synchronization, data fusion, data interaction and other technologies to achieve a seamless connection between the three-dimensional design and the material system. The system regularly updates the material basic data, automatically extracts accurate material reporting data based on the three-dimensional design results of the power grid project, and at the same time matches inventory information, performs material selection, compiles demand inventory, and pushes it to the material system to realize intelligent material reporting.

Keywords: Fuzzy retrieval, power engineering; integrated material management.

1. Introduction

Material management is one of the core contents of the production and operation system of power supply enterprises. The advantages and disadvantages of material management, control and usage directly affect the economic benefits of power supply enterprises, and even affect the safe production of power supply enterprises. Power supply companies at all levels are implementing large-scale urban and rural power grid construction and transformation, which greatly improves the level of urban and rural power grid construction and power supply reliability, and further guarantees and improves high-quality power supply services, promotes production, and expands domestic demand. Made important contributions to economic and social development. However, in the process of power grid construction and transformation, a large number of materials are involved, including transformers, switches, poles, cables, insulated magnetic parts, processed metal fittings, shaped metal fittings, wire clamps, and cable trays, Nails, instrumentation, etc. Due to the lack of management and the limitations of the application of the ERP system material management module, there are many problems in engineering material management, which seriously affects the efficiency of the enterprise and the overall construction of the project. Especially after the current State Grid Corporation implements the "three sets of five major" system construction, it puts forward higher requirements for the intensification of material
management. It is urgent to develop a new set of engineering material management information system software based on ERP to ensure completion on time, quality and quantity. The engineering construction task makes the engineering material management information system take the ERP system as the basic platform, and the project definition, material coding, work breakdown structure (WBS) coding, etc. as the relevant basis to assist the ERP system in material management and control, and cooperate with the ERP system to achieve: (1) Auxiliary management of the project and materials throughout the process; (2) Improve the efficiency of project management and reduce the pressure of project responsibilities and material management mechanization; (3) Improve the tracking and management of the secondary storage and construction process of the power supply station; (4) Expand the management depth of ERP in power supply stations and secondary units. At the same time, through a powerful database and Java2 platform Enterprise Edition (J2EE) middleware platform, the technical means are used to ensure the institutionalization and normalization of the fine management of engineering materials [1].

2. Fuzzy retrieval algorithm
The key point of the fuzzy retrieval algorithm is to construct the keyword semantic lexicon based on the frequency of keywords in the document. When searching, the cloud service provider can expand the search keywords submitted by the user using an algorithm, search for the keywords obtained by the expansion, and then sort the retrieved documents for relevance, and return the results (the user can specify the results (Quantity limit, if the limit is set, only the specified number of square files will be returned).

2.1. Keyword weighting
The weighting of keywords can effectively distinguish the relationship between documents and keywords. The method currently used in research is the TFx IDF algorithm. TF stands for the number of times the keyword appears. This attribute is used to judge the position of the keyword in the document. IDF stands for the ratio of documents containing keywords to all documents [2]. This value is an evaluation of the relevance of keywords to the entire document. This article uses the following formula to calculate the weight of keywords:

$$S(w,F_i) = \frac{1}{|F_i|} (1 + \ln f_{iw}) \ln \left(1 + \frac{n}{f_w}\right)$$  \hspace{1cm} (1)

In formula (1), $f_{iw}$ represents the total number of documents with the keyword $w$, $n$ represents the number of the entire document, and $|F_i|$ is the length of the document $F_i$.

2.2. Construction of encrypted metadata
Document metadata structure Any document has its corresponding document metadata. The metadata is composed of keywords and their weights. If the keyword $w_j$ appears in the file $F_i$, the tuple $\langle w_j, s_{ji} \rangle$ is placed in the corresponding metadata $M_i$. In this tuple, $s_{ji}$ represents the relevance value of the keyword $w_j$ and the document $F_i$. The metadata of all documents is collected together to form a metadata set.

Because of the unreliability of the cloud server in terms of security, metadata-related information cannot be uploaded in clear text, and encryption must be used for processing. Considering the problem of encryption efficiency, when encrypting metadata, symmetric encryption or hash encryption can be used. In this article, the encryption algorithm used is SHA-1. Because the final search results need to be sorted, the encryption algorithm of the preservation order is used to encrypt the weight values of the keywords. Finally, upload the encrypted data to the cloud server [3].
At present, the core mechanism of many order-preserving algorithms is to use a certain one-to-one form for encryption. After encryption, the order of plain text is retained. The function of order-preserving encryption is a corresponding relationship for converting plain text to cipher text, which can be expressed by the following function:

\[ f : D = \{1, ..., M\} \rightarrow R = \{1, ..., N\} \]  

(2)

In the above function, in any plaintext \( a, b \in D \), if \( a > b \), after encryption, it must be \( f(a) > f(b) \). The realization of this algorithm is realized by random function and hypergeometric distribution sampling algorithm. In the plaintext data, a sampling algorithm is used for sampling, a ciphertext interval is selected, and then a random element is selected as the corresponding plaintext \( c \). After the 2-frequent itemset are obtained in the previous step, any one of the keyword combinations \( x, y \) can be calculated using the formula (3).

\[ I(x, y) = \log_2 \frac{P(x, y)}{p(x)p(y)} \]  

(3)

In the above formula, \( P(x, y) \) represents the probability of \( x \) and \( y \) co-occurring in the same article. And \( p(x) \) represents the probability of \( x \) appearing alone in the document set. \( p(y) \) has the same meaning as \( p(x) \). When the semantics of \( x \) and \( y \) are more similar, the probability that they will appear together in the same document will be the larger, the larger the value of \( I(x, y) \). After receiving the query threshold \( T_w \), the cloud service provider first expands the keywords to obtain the expanded keyword set \( S_w \), and then uses this to index the query. The results obtained include extended keywords, so they should be the comprehensive correlation is calculated by the following formula (4):

\[ TScore(w, Fd) = Score_w + \sum_{i \in S_w} Score_{e_i} \times R_i \]  

(4)

3. System design

3.1. System structure design

The network architecture diagram of this management platform is shown in Figure 1. It is designed based on the B/S (browser/server) network architecture model and is divided into two parts, an internal LAN and an external public network. Due to information security, the main business is carried out under the local network of the State Grid; under the external network environment, the unicast and broadcast of messages are mainly carried out on the WeChat public account. This system uses the SSM framework, currently the most widely used Java Web framework, the front-end UI uses jQuery Easy UI technology, and the database uses the MySQL database.
3.2. Functional design

As the most basic module in the material management system, the warehouse management subsystem is the basis of other functional modules, and all other functional modules need to call the matching modules. In the design of this system, the management of the storage of materials is the top priority. At the same time, the other modules of the warehousing management subsystem also include materials inquiry and inventory, etc. These contents are all realized by the logic design of the system software, and no external hardware equipment is needed. It can complete the storage, storage, inventory and report management of warehouse items, as well as information query and other functions [4].

By decomposing the top-level data flow of the system, the whole system can be divided into three parts: material storage, material storage, and material inventory. Among them, the storage of materials is represented by P1, the storage of materials is represented by P2, and the inventory of materials is represented by P3. The basic idea of its workflow is to realize the storage location management of goods in and out of the warehouse through the use of RFID wireless identification technology; real-time tracking and monitoring of goods in the warehouse; the automation of multiple warehouse management links such as the automation of goods inventory, thereby improving material management efficiency and operating efficiency, as shown in picture 2.
3.3. Technical architecture
The system needs to adopt a multi-layer architecture design, the application layer and the data layer are separated, and the business logic is implemented at the application layer to ensure the high scalability and high availability of the system. The overall technical architecture of the system includes the Web layer, business layer, workflow engine, BI business intelligence, and data layer [5]. The overall technical architecture of the system is shown in Figure 3.

3.4. System database design
From the analysis of the material inventory business, the following entities can be quickly identified: purchase order, goods receipt, goods receipt, distribution order, storage order, storage material, picking list, inventory, outbound order, outbound Treasury materials, inventory entities. Among these entities, the goods, storage materials and outbound materials are all inventory materials, so these three entities are merged into one entity "materials", and the specific role is played by its role in the material management platform. Determine. In addition, there are many entities in the system that are not easy to see, such as: suppliers, registrants, apportions, inventors, financial personnel, etc. Since these entities have few connections with other entities, no specific conceptual model is given when designing the conceptual model. After analysis, the main entities after analysis are: materials, purchase orders, arrival orders, distribution orders, warehouse receipts, picking lists, inventory, warehouse receipts,
inventory orders, etc [6]. In the business process of material inventory management, there are physical connections between entities as shown in Figure 4.

![Conceptual data model diagram of material inventory management](image)

**Figure 4.** Conceptual data model diagram of material inventory management

### 4. System performance test

The main test categories for concurrent performance testing include test name, test purpose, scenario description, test steps, test indicators, etc. The specific test content is shown in Table 1 concurrent performance test table. Since the web logic application and the database are deployed on the same Linux server in the test environment, the performance index is the performance data of the whole machine. According to the test results, the actual transaction average response index (7 seconds) is much smaller than the expected index, and the overall server load is not high, so the conclusion of this performance test is passed.

| Concurrent number | Server type | CPU usage (%) | Remaining memory (M) |
|-------------------|-------------|---------------|----------------------|
| 80                | database application | 34.4 | 19.9 | 0.6 | 890 | 800 | 850 |

### 5. Conclusion

The power material management system is a construction material milestone. Through three material management plans, it is constantly dynamically adjusted, improved and updated to form a material management milestone system, and combined with the actual work implementation situation, a comparative analysis is carried out, and the work is reminded in a timely manner through multiple channels. And as an effective source of the annual material plan, material demand plan, material supply plan. This article introduces the main content and key technologies of the power material
management system, and completes the project requirements proposed by the power supply company's material supply centre. At present, the system has been officially put into operation, alleviating the contradiction between project management and material management, establishing a message reminding mechanism, and improving the efficiency of project advancement.

References
[1] Seckin, C. Sciubba, E. & Bayulken, A. R. Extended exergy analysis of turkish transportation sector. Journal of Cleaner Production, 47(5) (2013) 422–436.
[2] Stephens, I. E. L. Ducati, C., & Fray, D. J. Correlating microstructure and activity for polysulfide reduction and oxidation at ws2 electrocatalysts. Journal of The Electrochemical Society, 160(6) (2013) A757-A768.
[3] Pisani, R. Cesar, A. A. D. C. M., & Da Costa, A. A. Influence of population, income and electricity consumption on per capita municipal solid waste generation in so paulo state, brazil. Journal of Material Cycles and Waste Management, 20(2) (2018) 1216-1227.
[4] Lawrence, A. Karlsson, M., & Thollander, P. Effects of firm characteristics and energy management for improving energy efficiency in the pulp and paper industry. Energy, 153(6) (2018) 825-835.
[5] Collier, Z. A. Bates, M. E., Wood, M. D., & Linkov, I. Stakeholder engagement in dredged material management decisions. ence of the Total Environment, 496(10) (2014) 248-256.
[6] Zhang, Q. Sun, Y., Xu, W., & Zhu, D. Organic thermoelectric materials: emerging green energy materials converting heat to electricity directly and efficiently. Advanced Materials, 26(40) (2015) 6829-6851.