The Application of Big Data in Intelligent Management of Engineering Materials under the New Situation

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Abstract. With the deepening development of globalization and informatization, the scale and complexity of engineering projects are increasing day by day, and the requirements for engineering material management are also increasing. The traditional material management methods are no longer able to meet the needs of modern engineering projects, especially in the procurement, storage, transportation, and distribution of materials, facing problems such as low efficiency, high costs, and difficult to control risks.This article adopts the method of association feature mining for big data mining and optimization scheduling of engineering materials. Design an intelligent material management system in ARM and wireless networking environments. The main functional modules of the system include a database module, a program loading module, an information scheduling module, and a human-machine interaction module. Integrated development of logistics inventory intelligent management system using PCI bus technology. The system test results show that the designed intelligent management system for logistics inventory materials has good big data mining and classification recognition capabilities, and the intelligence of information management is good.

Keywords: big data; Engineering materials; Intelligent management system

1 Introduction

In today's rapidly developing era of informatization and digitization, big data technology has become an important force driving innovation and transformation in various industries. Especially in the field of engineering material management, the application of big data not only improves the efficiency and accuracy of material management, but also greatly promotes the development of intelligent material management. With the integration and innovation of technologies such as the Internet of Things, cloud computing, and artificial intelligence, the application of big data in intelligent management of engineering materials has shown unprecedented potential and value.

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As an important component of engineering project management, the level of intelligence in engineering material management directly affects the cost control, schedule management, and quality assurance of engineering projects. Traditional material management methods often rely on manual operations and paper records, which are not only inefficient but also difficult to achieve real-time monitoring and precise scheduling. The introduction of big data technology enables real-time collection, processing, and analysis of data in engineering material management, providing scientific basis for decision-making and achieving optimal resource allocation [1].

This article aims to explore the application of big data technology in intelligent management of engineering materials under the new situation, and analyze how big data technology can help achieve the transformation of engineering material management from traditional mode to intelligent and refined management. By analyzing the application cases of big data technology in engineering material management, this article will demonstrate how big data technology can help achieve more efficient, transparent, and intelligent management models in engineering material management, thereby promoting the transformation and upgrading of the entire construction industry.

2 Current Situation of Comprehensive Warehouse Material Management

2.1 In Terms of Quantity Control

The comprehensive material reserve warehouse often uses manual counting, manual bookkeeping, and other methods during daily inventory and inbound and outbound operations, which is time-consuming, laborious, and prone to errors. The arrangement of material stacking and stacking positions is limited to manual operation, with high labor intensity, low work efficiency, and great difficulty in daily management [2].

2.2 Quality Control Aspects

At present, the quality control of comprehensive material warehouses mostly adopts temperature and humidity control methods, mainly through the use of traditional testing equipment such as temperature meters, hair humidity meters, and bimetallic measuring meters for manual testing, which has poor timeliness, is laborious and time-consuming, and cannot truly reflect and monitor the temperature and humidity inside the material stack and the changes in data at different time periods in real time. Due to the lack of ventilation and dehumidification equipment, exceeding the standard temperature and humidity inside the warehouse will pose risks and hidden dangers to material quality control [3].

2.3 In Terms of Information Management

At present, the material management information system of the comprehensive material warehouse has not been constructed, and the inventory and accounting still use manual methods and paper reports. The data volume is large, the statistics are cumbersome, and the human error rate is high. The system lacks a unified resource sharing platform to achieve information sharing.

3 Technical Equipment Related to Intelligent Management of Comprehensive Materials

By drawing on the experience of advanced warehousing enterprises, consulting industry experts, and consulting relevant information, the following technical measures and related equipment can be adopted in terms of material quantity, quality, stacking, warehouse security, energy consumption monitoring, information management systems, etc.

3.1 Rfid Radio Frequency Scanning Technology

Including two parts: reader and electronic tag. Electronic tags can receive radio frequency signals from readers and obtain energy through induced currents, thereby sending stored information. The reader reads the information and decodes it, and then sends the relevant data to the central information system for processing. This technology can greatly improve the efficiency of automated management such as material inventory and piece counting, achieve remote automatic collection, processing, and information aggregation of material information, greatly improve the speed of information collection, reduce labor costs and error probability [4].

3.2 Intelligent Control of Material Quality

Temperature and humidity are the main parameters that affect the quality and safety of material storage, and mold, moisture, and corrosion prevention are the three important indicators to measure the quality of comprehensive warehouse management. To ensure the quality and safety of daily materials, it is necessary to strengthen temperature and humidity monitoring in the warehouse. The automated ventilation and temperature and humidity control facilities can transmit real-time temperature and humidity data collected in the warehouse to computer terminals or mobile platforms. The front-end equipment can be linked with relevant equipment to achieve automatic regulation, achieving intelligent management of quality and safety control [5].

3.3 Intelligent Warehouse Management System

The intelligent warehouse management system consists of a client management subsystem, a web management subsystem, and a mobile terminal management subsystem. Based on the basic management units of this information, warehousing, in stock, inventory, relocation, and outbound, optimize and standardize warehouse layout, stacking planning, storage capacity utilization, space utilization, equipment usage, and dynamic routes. Summarize inventory information, inbound and outbound records, maintenance status, etc., and generate reports through the system to achieve direct query and statistics. This system can provide accurate data and supply chain information in material rotation, emergency outbound, and other links, enhance the ability to respond quickly to emergencies, and provide data support for the allocation and deployment of resources throughout the system.

3.4 Warehouse Intelligent Security System

Generally, information control and processing, artificial intelligence, and multimedia technologies are used to meet warehouse security needs through security technology prevention systems such as location control, electronic patrols, drone patrols, intrusion alarms, identity recognition, and electronic maps.

4 Intelligent Big Data Mining and Scheduling of Engineering Materials

4.1 Big Data Mining Algorithms

Constructing a big data information collection model for engineering materials, using tag recognition and RFID technology for engineering material information collection, integrating and scheduling logistics material information in PCI bus mode, FFT processing of received engineering material information in DSP, analyzing the spectral information of engineering material information, using filtering and embedded scheduling methods in the original data collection, conducting big data sampling and information scheduling of engineering material information, obtaining the time-domain feature output of engineering material information collection as:

$$f_{Env(s)} = \begin{cases} \sqrt{\dfrac{2}{\pi}} e^{-s^2/2}, s \geq 0 \\ 0, y < 0 \end{cases} \tag{1}$$

$$f_{power}(p) = \begin{cases} \dfrac{1}{\sqrt{2\pi}} p^{1-/2} e^{-p/2}, p \geq 0 \\ 0, p < 0 \end{cases} \tag{2}$$

In the cloud computing system, digital filtering is applied to engineering material information. When the sampling time series satisfies $0 < \mu < \dfrac{2}{LS_{\max}} \sigma_{awgn}^2$, the given weight vector for engineering material information fusion is:

$$x(n)=\left[x(n),x(n-1),...,x(n-L+1)\right]^{T} \tag{3}$$

Combining MCA bus technology for big data scheduling of engineering material information, the output samples of big data are recorded as:

$$x_k=\sum_{n=0}^{N/2-1}2(a_n\cos\frac{2\pi kn}{N}-b_n\sin\frac{2\pi kn}{N}),k=0,1,...N-1 \tag{4}$$

Among them, a_n represents the bias amplitude of intelligent sensing information collection for engineering materials, b_n is the amplitude modulation component, the bandwidth for sampling material information is $T+\Delta$, such as $S_0(t)=a_0\delta(t)$, and the output big data mining spectrum feature quantity is:

$$h(A,B)=\frac{1}{N_A}\sum_{i\in A}\left\|x_i^a-x_{\varphi(i)}^b,y_i^a-y_{\varphi(i)}^b\right\| \tag{5}$$

Among them, N is the fuzzy classification set in the sample distribution space A.

4.2 Intelligent Scheduling Model for Logistics Inventory Materials

On the basis of data mining for engineering materials, in order to optimize the design of information management systems, the OLS fitting method is used to obtain the impact statistical analysis structures of logistics material information, which are:

$$x^{'}(t)=x(t)*h_w(t) \tag{6}$$

$$s^{'}(t)=s(t)*h_w(t) \tag{7}$$

The piecewise linear fitting function for engineering material information is:

$$x_k=\sum_{n=0}^{N/2-1}2(a_n\cos\frac{2\pi kn}{N}-b_n\sin\frac{2\pi kn}{N}),k=0,1,...,N-1 \tag{8}$$

By using the correlation feature decomposition method to test the volatility of engineering material information, combined with differential estimation methods, the estimated fusion scheduling value of logistics inventory materials is obtained as follows:

$$\hat{x}(k/k)=\sum_{j}^{m}\hat{x}^{i}(k/k)u_j(k) \tag{9}$$

$$P(k/k)=\sum_{j}^{m}u_j(k/k)^j\{(k/k)+\left[\hat{x}^j(k/k)-\hat{x}(k/k)\right] \left[\hat{x}^j(k/k)-\hat{x}(k-k)\right]^T\} \tag{10}$$

Among them, $\hat{x}$ represents the spectral component of engineering material information in the storage space, $u_j(k)$ represents the set of associated attributes of logistics inventory information, and u_j represents adaptive error correction. Adaptive block processing is applied to the sampled engineering material big data to obtain the material distribution state function of the intelligent management system, which is represented as

$$\dot{x}_i = f_i(x_i, u_i)D(x_i, A_j(L)) = \min\{D(x_i, A_j(L))\} \tag{11}$$

In the formula, $x_i \in R^n$ represents the state vector of the associated data distribution, $u_i \in R^m$ is the logarithmic likelihood value of engineering material information, and the scalar time series for sampling inventory information are:

$$x_i = (x_{i1}, x_{i2}, \ldots, x_{is})^T \tag{12}$$

The delay statistical characteristics of inventory material information management are:

$$e(n) = d(n) - u^T(n)w(n) \tag{13}$$

The intelligent scheduling of engineering materials is carried out using the following iterative formula, and the scheduling iterative formula is obtained as follows:

$$f(k+1) = f(k) - \mu \bullet \rho \bullet e_{MDMMA}(k) y^*(k) \tag{14}$$

In the formula:

$$e_{MDMMA(k)} = z(k)\left[|z(k)|^2 - R_{MDMMA}(k)\right] \tag{15}$$

Based on the above analysis, the Analytic Hierarchy Process (AHP) method is adopted, combined with correlation detection technology and data mining methods, to carry out intelligent management of engineering materials, improve information scheduling and intelligent sending and receiving capabilities of materials.

5 System Development, Design and Application

In the project deployment phase of the development of the intelligent management system for logistics inventory materials, CDN bus development technology is adopted, combined with embedded scheduling methods to develop the components and information loading of the intelligent management system for logistics inventory materials. The program loading and instruction compilation of the intelligent management system for engineering materials are carried out in an embedded ARM environment. The intelligent management system for engineering materials designed in this article includes a database module, a program loading module, an information scheduling module, and a human-machine interaction module. The database module of the intelligent management system for logistics inventory materials adopts MySQL design, and the mixed development of the database is mainly divided into three layers: WEB loading layer, HDF database management layer, and client layer. Combined with the human-machine interaction interface design method, during the program loading process, it is first necessary to ensure the security of the app code of the intelligent management system for logistics inventory materials. Including code obfuscation and encryption, using information encryption methods for inventory information encoding design, using PCI bus to cross compile and access control the collected logistics inventory material information, combining USB module to achieve data transmission and embedded scheduling of the database, using A/D transmission control instructions for optimized storage and video recognition of engineering materials, implementing intelligent control of the system on EISA and MCA buses. Based on the above analysis, the overall structure of the logistics inventory material intelligent management system designed in this paper is shown in Figure 1.

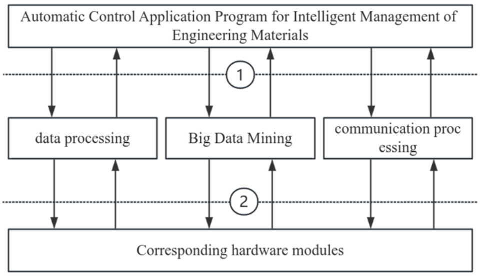

Fig. 1. Overall System Structure Design

According to the design system

In Figure 1, the network architecture of the intelligent management system for engineering materials is designed using the ZigBee protocol stack. Information fusion and clustering processing are carried out in an embedded ARM environment, combined with network module development and communication module development, to achieve modular component design for intelligent management of engineering materials. The functional component modules are shown in Figure 2.

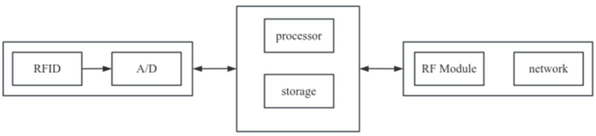

Fig. 2. Functional component modules of the system

6 Experimental Testing Analysis

In order to test the performance of the method proposed in this article in achieving intelligent management of engineering materials, experimental tests were conducted using Matlab 7 and Visual C++joint programming design. The frequency of collecting logistics inventory material information was 1.5 Hz, the cutoff frequency for big data transmission and reception was 14 kHz, the iteration step was 2000, and the sampling time for logistics inventory material information was 4 ms. The distribution of big data for engineering material information is shown in Figure 3.

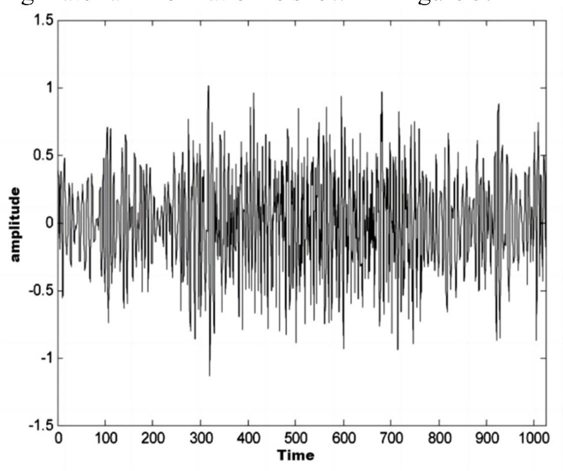

Fig. 3. Big Data Distribution of Engineering Material Information

Taking the above data samples as the test research object, intelligent management was carried out, and the accuracy transmission rate of inventory material scheduling was tested as shown in Figure 4. Analysis of Figure 4 shows that the scheduling performance of engineering material management using the method proposed in this paper is good.

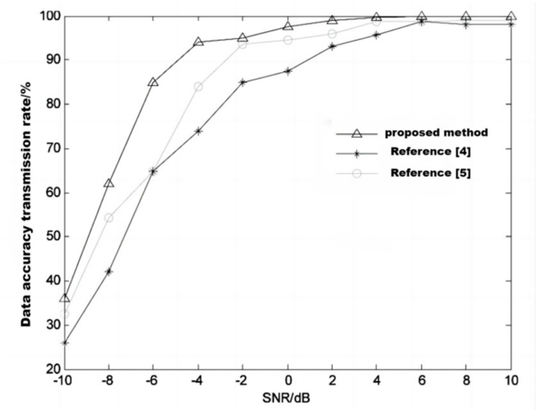

Fig. 4. Comparison of Engineering Material Scheduling Performance

Through Figure 4, comparing the methods in reference [2], reference [3], and this paper, it can be concluded that this paper's method has a much higher data accuracy than the methods in reference [2] and reference [3], indicating that this paper's method has better intelligence. In summary, the design method of an intelligent management system for logistics inventory materials based on big data analysis plays a significant role in engineering management and has great application value.

7 Conclusion

After in-depth research and analysis, this article concludes that big data technology has significant advantages in engineering material management. It can effectively integrate and analyze various aspects of engineering material management, achieve real-time monitoring and intelligent decision-making of material flow, and thus improve the efficiency and accuracy of material management. The application of big data technology has promoted the transformation of engineering material management from traditional manual operations to intelligent and automated management, improving management level and decision-making quality. However, the application of big data technology in engineering material management also faces challenges in areas such as data security, privacy protection, technology integration, and personnel training. Looking ahead to the future, with the continuous progress of technology, the integration and application of advanced technologies such as big data, the Internet of Things, and artificial intelligence will promote the development of engineering material management towards higher levels of intelligence and automation. In order to fully tap into the potential of big data technology, relevant enterprises and management departments need to strengthen data infrastructure construction, enhance data processing and analysis capabilities, pay attention to data security and privacy protection, strengthen personnel training and technological innovation, in order to address the challenges faced by future engineering material management, and promote the sustainable development and progress of the entire industry.

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