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Original Research Article

Application of internet of things technology in industrial big data platform

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Abstract: With the improvement of China's industrial level, the application of big data (hereinafter referred to as BD) technology in industry has been deepened, which provides important help for the improvement of China's industrial level. With the proposal of German industry 4.0, IOT (hereinafter referred to as IOT) technology will play a very important role in industry. Industrial BD is a new industrial ecosystem deeply integrated with the new generation of information technology and industrial field, which promotes the collection, analysis and in-depth application of industrial BD. Based on the characteristics of industrial BD, IOT technology has changed the source and collection method of industrial BD. Combined with data models and algorithms, we can analyze the applications of industrial BD in manufacturing enterprise R & D and design, production and manufacturing, remote operation and maintenance and digital operation management, which can give suggestions to promote the deepening utilization of industrial BD. Firstly, this paper analyzes the functional requirements of BD processing platform. Then, this paper proposes related algorithms. Finally, this paper constructs an industrial BD platform based on IOT technology.

Keywords: Internet of things technology; Industrial big data; Big data platform

1. Introduction

In industry, based on IOT, artificial intelligence, cloud computing, blockchain and other technologies, BD art has been deeply integrated with the industrial field, which will form a key infrastructure to support the transformation and development of enterprise digitization, networking and intelligence[1]. Therefore, industrial BD has realized the connection of all factors in the industrial field, such as people, machines, methods and environment, which has brought subversive changes and impact to the traditional manufacturing industry[2]. With the proposal of smart earth, it has become a future trend for sensors to embed various facilities and objects and connect them through the IOT, which will realize the integration of physical resources and information data[3]. Through the massive data processing of cloud computing, we can provide intelligent processing requirements for the operation of the IOT system, which will achieve the purpose of real-time and data sharing. Through the IOT technology, industrial intelligent control technology has been continuously improved, which will achieve the purpose of intelligence, automation, integration, platform and visualization[4-8]. Industrial BD promotes the great progress of computing power, which also speeds up the precipitation of deep learning algorithms and models. At present, the application of industrial BD has involved product R & D and design, production and manufacturing, operation and maintenance services, which will promote the development of industrial equipment in the direction of digitization and intellectualization[9].

2. Functional requirements of industrial BD platform

2.1. Real time display and query of energy consumption data of wireless sensor networks

For wireless sensor networks with underlying data acquisition, sensors are generating new data all the time.

Therefore, the original data can reflect the working state of single or multiple devices in a certain period of time[10]. The original data after simple design has a certain reference value. Therefore, users' requirements for data query and display mainly focus on two points. First, we can query the working state data of relevant equipment at a certain time, which will facilitate tracking the working state of the equipment. Second, we can display the current working state of the equipment according to the data, which will facilitate the daily monitoring of the working state of the equipment[11].

2.2. Smooth connection between wireless sensor network and BD platform

The bottom wireless sensor network nodes adopt special processor chips. At the same time, the network transmission protocols are proprietary protocols of the IOT, which leads to the direct interaction of data and control information between the wireless sensor network level and the BD platform. In order to ensure the perfection and automatic processing capacity of the system, we need to add relevant software and scripts between the sensor network layer and the BD platform, which will complete the connection between different networks and modules[12].

3.3. Statistical requirements for cycle performance consumption data

For the preprocessed sensor data, users will generate energy consumption data of work cycle every other period of time, which requires statistical processing. There are many sensor nodes, which will cause huge data accumulation. Therefore, the traditional data statistical analysis methods can't be completed in an acceptable time range, which needs to be calculated through the parallel computing framework based on BD. Through the BD platform, we can simplify the operations required for statistical analysis requirements, which can also save processing time[13].

2.4. Real time data query requirements

Real time data query processing based on BD platform can meet the needs of users for fast data query, which can quickly locate energy consumption information and equipment information in massive data. The storage space in the underlying sensor network is limited. Therefore, data coverage will be carried out every certain storage cycle, which is difficult to rely on the storage device of the underlying sensor network to complete the data query function in a long time range. Therefore, the long-term storage function needs to be completed by the BD platform[14].

2.5. Complex energy consumption data analysis requirements

Complex model data processing mainly aims at the data processing requirements of some complex calculations. Through data mining and data analysis, users hope to obtain more useful information from massive data, which will guide energy-saving production and equipment maintenance. Therefore, complex energy consumption data analysis requirements can model energy consumption data, which can use classification, clustering, regression and other algorithms to deal with the parallel computing framework of BD platform. Therefore, users want to be compatible with more algorithm frameworks as much as possible, which will meet the scalability of the algorithm implementation framework[15].

3. Correlation algorithm

3.1. Multi attribute decision making method

TOPSIS method was first used from the geometric point of view, which can compare the scheme to be evaluated with the idealized goal. TOPSIS is a sort method of approximation and ideal solution by sorting according to their proximity. In this paper, the normalized matrix is $R = \left[r_{ij} \right]_{m \times n}$, and the specific calculation steps of TOPSIS method are as follows.

First, we can calculate the positive ideal solution R_j^+ and negative ideal solution R_j^- of the evaluation scheme, as shown in Formula 1.

$$\begin{aligned} R_j^+ &= \max_i (r_{ij}), j = 1,2,..,n \\ R_j^- &= \min_i (r_{ij}), j = 1,2,..,n \end{aligned} \tag{1}$$

Secondly, we can calculate the distance d between the scheme to be evaluated and the positive ideal solution and the distance d_i^+ of the negative ideal solution d_i^-, as shown in Formula 2.

$$\begin{aligned} d_i^+ &= \left(\sum_{j=1}^{n} r_{ij} - r_j^+ \right)^{\frac{1}{2}}, i = 1,2,...,m \\ d_i^- &= \left(\sum_{j=1}^{n} r_{ij} - r_j^- \right)^{\frac{1}{2}}, i = 1,2,...,m \end{aligned} \tag{2}$$

Third, we can calculate the relative approximation SC between the scheme to be evaluated and the ideal solution, which can obtain the final ranking of advantages and disadvantages, as shown in Formula 3.

$$SC_i = \frac{d_i^+}{d_i^+ + d_i^-}, i = 1,2,...,m \tag{3}$$

K-means clustering algorithm

K-means clustering algorithm is one of the most popular algorithms in data mining. K-means algorithm divides multiple data into a certain number of clusters, and each data point belongs to the cluster represented by the nearest mean distance from it. In general, K-means can quickly converge to the local optimal solution algorithm, which can be similar to the EM algorithm used in the mixed Gaussian distribution of iterative optimization. Since the deviation is a squared Euclidean distance, the points are assigned to the nearest mean, as shown in formula 4.

$$S_i^{(t)} = \left\{ x_p : \left\| x_p - \mu_i^{(t)} \right\|^2 \le \left\| {}_p - \mu_j^{(t)} \right\|^2 \quad \forall j, 1 \le j \le k \right\} \tag{4}$$

Through the data points belonging to the cluster, we can calculate the new mean midpoint, which can be expressed by clustering, as shown in formula 5.

$$\mu_i^{(t+1)} = \frac{1}{\left| S_i^{(t)} \right|} \sum_{x_j \in S_i^{(t)}} x_j \tag{5}$$

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4. Application of IOT technology in industrial BD platform

4.1. BD platform layer technology

The data in the wireless sensor network layer needs to be preprocessed by the server. The BD platform layer undertakes the infrastructure function of the upper application of the whole BD platform, which builds a distributed storage system. Therefore, we can apply key components such as Hadoop and spark on the distributed scheduling management framework. Through the computing framework and machine learning algorithm library, we can process massive data. Through the scheduling framework in the platform, we can manage data for regression, clustering, classification and other processing. The design structure of BD platform layer is shown in **Figure 1**.

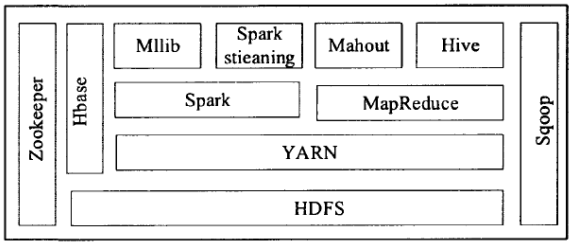

Figure 1. BD platform layer technology.

4.2. Industrial BD platform architecture

Architecture design will have a direct impact on the stability and reliability of industrial BD platform. At the same time, for the machine learning application scenario of industrial BD platform, we can build an industrial process requirements platform based on life cycle, as shown in **Figure 2**. The architecture of the industrial BD platform designed in this paper is divided into four layers, including infrastructure layer, scheduling layer, data service management layer and application layer.

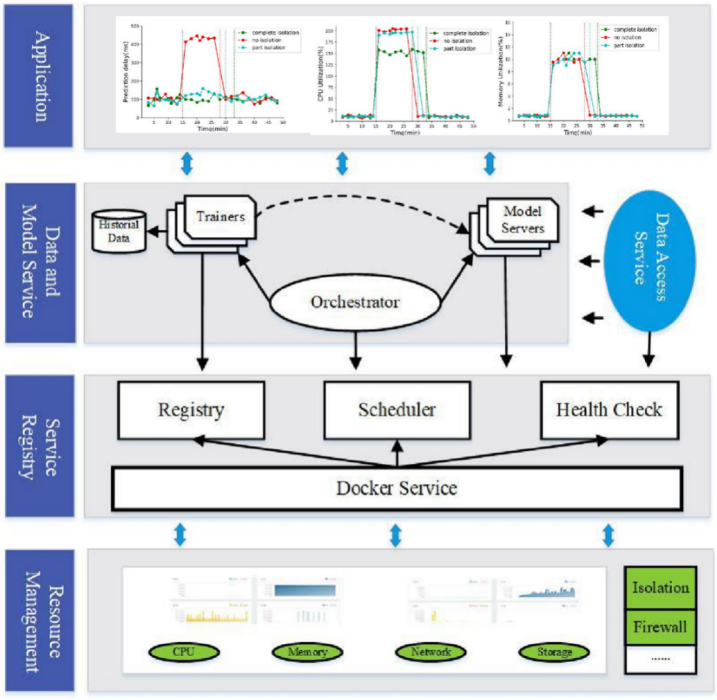

Figure 2. Industrial BD platform architecture.

5. Conclusion

At present, the digital economy has brought exponential growth of industrial data, which provides a broad basis for the application of industrial BD. The application of industrial BD can bring huge economic benefits in the process of transformation and upgrading of manufacturing enterprises, which needs to give better play to the value of industrial BD. By establishing a BD sharing ecosystem, we can realize the coordinated development of data resources. Through interconnection, we can use identification to create a data sharing mechanism, which will promote the open sharing of BD. Industrial IOT technology has been applied to all aspects of the industrial field, which has many advantages, such as security, real-time, automation, embedded, interoperability and interconnection.

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