

Application of Data Warehouse Technology in Digital Mine Information System

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Abstract—With industrialization process rapidly speeding up in our country and the dramatically growing of demands about mine development, people pay more attention to reasonably explore and effectively make use of mine resource, so it is priority to research the construction of digital mine. If data warehouse technology has been applied to the present mining industry, a new perspective to the analysis of mining data processing can be got, according to the requirements of the mining, on the basis of data reorganization and data storage, through on-line analysis processing and data mining techniques, hidden depth information in the huge amounts of data can be found; it can reduce repeat study and improve efficiency, and can provide more robust security decision supporting for mining services. The paper presents a new function hierarchy of digital mine information system based on data warehouse technology.

Keywords—data warehouse(DW); data mining(DM); on-line analysis processing(OLAP); digital mine information system(DMIS)

I. INTRODUCTION

Since proposing “digital mine” concept at the first session “international digital globe” congress in 1999, the thought of digital mine started to strike root in the hearts of the people, the DM scientific research and the technical attack have emerged quietly. The domestic and foreign experts and the scholar have done the massive research work in the digital mine or the intelligent mine aspect, and have made the substantial progress [1].

Along with the implementation of the mine informationization and the digitized project, mine enterprise accumulated massive mining geology exploration, excavation engineering, coal production management data, and so on. These data disperse in the enterprise interior different department and different system, they need to be inputted duplicately many times without data exchange mechanism, which caused data inconsistency, information feedback and sharing difficultly promptly, and produced so-called “the information isolated island”, has created the information resource and the equipment resources waste, moreover user cannot carry on thoroughly, systemic data analysis [2, 3].

Mine information database is the core of digital mine information system. Mine information database is a massive database, is the comprehensive database, multiple sources,

multiple scales and multiple categories. In the light of the characteristics of the current mine data and information: five nature and four multiplicity (complexity, massive, heterogeneity, uncertainty and dynamic, multi-source, multi-precision, multi-phase and multi-scale) [4], as a result, how to turn these numerous and jumbled, and various mine data into the valuable information, and how to organize, manage and share the mining data in a unified framework for space-time, which has become the most important problem of the mine informationization work, it is difficultly for traditional database to meet the needs of digital mine. To manage (gather, storage, organize, inquire, retrieve, and so on) these data efficiently, it is a very essential core link to research and establish data warehouse suiting mine own characteristic.

This paper describes the emergence and development of data warehouse, the concept of data warehouse, compares the differences between the traditional database and data warehouse. There are two important analysis tools in data warehouse, online analytical processing (OLAP) and data mining (DM).

In this paper, data warehouse technology has been applied to the present mining industry, a new perspective to the analysis of mining data processing can be got, according to the requirements of the mining, on the basis of data reorganization and data storage, through on-line analysis processing and data mining techniques, hidden depth information in the huge amounts of data can be found; it can reduce repeat study and improve efficiency, and can provide more robust security decision supporting for mining services. Finally data warehouse technology has been applied in digital mine information system.

II. DATA WAREHOUSE

The data warehouse technology was proposed in the 1990s, a data warehouse is a subject-oriented, integrated, nonvolatile, and time-variant collection of data in support of management’s decisions [5].

Data warehouse developed on the foundation of traditional database, database technology and their data organization method and so on also obtained full manifestation and application in data warehouse, data warehoused did not abandon traditional database thoroughly, but it aims at making up the insufficiency of traditional database in data analysis

ability aspect. Data warehouse stresses data analysis processing, but traditional database stresses data operation, data warehouse is one kind technology of management and analysis in view of the massive data. Comparing with traditional database, data warehouse has significant differences in aspects of overall characteristic, storing content, facing user and so on (TABLE I) [6]. The existence of these differences to realize the breakthrough of data warehouse technology in analysis ability.

Data warehouse technology includes data cleaning up, data integration, on-line analysis processing (OLAP) and data mining. OLAP is one kind of technology of on-line data accessing and data analysis of aiming at the specific question, it mainly realizes multi-dimensional data analysis of customer/server manner. OLAP supports the complex analysis operation specially, it stresses in supporting auxiliary decision-making of the personnel and management, it may realize complex inquiry of massive data fast and nimbly, moreover man-machine interaction form is direct-viewing and easy to understand. Data mining is a non-ordinary process of distinguishing effective, novel, potentially useful, as well as understandable finally pattern from massive, incomplete, noisy, fuzzily, stochastic database. Data mining carries on analysing enterprise historical data, makes inductive inference, unearths the potential pattern, forecasts the behavior of customers, helps policy-maker adjust market strategy and reduce risk [7].

TABLE I. DIFFERENCES BETWEEN TRADITIONAL DATABASE AND DATA WAREHOUSE

Contents	Traditional Database	Data Warehouse
data content	Detailed data related to production management	Compositive data related to decision-making
data model	Relational level indexical	Relational multidimensional
accessing manner	Always stochastic read-write	Always read-only operation
loading	Small amount of data used in a process	Large amount of data used in a process
transaction sendout	Commonly rare	Massive
operating requirement	Known in advance	Unknown in advance
frequency of updating	High frequently	Hardly update
data freshness	Real time save current data	Only save historical data
processing	Application-oriented transaction-driven	Analysis-oriented analysis-driven
data characteristics	Detailed data	Integrated, detailed and compositive data
data source	Mostly internal data	Internal , external data

OLAP is a tool of multi-dimensional inquiry and analysis, it supports policy-maker to carry on multiple perspectives and multi-level analyses to the data regarding policy-making subject. OLAP stresses on interaction, fast responsive speed and multi-dimensional view of providing data, but DM pays great attention to finding automatically pattern hiding in the data and useful information. The analytic result of OLAP may supply analytic information to DM as the basis of mining; DM

may develop analytic depth of OLAP, it may discover more complex and careful information that it cannot be discovered by OLAP. OLAP is on-line analysis processing, DM is a method and technology of obtaining knowledge through analysing the data of database and data warehouse, namely it discovers the pattern and the relation of hiding in the organizations and agencies database through building the model. The combination of the two may satisfy the requirements of ordering data and extracting information, it helps the managers of the enterprise to make decision-making.

III. APPLICATION OF DATA WAREHOUSE TECHNOLOGY IN DIGITAL MINE INFORMATION SYSTEM

If data warehouse technology has been applied to the present mining industry, a new perspective to the analysis of mining data processing can be got, according to the requirements of the mining, on the basis of data reorganization and data storage, through on-line analysis processing and data mining techniques, hidden depth information in the huge amounts of data can be found; it can reduce repeat study and improve efficiency, and can provide more robust security decision supporting for mining services.

Mine data warehouse is decision-making process of supporting mine production operating management, where data coming from various departments, various systems and different data source is processed in database for storage, extraction and maintenance, dispersed and difficult to access of trading data is transformed for concentrated unified and at any time available information, consequently it forms subject-oriented, integrated, stable and different period data collection, and it enhances speed and efficiency of accessing and processing data information.

Data warehouse function hierarchy of digital mine information system is as shown in Fig. 1. The whole System includes data acquisition system, data level, applied analysis system, and data accessing level. Its main component is the data source, data storage and management, OLAP, and DM, user access [2, 3].

A. Data Source

Data source is the basis of data warehouse system, including external information, internal data of mining enterprises, and documentation. External information refers to national policies, laws and regulations, raw materials market, mineral products market and so on. Internal data mainly refers to the data relating to mine daily production and sales activities, such as surveying data, mining engineering data, financial information, human resources information, equipment information, raw material consumption information and so on.

B. Data Storage and Management

Data storage and management are the core of the entire data warehouse system. On the basis of existing various business systems, it extracts, filters, transforms, integrates ,reorganizes data according to the theme, finalizes the physical storage structure of data warehouses, stores data warehouse metadata at the same time, realizes storage and

management of business data. Through the establishment of data model, in view of the application of different business agencies, it forms data marts, and provides a variety of presentation way: a variety data mining show, subject analysis, data querying, application of flexible reporting (multidimensional analytical table, dynamic analytical table, and so on), assists leaders and operational staffs work and decision support.

C. OLAP and DM

The goal of building data warehouse services for mining production operation and security management, the user analyses data through using data warehouses, produces data reports, assists management decisions. It extracts data from data warehouse, carries on data analysis, data mining, establishes analytical topics by business models,, provides decision support.

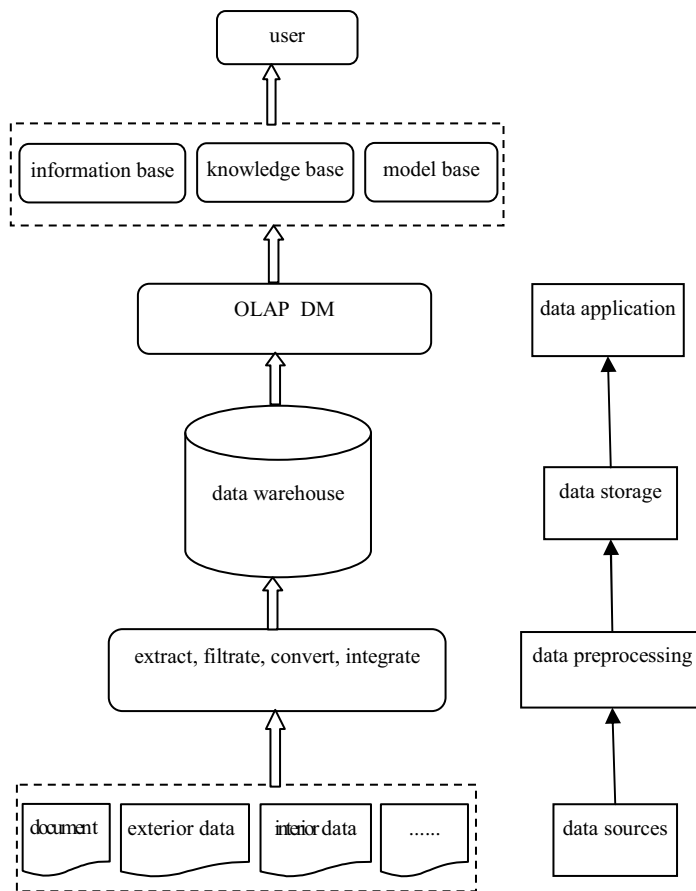


Figure 1. Data warehouse function hierarchy of DMIS

Data warehouse stores the massive data, which imply a lot deeper information, which possess more guiding significance to mine production and business activities, data mining is the favored tool to do this. Data mining bases on data warehouse, it can simplify data preprocessing procedure, the massive data in data warehouse happens to satisfy the request of data mining on the huge amount of data. The basic data of mine data warehouse is the object of mine data mining, according to determinate subject and decision task, mine data mining exerts

the expertise of mine domain, combines existent decision model, designs out related mining model, selects appropriate algorithm of data mining in method library, analyses, extracts, and mine out hidden mine law and potential information from mine data warehouse [3], to assist mine decision, forecast and guidance mine security, production, operating and management activities.

OLAP is a user interface part of data warehouse, from integrated data of data warehouse, it aggregates multidimensional detail data in accordance with prescriptive multidimensional data model. OLAP server restructures again the data of needing analysis according to multidimensional data model, to support user analysis of multiple angles, and multiple levels, to discover data trends.

In mine production management, OLAP can complete most decision tasks, such as production planning, economic effects, decision-making tasks on the subject of human resources, it is usually daily decision-making analysis report, and therefore, it can be achieved by operating multidimensional data cube on data warehouse. Another decision making tasks of decision support system are more complex, its data may exists in more than one subject domains, and after extracting the data from data warehouse, user requires to carry on processing of numerical computing, data mining algorithms, operations research, and other methods, this may requires a model library, method library, data warehouse and OLAP in several ways to complete collaboratively.

D. User Accessing

At the level of user accessing, facing business roles of mine enterprise at different levels, conducts applications such as data queries, business report generation and distribution, online business data reporting, and so on.

Data users of mine enterprise include three classes: the primary operation personnel, who is mainly responsible for collecting and importing data; middle management personnel of business sector, who gets supporting information of daily management decision by accessing data warehouse; the highest decision-making level of mine enterprise, using multidimensional analysis function of mine data warehouse, analysing production operating data from more perspective, providing information supporting for development and adjustment of production operating policy and enterprise strategy decision.

IV. CONCLUSIONS

Appling data warehouse technology will bring new changes to the mine enterprise informatization, promoting the construction of digital mine, raising the level of informatization of mining. By building mine data warehouse, forming data center within the enterprise, associating data within the enterprise organically, formatting data sharing within the whole enterprise, which will solve the data problems of independent and isolation effectively among the enterprise management, the business sector, the application system. Building mine data warehouse will provide strong data supporting for the operation and management of mine

production. Users may get useful information from data warehouse through various means, such as information inquiry, multi-dimensional analysis, data mining, and so on, then managers can master the information of resources, product, cost, security and market demand of mine enterprise comprehensively, promptly and accurately, which realizes decision-making of production operation scientifically and timely.

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