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Design of integrated manufacturing system of coal preparation plant based on multi-agent

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Abstract

Production process of coal preparation plant is a complicated process of multi-layer, which is determined by the production characteristics. The emphasis of information construction in coal preparation plant is the automatic data collection and data analysis. This paper constructs the integrated manufacturing system of coal preparation plant based on multi-agent, including the system analysis, module division, module construction, Agent construction, and software implementation. The production automation system has been successfully integrated with the information management, providing a useful auxiliary decision support to the production management in practice.

Keywords: Multi-agent; coal preparation plant; integrated manufacturing system

1. Introduction

Coal preparation plant is an enterprise where coal products of various quality and specifications are graded after removing impurities from raw coals. The whole production process of coal preparation plant is a complicated system of multi-layer and multi-structure, which integrates production control, operation and management and technology, with coal as the processing target. It is characterized by the close link of different operating processes, high level of mechanization and automation and continuity and short process\cite{1-2}.

The integrated manufacturing system of coal preparation plant aims at the successful integration of dispersed control system, scheduling system and management decision-making system, with the acquisition of all information required in the production process. With the application of automation technology, information technology, computer technology, minerals processing technology, and modern management science, an integrated manufacturing system characterized by excellent adaptation to various production environments and markets demand, optimal, superior quality, high profit, and high flexibility is expected to construct.

According to the author’s experience in studying the information construction of coal preparation plant over years, five problems as follows exist in the current integrated manufacturing system:

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(1) The production and operation of coal preparation plant should take initiative to meet the change of external environments. Otherwise, the survival and development of them will be a great challenge[3].

(2) The automation of a single machine and the centralization of technical process control require well-organized and soundly-planned automation technical transform.

(3) As a flow type enterprise, the automatic collection of data and analysis and extraction of effective information should be the emphasis of the construction.

(4) Intelligent motoring of production equipment operation, reasonable optimization of process parameters and the measurement and control of product quality should be realized in the production process.

(5) A good compatibility to the existing system should be guaranteed. In recent years, remarkable resultss have been achieved in automation and information management of coal preparation plant at home and abroad. As a result, the new system must be an open one.

2. Integrated manufacturing system module of coal preparation plant based on multi-agent

Nowadays, the production and operation of coal preparation plant are increasingly market-oriented and networked. The major functional departments and cooperating enterprises are geographically distributed and autonomous, which demands the resource coordination and cooperation to realize the aim of the system. According to the internal distribution of software and hardware resources, in the present study, the integrated manufacturing system of coal preparation plants is regarded as a system consisting of several interactive intelligent Agents, with one application corresponding to an Agent.

The integrated manufacturing system module designed in the present study is shown in Fig. 1[4]. The module consisted of several static and dynamic Agents. Communication between different Agents is conducted by KQML/XML. In order to solve the problems such as compatibility of application system and supporting platform, friendly interaction between human and machine etc., five Agents are designed in the system. The five Agents can communicate with each other through the proxy Agents and ultimately interact with the users[5-6].

Fig. 1. The integrated manufacturing system module of coal preparation plant based on multi-agent
3. Realization of integrated manufacturing system

Based on the module shown in Fig. 1, different types of function Agents were designed. In essence, the integrated manufacturing system is composed of many links bearing different tasks. The links cooperate to fulfill the task of coal processing while fulfilling their respective tasks.

Different types of Agents are decomposed in the present study. There are two modules of decomposition: function decomposition and entity decomposition [7]. The former involves the packaging of some functional modules with Agent, which has no direct corresponding relationship with the entity. While the latter involves the actual existing entity such as raw coal, the workers, the operation and so on. Thus Agent has a definite relationship with the entity. In the present module (as shown in Fig. 2, entity decomposition is mainly applied on the basis of function decomposition.

Concerning the production and operation features of the coal mine preparation plant, four major management systems were designed according to different functions. They are: supplier relationship management system (SRM), customer relationship management system (CRM), production process management system (PPM), and decision support system (DSS). Corresponding to each system, intelligent Agents ranging of SRM, CRM, PPM, and DSS were designed respectively. In each intelligent Agent, relevant function and entity decompositions were set. In order to create a harmonious internal and external environment for the integrated manufacturing of coal preparation plant, a coordination intelligent Agent of external system was also set.

4. Case study

The application of the designed system can be seen in the case of the production and management system of
LinHuan Coal Preparation Plant of Huaibei Mining(Group)Co., Ltd, where the production and management system consisted of production plan management subsystem, production scheduling management subsystem, storage and transportation management subsystem, quality management subsystem and production data management subsystem.

The function orientation of the production Agent is to obtain tasks, organize the production process and coordinate the operation etc. [4,8]. In this case, the Agent works as a function one. And internally, it is a multi-agent system, consisting of planning Agent, scheduling Agent, transportation Agent and some other Agents.

The detailed structure of the Agent can be seen in Fig. 3. Interface Agent is designed to use the existing software system such as personnel and financial management information system. Through ORB or XML, the interface Agent can exchange information with the existing systems. Proxy Agent is responsible for the coordination of production Agent and other Agents in the management system. Knowledge Agent is responsible for the management of special knowledge in the production Agent, and offered information and knowledge to other function Agents. According to the actual situation of coal mine preparation production, four functional departments including planning department, scheduling department, transportation and marketing department and coal quality management department are assigned. Accordingly, four subfunction Agents are designed. The subfunction Agents themselves are multi-agent system, which needs to be further studied.

5. Conclusion

With the acceleration of information construction, the integrated manufacturing system of coal preparation plant develops rapidly. The effective integration of real-time data acquisition and the production management information
in the system will be a good research topic for further study. In the present study, Agent is used as a tool and the integrated manufacturing system of coal mine preparation plant based on multi-agent is designed and studied with an application case. It reveals that such a system is helpful to the information production of coal mine preparation plant and provide a useful auxiliary decision support for the production command personnel.

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