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Application of Cloud Computation in Chemical Production

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With the continuous development of network communication technology, the development of simulation training system based on the power of the Internet has been studied. Chemical enterprises themselves have high risks, so the issue of safe production is more and more serious. In this paper, a simulation training system suitable for chemical production is developed according to the particularity of chemical enterprises, based on the cloud computation technology and combined with mathematical modelling. The system can be used for student simulation training or to deal with the failure through the data mining technology in computer network, in order to achieve safe production. In addition, the research on simulation training system for chemical production based on cloud computation technology is conducive to pre-employment training of chemical workers and can improve the quality of operators and managers and the operating conditions of production facilities.

1. Introduction

The chemical industry dominates the national economy and is the backbone of economic development. However, it involves many kinds of materials, and its production features high temperature and pressure, flammable and explosive, toxic and harmful, and continuous production. Therefore, the safety problems of chemical enterprises should not be overlooked (Cai et al., 2016, Xiao and Xu, 2015). Simulation training system is widely used in chemical enterprises in China and it is a training environment system which can fully demonstrate the students' creativity (Guo 2016; Nowicka, 2015). Compared with the traditional field training, the present simulation training system has several advantages, which not only can help the students understand the principles of process and chemical operation in a shorter period (Moghadam et al., 2015; Yang et al., 2015) but also enhance their practical ability and improve their ability to analyze and judge the dynamic operation of large-scale chemical production processes and to handle accidents (Wang et al., 2015; Czajkowski et al., 2015). Cloud computation technology is a new information technology service model that provides IT hardware and software to customers, as required, by self-help mode through the Internet (Chen and Chang, 2015, Kim et al., 2015). Its unique technical characteristics of flexibility, scalability, pay-as-you-go and shared environment provide a more economical, flexible and controllable future information solution for enterprises to cope with dynamic and complex environment (Venkateshwaran et al., 2015; Gambi et al., 2016). A wide range of control systems and production management system based on computer technology has been widely used, thus accumulating a large number of historical and real-time production data (Sakimoto et al., 2016). The historical data of massive disasters in industrial processes is important assets for research on the security of industrial process. However, these data are valuable only if information is truly revealed behind the original data (Baranovskiy, 2015). Therefore, it is of great significance to research cloud computation technology in this background.

2. Feasibility analysis of cloud computation technology in chemical production

Cloud computation is to achieve its goal from the technical "cloud" to reality. In the modern chemical production, the cloud computation can be applied in many aspects such as industrial production, chemical product flow, sales, after-sales information tracking and industrial information service. In order to adapt to the characteristics of the chemical industry, a cloud computation application system that meets the needs of chemical production should be established and comprehensively measured and implemented from the

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aspects of overall architecture design, platform construction, information resource preparation and data center construction, so as to promote modern chemical industry.

2.1 Technical feasibility

With the development of cloud computation technology in the Internet age, many research institutes, information experts in chemical industry and scholars in China have started the practical application of cloud computation in the modern agricultural information system. Therefore, the concept of cloud computation has been initially explored and used in the chemical industry of China. The chemical industry information cloud platform provides specific users with a software platform to interactively access relevant information, application systems and business processes through a highly personalized approach. Based on the integration of various application systems, data and Internet resources related to chemical product information and chemical production into a unified portal site, an integrated service management platform is established that can integrate the original division of the vertical and horizontal relationships, separate infrastructure and application systems. It provides a unified information access portal for users to achieve smooth upgrading and expansion of the chemical industry information platform and eliminate the “information silo” fundamentally, so as to construct an information network of chemical product chains.

2.2 Market demand

In recent years, the application of modern information technologies, represented by information resources such as Internet of things and cloud computation technology and the sub-commerce of the chemical industry, is oriented towards the entire industrial system of modern industrialization and has become an important driving force for the development of the modern chemical industry. And it is received by the market. Cloud computation technology provides a good solution to the bottlenecks in the construction of information networks and resources in the economic system of modern chemical industry. In the cloud computation environment, the information resources from different regions and departments are integrated through the “cloud” and thus industrial information on the Internet is changed into distributed online resources. This is like a giant web server for practitioners and chemical technicians, which communicate industrial sciences with technology information and eliminate low precision, poor timeliness and single forms of information, and accelerate the online application of chemical industry information and improve the efficiency of information application.

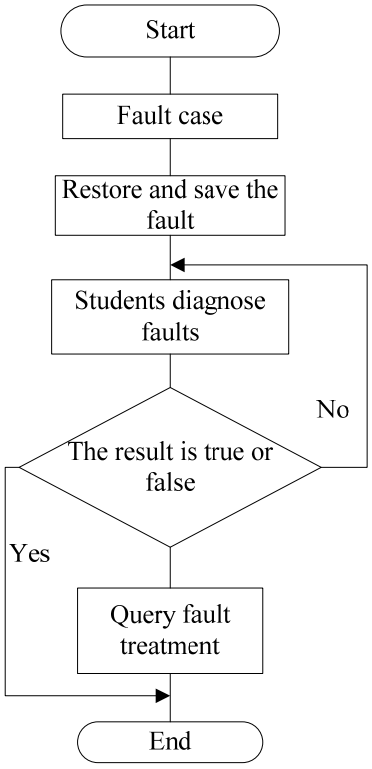

Figure 1: Basic flow of simulation training system

3. Design of simulation training system for chemical production based on cloud computation

Simulation training system is a powerful tool for training and assessment of students' skills, design and research of complex systems. It has changed the traditional skill-based training model and avoided the risk due to error-prone operations when the training on real process equipment is conducted. Therefore, it has become an ideal model for pre-employment training on operators and technicians by modern chemical companies, and an essential tool for training in the operation of complex process equipment by petrochemical enterprises.

3.1 Basic process of simulation training system

Simulation training includes fault setting, alarm information display, fault diagnosis, system evaluation, access to initial measures and other steps, and its basic process is shown in Figure 1. After the end of fault setting, the system should recover the fault components and operation modes, and save the measures for the inquiry by students. Student station can repeatedly check the alarm information in the troubleshooting, and the students can inquire the recovery measures at the end of troubleshooting.

3.2 Detailed system design

Simulation training includes fault setting, alarm information display, fault diagnosis, system evaluation, display of processing measures, etc. After the fault is set, the measures are saved for the inquiry by students. The system needs to recover and process the fault components and operation modes. The student station can query the alarm information repeatedly during the fault diagnosis. Students can query the recovery measures after the fault diagnosis.

Components of student station: the student station component is a skill training portal for the entire simulation training system of chemical production. Students can enter the system by entering the correct user name and password and invoke the component for training. If the user name and password do not match, the control software will shut down the system to prevent illegal users to enter after 3 times of failure to login system. You need to restart the computer to log in again. In addition, the functions of student station component include: students maintaining their own information, questions to the trainer and selecting the training content. The operation process of training after the students log in through the student station component can be illustrated in Figure 2:

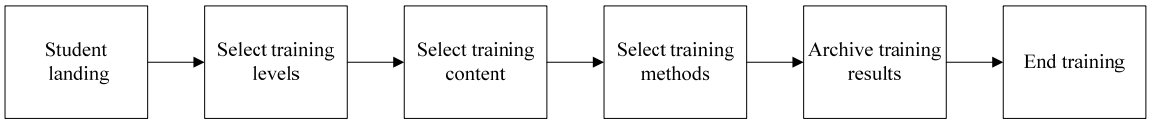

Figure 2: Operation flow of components in student station

Components of central control station: the design concept of the central control station is to imitate the main functions of the universal station. The main operation screen includes the screens of group operation, flow chart, unit trend, unit alarm and alarm overview. In the specific implementation, a variety of screen display will be directly controlled with the mouse or keyboard, so that students can master the actual production operation in a virtual training environment. The overall design flow of the central control station is shown in Figure 3. After the program is initialized, the time should be detected whether to reach specified by the timer. If it arrives, the data should be read from the component of simulation model station, and the data modified by the students is sent back to the simulation model component, so as to change the corresponding data in the components of central control station. The components of central control station also need to accept the instructions from trainer and process accordingly to further decide which process data to read in the components of simulation model station or to exit the program. If a new event is detected, it needs to be dealt with accordingly. In addition, if there is a key instruction of students or new data input, the screen should be refreshed.

On-site station components: the function of the on-site station components is to enable the students to simulate the on-site operation of the production process through the flow chart displayed on the computer. The main operations include the adjustment of instrument in reaction zone, manually adding material to the feed tank and valves. In addition, the on-site station can also monitor the operation of the central control station. If the central control station issues any operation instructions, the on-site station will simulate the operation according to the instructions and feed back the result to the central control station. The operation procedures of on-site station are as shown in Figure 4.

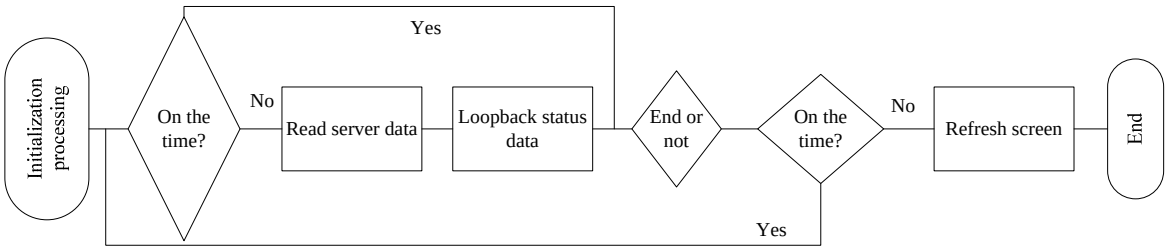

Figure 3: Operation flow of component in central control station

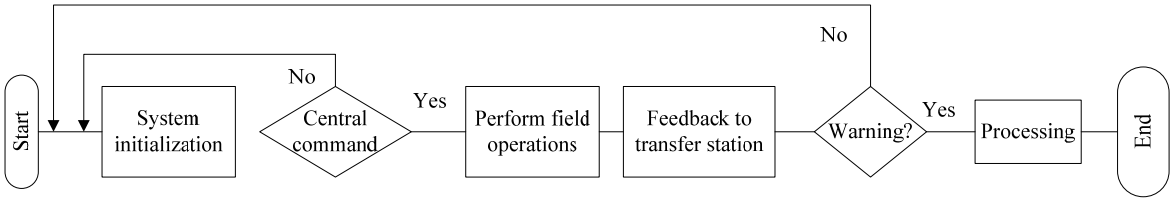

Figure 4: Operation flow of field station components

3.3 Application of chemical simulation training system in the production process

In the chemical industry, most factories have accumulated a large number of actual production-related data. These data are mostly stored in the form of data files, production records, large databases, etc., and contain production-related regularity and important production experience of operators. However, these useful data have not been effectively used. The cloud computation technology is used in the simulation training, which can find out the potential relationship between the past data from the massive original data, thus obtain the information in favour of user's decision-making and increase the productivity. The chemical production process is divided into two parts: simulation training system of synthetic process; real-time data and data mining system. Simulation training system contains a control system that connects with real-time database and data mining systems through network.

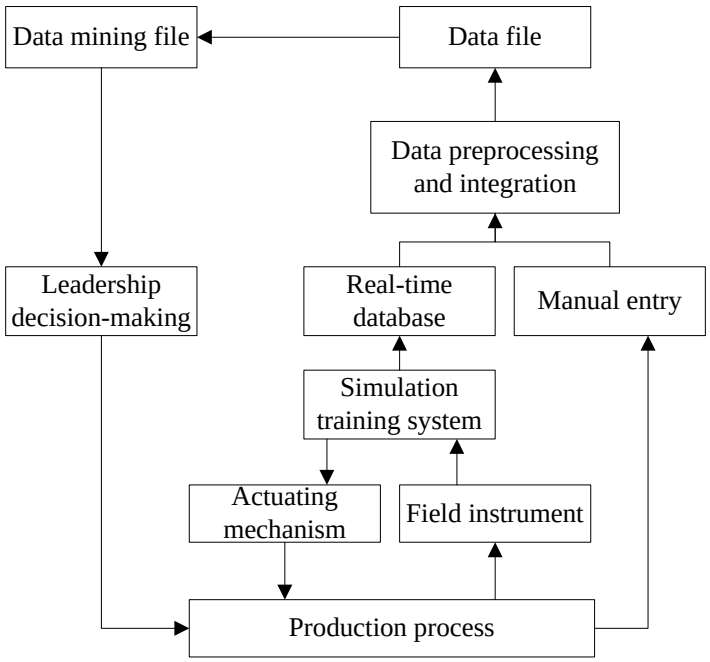

Figure 5: System general architecture diagram

3.4 Establishment of accident diagnosis system in chemical production

Chemical simulation training system can use the data mining technology to detect abnormal conditions in production, and conduct cluster, classification and correlation analysis of the data in various fault states to establish a system fault diagnosis model. Data mining technology can make use of the existing fault information, including the fault phenomenon, cause of fault, mechanism of fault and solution, etc., to extract the fault rule to realize the real-time monitoring and fault diagnosis of the chemical industry production, as shown in Figure 6.

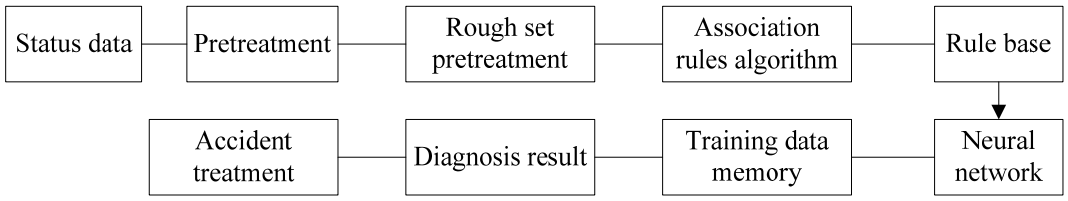

Figure 6: Structure of accident diagnosis system

4. Conclusion

In this paper, a chemical simulation training system is designed based on cloud computation technology, and the application of the simulation system is known through reference to relevant literature. The chemical simulation training system which is designed using the chemical expertise learned according to the characteristics and particularity of chemical companies has a positive significance on safe production in enterprises, accident diagnosis and treatment, speeding up the production automation and improving business productivity, etc. Firstly, the simulation training system is based on web architecture with the browser as the client, and the system software is installed on the server side, so that the client can access the system through the browser to participate in training. It is simple and convenient in operation. Secondly, the correct user name and password should be input into the system before simulation training to ensure the safety of students' information. The system plays the advantages of the Internet, and its reusability and versatility are improved through the production process model using modular design. In the simulation training, the data mining technology and accident diagnosis system can make full use of the historical data in the production process, diagnose and analyze these data and improve the model continuously, so as to provide the key information that can assist the user in decision-making.

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