The Architecture of P2P Computer Collaborative Design System Based on Artificial Intelligence

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Abstract. The design of complex products is the result of applying multi-domain knowledge. Moreover, global competition also requires enterprises to speed up the progress of new product development and shorten the r&d cycle in the "unpredictable and continuous and rapidly changing competitive environment". So in today's highly developed information technology, how to in the computer, so will the design knowledge in the field of multidisciplinary combined effectively, so that you can in a shorter time to provide the market with higher quality, more reasonable cost, better service and more environmentally friendly products, to maintain and expand the competitive advantage, is the key to successful product design. In this paper, we study the Internet environment based on P2P technology of artificial intelligence distributed collaborative design system, first of all, the operation mode of the distributed collaborative design and functional requirements and so on has carried on the system analysis and research, and based on this, advances based on P2P technology of artificial intelligence the architecture of collaborative design system, transfer the data management in collaborative design and collaborative processes to the coordination between site directly, in all of the site is established between the resource sharing, dynamic adjustment mechanism, and obtained better effect of collaborative design.

Keywords: Computer Supported Collaborative Design, P2P Network, Process Planning, Conflict Resolution

1. Introduction

With the progress of The Times, digitalization, networking and informatization are and will continue to promote global economic integration [1]. The digitization of information content provides a foundation for the computer processing of information; the networking of information exchange eliminates the time and space restrictions of information transmission [2]; the informatization of
management mode enables information to be transferred quickly, accurately and flexibly among enterprises, and the connection between enterprises is closer [3]. Internet platform is different from the traditional computer hardware platform, it has the following basic characteristics; The "true" distribution without unified control, the high degree of autonomy of nodes, the openness and dynamics of links with points, the multiple heterogeneity of people, devices and software, the unpredictability of entity behavior, the potential insecurity of operating environment, the personalization and flexibility of usage, the diversity of network connection environment, etc. [4]. This makes the environment of computer software development, deployment, operation and maintenance start to move from closed, static and controllable to open, dynamic and difficult to control [5].

With the aggravation of market competition, each department in the enterprise and each enterprise has become an interdependent close group. The traditional single-player working mode is gradually replaced by the group working mode, and the operating environment of business process also needs to be built from the "isolated" environment into the collaborative working environment [6-7]. The development of collaborative working environment develops with the development of computer technology and network technology, which has gone through a process from simple to complex [8]. Traditional way of meeting is the most simple of collaborative working environment, suitable for real-time, face-to-face communication between members, then developed work conference calls and video conference was liberated from the limit of space in [9], but because of the limitation of the system itself, it cannot meet all the requirements to the computer as a platform to work now, a collaborative design system based on client/server mode is the revolutionary development of collaborative working environment, it makes the collaborative participants of collaborative behavior has the stronger control and processing ability, and can get more support system [10].

In this paper, based on P2P technology of artificial intelligence the architecture of collaborative design system, transfer the data management in collaborative design and collaborative processes to the coordination between site directly, in all of the site is established between the resource sharing, dynamic adjustment mechanism, obtain better collaborative design effect, finally to collaborative design needs to solve some key technologies are analyzed.

2. Method

2.1. P2P Network Model

In P2P network, resources are scattered on each peer, and the peers join and exit very frequently. Therefore, it is very important to establish a reasonable P2P network model and find nodes and resources on nodes quickly and accurately. At present, P2P network models mainly include the following three types:

1) Centralized P2P: The centralized P2P model has one or more central servers to record Shared resources and answer queries about these resources. The centralized P2P network model is shown in figure 1. This form of P2P network has one or more central servers to provide users with the service of sharing and searching files.
(2) Distributed P2P: Distributed P2P model is a pure P2P model, which does not need a central server, and each peer on it is completely equal. Each Peer can act as both a client and a server, and they have the same capabilities as their neighbors. Software in the form of distributed P2P is known as the second generation P2P, such as Gnutella, Freenet is a representative of this form, distributed P2P network model is shown in Figure 2.

![Figure 1. Centralized P2P Network Model](image)

![Figure 2. Distributed P2P Network Model](image)

2.2. **Collaborative Design System Architecture based on P2P Technology**

This paper established a collaborative design system based on P2P is to make full use of the technology of these features, and absorb a variety of software that represent the future development trend of advanced ideas and technology, and then take advantage of these features and technologies of the collaborative design system structure and operation way, enable it to adapt in the open, dynamic and heterogeneous distributed environment under the requirements of collaborative design. The system has made many significant improvements in distributed technology from the aspects of resource management, standardization, Internet collaboration and intelligentization, etc. It supports large-scale resource sharing, parallel processing, remote collaborative work, support open standards, support dynamic changing services, and realize highly intelligent man-machine dialogue.

In this paper, using the technology to build a loose, the framework of collaborative design of open mode, the system can according to need to set up a unified server in peer-to-peer networks can also be gathered as a super peer, relative to ordinary peers, it save more resources, have more service function, other each peer is equal, the system resource distribution according to need of stored in each node and server.
3. Experiment

3.1. Experimental Platform and Environment

In order to simplify the analysis process, this paper only considers to test the performance of the collaborative design experimental system in the case of local area network environment and the same peer group, and analyzes the test results.

The experimental environment was constructed in the laboratory LAN environment, and the network topology environment was designed. This includes 10 peer sites and 1 server, each of which installs a P2P collaborative design prototype system, while the server installs a corresponding collaborative design system with more functions and sets the server as the aggregation peer.

3.2. Experimental Parameters

Sending rate V: Number of request messages per second issued by ordinary peer entities. When the sending speed is too fast, the message will be queued and the packet will be lost.

Message rate M: Divide the message into N types, and the proportion of new message types in the sent message.

Message processing delay: The time each message is sent to receive a reply message.

Average message processing time: \( L = \frac{\text{total wait time}}{\text{number of messages sent}} \)

The standard variance of message processing is \( \sigma_L \):

\[
L_i = \frac{1}{n} \sum_{i=1}^{n} L'_i
\]

Where \( L_i \) represents the delay of the \( j \) request.

\[
\sigma_L = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (L'_i - L)^2}
\]

4. Discussion

4.1. System Message Processing Delay Analysis

In this model, after sending the service request when ordinary peer entities, it first query the history of local access records, check whether the requested service is visited service whether it hit, and if so, then returned directly access records stored in the history of the service information if not, then the service discovery requests to central peer entities. The missed service discovery request involves two waits, the local wait queue and the central peer wait queue. Therefore, if the rate of message change continues to be high, the message processing delay will be longer.
In order to analyze the effect of different message rates on delay, this paper takes 30% and 70% message rates to analyze the effect on delay. From the above two figures, it can be seen that in the case of low request rate, the change of average delay with the request rate is not obvious, and it can be basically considered that the change of request rate has no effect on the average delay. As the request rate increases, if the message rate changes at 30%, the average delay grows much more slowly than the average delay at 70%. With the decrease of the rate of message change, the delay situation will be improved continuously.

4.2. System Model Performance Analysis

According to the above experimental results and the characteristics of P2P collaborative design system, it can be seen that the architecture-based collaborative design system proposed in this paper provides a distributed, efficient, reliable and safe system framework for collaborative design work. In addition, the mechanism of equality and sharing of resources among all collaborative sites provides a new design method for improving the mutual perception model among collaborators. It makes use of the collaboration between all the collaborative sites to provide appropriate relevant data for all customers, and the balanced use of network resources in the entire collaborative team, so that more
optimized collaboration can be achieved.

Based on the data analysis of the experimental results above, the P2P technology-based collaborative design system established in this paper has significantly reduced its dependence on the server, which has well overcome the bottleneck effect caused by the server. Most of the functionality and power of the server is returned to the peer, allowing the core of the network application to spread from the central server to the terminal devices on the edge of the network. It solves the problem that most collaborative design systems depend too much on server.

All collaborative users communicate with each other via virtual links. When the data link between the two sites is blocked or unavailable, a new virtual link is established between the two sites through the link information with other collaborative sites to ensure the reliable transmission of data. This paper compares the reliability of the proposed P2P framework structure with that of the traditional point-to-point communication process, and the results are shown in Table 1.

**Table 1. Reliability Comparison between P2P Communication and Traditional Point-to-point Communication**

| Site number | P2P Communication | Point-to-point Communication |
|-------------|-------------------|------------------------------|
| Single connection reliability | 0.999 | 0.999 | 0.99 | 0.999 |
| 3            | >0.999 | >0.9999 | 0.97 | 0.997 |
| 4            | >0.999 | >0.9999 | 0.94 | 0.994 |
| 6            | >0.999 | >0.9999 | 0.86 | 0.986 |
| 10           | >0.999 | >0.9999 | 0.64 | 0.956 |

5. Conclusion

At present, under the dual effect of globalization, open market competition and technological progress of product development, the development progress of new products is further accelerated. At the same time, enterprises are forced to adopt the strategy of leading the speed of product development and market input in order to gain the leading edge of product development. Therefore, based on the distributed collaborative design model realized on the basis of technology, the following achievements in product development process planning and management, collaborative design theory and method are of great theoretical and practical significance for enterprises to improve their competitiveness. Collaborative design contains a wide range of contents. This paper makes some exploratory research on some contents of collaborative design, and obtains preliminary results in theoretical methods and development technologies. However, the architecture of collaborative design system still needs to be further improved. In this paper, only the basic construction of P2P collaborative design system based on artificial intelligence is preliminarily studied. In the future, the overall architecture of collaborative
design system and the organization and presentation of intellectual resources need to be further and systematically studied, and the usability and intelligence of the system need to be quantitatively analyzed.

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