Research on 3D CAD Design of Manufacturing Domain Integration System based on Cloud Computing

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Abstract. CAD is a comprehensive and integrated system, which integrates information technology and application domain technology. The objective behind this study is to realize the development trend of manufacturing industry towards networking, informatization, intelligence, industrialization and integration. This project takes cloud computing as a new technology, and according to the application requirements of manufacturing informatization, it puts forward the deployment and release of business application services according to user needs. The experimental results demonstrate the feasibility of applying cloud computing technology to manufacturing information management software. Reasonable allocation and scheduling of soft manufacturing resources, avoid resource waste and resource conflict, and maximize resource utilization.

Keywords: Cloud computing; Integrated system; 3D CAD
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1 INTRODUCTION

At present, China's manufacturing industry is transforming from production-oriented to service-oriented, and manufacturing service is becoming a new economic growth point of manufacturing industry. To realize this transformation, related technologies, platforms and new models are needed. In recent years, cloud computing, a service-oriented computing model, has been developing rapidly, along with the development of information science and technology such as Internet of things technology, high-performance simulation, intelligent science, etc. Cloud computing is the integration of advanced information technology, enterprise collaborative manufacturing technology (model design, process design, processing simulation, workshop production, production management and resource integration) with the emerging Internet of things technology, intelligent scientific service technology, computing technology and other technologies.

Through the virtualization of manufacturing resources and manufacturing capabilities, a manufacturing service resource pool is constructed. Through the extensive Internet infrastructure, users can obtain relevant resources anytime and anywhere through the cloud. Enterprises can respond to the market quickly according to customer needs, improve service quality, and bring high added value to products [1]. There are many kinds of spatial cam deceleration mechanisms, such as single-head, multi-head, left-hand and right-hand. In the actual application process, the left-handed single-head spatial cam deceleration mechanism is often used [2].

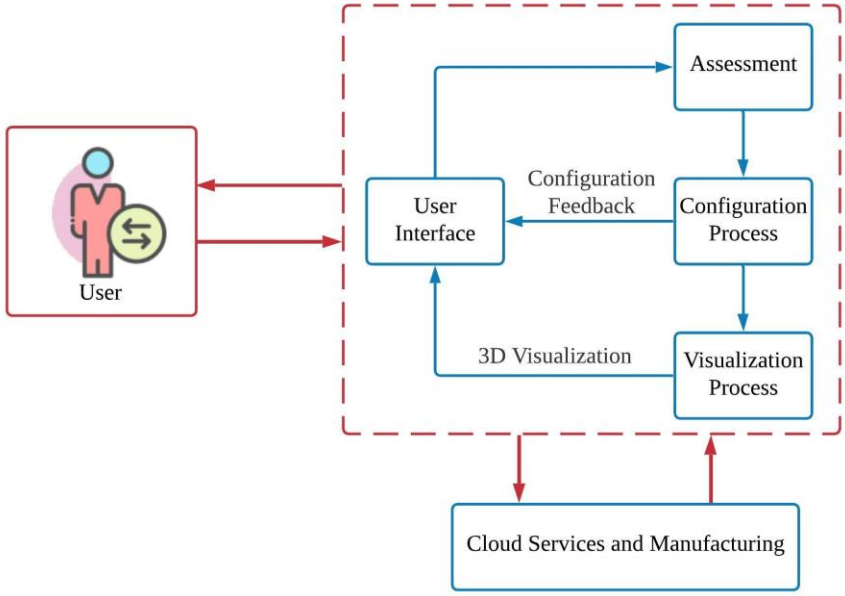

Figure 1: Relation among the cloud services and configuration process.

Figure 1 represents the configuration system of the proposed design using cloud services that consists of five basic models in order to enable the product configuration. The five steps are visualization stage, confutation stage assessment stage, cloud services and product assessment stage. Cloud services for a manufacturing product supports the configuration of product. What's the request is received the cloud services check the request for its validity and then send the required data for the product manufacturing to the system. After the completion of product configuration, the information regarding product specification is submitted for or the further processing.

Sometimes, because of the different transmission ratio requirements, two-head cams are also used, but the outline of three-head and more than three-head cam mechanism is complex, and seldom used [3]. Usually when the transmission ratio is less than 6, two or even multi-head cams are often used to avoid the large pressure angle caused by too small cam mechanism, which reduces the transmission performance of the mechanism [4]. When the transmission ratio is greater than 6, single-head cams are mostly used; the follower rollers of the mechanism have more shapes, usually cylindrical and conical [5].

CAD is a comprehensive and integrated system, which integrates information technology and application domain technology [6]. It involves information technology: computing technology, including computer hardware and software; graphics, including graphics algorithm and its implementation, graphics software, graphics equipment data management, engineering database management system, can process text, standards, specifications and other engineering data; numerical analysis, including finite element analysis, simulation, simulation and other technologies; intelligent technology [7]. It includes knowledge engineering, expert system,

artificial intelligence interface, etc.; man-machine interface, such as graphical user interface, multimedia, etc.; network communication, including LAN, Internet, intranet, etc [8]. The hardware of CAD consists of computer or workstation, large capacity memory, graphic equipment and other external transfer equipment, communication and network equipment [9]. CAD technology has become a key technology for enterprises to improve their innovation ability, product development ability and competitiveness. Users and manufacturers engaged in packaging industry are no longer satisfied with the original CAD software system, they expect more specific functions for the packaging industry CAD software [10].

The rest of the manuscript is organized as the recent work in the field 3D CAD design of manufacturing based on cloud computing is described in Section 2. The design analysis of cloud computing is described in Section 3. In section 4 the design of 3D CADDCAM integrated service framework based on cloud computing is presented. At last the conclusion drawn from the experimental analysis of proposed design is described in Section 5.

2 LITERATURE REVIEW

In recent years, the concept of cloud computing has attracted the attention of the international academic community. Many countries have carried out research on cloud computing. The development of cloud computing is based on cloud computing. The concept of cloud computing was first proposed by Google in 2006, which started a new round of research and development boom of it technology. Different enterprises have different standards. IBM believes that cloud computing is a platform that can dynamically deploy, configure, reconfigure, and revoke services according to requirements. It also provides instant services to customers by launching the "blue cloud" program C. Cloud computing system is a kind of permanent information stored on the server in the cloud [11] which is cached by the client. Ji Ye of Berkeley University and others support the idea that cloud includes hardware and system software of data center [12-15].

On the market point of view, Cao, H. and others believe that cloud computing provides users with computing resources dynamically through service level agreement. The system is a parallel distributed computing system composed of a group of interconnected virtual machines, etc. Cloud computing is a service-oriented, sharing hardware and software resources, integrating and managing enterprise resources. Facing large-scale distributed environment, cloud computing provides services to users by a third party, and charges on demand. Therefore, cloud computing has the characteristics of virtualized resources, resource sharing, high reliability, scalability, economy and security.

The cloud technology has been integrated into the manufacturing enterprise, and the cloud technology has been integrated into the manufacturing enterprise. Cloud computing is a new mode and means of Intelligent Manufacturing Based on network and service-oriented [16]. Elhoone, H, for large group enterprises, R & D and design capability service platform, regional processing resource sharing service platform, manufacturing service-oriented support platform, public service platform for small and medium-sized enterprises, and manufacturing service platform driven by logistics, the corresponding resources, service objects and service types in five directions are summarized. The application of cloud computing in aerospace R & D and manufacturing process is proposed, so as to reduce information cost, allocate large manufacturing resources efficiently, enhance group management and control ability, and improve R & D efficiency [17, 18].

Thus, with the deepening of cloud computing research and development, the application of cloud computing in enterprises has also been expanded, and products have gradually changed from manufacturing mode to "manufacturing as a service" mode.

Enterprises can use the built cloud service platform to integrate manufacturing resources, store data to the cloud, and form a collaborative R & D and manufacturing environment; enterprise employees can collaborate on the cloud computing platform to improve R & D efficiency. Users through the cloud computing platform, according to the needs of customization, to meet personalized, diversified needs.

3 DEMAND ANALYSIS OF CLOUD COMPUTING

3.1 Advantages of Cloud Computing Architecture Information Management Software

The advantages of cloud computing that can't be ignored make the enterprise information system cloud computing the trend.

- Data consistency. The data of cloud architecture is stored in the headquarters database, and there is no problem of data synchronization.
- Data real-time. Cloud architecture platform business can be real-time refresh, real-time data has been well protected.
- High reliability. The file system of cloud computing uses the fault-tolerant mechanism of multiple copies of data, the isomorphism and interchangeability of computing nodes, etc., which ensure the high reliability of services.
- High scalability. The scale of cloud computing can be dynamically scalable. Service providers can increase server nodes according to the growth of users to improve the computing power of cloud computing services.
- On demand service.

Because the computing and service capability of cloud computing is a huge shared pool for all users, users can choose different modules according to their own needs, so as not to occupy unnecessary resources. When the related services are not needed, users can easily return the occupied resources to the resource pool.

3.2 Integration Requirements of 3D CAD and PDM

PDM is the core and platform of manufacturing information solutions. It is based on software and manages all the information about products, such as engineering drawings, product structure tree information, database records, etc., as well as the process information about products, such as workflow and change process. It provides the information management of the whole life cycle of products. However, the product results designed by CAD system can only output drawings and relevant technical documents. Similar information cannot be directly used by CAPP, so that the process design cannot be carried out. Manual human-computer interaction is also needed to make the CAPP system produce the processing process cards of parts. Therefore, the integration of PDM and 3D CAD is a crucial step in manufacturing informatization.

From the point of view of 3D CAD system, the main function of PDM is to check in CAD information, check-in and check-out of CAD system. It includes the information of the parts, such as drawing.

In the following, we will analyze the integration requirements of each functional module of PDM and CAD integration respectively.

- Document management of drawings. The file management of drawing includes drawing file checking in, drawing checking out and document searching.
- BOM table information management of drawings. PDM focuses on product data such as product structure and component attribute information of CAD drawings. BOM table is the carrier of these product data in the whole life cycle of products, and it is also a product structure data file that can be recognized by computer. Therefore, the BOM table management of drawings is an important requirement function in the integration of PDM and 3D CAD. This function extracts the product structure and component attribute information of CAD drawings, and stores them with XML. XML as the data model of unified CAD information model. The data model is transformed into PDM data model by PDM logic. So as to realize the management of product structure and configuration.
- Editing of 3D model drawing

However, due to the technical limitation of 3D PDF, 3D CAD still needs to be integrated to meet the functional requirements of 3D model editing [19].

4 DESIGN OF 3D CADDCAM INTEGRATED SERVICE FRAMEWORK BASED ON CLOUD COMPUTING

4.1 Overall Architecture Analysis of Cloud Computing Platform

The infrastructure of information system based on cloud computing can be roughly divided into three layers, as shown in Figure2. The infrastructure layer at the bottom provides the hardware resources needed for the storage and operation of software resources, and plays a supporting role in the system architecture. The virtual resource architecture layer is the core layer in cloud computing applications, which virtualizes the underlying hardware resources through virtualization technology. It eliminates the limitation of its physical distribution, realizes the sharing of resources, improves the storage and computing capacity of the system, and expands the service range of resources. In the cloud user architecture layer, it completes the service deployment and release of business applications, and realizes the provision of application service nodes. In this paper, the main content focuses on the research on the integration technology of PDM and 3D assembly CAPP in this layer.

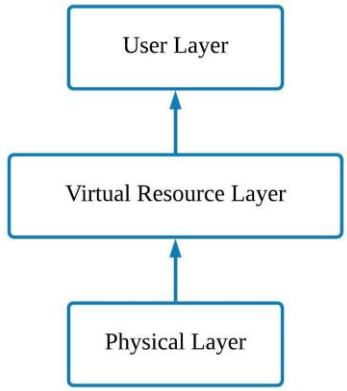

Figure 2: Cloud computing system infrastructure diagram.

4.1.1 General architecture of system platform

According to the above three-tier infrastructure idea of cloud computing system, and realize the deployment and release of information system on this cloud platform architecture. The overall architecture deployment is shown in Figure 3. As for the three-tier infrastructure of cloud computing system, the virtual resource architecture layer and basic physical architecture layer are mainly reflected in the cloud infrastructure resource layer. It realizes the construction of infrastructure and the virtualization and service of resources, but the focus of this topic is cloud user architecture layer, which is subdivided into customer access layer and cloud service scheduling layer [10]. The system architecture has the following four characteristics: (1) heterogeneous (2) reconfigurable (3) clustering (4) access to the Internet of things.

4.2 Integration Framework of 3D CAD and Information System

For the integration with 3D CAD and PDM system, the interface exchange technology is used to put the integration service in the service center layer of the platform architecture, showing the cloud deployment of enterprise private cloud, making full use of the advantages of cloud computing, such as virtualization, high reliability and versatility, to make the PDM system desktop application. There is no need to worry about the disadvantages of installing corresponding 3D CAD software on the client side when the process documents and engineering drawings are signed and approved, and

the integration mode of 3D CAD and PDM based on unified agent is provided to shield the difference of secondary development interfaces of different 3D CAD.

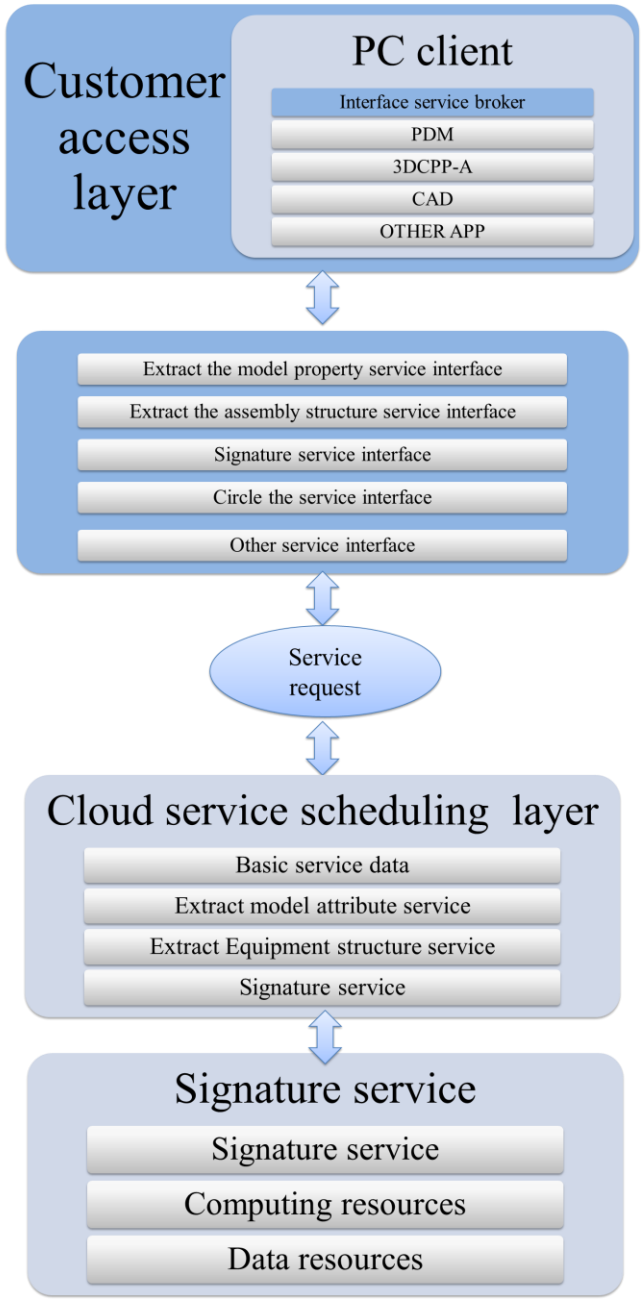

Figure 3: Overall architecture of a private cloud system.

This paper first introduces the selection of integration mode of CAD and PDM. According to the degree of integration, it can be divided into three modes: encapsulation, interface and tight

integration. Among them, the interface mode is the most suitable for the integration of 3D CAD and PDM, because the required information is extracted according to the API functions provided by the two application systems. In this mode, the application system can access the internal data of the system through API functions. The feature of the integration of interface mode is that some data objects of the application system can be automatically created into the PDM system environment through the data interface according to the shared data model between the application system and PDM system, or to call the application system from PDMSome data objects to be used.

Although there are many differences between them and the mainstream software such as CATIA and Solidworks in the aspect of data storage and manufacturing, there are still many differences between them and the mainstream software in the aspect of data storage and production. Form a consistent data model and establish a general integration framework.

4.2.1 Data exchange technology

Figure 4 represents the data conversion from 3D CAD to PDM. For the data model, from the integration requirements of PDM, we can see that it mainly includes the structure and relationship among component model, component attribute, component family member, component assembly relationship and engineering drawing document. Therefore, the corresponding data model must be established in PDM. In PDM system, the corresponding relationship between data model and 3D CAD is as follows: component model and component family members are expressed by component object in PDM; assembly structure is expressed by aggregation relation of component object in PDM and stored in component object as feature attribute; CAD document is associated with component object in PDM. The corresponding relationship between the product structure and the product.

After defining the corresponding relationship between the data model of 3D CAD and PDM, the data model conversion between the two software's should be considered. Because the data models of different 3D CAD are different and the API interface forms are different, the establishment of a unified data conversion model is the core of the problem. XML, which has the advantages of platform independence, portability, openness, extensibility and self-description, is an appropriate technology to express CAD feature information. As a structured language, XML can express component structure relationship and feature attribute information in an orderly manner, and decompose XML file into object model by Dom. Solve the problem of data model conversion between PDM and 3D CAD.

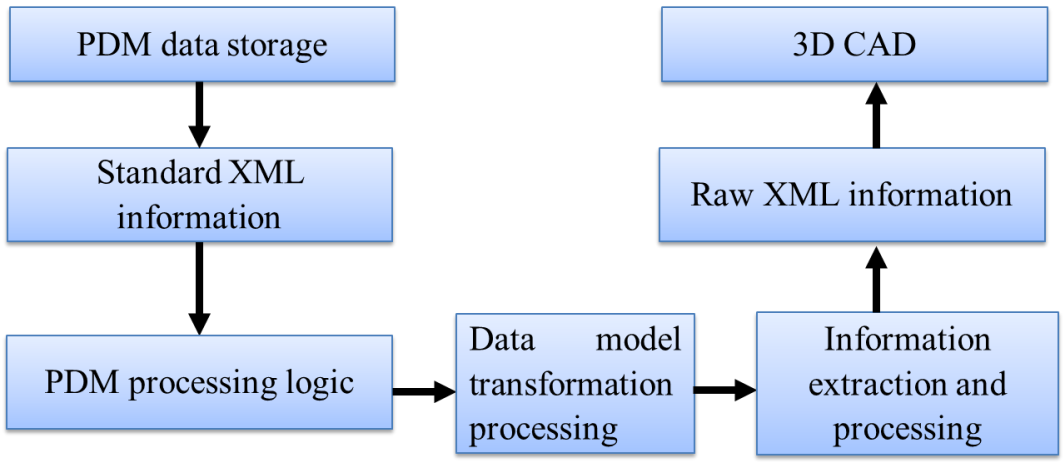

Figure 4: Data conversion from 3D CAD to PDM.

The information data is extracted from 3D CAD, stored in XML file, and transformed into PDM data after data model transformation and PDM logic processing. The process of data from PDM to 3D CAD is the opposite.

4.2.2 Integration framework structure

The integration framework controls all kinds of interfaces through component scheduler.

- Different 3D CAD software's call their own integration components, extract common features and co-exist in XML, i.e., CAD data model. The processing result of this interface is the original XML file expressing CAD data model.
- Data model conversion interface the original CAD data model is transformed into standard XML information after the interface processing.
- This interface encapsulates the general processing logic of three-dimensional data model in PDM and realizes the storage logic of PDM. As shown in Figure 5, the structure of integration framework between PDM and 3D CAD is shown. After users register relevant 3D CAD integration components, PDM calls registration components through integration framework component scheduler. Send edit or browse request to CAD.

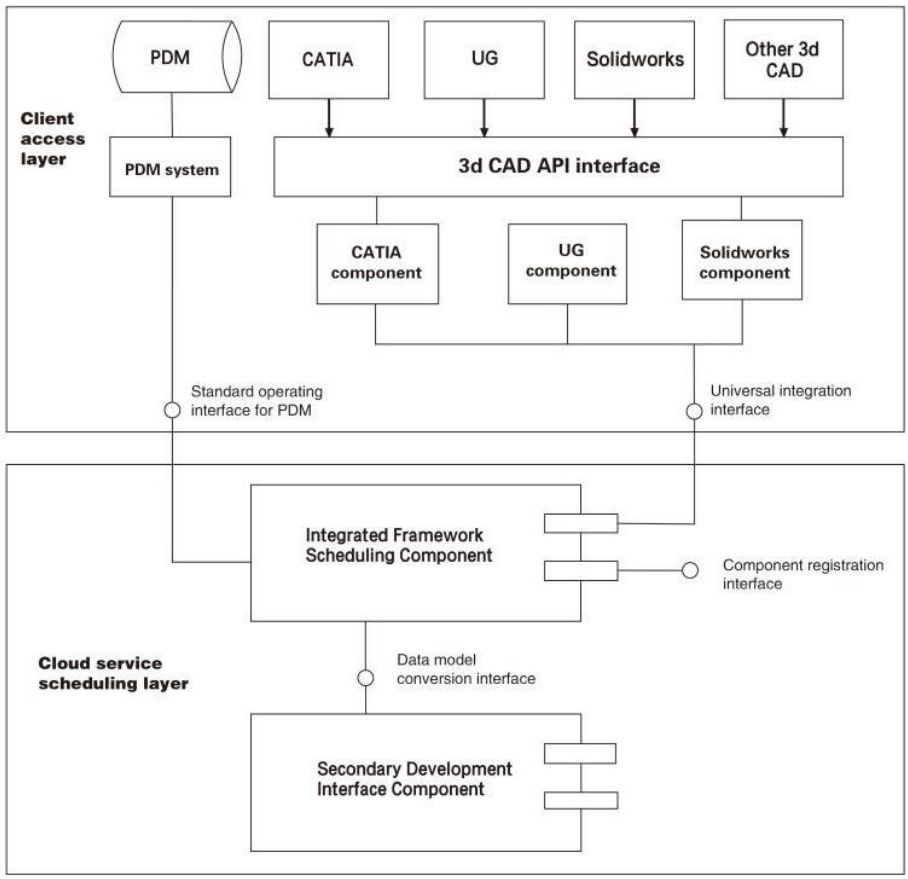

Figure 5: Integrated framework structure of PDM and 3D CAD.

4.2.3 Integration framework of 3D CAD and 3D assembly CAPP

The 3D assembly process planning system can introduce the 3D assembly model generated by 3D CAD system. Based on the 3D product assembly model, according to the layout of the actual assembly station and the characteristics of the product parts, the assembly structure of the

product can be reorganized. The user can plan the assembly process of the product by referring to the realistic 3D product model. Select the assembly object of each process, define the assembly activities to be completed in each step of the process, introduce the "process equipment" used in the assembly process and define its activities in the assembly process. Finally, complete the complete assembly process of the core parts of the whole product. Through the simulation function provided by the system, it shows the user a realistic three-dimensional assembly process simulation. The rationality of assembly process is evaluated. Finally, assembly process documents, assembly "explosion diagram" and animation are generated to guide assembly field operation.

The core layer of 3D assembly CAPP is 3D modeler, 3D model display and 3D model converter. The model in 3D assembly CAPP is generated based on ACIS modeling and hoops model display interactive platform. When importing 3D CAD assembly model into 3D assembly CAPP, the necessary assembly model information is extracted to eliminate redundant information in model drawing. As a result, it is necessary to integrate the 3D information of CAPP with that of CAPP.

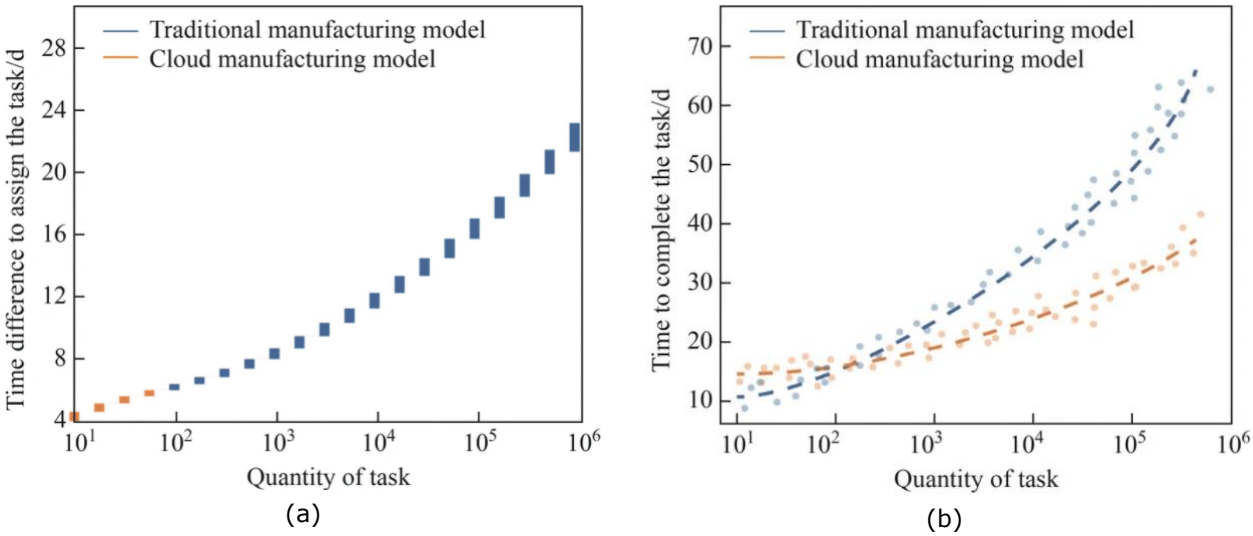

Figure 6: Time difference between assigning and completion of task.

Figure 6 represents the performance analysis of the proposed design in terms of time difference between the assignment of a task and completion of a task. The graph represents the difference in time required from the design to assign task for the manufacturing. It is observed from the analysis that during the initial stage because of the complex mechanism of cloud-based manufacturing the feedback speed it is not good in comparison with the traditional designs. With the increase in number of tasks to certain level the performance of the system is improved and therefore the advantage of computation is observed on the basis of cloud manufacturing.

5 CONCLUSION

Based on cloud computing technology, this paper studies the integration of 3D CAD, and understands the 3D CADDCAM based on cloud computing platform. With the expanding and popularization of CAD technology in the packaging industry, the demand for paper packaging CAD software has not only stayed in the simple graphic design function, but also applied the packaging design knowledge to CAD to make it more professional and meet the needs of all kinds of people and enterprises. The advantages of integrated services, and analyzes the application mode and characteristics of cloud computing platform, it is concluded that cloud computing is the future of

manufacturing industry. By designing the integration framework and system architecture of 3D CADDCAM for cloud computing platform. The information model obtained is standardized under the condition of using data conversion technology, so as to realize the transmission and exchange of data in cloud computing platform.

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