A Collaborative Design Platform for Assembly Process Planning

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Abstract. This paper presents a web-based virtual environment which supports designers geographically distributed to engage in the same assembly scenario and complete the assembly task synchronously. Firstly, a client-server based architecture for collaborative assembly is discussed. The discussion highlights how to decompose the collaborative assembly environment into several functional modules, and how to deploy the right module on the right side. Secondly, some key technologies including task classification and subdivision, and multimodal interaction, are discussed in detail. At last, we give our implementations and discuss limitations in our current research effort.

Keywords: Virtual Reality, Collaborative Design, Assembly Design.

1 Introduction

Product design is a complex activity which involves collaboration between designers geographically distributed. Starting from the end of last century, more and more research and development work has been done to renovate traditional CAD systems to be distributed and collaborative[1].

Assembly design is part of the product design and is typically a highly iterative activity from the conceptual design phase to the detail design phase. Till now, there has not been a single tool which can help designers to complete the whole assembly design process, including assembly planning, evaluation and verification.

And what's more, virtual reality(VR) technology has become another research hotspot to integrate different CAD tools into an assembly design environment. VR is a technology which is often regarded as an extension to 3D computer graphics with advanced input and output devices. By virtue of VR, designers can plan, evaluate, and verify the assembly of mechanical systems more intuitively.

This paper introduces our web-based collaborative virtual environment for real time assembly design. The architecture of the system and some key technologies are discussed in details.

2 Related Research

The collaborative virtual assembly environment crosses multiple domains and involves multiple technologies, including the architecture, the model representation,

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the communication and conflict, and the multi-modal interaction. There have been many researches about VR based assembly design and collaborative assembly design up to now.

Gao[2] gave a summary about the research and development status of collaborative computer-aided design. Typically, according to on which side the assembly functions performed, the architecture of the real time assembly system can be classified into three types: the "thin server + strong client" type, the "strong server + thin client" type, and the "peer to peer" type. Shyamsundar and Gadh[3] presented a three-tier client server architecture in their cPAD(collaborative product assembly design) system, including the intelligent server, the application server and the client. The architecture can be considered the extension of the "strong server + thin client" type, and the intelligent server, as the middle tier, mediates all requests between the client and the servers.

The product attribute and behavior information in virtual assembly including information for product, feature, geometry & topology and display are organized differently. Shyamsundar and Gadh[4] also presented a compact Internet centric product assembly representation called AREP. The AREP represents a collection of assembly features to constrain the design assemblies assigned to individual designer, further to form a whole collaboratively developed assembly. Liu[5] presented a multi-level representation of product information for virtual assembly. Different levels are linked together, and the model can meet the requirements of real-time VR assembly system. Methodologies to detect and manage conflicts arising from a collaborative activity are also investigated[6].

Jayaram[7] has developed a virtual assembly design environment(VADE) granted by NIST to investigate the use of virtual reality for assembly design. VADE combines advanced CAD/CAM software with the virtual reality technology to produce an environment that allows engineers to virtually assemble a series of components. Based on the assumption that "if you can disassemble a component, you can assemble it, and vice versa.", Wan[8] also developed a virtual disassembly environment on their CAVE platform. It provides designers with a fully immersive 3D environment for assembly design and analysis. Rajarathinam[9] described the framework of a collaborative virtual environment (V2V), which allows the same site and the remote site multi-modal collaboration between multiple designers primarily focusing on collaborative engineering, but didn't talk about how to avoid conflicts on the collaborative condition.

3 Architecture of the Environment

As mentioned above, according to on which side the assembly functions performed, the architecture of the real time assembly system can be classified into some types. Pure "thin server+ strong client" and "strong server+ thin client" type both have their advantages and disadvantages. Data streaming technology based on commands instead of 3D models is propitious to light-weight the bandwidth of Internet; clients can manage the assembly calculations locally which are easy such as interactive manipulation, orders execution, display, etc; it's easy to deploy a collaborative