

Real-time Collaborative Design and Dimension Verification over the Internet

In-Ho Song, Kwang-Heum Yeon and Sung-Chong Chung

Hybrid Systems Design & Control LABORatory
Department of Mechanical Design & Production Engineering
Hanyang University, SungdongGu, Seoul 133-791, KOREA

Abstract: The objective of this paper is not only the development of a real-time viewer for the real-time collaboration of design reviews, but also the real-time verification of dimensions over the Internet. As the anytime-anywhere access is possible via the Internet, remote collaboration in the design and manufacturing process is realized. The developed system is also designed to eliminate network dependency, so that it reduces the cost of implementation and management of the system. This system runs on all types of networks from high-speed LANs to wireless connections. Collaborators can check dimension errors, human factors, form errors, as well as mark up the important parts and make a statement of their views over the Internet. 2D and 3D data viewing, markup and annotation, dynamic sectioning, printing services, and real-time conferencing combined with PDM bring real-time benefits to reduce production time to market and design cost. The usefulness of the developed system is confirmed through a case study.

Key Words: ActiveX, Apache, Dimension verification, HTTP, Internet, Native file, Real-time Collaboration

1. Introduction

Concept of remote collaboration in the design and manufacturing processes is strongly required to reduce design conflicts and uncertainties in the early design stage and manufacturing processes, as well as cost and time-to-market. Internet based CAD/CAM conference systems assist designers to review design results through real-time viewers, to communicate design ideas through markups and chatting, as well as to simulate manufacturability and to measure dimensions for correction of design conflicts. Real-time collaboration reduces production ambiguity, product development lead-time and manufacturing cost to a large extent. The objective of this paper is not only the development of a real-time viewer for the real-time collaboration of design reviews, but also the real-time verification of dimensions over the Internet.

Kan, et al [1] have discussed the real-time collaborative system for product design in Internet environment using Virtual Reality Modeling Language (VRML) form and Java applet. Huang, et al [2] have begun to create a standard Internet based Design for X (DFX) shell that provides a framework in which many types of DFX tools can operate. Chen, et al [3] developed the Internet-enabled real-time collaborative assembly modeling system using Java RMI and STEP. However, they have following problems: (1) Previous systems use the middleware such as CORBA. CORBA requires high performance hardwares and is very expensive. (2) Since a lot of data

is transmitted during the collaborative operation, it is impossible to realize the real-time collaboration over the low speed network environment. (3) It is impossible to transmit information across the firewall installed in most companies. (4) Since the program to be installed in a client side is very large, it takes much time to execute the viewer.

To overcome these disadvantages of the previous viewing systems, a real-time multi-viewer is developed on the open-architecture web server, Apache, in this paper. As the Apache is used for the viewer, it is inexpensive and does not require high-performance hardwares. In order to increase the data transmission capability, all transmission data are converted into parameters. This conversion decreases the transmission time. And the developed system works well even on the low speed network environment. It runs on all types of networks such as high-speed LAN, dial-up modem, wireless connection and so on.

As the real-time viewing functions are constructed over the ActiveX control environment, client application for the design and dimension verification does not need to install the developed software before using the system. Collaborators are able to perform real-time 2D and 3D viewing, precision measurement, markup and annotation, dynamic sectioning, printing services, real-time conferencing combined with PDM and so on over the Internet Explorer. The proposed system helps to reduce production cost, errors and lead-time to market. Performance of the developed system is

confirmed and verified through a case study.

2. System Architecture

Fig. 1 shows the architecture of a collaborative server. As the collaboration server, four-tier architecture is proposed to enable a distribution processing when multiple users connect to the server at once. Four-tier client/server architecture is proposed to realize the real-time collaborative product design and dimension verification system. The first tier in the client region consists of an administration web page and viewing ActiveX control. The second tier is the web server. It controls clients by using the administration page. Clients communicate with the server through the HTTP protocol. The third tier, which is realized through the JSP(Java Server Pages) and the Servlet engine(Tomcat), is the web container dealing with dynamic web service. Tomcat of the Apache Software Foundation is selected to act as the engine of JSP and Servlets. The fourth tier, collaboration extension module, takes charge of the collaboration functions such as transmission of parametric data, files, markups and chatting information. This is realized through Java. Real-time viewing functions are constructed over the ActiveX control environment.

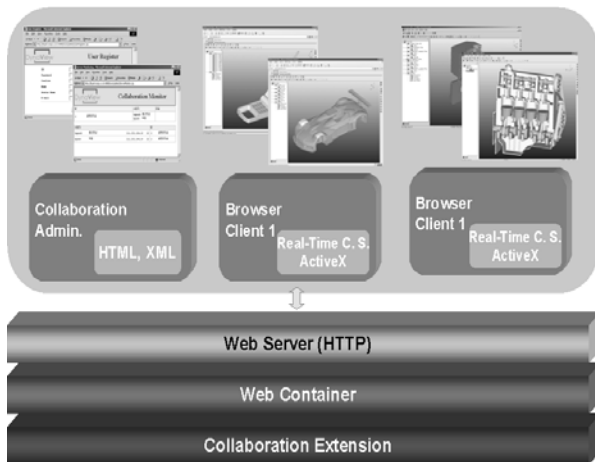


Fig. 1 Structure of the real-time collaboration system.

3. Real-time Collaboration Work

Collaborators are able to conduct real-time 2D/3D viewing, precision measurements and markup through the proposed real-time collaborative system.

ActiveX control is downloaded directly into the client system from the server. In order to protect the collaboration work, communication between the client browser and the collaborative server is performed through the encrypted mode. Functions of the real-time viewer are constructed over the ActiveX control using

the visual C++ and OpenGL. Fig. 2 represents a configuration of the collaborative ActiveX control.

In the previous system[4], it is impossible to conduct real-time collaborative processes on low-speed network environment because a share of CAD data causes overload to the network. In order to accelerate the data transmission capability, the developed system is constructed to share the native file instead of the CAD file, and all transmission data are converted into the parameters.

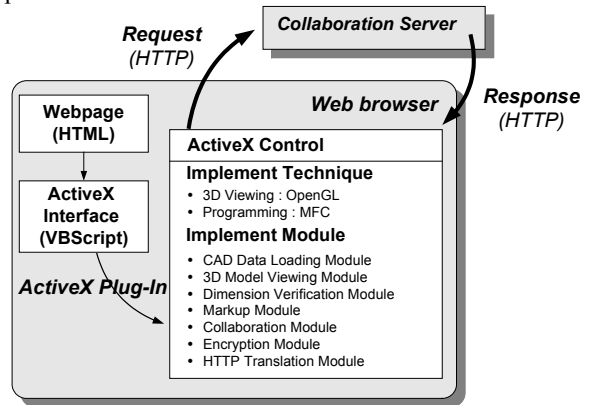


Fig. 2 Configuration of the client ActiveX for the real-time collaboration.

Functions of the developed system have been constructed by using the ActiveX control plugged in the Internet Explorer. All contents of collaborative works are transmitted to multiple users through the collaboration server as shown in Fig. 2.

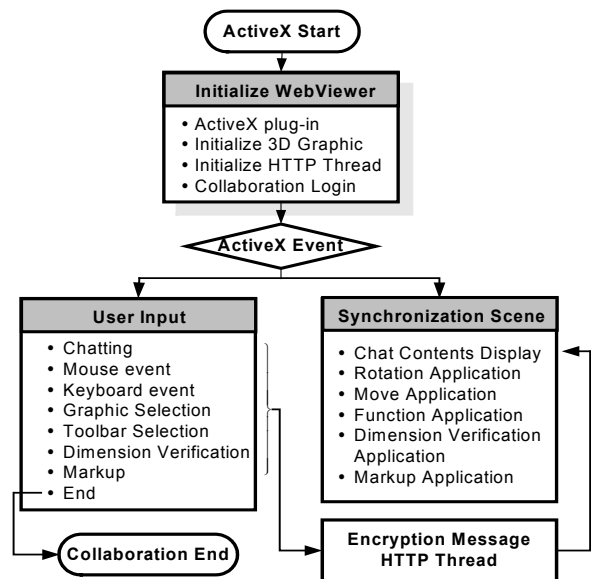


Fig. 3 Algorithm of the client ActiveX for the real-time collaboration.

In order to protect the collaborative work, communication between clients and the collaboration server is performed through the encryption mode. Moreover, the proposed system applies HTTP protocol to transmit data and to overcome firewall systems in companies. Fig. 3 represents work flows of the collaborative ActiveX control[5-7].

4. Design of the Native File

In general, VRML is considered as a viewing tool of CAD data on the Internet environment. However, it takes much time to transform the CAD data into ASCII format by using the CAD API. Moreover, VRML has only the facet data. It is not sufficient for the dimensional verification. In order to overcome these problems, the proposed system uses the native file transforming the CAD data into optimal format through the translation server constructed by using the ACIS kernel and InterOP. The native file includes not only facet data for design verification, but also edge and topological information of CAD data for the dimension verification. New dimension verification results or mark up messages are included in the mark up file followed by a separator. In order to allow a lot of consultation from the clients, a hyperlink function is also used in the mark up function[5]. The native file size is reduced to around 90% through a binary conversion and compression processes.

Fig. 4 shows a structure of the native file converter.

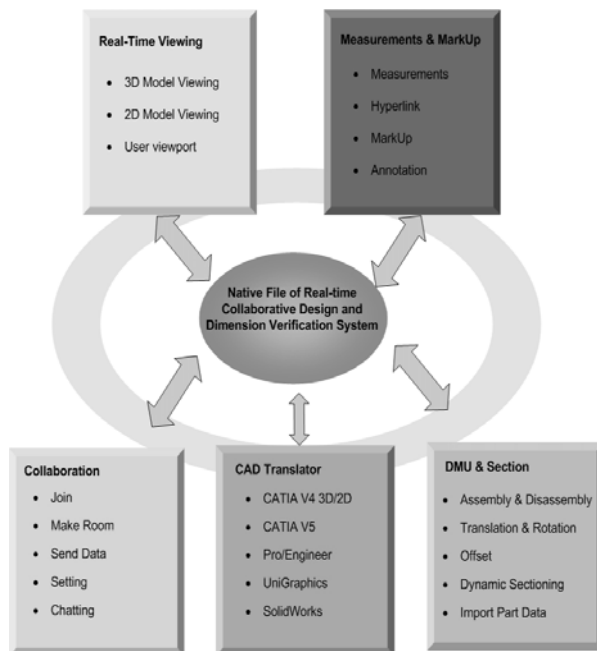


Fig. 4 Structure of the native file converter.

5. Case Study

Effectiveness of the proposed system is verified through design verification of car clutch parts. Fig. 5 shows a Graphic User Interface(GUI) and a start-up process of the real-time collaboration system. The symbols [A], [B], [C], [D], [E] and [F] in Fig. 5 mean verification and markup toolbar, management treeview, a login window, a dialog box for chatting, graphic set up toolbar and display area, respectively. Real-time collaboration procedure is described as follows:

- (Step 1) Access the web page and plug the real-time collaboration system in the user's web browser.
- (Step 2) Click the collaboration start icon, and input ID and a password through the login window.
- (Step 3) Select a session for collaboration.

Fig. 6 shows a design and dimension verification example. Collaborators related to the development of a new product are able to perform real-time collaboration according to the above steps.

If collaborators do not satisfy certain design results after the dimension verification procedure, they will leave verification message by using the markup and annotation function. As shown in [A] of Fig. 6, the rectangle and the arrow existing in the markup function deliver another verifier's message regarding the problem of the current design. Since this markup function can be added on the verification file as a hyperlink function, clients are able to deliver their opinions in detail.

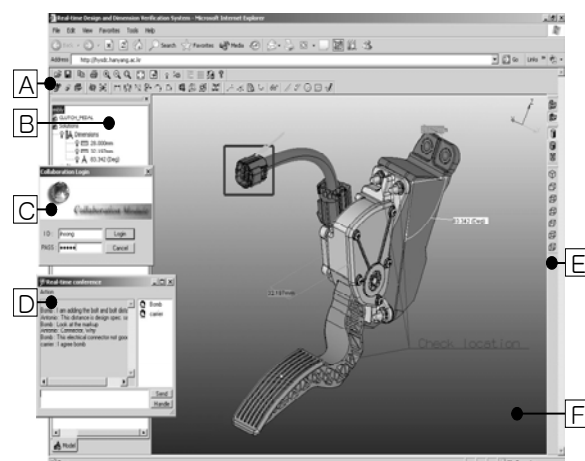


Fig. 5 Graphic user interface of the developed system.

If a collaborator wants to verify the thickness of the clutch cover, the collaborator should select the lines [B] and [C] after selecting the icon existing on the

verification and markup toolbar shown in [A] of Fig. 5. These actions compute the minimum length between the lines. Dimension verification data of the clutch cover is given by 32.197 mm as [D] of Fig. 6.

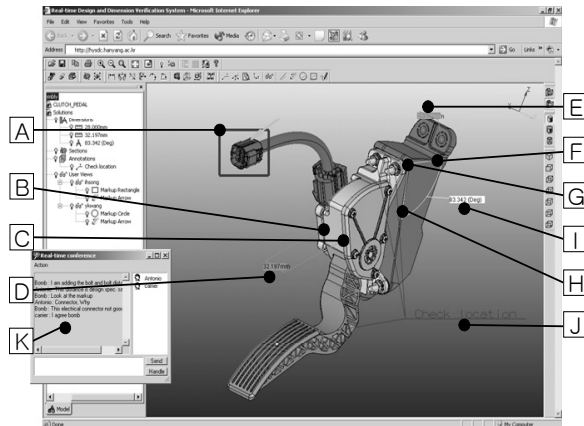


Fig. 6 Design and dimension verification.

[E] of Fig. 6 shows the distance of 28.000 mm between bolts by using the function to compute the minimum gap between circles. After selecting the angle measurement icon and clicking [F], [G] and [H] points successively, the angle of 3 points, 83.342° , is obtained as [I] of Fig. 6.

[K] in Fig. 6 shows a communication example among three collaborators by using a chatting function. This function assists collaborators to communicate design ideas in detail. Moreover, all collaboration contents, such as precision measurement, markup, annotation and chatting contents, are saved as a native file. After disconnecting the server, a design supervisor can modify the current design as an updated design according to the collaboration contents.

All contents described above have been observed and controlled by collaborators participating the collaboration at the same time. Collaborators attending the collaboration session are able to express their design and production ideas at real-time.

6. Conclusions

A real-time collaborative design and dimension verification system is proposed for the rapid design and manufacture. The developed system is executed on the Internet Explorer without using the commercial CAD systems. Designers, customers and manufacturers, who are geographically separated, are able to verify design results and dimensions over the Internet.

The native file converter is developed to make a real-time collaboration system over the Internet. Using the ActiveX control, users do not need to install the developed system prior to using the system. System updates are accomplished through the server. It is adequate for the distributed environment.

In order to protect the collaborative work, communication between clients and the collaboration server is performed through the encryption mode. To overcome the firewall in companies, HTTP protocol is used for the data transmission. As the system is an open-architecture and does not use CORBA, additional functions could be added to the system moderately and easily.

The usefulness of the developed systems has been confirmed through a case study.

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