An APPLICATION OF VRML TO CALS

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ABSTRACT. The Virtual Reality Modeling Language(VRML) is the file format standard for 3D multimedia on the Internet. It provides advanced operating features for 3D objects across platforms and operating systems. I propose to use VRML for the 3D CAD/CAM design and I describe by comparing with STEP how VRML is useful in CALS framework.

1. Introduction

In recent years, the Internet is widely used in society, and as the technology using the Internet, the VRML[1][2](Virtual Reality Modeling Language) is paid attention to as the information technology operating three Dimensional(3D) data on World Wide Web(WWW). The 3D CAD/CAM system is necessary for the various product design, because it makes us to develop and to design like real production. But, as the system is expensive and there are data conversion problems, it is not able to use widely in maker. ISO10303 which calls itself STEP(Standard for the Exchange of Product model data) is the international standard of data translation for product life-cycle from design to production, maintenance and it settle the data conversion problem between different 3D CAD/CAM system. In this paper, I propose VRML as the standard of 3D CAD/CAM data format, because it is superior to use the Internet, to be high cost-performance, and to be platform independent.

In this paper, first, I present what is VRML, feature of VRML and explain the merit which apply VRML to 3D CAD/CAM design and the mechanism of behavior simulation. Second, I discuss the role of VRML comparing with STEP. Finally, I consider about CALS applying VRML, and about these merits, about future problems.

2. About VRML

(1) What is VRML

The VRML is the file format standard for 3D multimedia and shared virtual worlds on the Internet. The first release of the VRML1.0 specification was created by Silicon Graphics, Inc. and based on the Open Inventor file format. The second release of VRML adds more interactive capabilities(sound and behavior function, etc)[3]. The VRML data is represented as 3D graphics on WWW and is able to operate various forms like rotation, zoom and reduction. Further, by composing VRML to Java, it is realized the moving data(it is said “behavior” in VRML), VRML is capable for various programming language as the behavior description. But I think that Java is the most suitable, because it is platform independent.

(2) VRML browser

VRML browser is necessary for browsing VRML data. The VRML browser is constructed for three parts, the QvLib(which is library for syntax analysis), 3D graphics library like OpenGL and Java interpreter. Figure 1 represents the browser structure.
3. Realization of movement simulation by VRML

One of the merits which we apply VRML to 3D CAD/CAM design is to operate dynamically 3D design data. That is, we can execute movement simulation. In the following, I present the behavior function mechanism[4] to realize the movement simulation.

(1) VRML data structure

To realize movement, VRML description is separated the two parts, one is the 3D data description part and the other is the changing description part which is wrote down as a program. That program is defined as Script in VRML and various language (Java, Java script and so on) are capable for Script description language. I think the best language is Java, because Java is multi-platform and the Internet friendly. Figure 2 represents the VRML data structure.

(2) Mechanism of behavior function

I explain about the movement mechanism in VRML. In VRML, it is defined the external factor (mouse clicking, a lapse of time, etc.) to be changed VRML data as event. The event is transmitted to the event handler method that is defined in Java language, and finally the Script which corresponds to the event is executed to change and move VRML data. That flow of data changing is represented in Figure 3.
Next, I illustrate the VRML data constructor and the mechanism of data movement in Figure 4. We define the contents of data change in Java program and designate the Java program’s name in the Script node, which is the data changing procedure part. We can do various data changing by modifying the Java program. As the VRML data is separated into the 3D data description part and the data changing transmission part, it is flexible and extensively.

Purpose of STEP (ISO10303)

Purpose of STEP is that the product technical data and documents interchange each other through all phase of product life-cycle[5]. In STEP, the standard about 3D shape data and structure information is defined in Application Protocol 203(AP203). Each AP is defined apart from each industry. In Japan, centering around Nippon CALS Research Partnership(NCALS), actual proof experiments has been put in practice at the automobile, shipping and so on[6][7].

(2) Purpose of VRML

In planning phase and first stage of product design, we try many different design and check for various product parts composition. At that time, to operate and to process easily 3D data are important. For these requirements, I think to be suitable to VRML than “heavy” STEP that has many attribute information. So, for the planning, for product design and its design verification, I propose to use VRML as the standard data format. Finally, we convert VRML to STEP and add STEP to formal attribute information. I show the 3D product design flow using VRML in Figure 6 and illustrate the design verification flow in Figure 7.

4. VRML position in CALS promotion

I consider the role of VRML in CALS promotion comparing with STEP.
5. About working forms

I think that the practical use of VRML as 3D CAD/CAM data is powerful means which forwards the con-current product design regardless the company inside works or the business among different companies. I discuss below the concern about con-current engineering realization. I tell the two parts about it, one is the Intranet, the other is the Extranet which forwards the business among different enterprises.

(1) Intranet

I explain about the common use of product design data and the concrete result through its effective use.

(a) Realization of con-current engineering

If we put in practical use of 3D design data, which are developed by a planning or design section, for the other sections, we can simultaneously examine in actual image about the manufactured goods for various manufacturing processes. And so, we can detect the problems in design, product structure and production, we can solve those in an early stage. For example, by using the VRML data of product outward form, we can examine to develop the mold in first development stage. So that, we are able to find out and solve in good time the point of issue or modification. Next, now, though we do the movement inspection of product in the manufacturing for trial by using real parts, that inspection is possible in design phase. So, we are capable of accomplishing the reduction of development expense, man power and development period.

(b) Design data library

We create the common design data which are usable to various product design in VRML and store these data as library in database. The movable parts data in library are added to a behavior function in Java. When we develop the new product in each section, we refer to the library and include the required data. Accordingly, we can realize the development efficiency and the improvement of design confidence. For the data which are composed the movable parts data, we can execute directly the movement simulation. When we can’t use the library data as it is, as VRML is described in text, we can modify and use it. Figure 8 is explained that working form.

(2) Extranet

If we define to the standard CALS data format, we can construct the global development and production environment with the Internet between an assembly maker and a parts maker.

(a) data open

The parts maker puts the own parts catalog files created by VRML on a server computer, the assembly maker can freely use these catalog files through the Internet and apply it to the own product design. This is shown in Figure 9. This is the same situation as the Intranet library except accessing from the outside. As described above, the con-current engineering will be more promoted in both the Intranet and Extranet. Further, I think that it is necessary to construct the VRML database for many servers like Domain Name System(DNS) which manages unified IP addresses. Therefore, we must define the unified rule for naming the VRML server and library belonging to each companies.

(b) Enterprise publicity

For the parts maker, the open of parts data itself is the advertisement and commercial message of company. According to open the parts data or fundamental manufacturing data, assembly maker can plan and consider to apply this data(as “actual image data”) to the own products in the planning and development phase. So, it is possible to generate new business chance among various companies. Especially, smaller enterprises which have a excellent technology, but have been belonging to “KEIRETSU”(series of big company), will grow independent of “KEIRETSU”. I think that it is important to open the parts CAD data which is created by VRML for the world through the Internet, because it is informed globally the own company’s technology. Next, in the case of cooperative development between overseas positions, it is very important to have in common and to transfer rapidly the products design data. If we design to use the CAD/CAM system dependent on a specified vendor, we influence the various problems(for example, data exchange, vendor dependence of software and hardware equipment, etc.) and the efficiency of research or development, production goes down evidently. But, if we use VRML which is independent of vendor, we are not affected by these problems.
6. Conclusion

I proposed above to apply VRML to 3D CAD/CAM product design and verification in CALS, and described the working form using VRML in the Intranet and the Extranet. Finally, I represent the subjects to realize these and a view in future.

(1) Subjects

In future, in order to realize CALS using VRML, we need to prepare to below.

(a) ISO standardization for VRML

(b) Development of conversion tool from VRML to STEP

(c) Development of excellent editor for VRML and modeling

(d) Conversion from the existent CAD data formats to VRML

(e) Accumulation of VRML library data

The others, we have to define the rules for the naming and storing means of STEP and VRML library data, which we can rapidly and easily refer to it. And we must construct the VRML library server based above and develop the fast reference system for server.

(2) A view of in future

As now progressing the standardization of VRML2.0, I think to turn VRML into ISO standard. According to this, I think to be proposed new usage in various industry fields. There is a 3D CAD/CAM product design in CALS as one usage of these. I think of STEP as the final marketing data to realize the efficiency of products development, manufacturing and the reduction of development cost in company. I propose to apply VRML to 3D CAD/CAM products design, verification and data library, therefore, to CALS as the means of realizing the real con-current engineering between companies. I will want to contribute actually to put VRML to practical use.

References:

1) About VRML: http://www.vrml.org
3) VRML2.0 Specification: http://www.vrml.org/Specifications/VRML2.0/FINAL
5) ISO 10303 Standard: http://www.jstep.or.jp/ja/iso