Web-based maintenance manual with three-dimensional simulation model

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Abstract Currently manufacture industry increasingly needs to make their service engineer to understand for maintenance process easily. In order to use the maintenance information effectively, maintenance documents are necessary to apply the multimedia technology and telecommunication technology. This research is to develop the Web-based multimedia manuals using three-dimensional simulation model applying for the maintenance. The goal of this research is to implement to industries the multimedia maintenance manual that integrates a virtual equipment model with assembly process and disassembly process through INTERNET. We developed Web based simulation environments named World Wide Simulation Environments (WISE). The WISE is a remote simulation system on the Web. The multimedia maintenance manual is applied the WISE and other information communication technologies.

1 INTRODUCTION

Under increasingly competitive conditions in manufacturing sector, process engineering requires drastic improvements in all process. Simulation-based design is a new approach, which, aims at creation and operation of virtual and real products and process, in order to increase real product value and to reduce life cycle cost.

The main object of simulation-based design is to generate a virtual environment that can provide support, information and control during all phase of the product life cycle. Furthermore, this environment has to support internationalisation and decentralization of the design, production activities

and maintenance processes. To realize the environment, a simulation technology is very effective tool. However, a simulation technology is not good enough to apply to maintenance process. Therefore, to construct the next simulation-based design, the following items must be considered; (1) the environment can support the all phases in the product life cycle, ranging from the planning to production, maintenance and reuse, (2) the environment can use a multimedia technology with Web browser, and (3) the environment has a simulation ability to predict the future behaviours.

The final goal of this study is proposed to construct the simulation-based design environment that simulates a virtual manufacturing on a global communication network. This concept of the simulation environment is named the World Wide Simulation Environment (WISE).

This paper features an application of the WISE in the maintenance phase. The WISE has physically meaningful models or product models with behaviours for maintenance activities. The models are built in a distributed environment and distributed throughout a network. The models are made to represent the function, behaviour, and performance of real equipments and human beings by giving behaviours programs to three-dimensional CAD models that represent virtual equipment with motions and correspond to the "behavioural multimedia manual" of real equipment.

Users can thereby collect these multimedia manual through a wide-area network, confirm and evaluate these maintenance activities. The virtual environments that these activities are considered constrains among them is easy and effective for service engineer to understand and capture these disassemble activities and assemble activities in the maintenance phase. The virtual environment drastically improves the maintenance service effectively among distributed company and virtual enterprise.

2 WISE ARCHITECTURE

The WISE architecture is shown in Fig. 1. The WISE model can be transfer to the client side to the designated URL address in the WWW browser based on the HTTP protocol. The model is an encapsulated components file of three-dimensional model, HTML multimedia-documents, inputting menus for GUI and object oriented programs showing its behaviours. An engineer can execute the simulation by communicating via HTML multimedia-documents after acquiring the digital manual through the INTERNET.

Figure1 World Wide Simulation Environment (WISE) Architecture

3 REQUIREMENTS FOR MAINTENANCE MANUALS

Currently, maintenance manual is publishing as the digital documents. However, it only includes the static two-dimensional drawing data. It's not effective only static data to train maintenance process from any viewpoint. Considering the Information Technology, the various method are possible to applied to the maintenance manual for service engineer to confirm and to train the disassemble process and assemble process, For Example, multimedia technology, three-dimensional model from CAD systems and simulation technology for three-dimensional model are effective in visualizing documents to understand easily. VTR have a reality to visualize, however, the viewpoint is limited. VRML technology or Java 3D, is the effective in visualizing motion form any angle. However, it is not suitable interaction between the instruction sentences in HTML and three-dimensional model with motions like maintenance manual. Integration of multimedia technology, three-dimensional model from CAD systems and simulation technology still not used. We redefine the requirements from view point of Integration among multimedia technologies, three-dimensional model from CAD systems and simulation technology. Therefore WISE technology is applied to the maintenance manual. Additionally reuse of

three-dimensional model from CAD system is important from all life cycle cost. In order to realize the maintenance manual on the proposed WISE architecture, there are the language level requirements. The requirements are follows:

- The creation of a three dimensional model in order to represent each product model.
- As shown the object-encapsulation specification described in the reference [1], contents data and program components treat as an encapsulated component.
- Hierarchical programming, which is handled as a unique unit, and creating a new program combining with the existing program and the object oriented language that can create a reusable object encapsulating data and function.
- Cooperated operation with a scheduler function, a control function for an autonomous behaviours of each machine object, and a definition and communication function for controlling a signal to control behaviour.
- HTML file and programs linking each other, if an icon or an instruction on documents is clicked, related behaviour or activities are executed.
- Interpreter and compiler language for creating the program flexibly and quickly.
- As shown the electronic addressing specification described in the reference [1], transmission of the digital manual via the INTERNET by the designated URL address, accessing to the component on the Web, which implement the programs in HTML function.
- An animation function that operates while simulation is running to enable the engineer to easily understand the behaviour of the virtual machine and activity of the virtual factory.

4 SYSTEM ARCHITECTURE OF WEB-MAITENANCE

Virtual enterprise has to consdsider the change of maintenance in global decentralization environments. Therefore, they require needs for maitenace manual via global communication and managed the contents in centralization or decentralization environments. Our company have to support maintenance-training system through global branch. Considering the maintenance manual via INTERNET, the contents should be to manage in server. The update contents should be reflected to the client. Most new information is distributed to the clients. Browser environments are suitable documents interaction. Therefore, to realize WISE architecture, Web-based client and server environments are selected. Behaviour Engine is selected to

implement the application programs in order to satisfy the requirements of maintenance manuals. It has integrated capability of documents, three-dimensional model from CAD systems and simulation technology.

Figure2 The system architecture of Web-maintenance

The system architecture of Web-maintenance is shown in Fig. 2. This system uses the client and sever environment on the WISE architecture. The client side has a browser, the Open Inventor windows and the helper software called Behaviour Engine Player. Sever side is installed the Web-server like Windows IIS. The WISE objects are created by Behaviour Engine Designer and place on the Web-server. The WISE object is downloaded to the client side by URL address in other object or main WISE object. The instruction and inputting menu written in HTML and Active X is called a motion program in WISE object via the JavaScript. The motion programs in WISE object written by Umbel like Pascal Syntax represent the motion of three-dimensional model by simulation clock. This simulation function has a capability to do the concurrent simulation of motion for three-dimensional model. Therefore, the geometry transfer matrix of three-dimensional model and motion class is used to move the motion.

Clicked on instruction text or button by HTML, motion programs are executed concurrently. Since the simulation has a functionality of signal control of motion, Interlocks of motion are implemented.

5 WEB-BASED DEMONSTRATION SYSTEM

The Web-based demonstration system for maintenance activity is developed in order to evaluate the proposed architecture and a possibility of usage to a maintenance field. The system is applied to two kinds of product. One is the AGV for heavy weighted part and second is the turbocharger for diesel engine. These products are produced in Mitsui Engineering & Shipbuilding Co., Ltd. The multimedia manual consists of equipment class, behaviour programs, three-dimensional models by Open Inventor, and an input panel for teaching and executing behaviours by HTML. It is able to communicate through INTERNET.

5.1 AGV for Heavy Weighted parts

Figure 3. A manual of Braking test instruction for AGV

The AGV for heavy weighted parts are used in the steel manufacture fields and container terminal of ports. It has a few dozen of adjustment items. All of them adjust to motion parts. The purpose of this demonstration is linkage between an adjustment instruction and a three-dimensional motion

in the virtual environment. The developed Web-manual of the rubber tire in the AGV is shown in Fig. 3. The instructions of adjustment activities are written in HTML. Each instruction links the corresponding adjustment motion. The figures show experiment tests for braking.

5.2 Vessel diesel engine with turbo-charger

The diesel engine is the main machine for the vessel. They require the periodical maintenance. Therefore, these training processes are important for the technical crews. To acquire effectively the maintenance activities from crews, the manual has to improve serviceability for maintenance. Figure 4 is an example of web-manual for turbo-charger of diesel engine. The Figure shows the disassembling process a turbo-charger for overhaul.

Figure 4 a manual of disassemble process maintenance for a turbo-charger

6 CONCLUSIONS

Web-based simulation architecture and its configuration for a communication model (WISE model) that is able to represent exactly real

equipment in the software are presented. A WWW browser-based maintenance system is then developed to meet the requirements. The effectiveness of the principle demonstrated is validated.

The purpose of the study is to create such an environment that can execute a virtual maintenance with simulation in accordance with instructions in HTML through INTERNET. These web-based maintenance manuals satisfy with the requirements of DoD IETMs's Class 5 by Web-Server. This web-based multimedia manual confirms that they are very effective to the service engineer to train, evaluate the maintenance activities. The selection of tools is very good for maintenance manual, especially interaction sentence in HTML and Three dimensional model with motion. The service engineers can effectively learn and confirm the maintenance process from these documents with motion. The size of the contents for turbocharger is 5Mbyte. The fidelity of three-dimensional model is suitable for service engineer to understand the shape of part itself. These maintenance manuals offer the effective computer aided training ability for service engineer. It took 1 week to add the motion to the three-dimensional model from CAD system. This is the tolerable time to develop the contents. Furthermore, the virtual maintenance itself provides through INTERNET, This system offers wide-area collaborative engineering environment in order to support the virtual enterprise.

Next Step of our study is the creation of system that satisfies intelligence of Class 5 in DoD IETMs specification by XML and linking procurements system and diagnosis system.

Finally, this research and development is implemented as a part of GLOBEMEN project under the umbrella of International IMS program.

7 REFERENCES

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