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WEB BASED OPERATION INSTRUCTION SYSTEM USING WEARABLE COMPUTER

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Abstract: In our research, the Web-based Instruction System using the wearable computer is developed. The system consists of a wearable computer, a wireless communication system and web-applications. Web-applications are included to a time estimation system, a simulation system, an active instruction manual system, a scheduling system and a statues acquisition system.

In this paper, a system configuration is described, each application is explained, and the result of application is summarised. And in this paper, we pointed out the issues for using the system in the assembly line.

This system is developing under the GLOBEMEN project in the IMS program.

Key words: Wearable Computer, Operation Instruction, Simulation, Web Application

1. INTRODUCTION

Recently, manufacturing systems have begun change from mass-production to small-batch and frequent change of production volume. And also, manufacturing systems change from full-automation to manual operation. In order to operate the system, we should consider instructing effectively the operation to operators in the system [1]. Especially, in global manufacturing system, operation planning division and operation site are at long distance. It is necessary to direct operations based on operation situations.

In order to solve the issues, the Web-based Instruction System using the wearable computer is developed. The system consists of a wearable computer, a wire-less communication system and web-applications. Web-applications include a time estimation system, a simulation system, an active instruction manual system, a scheduling system and a status acquisition system.

The web-applications are located in the server in the network. The operators wear the computer and operators can get the necessary information from the server. The wearable computer is equipped with a camera and a bar-code reader. Operation planning division staff can get the operation status through the camera and bar-code reader. Operators and Operation planning division staff can communicate through the system and network.

In this paper, a system configuration is described, each application is explained, and the result of application is summarized. And in this paper, we point out the issues for using the system in the assembly line.

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2. OPERATION INSTRUCTION SYSTEM

Recently, assembly systems are installed a cell production system, because production volume becomes smaller than ten years ago. The cell production system is a small shop that consists of a few operators [2]. Operators in the Cell have many operations to be assembled. Operators have responsibility to complete the product. Typical Cell system is shown in Figure 1. However, operators can not share training time for new model to be assembled. Therefore, we are necessary to use instruction system for assemble operations in real time.

Figure 1. Typical Cell Production System

We analyzed operations in the cell production system, and then we extract the requirements for a real time operation instruction system. These issues are the following;

1. To indicate the information for need to know.
2. To indicate the newest information.
3. To inform to operator on moving to station.
4. To indicate the easy understandable information.

To satisfy the requirements, we are developing the web-based instruction system by wearable computer (WBIS).

The system consists of the simulation system on the web-application, wearable computer and the wireless LAN. The system configuration is shown in Figure 2. This wearable computer is XYBERNAUT Mobile Assistant IV.

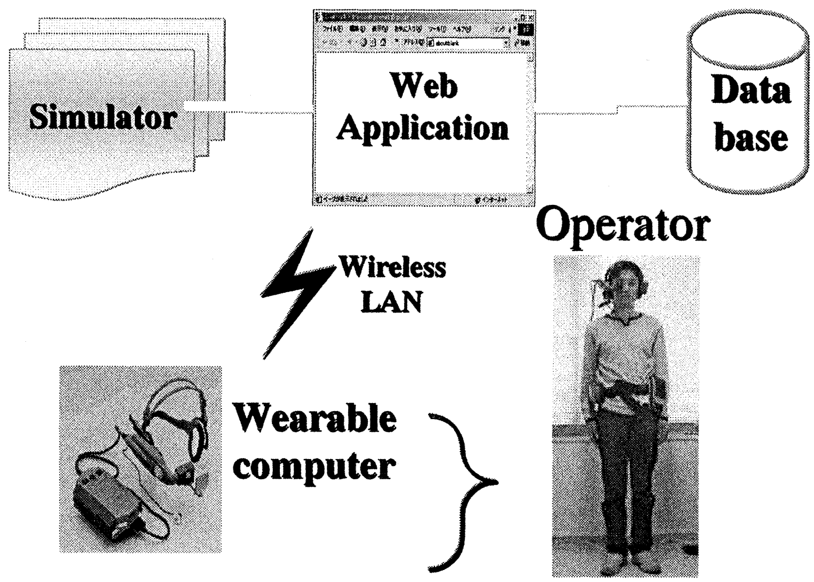

Figure 2. The System Configuration

Web application is included the instruction manual, simulation and scheduling based on the progressing operation. The web-application is called "web-instruction simulation system (WISS)".

Wearable computer can indicate the operation instruction on working the operation [3] [4]. Wearable computer is equipped the wireless LAN. Therefore the operator can get the context for instruction from web-server computer. Also wearable computer has a video-camera near by operator's eye. The camera can take a view and send the visual data to server.

3. WEB-INSTRUCTION SIMULATION SYSTEM

3.1 System Configuration

The Web-Instruction Simulation System (WISS) is a core system in the Web based operation instruction system. WISS provides the contents to the wearable computer. This system configuration is shown in Fig 3.

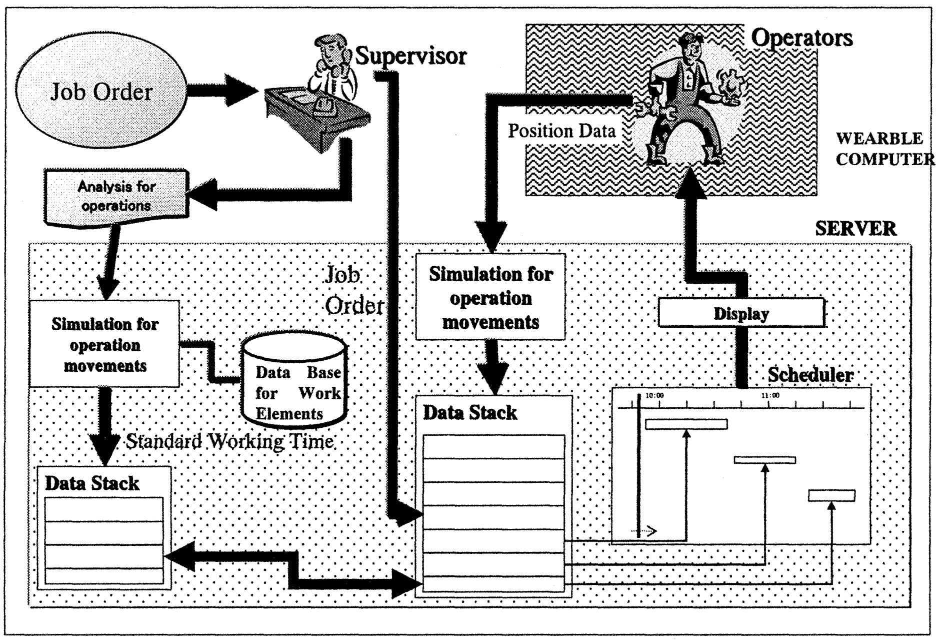

Figure 3. WISS System *Configuration*

WISS has a simulation for work time estimation. This simulation decides the work time and work movements depend on the work order from the supervisor. The simulator has a data base for work elements in the assembly shop. The data base provides the work element for assembly job to simulator. The simulator can calculate the working time. However, the calculated time is not included the moving time from present position to working position. Operator input the position data by wearable computer on finishing pervious work. Simulator will indicate the next work and the next position on the screen in the wearable computer. And also, if operator requests the working procedure, wearable computer can provide the manual to operator. The operator manual is edited by the simulators.

3.2 Simulator for time estimation

This simulator is for estimating the assembly time and the movement for the assembly work. Assembly work breaks down into the elements of work, such as handling, walking and waiting. The element also breaks down into motion elements such as Reach, Grasp, Move, Position and Release with MTM method. The system calculates the assembly time based on the motion elements. The system has the formulated functions for estimating the time [5]. Example of the function is followings;

Time of operation to hold (Grasp)

S : The size of the parts to hold (path)

$2<S<8$ (mm)

In the case of perpendicular supply

$$T= 10^{0.94-0.3S} \times 1/100$$

In the case of level supply

$$T= 25.12\ S^{0.94-0.56} \times 1/100 \text{(Unit 1/100sec)}$$

And then, each motion elements are aggregated to assembly work by the simulator. The simulator can consider the effective sequence and can display the result, as figure 4. The human model in the simulator can be animated. And the result is also in the manual for assembly operator. The human model can be abatable based on the individual physical size.

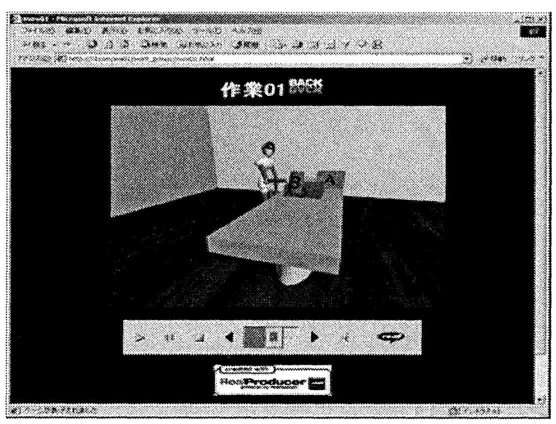

Figure 4. Simulation Output

3.3 WISS human interface

WISS is equipped some applications, such as moving analysis, scheduling, position information, assembly manual, notification, and animation for assembly work. And also, WISS has a database for standard time and a database for work assignment.

However, operators do not need much information on working. Therefore, WISS is separate the information which is processed by supervisor and operator. Supervisor side prepares the moving motion and the standard time for assembly by simulator and analyzer. And Supervisor side makes a planning and a schedule by scheduler, and makes manuals and notifications for assembly work by the simulator. This information is stored in the web-server by HTML format.

The operator side inputs the individual physical data before working. And the operator inputs signal after working. If the operator needs the information, they request the data on the screen in the wearable computer. Software configuration is shown in the Figure 5.The software is running on the Table 1 specifications

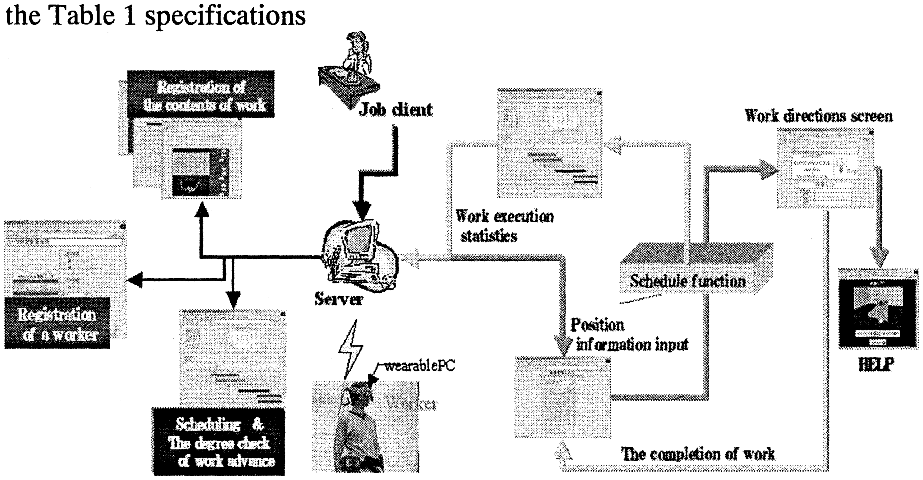

Figure 5. Software Configuration in WISS

Table 1. Software Specification

Operation System	Windows2000 (server), Windows CE(Client)
Web server	IIS5.0 (Internet Information Server)
Database Server	SQL 7.0 & Microsoft Access 2000
Programming	ASP, SQL, Java, HTML, JavaScript
Browser	IE5.5

4. AN IMPLEMENTATION EXAMPLE

For evaluating the proposed system, we have done a simple experiment. The experiment environment is U-shape assembly system. The operator equipped a wearable computer. Operator assemble three parts into a product depend on the web-instruction. The experience scene is in Figure 6.

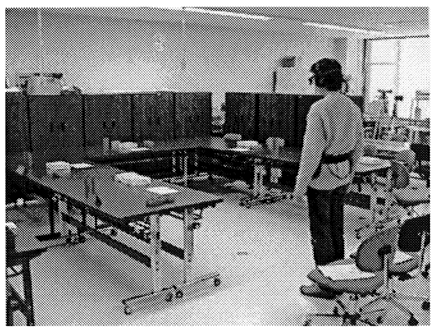

Figure 6. Experience Scene

We have two experiences, one is with wearable computer, and another one is without wearable computer. In each experience, 8 students are as testee.

The results are Figure 7 and Figure 8.

According to the results, we can recognize that the WISS squeezes the amplitude of the working time.

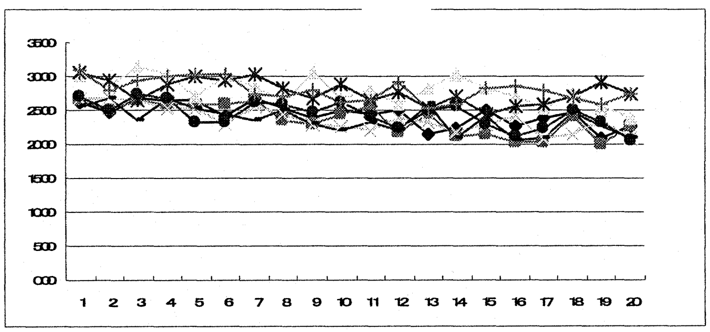

Figure 7. The Assembly Time without WISS

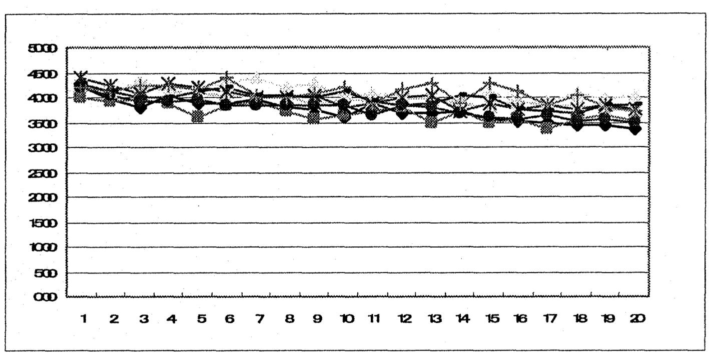

Figure 8. The Assembly Time with WISS

However, the assembly times with WISS are bigger than the one without WISS. The testees said that WISS is helpful for the instruction, but WISS is disturbed the operation. We are necessary to modify the interface of WISS.

5. CONCLUSION

We have developed the Web-based Operation Instruction System using a wearable computer. And we applied the system to the assembly system. The system can communicate the data on working the job. But some problems are clarified by our experience. Wearable computer has a poor display function on working, has a poor input function on wearing.

Simple job is not necessary to use the system; however we can believe the usefulness tools for maintenance and repair field. Web-manual and web-application is powerful tool for instructing the complex work. And we can change easily the content in the web-server from assembly to maintenance.

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