VR-based Interactive Learning Environment for Power Plant Operator

Yukihiro Matsubara and Toshinori Yamasaki
Faculty of Engineering, Kagawa University
Hayashi, Takamatsu, Kagawa 761-0396 Japan
Email: {matsubar, yamasaki}@eng.kagawa-u.ac.jp

Abstract

This paper presents a VR-based ILE, which integrates virtual reality (VR) technology into interactive learning environment (ILE). It is said that ILE is composed of Intelligent Tutoring System (ITS) and micro world. ILE supports a student's discovery learning activity and fosters his/her creativity and adaptability. Moreover, we integrate VR technology into ILE and build discovery learning environments with reality. Using VR-based ILE, it is possible for a student to relate knowledge to skills and to acquire both of them. Student can get confidence and experience with reality. We apply the VR-based ILE to a training system for power plant operators.

1 Introduction

The aim of Intelligent Tutoring System (ITS) is to design the behavior of intelligent human teachers on computers. ITS has a student model and an individual tutoring model, and realizes the individualized instruction of all students. However, students often become passive, because ITS takes the initiative in their learning process. In general, it is said that ILE integrates the advantage of micro world with that of ITS. Micro world does not have the function of positive teaching but encourages students to take spontaneous and discovery activities. On the other hand, because of the progress of hardware, various kinds of media are developed. Especially, it is virtual reality (VR) technology that has the potential to be applied to educational systems.

In this paper, we propose a VR-based ILE which integrates VR technology into ILE. The aim of our research is to develop VR-based ILE. Particularly, the learning target is operator training on a power plant control room. The demand for safety measures is increased from year to year, and we focus on educational curriculums not only to give knowledge but also to relate knowledge to skills and to acquire both of them.

2 VR-based ILE

ILE unites the advantage of ITS which can teach the knowledge systematically and the advantage of micro world which can support individual discovery learning, and it supports two types of tutoring methods, system oriented and learner oriented ones. The VR-based ILE is tutoring systems that incorporates VR into micro world, which can instruct with immerse viewing.

We focused on the subjects as sub-operators (novice operators) who don't have experience to control a power plant. And the goal is to acquire knowledge on emergency procedures. At first we produced a prototype system, which can teach "Loss of Coolant Accident" (one of actually occurring accidents). The configuration of the system is shown in Figure 1. The system is composed of a VR module and ITS module. The ITS module gives the domain knowledge, and catches the student's level of understanding, and it can teach individually. The VR module simulates a power generating system and a central control room. It deepens learners' understanding about the internal structure of a power plant, and how to operate a plant in case of an accident.

3 VR Module

The VR module is composed of two sub-modules as follows: One, which is called Walk-through sub-module, enables students to explore freely in VR environments which show the structure of a power plant. The other, which is called VR-simulation sub-module, enables them to learn skills/operations. The system configurations of both sub-modules are oriented to that of micro world, and both sub-modules encourage students to take spontaneous and discovery activities. The VR module has four kinds of interface, namely Head Mounted Display (HMD), magnetic track, 2D-mouse and space-ball.

3.1 Walk-through sub-module

One of the effective ways in which people can understand the target knowledge is to allow for different approaches to the target, based on the student's abilities/desires. It is more effective for them to get visual instructions too. By the way, it is difficult for human to approach the power plant because of its dangerous structure. Accordingly, the operator and sub-operator used to get knowledge about the power plant structure with models, 2D-pictures, photographs and so on. That is the reasons why it is not possible for them to acquire knowledge with reality, and it is difficult for elementary operators to understand knowledge about the power plant structure. Therefore, the walk-through sub-module shows students more real 3D-pictures with VR technology and gives the environment to support spontaneous learning by themselves.

3.2 VR-simulation sub-module

The aim of VR-simulation sub-module is to support discovery learning by students themselves. This sub-module provides them learning environments, which support the acquisition and simulation of skills/operations by using their knowledge and to set up situation freely. The roles of the plant operator are mainly "Watching", "Judgment" and "Operation". Therefore we build the functions of the power plant with VR technology. This sub-module enables sub-operators to learn how to operate with reality which they can't get...
on the traditional CAI for operator training.

4 Example

We show system examples concerned with the operator training system along the learning process. Particularly, examples give the learning process from the applied questions on ITS module to the simulation on VR-simulation sub-module as shown in Figure 2.

[Step 1] On the ITS module, a student learns the plant operational procedure and knowledge related it by using text knowledge and fundamental/applied questions oriented actual situation on the plant control room. In the case of applied questions, if a student has errors (miss conception), this module retrieves some related questions, namely fundamental questions, and gives the low understanding level questions. Also, if the current question is the question about operation, this module enables a student to make sure of the plant transitional process based on the correct answer with a simple control panel as shown in Figure 2(a).

[Step 2] After the learning on the ITS module, the student model is transferred from the ITS module to the VR module. The VR module gives the student messages about the procedural knowledge of the low level understanding based on the student model as shown Figure 2(b). Then, the student simulates and practices skills, paying attention to those messages.

[Step 3] The student simulates by using the virtual power plant control system as shown Figure 2(c) and (d). He/She relates skills to procedural and declarative knowledge and acquires them. At the same time, the VR module creates the operations history during simulation.

[Step 4] After the VR-simulation, it is possible for the student to examine his/her right and wrong information.

5 Conclusions

This paper proposed a framework of the VR-based ILE. VR-based ILE supports discovery learning with reality. It is possible for students to relate skills to knowledge and to acquire both of them. And we described prototype system for power plant sub-operator.

This research has been made possible through Grant-in Aid for Scientific Research (B)(13558018), (C)(13680242) and on Priority Areas (A)(13020234) from The Ministry of Education, Culture, Sports, Science and Technology of Japan.

References