Training of Industrial Assembly Processes: an Immersive Approach

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German Abstract

Dieser Artikel beschreibt eine computerbasierte verteilte Trainingsplattform in einer virtuellen immersiven Umgebung, in der verschiedene Interaktion- und Visualisierungssysteme benutzt werden. Der Trainingsleiter hat Zugang zur Steuerung und Kontrolle der Daten eines jeden Mitarbeiters (Trainees) und dessen Trainingssession, wobei sämtliche Aktionen des Trainees in einer Datenbank gespeichert werden. Da die hierzu zur Verfügung stehenden Anwendungen über beliebige (TCP/IP-basierte) Netzwerke aufgerufen werden können, muss sich der Trainingsleiter nicht unbedingt am Trainingsplatz aufhalten (Fabrik). Der Artikel beschreibt des weiteren die (verteilte) Architektur des Systems sowie die darin eingebundenen Module.

Virtual Reality and Training Assembly Operations

Today's Virtual Reality (VR) systems have reached an advanced stage of development mainly thanks to the efforts made in research centers where generic new interaction and visualization paradigms are analyzed, modeled and integrated into new system releases. On the other hand, VR has also been improved by direct application when solving problems in areas like architecture, medicine, scientific visualization or industrial prototyping and training application. The focus here lies more on the specific functionality of each solution scenario than in the show-effect that is usually achieved by VR.

For those industrial processes that require a training for the assembly line, the trainee is given a theoretical course, followed by a very short training period at an actual assembly workplace. Then, he or she is sent directly to the production lines. The factories avoid long periods at »real« assembly workplaces for the trainees because raw material is wasted and they need the appropriate number of ready assembly line operators quickly. Consequently, the learner does not have enough time to practice assembly operations and handling tools. This approach normally leads to considerable delays at the production line. Also, an initial phase of a high level of mistakes, reducing the overall productivity must be considered. An Immersive Training System (ITS) aims to solve the problem of assembly processes by providing an immersive environment for training purposes. Aided by this system, the learner can get used to the assembly artefacts and actions that he/she has to handle very quickly and without any waste of raw-material.

Training Process

An Immersive Training System, integrated in a national R&D program, has been developed by CCG for the specific case of the wire twist assembly. It is based on real workplaces from specific industrial partners. The actual process is composed of several adjoining workplaces each with a panel where several objects and tools are placed. They must be processed according to a specific assembling order. The application recreates an entire workplace offering the worker his/her natural (future) work environment – yet without physical constraints. Thus, the workers may complete several training sessions by repeating difficult actions, starting new ones or simply by concentrating on special aspects of the assembly process. The given approach is less time-consuming and also reduces the waste of raw material as well as inappropriate usage of the tools. Another advantage is the availability of monitoring facilities for each training session, considering both the ones actually running and those already completed, stored as sequences of assembly actions. The trainer can choose the trainees, the exercise, its level of difficulty and the time the specific training session shall start. Afterwards, the trainer can monitor each training step, observing the running actions on a map of his system Web interface. This dynamic map is completed while the worker(s) accomplish(es) the exercise, showing all the details of the processed objects including mistakes that he/she makes during the exercise. In the meantime, all this data is stored in a corre-

Figure 1: Typical Assembly line

Figure 2: Aspect of a training session

sponding database in order to permit subsequent analysis. This system also allows several workers and trainers to operate at the same time.

System Architecture

The implementation of the system architecture follows a client-server structure. The server maintains the coherence of the system, and provides the required services. It contains a database with the information about the objects being used, the configuration files of the assembly operations as well as the actual information about the running training sessions.

The architecture consists of 3 main modules: administrator, trainer and trainee. The administrator module is located in the main server and is used for control by administrators and when new virtual assembly processes are defined (for later training use).

The trainer module provides the means to control the training process, its actual monitoring and access to statistical results of each completed training session. This module uses a web browser interface.

A graphical engine, interaction devices (HMD, Tracking System and Cyberglove) and a tutorial sub-system make up the trainee module.

The ITS also allows to reproduce copies of the models – trainer and trainee – along a distributed configuration which permits several instances of these processes to run at same time, at different places over the Internet. It requires, however, that the adequate equipment (e.g. HMD) is available for each trainee module.

Future Work

The aim of this project is the development of an effective ITS and its integration in concrete industrial training scenarios. Is has to take into account specific workspace constraints and the problems of VR´s actual limitations. An extension of this application to industrial processes not restricted to assembly lines is planned as well as the integration of a second data glove and force feedback mechanisms.

Points of contact

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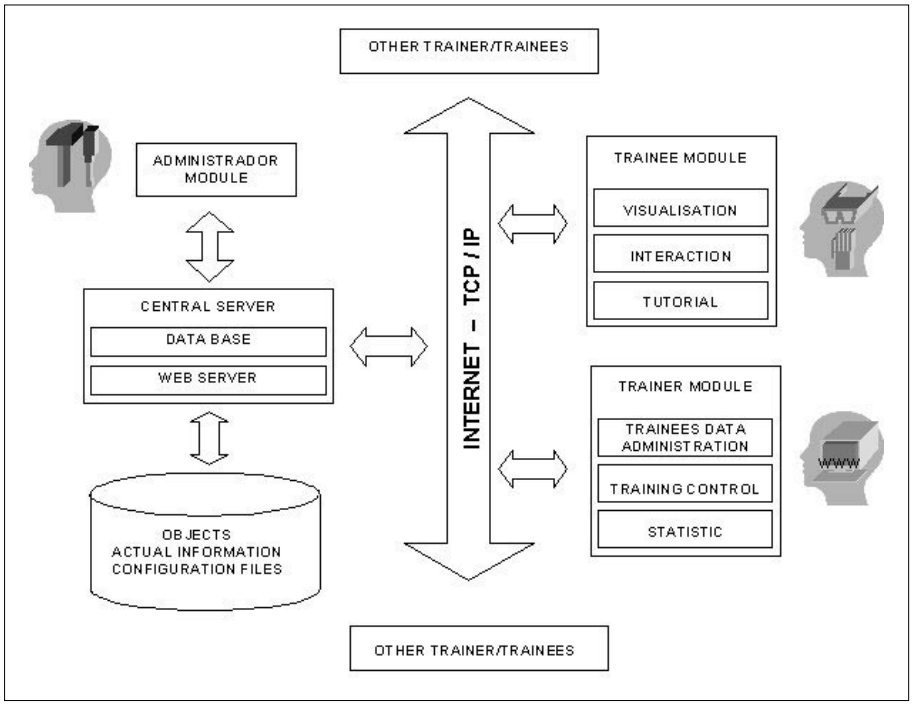

Figure 3: The ITS main Architecture