CONTINUOUS EVALUATION IN TRAINING SYSTEMS BASED ON VIRTUAL REALITY

Ronei Marcos de Moraes[1] and Liliane dos Santos Machado[2]

Abstract — *The approach of continuous evaluation is an important tool in the learning process. However, in training based on virtual reality it is not applied. This paper presents a methodology of evaluation that uses the continuous evaluation approach to provide an user profile from his several training. This information can be used to improve the user performance in the real execution of the task. The methodology proposed is given by the union of classical statistics tools and an expert system to construct an individual profile for each trainee. The statistical tools used are measures of describing center and spread of distributions, tables and statistical graphics (time depended or not). Beyond the data collection, these tools provide information to the expert system for the profile composition throughout training process. This new approach is a diagnostic tool that enables a trainee to understand the areas in which he presents difficulties and to concentrate to solve them.*

Index Terms — *Continuous Evaluation, Evaluation Training, Expert Systems, Statistical Tools, Virtual Reality.*

INTRODUCTION

The researches in training evaluation based on virtual reality [3] are recent. The first work on this was presented by Rosen et al. [19] from Washington University in 2000. That work was based on Discrete Hidden Markov Models to execute an off-line evaluation on laparoscopic training executed by a trainee. However, that methodology was not applied on virtual reality simulator, but on a guinea pig with several sensors. A few months later another evaluator was proposed by Machado et al. [6] which it was based on a fuzzy expert system to evaluate a bone marrow harvest simulator based on virtual reality. In this case, the evaluator works on-line.

Several other evaluation systems are proposed after by Rosen et al. [20] and Moraes and Machado [7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18]. However, those methodologies did not use any technique of continuous evaluation to improve trainee performance. Continuous evaluation is a good tool used in present and distance learning to help the construction of the knowledge and the cognitive training [1, 5]. In our case, the goal is to construct a diagnostic to help trainees to understand their difficulties.

This work proposes a new conception of continuous evaluation to construct a trainee profile from his several trainings and to help him to improve his performance [2, 4]. The union of statistical tools, for measure observed variables during training, and an expert system, to construct the trainee profile, composes this conception.

METHODOLOGY

A tool for continuous evaluation must be interconnected with an on-line evaluation system and must receive from it information about all variables of interest. An evaluation system works near a virtual reality simulator, as Figure 1 shows [15]. In general, an on-line evaluation system should be capable to monitor user interactions while he operates the simulation system. For that is necessary to collect the information about positions in the space, forces, torque, resistance, speeds, accelerations, temperatures, visualization and/or visualization angle, sounds, smells and etc. These information will be used to feed the evaluation system. In the Figure 1, we can observe that the virtual reality simulator and the system of evaluation are independent systems, however they act simultaneously.

The user interactions with the system are monitored and the information are sent to the evaluator system that analyzes the data and it emits an evaluation report about the user performance at the end of the training according pre-defined classes of performance. A set of rules of the expert system defines each one of the possible performance classes and it is defined from specialists knowledge.

The interaction variables will be monitored according to their relevance to the training. This way, each application will have their own set of relevant variables that will be monitored [15].

The methodology proposed for continuous evaluation uses data collected from user interaction in his several training to create a user profile. That information is used to evaluate trainee and improve his performance in real tasks [21]. From data collected from training a database is created with specific and relevant variables. New information is stored from each training executed.

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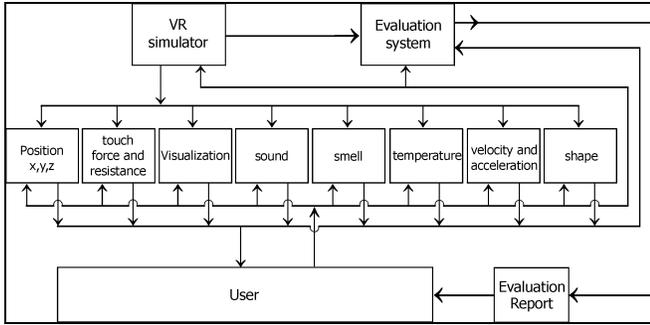
FIGURE 1.
DIAGRAM OF A VIRTUAL REALITY SIMULATOR WITH AN EVALUATION SYSTEM.

Our methodology makes a union of statistical tools and an expert system to construct an individual profile for trainee. Statistical tools are programmed to make an automatic analysis of the database and construct statistical measures, tables, graphics and statistical models (time dependent or not). From these information (statistical measures and parameters), an expert system can create a user profile and an continuous evaluation report. The continuous evaluation report presents the trainee profile and shows, with statistical measures, tables, graphics and models, execution performance of specific tasks. Figure 2 shows the new methodology presented.

It can be observed that the Evaluation System from Figure 1 has more components now. The Continuous Evaluation Tool and the User Profile were incorporated (gray area in Figure 2). The new evaluation system creates two kinds of report: evaluation report and continuous evaluation report. The first report is about the user performance on the last training. The continuous evaluation report is about all set of training.
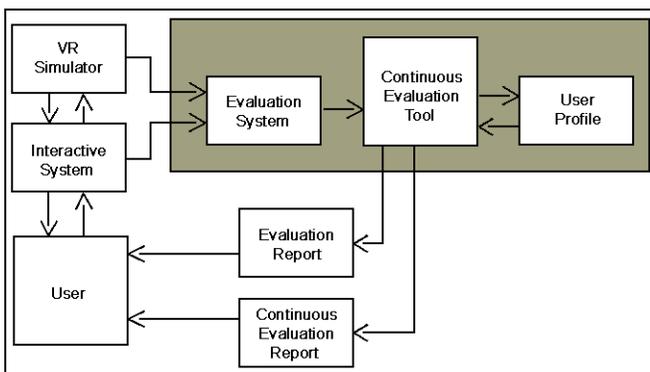

FIGURE 2.
DIAGRAM OF NEW EVALUATION SYSTEM WITH APPROACH OF CONTINUOUS EVALUATION.

In the first time when user execute his training, the Evaluation Report emits information about the user performance at the end of the training according to classes of performance previously defined. The Continuous Evaluation Report presents information about user performance above specific tasks using statistical measures, tables, graphics and models. Both reports present information from the present training. But, additionally, the Continuous Evaluation Report will show accumulative information about sequence of training for that user.

APPLICATION

This methodology can be applied for any activity, specially those where there is some risks to user or some people who depends of him. In this context, continuous evaluation is an interesting tool to improve knowledge constructing. For example, in medical areas, where invasive procedures can be simulated by virtual reality and they are subject of researches, it is necessary some kind of evaluation tool with properties of continuous evaluation. These tool are capable to show to the user his qualities and his deficiencies in execution of medical procedures.

An example is the bone marrow simulator, a virtual reality simulator to training the extraction of bone marrow in children [9]. In this application the user is a novice surgeon that must acquire dexterity to insert a needle in the pelvic region of a child until it find the bone marrow, located inside the iliac bone. As interaction tool, the user manipulates a haptic device, observed in the system as the needle. This device is responsible to give him all tactile sensations related to the manipulation of a needle in a real patient. Figure 3 shows a screenshot of the bone marrow simulator and Figure 4 shows the haptic device used for interaction.

For this simulator, the use of a continuous evaluation tool could provide the performance improvement of the user during a training stage. In this case, the relevant variables to be monitored could be the position, angles and forces applied during the interaction performed with the haptic device. This way, the evaluation system would provide an on-line evaluation and the continuous evaluation tool would analyze the user performance improvement, pointing his dexterity to perform a real procedure in a child.
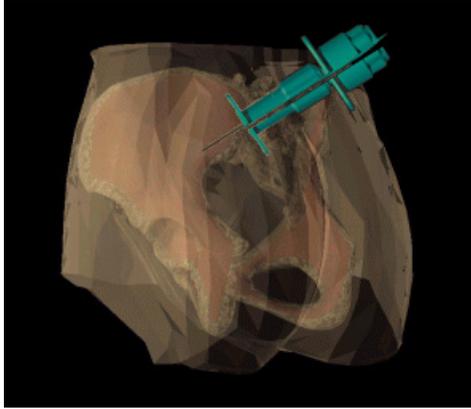
FIGURE 3.
SCREENSHOT OF THE BONE MARROW SIMULATOR WITH SEMI-TRANSPARENT VIEW OF THE PELVIC REGION.

FIGURE 4.
HAPTIC DEVICE FOR INTERACTION WITH TACTILE SENSATION.

CONCLUSIONS

In this paper we introduce a new methodology for evaluation training using the continuous evaluation approach. This methodology can emit to the user information about his performance at the end of the training according to classes of performance previously defined, as proposed in others methodologies. Moreover, this methodology can provide user with information about his performance in specific tasks in the training.

A system developed using the proposed methodology is a diagnostic tool, which helps a trainee to understand his difficulties. From information presented the trainee can solve his difficulties and improve his performance.

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