Improving CBT by VR elements

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Abstract

Pushed forward by massive economical improvements in the realm of simulation, we currently observe an accretion of the Computer Based Training (CBT) sector with the simulation sector. The availability of low-cost systems for 3D visualization on the basis of PCs allows the incorporation of simulator components into classical CBT programs. This in effect makes it possible to use constructive learning theories as the simulation components allow for a very realistic interaction of the learner and the training object, so that quasi-free exploration techniques are within the reach of CBT.

An operational field for coupling classical CBT with VR-techniques is the training of EOD-units within the German Navy. The trainees shall learn categorization and identification of all sorts of munitions and bombs. Further more they shall be trained in proper disarming and handling the explosives. At present these goals are taught by means of classical lessons. Teaching the construction of the objects is accomplished by means of visual instructions using structural models. Environmental effects which the trainee is confronted with in real life demand long and expensive preparations and are therefore rarely used in current lectures.

CCI GmbH and the Bundesamt f r Wehrtechnik und Beschaffung develop in close cooperation with the weapon diver battalion of the German Navy a CBT program based on a combination of classical CBT techniques and VR techniques. We use a stepwise explorative didactical approach. The program uses several VR-Visualization techniques based on a database containing 3D-models of bombs and munitions. The simulation of environmental effects as the reduced visibility under water and other influences are applied as well as a scenario editor to be used by instructors. This paper presents the current state of development.

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Overview

The Federal Office for Defense Technology and Procurement (BWB) has long-standing experience in CBT development. In 1999 an R&T project Combination of CBT and Virtual Rea lity (VR) was launched in order to research the potentials and implications of modern VR-technologies on CBT-methodologies. This year the project will be continued by the development of a VR/CBT demonstration application for the German weapon diver battalion.

Introduction

The frequent use of large-scale simulators in many different fields in spite of the very high costs of such systems shows the demand for training systems incorporating a certain amount of realistic behavior. Further advances in PC performance induce the question whether technologies from the fields of simulation and virtual reality (VR) now become available for widely used computer-based education and training systems.

Our investigations have shown that VR-technologies especially in the field of visual and acoustic simulation and in the field of tracking systems are available on PCs right now. PC based graphics systems offer a performance that beats old specialized graphics-workstations by a factor of 4 at a price of less than 5% compared to the old systems. High-quality—low-cost PCs thus enable the use of these VR-techniques in widely used CBT-programs.

Virtual reality methods generally aim at invoking high degrees of immersion on participants of synthetic environments. Beside the flexibility offered by the programmable environment, this effect causes high degrees of concentration of the participant on the objects shown in the virtual world. Using this phenomenon in VR/CBT-programs might therefore increase the impact depth of learned knowledge.

In combination with simulations in the VR/CBT environment an author now also has methods available for using constructive learning theories in her/his VR/CBT program. The mathematical model behind simulations makes a more or less free investigation of teaching objects possible. This allows the trainee to acquire knowledge in his/her own way as demanded by the constructive learning theory. The author can use the constructive learning approach either alone or in combination with cognitive learning methods to expand and facilitate the operationalization of learning goals.

In order to find a demonstration example for a combined VR/CBT-application we categorized CBT-programs currently in use in the German Army into application areas and compared these with potential improvements introduced by VR-technologies. It turned out that especially for teaching technical subjects with demanding geometrical content, an additional VR-visualization and a simulation using three-dimensional models in combination with a stepwise constructive approach promises great improvements on currently used multimedia techniques.

In the following we would like to present an overview of a VR/CBT demonstration program teaching EOD-units in the weapon diver battalion of the German Navy.

Learning Goals

For successful disposal of explosive ordnances (EO) a weapon diver has to know principles of operation of EO, distinguishing characteristics of certain types of EO as well as procedures for disposal.

A first learning goal therefore is the knowledge of construction principles of EO. This comprises knowledge about detonators, activating mechanisms, securing mechanisms, sterilizing devices, boosters and main charges in diverse forms. Most of these items have complicated geometric forms and their construction and functioning is currently taught by visual instructions using structural models if available.

As a second learning goal the trainee shall know distinguishing elements of mines, so that he/she is able to characterize mines for identification. This goal is currently taught by visual instructions using structural models of mines.

A third learning goal is the correct deployment of procedures for the disposal of explosive ordnances. For reaching this goal the trainee must take many environmental aspects into account and he/she also has to apply knowledge acquired from the previous two learning steps. At present this learning goal is accomplished by classroom teaching combined with live simulations which are expensive, need demanding and time-consuming preparations and are, in parts, dangerous for the trainee.

We apply the above learning goals as a starting point for the development of our VR/CBT-demonstrator to moored mines which form a subset of underwater mines.

Structure of the VR/CBT-program

Our VR/CBT-program is subdivided into two parts as shown in figure˚1.

In the first chapter generic principles of all three learning goals are taught. The construction principles, functional principles and procedures for disposal of underwater mines are explained in a tutor-based approach. In this part we exemplify generic principles of the mines and demonstrate them by examples. The geometric models used are mostly based on 3D-models. We also use classical multimedia techniques like pictures and speaker texts in connection with computer animations based on the 3D-models. To support the generic nature of parts of the mines we developed a functional color scheme in close cooperation with the weapon diver battalion of the German Navy.

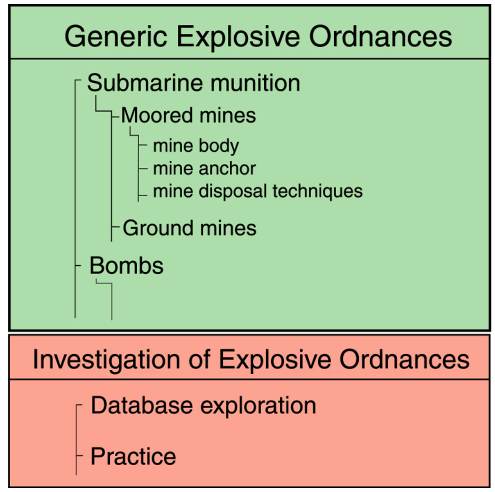

Figure 1: General Structure of the VR/CBT demonstration program.

For a deeper understanding of technical details within the first chapter we offer the trainee a simulation-based exploration of the 3D-models. In this exploration the trainee is free to choose his point of view. He/she can also interact with the 3D-model itself. This interaction allows him/her to change the appearance of the object from a realistic view (shown in fig.˚2) using realistic textures

Figure 2: Realistic underwater views onto the mine body of a moored mine.

to a functional view (shown in fig.˚3).

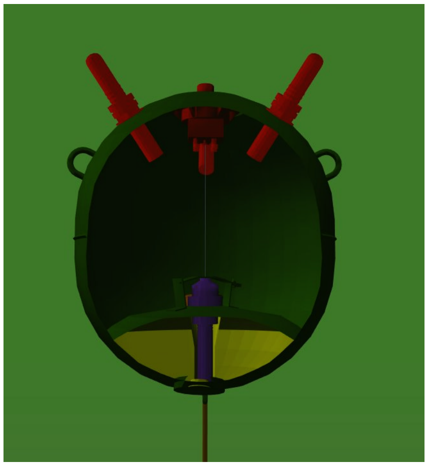

Figure 3: Functional view onto the mine body of a moored mine.

One can also fade parts of the object (shown in fig.˚4) to see inside the object. A functional investigation of the object is also available where appropriate.

Figure 4: View onto the mine body of a moored mine. The cover of the minebody is faded. Interior parts are visible.

By this approach we couple the classical cognitive approach with a constructive approach where the trainee can acquire knowledge by experimentation supported by advanced visualization techniques.

In the second chapter of the VR/CBT-program the trainees knowledge is used, further trained and expanded by the investigation of mines from a database containing 3D-models. These mines can be investigated in two levels.

In the first level the trainee can investigate the full mine-model in a virtual EOD-hall. He has all methods at hand he has already used in the first chapter. In order not to leave the trainee alone in this constructive learning situation we have introduced a help˚on˚demand -mechanism based on object properties. According to the object s type, e.g. a booster, help is given in that the trainee is redirected to the corresponding subchapter about boosters in the first part of the program. Here he has the possibility to learn more on the principles underlying the object. Additionally a datasheet gives more specific information on the object.

The objective of the second level of free investigation is to confront the trainee with real world situations in the VR/CBT-program. Objects from the database are placed in specific underwater situations characterized by limited visibility and dynamically changing light conditions. The instructor can create scenarios of sunken and partly hidden mine bodies with the help of a scenario editor and place them inside the database. So the trainee has to solve situations under imperfect conditions, just as in real world. As a positive side effect of this approach long and expensive preparations of training situations are needed less often.

3D-Models

The 3D-models used in the VR-simulations and for animations are created in an object-oriented manner in MultiGen-Creator. The graphical representation, which is shown e.g. in figure 2, corresponds to an object tree as shown in figure˚5.

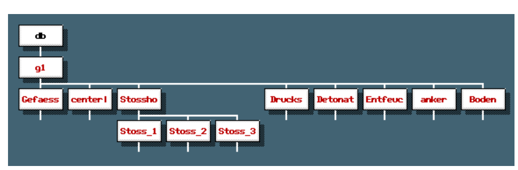

Figure 5: Object tree for a moored mine. Individual elements like sterilizing devices and others are indicated.

One can see that the mine body and other graphical elements of the mine as sterilizing devices, activating and deactivating mechanisms are grouped in this tree.
Using one of our tools, the so-called VR-Designer , we expanded the pure graphical representation of MultiGen by attaching object properties and functions to individual nodes in the hierarchy. This, in connection with another tool called VR-Engine is the key for implementing the interaction of trainees with the objects.

Trainee Workplace

Due to the combination of a tutor-based approach and a VR-based approach we use a combination of two PCs as the trainee workplace. The tutor-system is implemented under Toolbook on a Windows PC. The VR-system is implemented by using SGIs Performer-API and a couple of tools on a Linux-PC with a powerful graphics card. Both systems are equipped with a 19 monitor.
The input methods on both systems differ in order to give the trainee a clear orientation. For the tutor-system we use keyboard and mouse whereas for the VR-system we use a three-axis joystick and a touch screen for user input.
A local area network (LAN) couples both systems. The communication between the Toolbook-application and the VR-application is message oriented and based on the High-Level-Architecture (HLA). The use of the HLA protocol also makes it fairly easy to set up a monitoring of the trainee workplace and to enable interaction with the instructor s workplace and the trainee s workplace.

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References

Innovationsforum ª Multimedia-Anwendungen des Bundeslandes Baden-W rtemberg. (1999). Final report. Stuttgart, 18.02.1999. http://www.mfg.de/innovationsforum2/documents/Ergebnisdoku.pdf (1999, Aug.)

Meyer C. (1999). Untersuchungen der Einsatzm g lichkeiten von virtueller Realit t (VR) in Kombination mit computerunterst tzter Ausbildung (CUA). Study on demand of the German Federal Office for Military Technology and Procurement (BWB) under contract no. E/F11B/Z0166/K5106.

Schlotfeldt T. (1999). Phychologische Grundlagen. http://www.toppoint.de/~timfly/dpl/Psych_Grundlagen.html (1999, Sept.).

Thissen F. (1997). Das Lernen neu erfinden — konstruktivistische Grundlagen einer Multimedia-Didaktik. (PDF). http://machno.hbi-stuttgart.de/~thissen/lt97.pdf (1999, Sept.)

Thissen F. (1998). Lerntheorien und ihre Umsetzung in multimedialen Lernprogrammen — Analyse und Bewertung. http://machno.hbi-stuttgart.de/~thissen/lernen.pdf (1999, Sept.)