Usage of VR methodology in NRI Rez

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Abstract

This presentation is a brief report about NRI Řež plc activities in the area of virtual and augmented reality.

The preceding stage of our effort on virtual reality application was focused at the schooling and training of personnel of the complex mechanical equipment. Utilising simulation technologies based on virtual reality we have developed an open system of SW tools for simulating repair and maintenance of such equipment with the objective to train service personnel and to test their knowledge. The SW system for the repair and maintenance simulation combines presentation and control of the monitored equipment and evaluates knowledge of the entered work procedure using virtual reality tools. The system also contains applications, which enable to create and to modify knowledge databases of the work procedures, including their connections with the virtual reality tools.

At present, UJV has launched programme for the preparation of tools, which will allow to enhance safety and efficiency of demanding and risk-involving operations. The main objective of this programme is a proposal and complex verification of the augmented reality application as an information support for a person supervising or controlling a certain activity within the given process or for a person who carries other, especially risk-related activities.

1. SIMULATION OF MACHINERY REPAIRS AND MAINTENANCE

Utilisation of the presentation and interactive capabilities of virtual reality is one of the ways, how to enhance efficiency on theoretical and practical levels in schooling the repair and maintenance personnel of complex mechanical equipment. For achieving unchallenged mastering of repair and maintenance of such equipment practical training cannot be entirely substituted, however such training could be too expensive, could be damaging to the environment and could include health hazards for servicing personnel. The computer simulations based on virtual reality can substantially reduce these negative effects and up to a certain degree – replace the practical training.

UJV Řež has developed an open system of SW simulation tools, applicable for the schooling and training of mechanical equipment servicemen. The main part of the system is testing of personnel theoretical knowledge and practical skills on the basis of work procedures, which were prepared to assure correct and safe performance of any tasks within equipment repair and maintenance. The system is designed for personal computers with Microsoft Windows 2000™ and its hardware configuration requirements do not exceed the usual present PC standard. Users are allowed to easily create own applications of the training simulation, within unlimited number of testing tasks and for different knowledge levels.

In its basic version, the developed simulation system uses SW tools of MultiGen-Paradigm, Inc. Models in the virtual reality are developed using graphic 3D editor, which allows to develop objects in three-dimensional space with a high degree of authenticity. Subsequently, these objects are combined (using a

configuration SW tool) into overall virtual reality scene, including assigning to it the certain global parameters. The very system of the repair and maintenance simulation represents the virtual reality scenes through library modules, which are dynamically activated at the system start-up.

The SW tools of the simulation system comprise the basic testing application designed for testing the work procedures knowledge, as well as the supporting editing and viewing applications, which allow to create and modify the knowledge databases of work procedures, including their linkages to the virtual reality tools.

A work procedure for a certain task unequivocally defines the exact sequence of the interventions performed at the mechanical equipment in question. It is created using the work procedures editor and stored in the knowledge database, which contains the complete description of the work procedure, including the relevant references to the individual objects of the virtual reality scene. The editor also checks on the data consistence and thus excludes possibility of a non-complete or information-wise contradictory database. The work procedures browser presents the text description of a selected work procedure and can be used as a study aid of the work procedures.

The testing programme represents the treated mechanical equipment in virtual reality and tests the user's knowledge in the step sequence of the selected work procedure. In each sequence step, the user selects the required activity out of several offered possibilities and then – the corresponding virtual reality object on which the selected activity is applied. Mistakes made are reported to the user and he is required to make a new correct selection of the activity or object. When correct objects are selected, the virtual scene reacts by changing accord with the performed activity. After the steps sequence of the selected work procedure is completed, the user receives the test evaluation.

Development of an alternative system version for the simulation of mechanical equipment maintenance and repair led in its next stage to transformation of the working procedures database into VRML language code. Thus, personnel knowledge can be tested on the standard VRML format using routinely available VRML viewers and the developed supporting SW. Thus, testing applications are not dependent on a concrete custom SW, and virtual models can be created using various 3D modelling SW or modelling CAD systems, with a possibility to transport into VRML format.

The key programme module of this simulation system version is the programme module of the concrete testing application code generator in VRML format. The testing application is focused directly at the concrete working procedure and the applications generator creates it automatically by processing the work procedures input data. An auxiliary communication module in Java language performs the text part of communication with the user and synchronising user’s activities with the operations within VRML code.

Along with development of the simulation system the knowledge database and virtual models of selected components of the heavy terrain truck T-815 were created. The whole system was installed (within the Czech Army modernisation) at the Military Academy Brno, and thus its students, in addition to practical training, are able to take an active part in creating new work procedures.

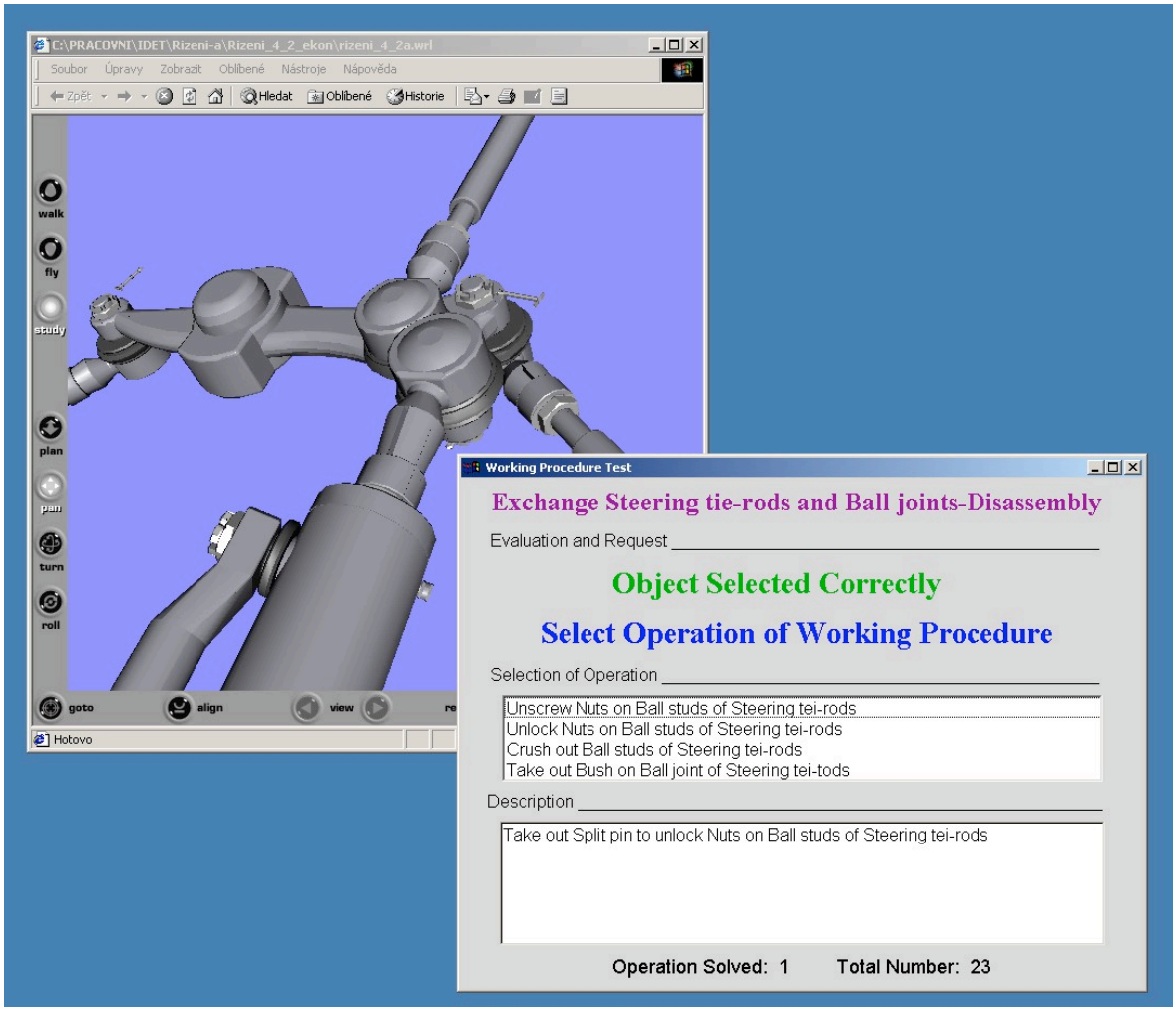

Figure 1. Example of VRML test application GUI

2. SAFETY AND EFFECTIVENESS ENHANCEMENT OF HIGHLY DEMANDING AND/OR RISKY TASKS PERFORMING

Successful implementation of the virtual reality technologies in the SW system designed for schooling and training of personnel servicing mechanical equipment, together with the acquired experience, are an important "springboard" in the new project on preparing tools for safety and efficiency enhancement in demanding and risk-qualified human operations. The augmented reality technology opens new possibilities, especially of possibility to combine the real environment picture with the visualisation of this environment negative parameters, which are not discernible/measurable by human senses, as for instance radiation, toxic contamination, noise, vibrations, etc.

The main objective of the project is proposal and complex verification of the augmented virtual reality application for ensuring the necessary information support of:

- personnel who supervise or control activities within the certain process framework – to enhance their safety and efficiency and thus – of the whole process,
- personnel who perform concrete activities, especially those – risk classified.

The project main output is proposal and verification of methodical, organisational and SW tools for the on-line information support of personnel who perform complex and/or risk-involved activities requiring mental concentration, aggravated by stress and time shortage for decision-making. The main attention is focused at the economic factors of supporting correct behaviour of a person in solving cognitive demanding tasks, in the sense of eliminating his/her possible failure, as for instance:

- disregarding,
- information overloading,
- misunderstanding of priorities,
- incorrect interpretation,
- error in decision-making,
- error caused by stress factors.

The concrete outputs of a complex project comprise:

- proposal and verification of methodical, organisational, SW and logistic tools for selected categories of human activities,
- proposal and verification of individual modules for selected categories,
- proposal and verification of visualisation tools for selected parameters of the technological process and selected environmental characteristics,
- proposal and verification of time and space distribution models of selected negative impacts.

While selecting human activities, the criterion of risk minimisation and possible direct damage range is considered, as well as minimisation of risk to individual and population health and environmental impacts. Therefore the attention is concentrated on:

- support of selected work procedures in supervising and controlling complex technological units with the potential threat of dangerous substances release into the environment,
- support of intervention units involved in management of an emergency situation with dangerous substances release into the environment,
- support in emergency situations management and their accompanying consequences.

Concrete applications are planned for the following areas:

- Interventions and manipulations with the NPP primary circuit equipment,
- interventions and manipulations with the NPP secondary circuit equipment,
- interventions and manipulations with equipment of complex chemical technology,
- interventions in radioactivity contaminated area,
- interventions in toxically contaminated area.

The problem under consideration covers also safeguards of the utilised information systems against electronic intervention, as well as selection of the appropriate modelling of the radioactive substances behaviour and spreading in a real environment. The objective is creation of open models of the time and space distribution for the selected environmental parameters in dependence on the source location and magnitude, as well as of the functionally and ergonomically verified programme modules for the environment visualisation.

3. REFERENCES

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