Application of the Virtual Reality Modeling Language for Design of Automated Workplaces

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Abstract—Virtual Reality Modelling Language (VRML) is description language, which belongs to a field Window on World virtual reality system. The file, which is in VRML format, can be interpreted by VRML explorer in three-dimensional scene. VRML was created with aim to represent virtual reality on Internet easier. Development of 3D graphic is connected with Silicon Graphic Corporation. VRML 2.0 is the file format for describing interactive 3D scenes and objects. It can be used in collaboration with www, can be used for 3D complex representations creating of scenes, products or VR applications VRML 2.0 enables represent static and animated objects too. Interesting application of VRML is in area of manufacturing systems presentation.

Keywords—Virtual reality, virtual reality modeling language, design of workplaces, technological workplaces.

I. INTRODUCTION

HISTORICALLY, virtual reality has entered into the public awareness as medial toy with equipment „helmet-glove", which was preferentially determined for wide public and the price of this system had also to correspond to this fact, so price could not be very high. As follows, the producers of virtual reality systems have aimed at developing and providing of the systems for data collecting and analysing and systems supporting economic modelling. It is obvious that, from among areas, where virtual reality systems can be most frequently used are applications based on 3D-space analysing and physical dimension visualisation. Virtual reality with ability to show data 3D and attach sounds and touch information increases extraordinarily data comprehensibility. Along with increasing the number of data are increased the effects from virtual reality too [1].

Virtual Reality is technology for presentation of complicated information, manipulations and interactions of person with them by computer. Method of dialogue of person with computer is named interface and virtual reality is newest of row this interfaces. After applications of virtual reality in area of computer games are rise need to exercise these technologies in industry. Main areas of using of virtual projecting and prototyping are automotive and air industry in

this time. Virtual projecting as very perspective method must by using in area of projecting of manufacturing systems, too.

II. VIRTUAL REALITY TECHNOLOGY

At the beginning of 1990s the development in the field of virtual reality became much more stormy and the term Virtual Reality itself became extremely popular. We can hear about Virtual Reality nearly in all sort of media, people use this term very often and they misuse it in many cases too. The reason is that this new, promising and fascinating technology captures greater interest of people than e.g., computer graphics. The consequence of this state is that nowadays the border between 3D computer graphics and Virtual Reality becomes fuzzy. Therefore in the following sections some definitions of Virtual Reality and its basic principles are presented.

Virtual Reality (VR) and Virtual Environments (VE) are used in computer community interchangeably. These terms are the most popular and most often used, but there are many other. Just to mention a few most important ones: Synthetic Experience, Virtual Worlds, Artificial Worlds or Artificial Reality. All these names mean the same [4]:

- "Real-time interactive graphics with three-dimensional models, combined with a display technology that gives the user the immersion in the model world and direct manipulation."
- "The illusion of participation in a synthetic environment rather than external observation of such an environment. VR relies on a three-dimensional, stereoscopic head-tracker displays, hand/body tracking and binaural sound. VR is an immersive, multi-sensory experience."
- "Computer simulations that use 3D graphics and devices such as the DataGlove to allow the user to interact with the simulation."

Although there are some differences between these definitions, they are essentially equivalent. They all mean that VR is an interactive and immersive (with the feeling of presence) experience in a simulated (autonomous) world – and this measure we will use to determine the level of advance of VR systems [2].

VR systems could be divided by ways of communication with user to such groups:

1. *Window on World Systems* – for displaying the virtual world are used conventional computer monitors. This system is also called Desktop Virtual Reality, but usually it is called as Window on World (WoW).

World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:1, No:7, 2007

2. *Video Mapping* – This system is modification of WoW system, where the siluetes of human body could be displayed in 2D. User could see himself or herself on monitor in interaction with environment.

3. *Immersive Systems* – basic VR systems, which enables user to be in virtual environment. The feeling to be in is created by Head Mounted Displays (HMD). This HMD could be with or without limitation of moving. Example of HMD application is on Fig. 1. On Fig. 2 are presented special gloves with sensors for VR.

Fig. 1 Special Head Mounted Display for Virtual Reality

Fig. 2 Gloves with Sensors for Virtual Reality

4. *Telepresence* – Attached to a high – speed network, VR takes telepresence to next level. Participants can be thousand of kilometres apart and yet feel as if they are all standing in the same virtual office or laboratory, with their product, design, or experiment right in front of them not only talking about it, but interacting with it, change it etc. This technology connects sensors, which are apart in real world. Sensors could be placed on robot or on presented tool.

5. *Mixed reality* – This system is created by connecting of telepresence and Seamless Simulation Systems. Computer generated data are connected with telepresence entries and with user sight on real world.

6. *Fish Tank Virtual Reality* - System created in Canada. It is a combination of stereoscopic monitors and tracking system measures position and orientation of a hand.

Augmented reality (see Fig. 3 and Fig. 4) offers the enhancement of human perception and was applied as a virtual user's guide to help completing some tasks: from the easy ones like laser printer maintenance to really complex ones like a technician guide in building a wiring harness that forms part of an airplane's electrical system. An other example of augmented reality application was developed at the UNC: its goal was to enhance a doctor's view with ultrasonic vision to enable him/her to gaze directly into the patient's body [6], [7].
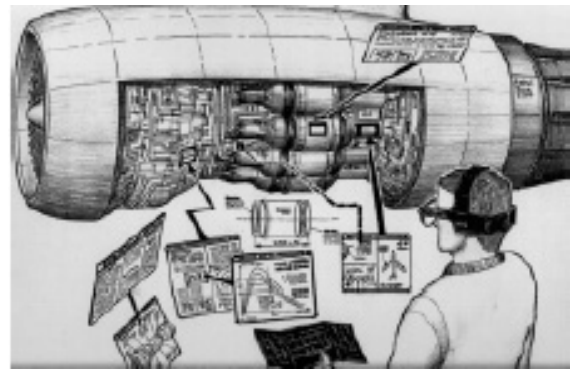

Fig. 3 Idea of Augmented Virtual Reality System

Fig. 4 Augmented Virtual Reality Manufacturing System

III. VIRTUAL REALITY MODELING LANGUAGE

VRML is description language, which belongs to a field Window on World System. Development of 3D graphic is connected with Silicon Graphic Corporation. This corporation creates expanded Open GL library. Under this library was proposed the format Open Inventor, which is the base for creating VRML 1.0. Official specification of VRML 1.0 was finished in 1995. In autumn 1995 arise independent expert group - VRML Architecture Group (VAG), which aim was co-ordination of other advance, to map user requirements for developing of new VRML format.

VRML 1.1 was only as working proposal. The new format VRML 2.0 was approved in 1996 as ISO/IEC standard and became as international standard VRML 97 [5].

Format VRML 1.0 is the same format like Open Inventor, which is used by SGI. It is created for describing of static 3D

World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
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scenes and enables connecting with URL. VRML 1.0 scene is presented by ASCII text file format. File VRML 1.0 has WRL suffix (world).

VRML 2.0 (VRML 97) is accurately new language than only expansion of VRML 1.0. Against the version VRML 1.0 has lots new abilities and simultaneously take off or make some properties from proceeding version, easier. VRML 2.0 is the file format for describing interactive 3D scenes and objects. It can be used in collaboration with www, can be used for 3D complex representations creating of scenes, products or VR applications VRML 2.0 enables represent static and animated objects too. It enables connection with sound, films, and pictures. Basic elements of VRML 2.0 correspond with usually used 3DAPI (Open GL, Direct 3D) [3].

IV. APPLICATION OF VRML FOR DESIGN OF AUTOMATED WORKPLACES

Computer system ROANS is a software package on PC base created for 3D simulation and programming of automated workplaces, robots and other peripheral devices. ROANS offer to user all needed tools for robots creating and simulation. After designing of workplace subsystems and their placing in space, is able to create control program for all workplace is working in multitasking mode. For minimalization of mistakes in program and for simple programming is added program editor [5].

ROANS with help of integrated postprocessor program generates control code for specific robot language. PC hardware enables ROANS to communicate straightly with robot (reading of joint co-ordinates from encoder of robot, translating of code from postprocessor into robot controller).

The sample of automated workplace with robots created in ROANS and displayed in shade regime is on Fig. 5.
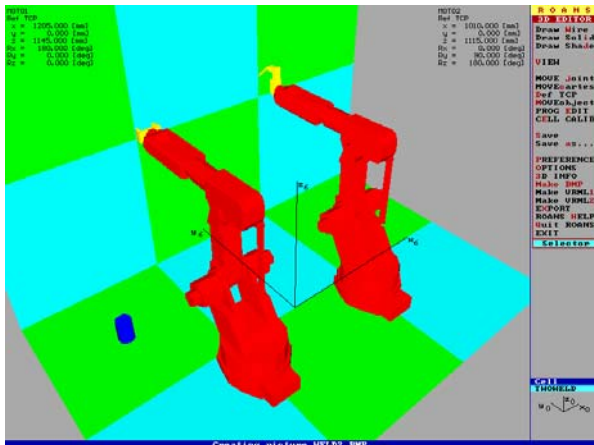

Fig. 5 Robot Workplace in Software ROANS

Before initiation of VRML implementation into system ROANS is needed to identify difference between structures in ROANS system and in VRML. This difference mainly comes from used program languages. ROANS were created in program language PASCAL. When the data are writing into the file they are indexed with rising value from number 1.

VRML language was created in C++ language and data writing to file uses abilities of this language. Data are indexed with rising value from number 0.

Differences in describing of points in ROANS system and VRML are in points indexing and in dimension units. Millimetres and indexing by rising value from 1, 2, 3, … are used by ROANS. Meters and indexing by rising value from 0, 1, 2, … are used by VRML.

Differences in line defining in system ROANS and VRML are in colour indexing and indexing of points which are needed to line defining. Line colours have their own identification number in ROANS system. Identification number of a colour depends on order of colour defining in knots.

Differences in surface defining in system ROANS and VRML are in points indexing and in order of points, which describes creating of surface. Every surface has 2 sides. Feature in which surface is drawn in one or other side of object depends on order of point defining. ROANS system uses opposite principle for point defining like VRML. That is why the program for VRML creating needs to write this indexing in opposite order like in ROANS. Adjustment of menu in ROANS is obvious from Fig. 6 and Fig. 7.
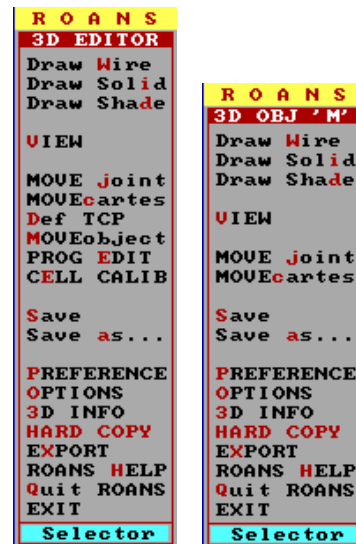

Fig. 6 Original Menu of ROANS Software

The program for export ROANS data to VRML language is solved as part of ROANS system. In this case there are some changes in ROANS menu. The changes are: 3D Editor for Object structure, 3D Editor for Cell Structures, 3D Anim for Cell Structures. Created program works with data, which are saved in memory of computer. This is the reason why displaying of workplace is not needed for exporting into VRML.

World Academy of Science, Engineering and Technology
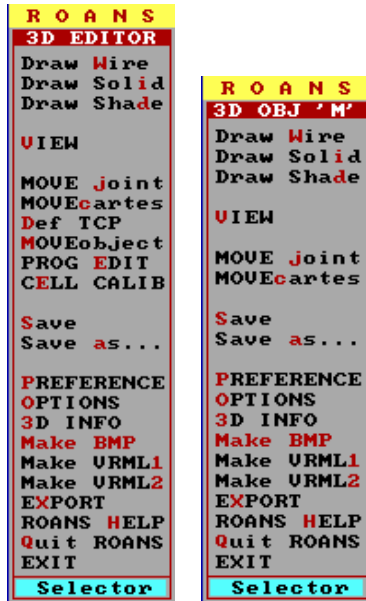International Journal of Computer and Information Engineering
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Fig. 7 Adjustment of Menu in ROANS

By activating of item MAKE VRML1 (stand with cursor on this item and than press ENTER, or right click of mouse, or pressing of hot key "1") is initialised activity of program. After this step you need to set the name of file in which will be result of export saved. It is needed to enter the name without extension, which will be automatically added. After file creating, starts export of data. First are exported header and preparatory knots (Info, BackgroundColor, ShapeHints, Material Binding, and Material). After this are exported data of points (Coordinate3) and depending on displaying regime are exported data of lines (IndexedLineSet) and surfaces (IndexedFaceSet). After ending of export is exported file closed and it is possible to work in ROANS system like before.

Activity of making VRML 2.0 is similar like in VRML 1.0. It is initialised from menu by activating MAKE VRML2 item (stand with cursor on this item and than press ENTER, or right click of mouse, or pressing hot key "2"). After this procedure follows set of file name without extension WRL, which will be added automatically. After file creating, starts export of data. First are exported header and preparatory knots (WorldInfo and Background). After this, all data are exporting in dependence of displaying regime. Export of lines (Shape - for lines) and surfaces (Shape - for surfaces). In no visible shapes regime is process of points writing arranged. This is made in the case that some points are written twice and than they are marked with name "pts". When a points and surfaces are defined they are extended by name ("pts"), which were defined in lines. After ending of export is exported file closed and it is possible to work in ROANS system like before. On the Fig. 8 we can see displaying of automated workplace in VRML environment.
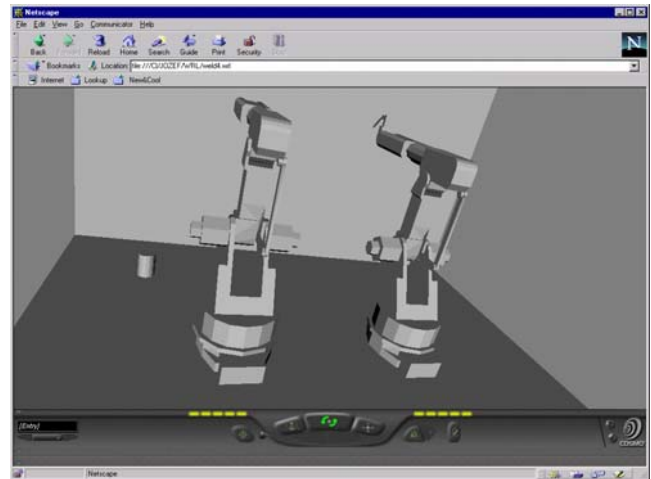

Fig. 8 Robot Workplace in Netscape Navigator Environment

V. CONCLUSION

After implementation of VRML maker into the ROANS system it is possible to represent all 3D automated workplaces with robot created in ROANS system by VRML browser, and it is not needed to have a license for ROANS. This enables companies, which use ROANS system, to communicate better without personal contact even they are thousand kilometres apart. This could safe financial resources and expressively decreases time of workplace designing expressively. VRML maker is integrated part of ROANS and do not increase hardware even software requirements on system. It is needed to be able work in ROANS system when you want to make VRML, because created data depends on displaying mode, which is set in menu Options. It does not need to know how VRML works. Exploring of created scenes is able by individual programs (VRML browsers) or by additional programs for existing www browsers Netscape Navigator, Microsoft Internet Explorer (so called "plug in"). Introduced browsers and additional software is possible to get on Internet from web pages of its companies. Hardware and software requirements for scene exploring depend on used software.

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