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DESIGN OF MANUFACTURING SYSTEMS WITH SUPPORT OF THE AUGMENTED VIRTUAL REALITY TECHNOLOGY

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Abstract: *Applications of virtual reality in area of computer games was first and in this time is rise need to exercise this technology in industry. Main areas of using of virtual reality and augmented reality are automotive and air industry in this time. Method of dialogue of person with computer is named interface and virtual reality is newest of row this interfaces. Augmented Reality is technology for presentation of complicated information, manipulations and interactions of person with them by computer.*

Key words: *virtual reality, augmented virtual reality, manufacturing systems.*

1. INTRODUCTION

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 analyzing and systems supporting economic modeling. It is obvious that, from among areas, where virtual reality systems can be most frequently used are applications based on 3D-space analyzing and physical dimension visualization. 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, 6].

2. VIRTUAL REALITY

After the first applications of Virtual reality (VR) in the field of flight simulators and computer game creating, arisen the need to implement the virtual technologies into industry. Product design and virtual prototyping is one of the greatest successes of VR applications in industry. The main attention in the field of VR system applications in the technical practice is given to CAD/CAM/CAE systems of higher level. It is for the cause of realization of export in format VRML (Virtual Reality Modeling Language). The newest versions of these systems could aid both existing formats VRML 1.0 and VRML 2.0 (97). The cost of a VR system is very specific problem. The real cost of an effective system can only be assessed in relation to the benefits it brings to a company. Such hardware and software is so expensive that only large corporations could afford to build virtual environments. One of the possible ways to solve the problem is to implement a VR format to a lower systems with aim actively utilize systems of Computer Integrated Manufacturing [10].

VR systems could be divided by ways of communication with user to such groups [11]:

- *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).
- *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.
- *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 and Fig. 2. On Fig. 3 and Fig. 4 are presented special gloves with sensors for VR.

Fig. 1. Head mounted display for VR.

Fig. 2. Glasses for VR.

Fig. 3. Glove with sensors for VR.

Fig. 4. Manipulation with objects by VR glove.

- *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. All the sensors could be placed on robot or on presented tool.
- *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.
- *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.

Distribution of VR systems by hardware equipment is in these levels. Some levels are not strictly kept, mainly in VR systems of higher levels [12, 13].

- *Entry Systems* – takes a capacity of personal computers and workstations for implementation WoW systems. They are usually based on IBM compatible computers or Apple Macintosh. Computers contain mainly graphic display, 2D entry devices – mouse joystick or trackball and keyboard.
- *Basic Systems* – involve basic interacting and innovated display resource. A resources of interactivity can be stereographic spectacles, entry control devices like data – gloves, multidimensional (3D, 6D) mouse or joystick.
- *Advanced Systems* – are marked by better aiding of graphic (render accelerator, frame buffer), or parallel processors for hand entry. Systems can be equipped by sound card for mono, stereo or 3D output.
- *Immersion Systems* – systems like HMD or multidimensional multiple displays. These systems also could be based by touch feedback.
- *Cabin Simulators* – virtual world is displayed on monitors or on screen. Simulators can be placed on moving base, what can evoke imagination of multi-moving. Typical representatives are flight simulators, car simulators, fighting vehicles etc.

3. AUGMENTED VIRTUAL REALITY

Augmented Reality (AR) is a growing area in virtual reality research. The world environment around us provides a wealth of information that is difficult to duplicate in a computer. This is evidenced by the worlds used in virtual environments. Either these worlds are very simplistic such as the environments created for immersive entertainment and games, or the system that can create a more realistic environment has a million dollar price tag such as flight simulators. An augmented reality system generates a composite view for the user. It is a combination of the real scene viewed by the user and a virtual scene generated by the computer that augments the scene with additional information. The application domains reveal that the augmentation can take on a number of different forms. In all those applications the augmented reality presented to the user enhances that person's performance in and perception of the world. The ultimate goal is to create a system such that the user can not tell the difference between the real world and the virtual augmentation of it. To the user of this ultimate system it would appear that he is looking at a single real scene [16].

Virtual reality is a technology that encompasses a broad spectrum of ideas. It defines an umbrella under which many researchers and companies express their work. The phrase was originated by Jaron Lanier the founder of VPL Research one of the original companies selling virtual reality systems. The term was defined as "a computer generated, interactive, three-dimensional environment in which a person is immersed." There are three key points in this definition. First, this virtual environment is a computer generated three-dimensional scene which requires high performance computer graphics to provide an adequate level of realism. The second point is that the virtual world is interactive. A user requires real-time response from the system to be able to interact with it in an effective manner. The last point is that the user is immersed in this virtual environment. One of the identifying marks of a virtual reality system is the head mounted display worn by users. These displays block out all the external world and present to the wearer a view that is under the complete control of the computer. The user is completely immersed in an artificial world and becomes divorced from the real environment. For this immersion to appear realistic the virtual reality system must accurately sense how the user is moving and determine what effect that will have on the scene being rendered in the head mounted display.

The discussion above highlights the similarities and differences between virtual reality and augmented reality systems. A very visible difference between these two types of systems is the immersiveness of the system. Virtual reality strives for a totally immersive environment. The visual, and in some systems aural and proprioceptive, senses are under control of the system. In contrast, an augmented reality system is augmenting the real world scene necessitating that the user maintains a sense of presence in that world. The virtual images are merged with the real view to create the augmented display. There must be a mechanism to combine the real and virtual that is not present in other virtual reality work.

The computer generated virtual objects must be accurately registered with the real world in all dimensions. Errors in this registration will prevent the user from seeing the real and virtual images as fused. The correct registration must also be maintained while the user moves about within the real environment. Discrepancies or changes in the apparent registration will range from distracting which makes working with the augmented view more difficult, to physically disturbing for the user making the system completely unusable. An immersive virtual reality system must maintain registration so that changes in the rendered scene match with the perceptions of the user. Any errors here are conflicts between the visual system and the kinesthetic or proprioceptive systems. The phenomenon of visual capture gives the vision system a stronger influence in our perception. This will allow a user to accept or adjust to a visual stimulus overriding the discrepancies with input from sensory systems. In contrast, errors of misregistration in an augmented reality system are between two visual stimuli which we are trying to fuse to see as one scene. We are more sensitive to these errors.

A standard virtual reality system seeks to completely immerse the user in a computer generated environment. This environment is maintained by the system in a frame of reference registered with the computer graphic system that creates the rendering of the virtual world. For this immersion to be effective, the egocentered frame of reference maintained by the user's body and brain must be registered with the virtual world reference. This requires that motions or changes made by the user will result in the appropriate changes in the perceived virtual world. Because the user is looking at a virtual world there is no natural connection between these two reference frames and a connection must be created. An augmented reality system could be considered the ultimate immersive system. The user can not become more immersed in the real world. The task is to now register the virtual frame of reference with what the user is seeing. This registration is more critical in an augmented reality system because we are more sensitive to visual misalignments than to the type of vision-kinesthetic errors that might result in a standard virtual reality system. Fig. 5 shows the multiple reference frames that must be related in an augmented reality system.

The scene is viewed by an imaging device, which in this case is depicted as a video camera. The camera performs a perspective projection of the 3D world onto a 2D image plane. The intrinsic (focal length and lens distortion) and extrinsic (position and pose) parameters of the device determine exactly what is projected onto its image plane. The generation of the virtual image is done with a standard computer graphics system. The virtual objects are modelled in an object reference frame. The graphics system requires information about the imaging of the real scene so that it can correctly render these objects. This data will control the synthetic camera that is used to generate the image of the virtual objects. This image is then merged with the image of the real scene to form the augmented reality image.

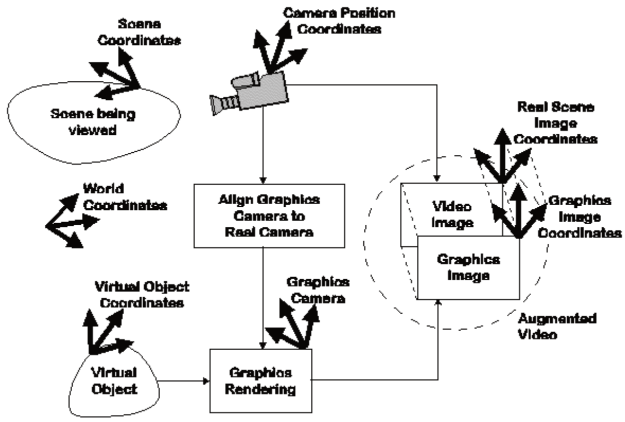

Fig. 5. Components of augmented reality system.

The video imaging and graphic rendering described above is relatively straight forward. The research activities in augmented reality centre around two aspects of the problem. One is to develop methods to register the two distinct sets of images and keep them registered in real time. Some new work in this area has started to make use of computer vision techniques. The second direction of research is in display technology for merging the two images [15].

The combination of real and virtual images into a single image presents new technical challenges for designers of augmented reality systems. How to do this merging of the two images is a basic decision the designer must make. Milgram Extent of Presence Metaphor directly relates to the display that is used. At one end of the spectrum is monitor based viewing of the augmented scene. This has sometimes been referred to as “Window on the World” or Fish Tank virtual reality. The user has little feeling of being immersed in the environment created by the display. This technology, diagrammed in Fig. 6, is the simplest available. It is the technology that augmented reality demonstration uses as do several other systems in the literature.

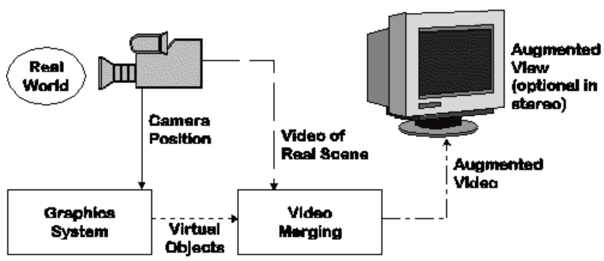

Fig. 6. Monitor based augmented reality.

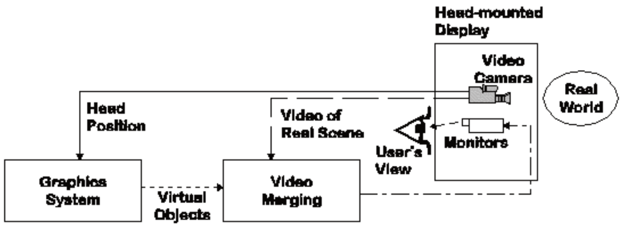

Fig. 7. Video see-through augmented reality display.

To increase the sense of presence other display technologies are needed. Head-mounted displays (HMD) have been widely used in virtual reality systems.

Augmented reality researchers have been working with two types of HMD. These are called video see-through and optical see-through. The "see-through" designation comes from the need for the user to be able to see the real world view that is immediately in front of him even when wearing the HMD. The standard HMD used in virtual reality work gives the user complete visual isolation from the surrounding environment. Since the display is visually isolating the system must use video cameras that are aligned with the display to obtain the view of the real world. A diagram of a video see-through system is shown in Fig. 7. This can be seen to actually be the same architecture as the monitor based display described above except that now the user has a heightened sense of immersion in the display.

4. CONCLUSION

The present development of manufacturing systems is closely connected with the advances in knowledge about the manufacturing of machines and technological faci1ities, in the computer aided design of products, processes and whole manufacturing systems and in their control at all levels on both a local and a global sca1e. The more complex products, the processes of their manufacturing and business conditions become, the more vital role the computer support of them plays in increasing the productivity of industrial plants, reducing the production costs and shortening the manufacturing cycles. The complex tasks of manufacturing process computerization require great computing power but its cost has been steadily decreasing while the speed of processing has been dramatically increasing.

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