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Key impact of virtual reality on industrial plants

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Abstract

Technology of virtual reality (VR) has received an enormous amount of publicity over the past few years. Along with this publicity has arisen a great deal of conflicting terminology and some unrealistic expectations. History shows that it was initially intended only for personal experiences. However, its development has proven that in some production areas it has become a key aspect that can have a significant positive impact on many industries. The paper describes the development of the first virtual reality devices, general knowledge of virtual reality, its definition and architecture. It also describes the data flow between the CAD and VR systems, which improves design and prototyping process while shortening the production cycle and reducing manufacturing costs.

Keywords: Virtual reality, 3D CAD, computer modelling.

Introduction

In the current digital era, the development of new prototypes is inherently linked to computer technology, which has a significant impact on manufacturing processes in companies. Virtual Reality (VR) provides a computing environment for prototype design or production process simulation. VR integrates computer technology, information, image processing, communicates and controls immersion elements. It is also successfully used in space exploration, health care, military simulations, as well as in wide area of entertainment industry. 3D computer graphics are continually followed by new VR technologies with progressive input-output devices that are constantly being developed and applied in the world's leading research centers.

Virtual reality – history

The first virtual reality device is considered Sensorama, introduced in 1962 by Morton Heilig. The mechanical device included a stereoscopic color display, fans, odor emitters, a stereo sound system, and a movable chair. The device played 5 movies. One of them was a motorcycle simulation in New York. The spectator sat on an imaginary motorcycle, perceiving the street through the screen, the fan-generated wind, and the simulated noise and smell of the city. Noise and odors were distributed at the appropriate time as the rider approached the bus, the exhaust chemicals were released. Heilig was unable to obtain financial support for his visions and patents, so work on Sensorama was stopped. Although the machine is still working today, the audience cannot interact with it because the device does not respond to user actions. Figure 1 shows the Sensorama.

Figure 1 - Sensorama [2]

In October 1960, Heilig patented a stereoscopic television device for individual use in portable form, which could be attached to the user's head. The

Telesphere mask consisted of optical units, television tubes, headphones, discharge nozzles designed as a customized device that could be adapted to individual comfort. The simulation mask provided stereoscopic wide vision (3D) and stereo sound. [1]

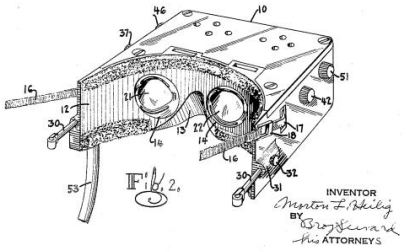

Figure 2 - Telesphere mask [2]

Heilig's work was followed by several inventors, engineers and scientific teams. In 1965, Ivan Sutherland proposed a virtual reality target solution: the concept of artificial world construction, which included interactive graphics, force feedback, sound, smell and taste. [3]

Virtual reality - definition and architecture

VR technology generates a synthetic virtual environment that enables three-dimensional presentation of the prototype, tool, real-time process in real-world conditions and user interaction. The power of interaction contributes significantly to the user's feeling of immersing himself in the real-time environment.

There are many definitions for virtual reality, but they are similar, such as a computer-generated environment, an interactive three-dimensional (3D) computer graphical interface, or an immersive interactive environment. The basic properties of virtual reality are:

• all is happening in real time, preferably with immediate response to user action,

• virtual world and its objects are three-dimensional, or at least give the impression

• user is allowed to enter the virtual world and move in different paths (walking, flying, jumping, moving quickly to a predefined location),

• virtual world is not static. Its parts can be manipulated by the user. Virtual bodies move along animation curves, affecting the user and each other. [5]

At present we classify virtual reality as follows:

• Immersive virtual reality
• Augmented virtual reality
• Projected virtual reality
• Low-end virtual reality

VR technology is a natural extension of 3D computer graphics with advanced I/O devices. VR users can interact with a simulated immersive 3D environment in real time through multiple sensor channels. Figure 3 shows a virtual reality system, composed of five parts: VR engine, VR database and model base, I/O devices, User, and Target/Task. VR engine is a system of graphic modeling and processing. It is designed for object modeling, texturing, mapping, lighting, rendering and final rendering of 3D scenes in real time. It is the CoR infrastructure. The VR database and model base stores virtual objects that are ready to load into the scene whenever needed. I/O devices provide a human-machine interface to control and communicate the VR system. [4]

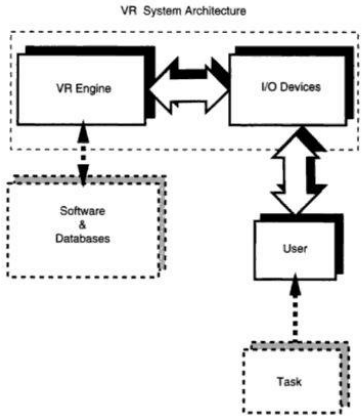

Figure 3 - VR system architecture [4]

Virtual reality as a key tool in the design and production of industrial plants

At present, high demands are placed on prototypes, which must satisfy a wide range of customer requirements, including: attractive design, reliability, durability, modularity. Many manufacturing companies compete with each other for the attractiveness, quality and speed of product placement to market to achieve a high proportion of product sales to customers. Highly important part of the production process is the creation of 3D digital models - prototypes using 3D CAD (Computer Assisted Design) parametric and explicit software applications. According to [6], over the past 30 years, older software is still evolving, enabling new functionality such as simulations, optimizations, reverse modeling, and more, and new software is also being developed. These options contribute to accelerating the prototype manufacturing process.

Virtual reality is also one of the factors contributing significantly to the acceleration of

production. A designer in a VR environment has a sense of genuine interaction with a product that can reach natural size. This is particularly important at the detailed prototype design stage, virtual assembling of assemblies, or in the control of complex product characteristics across industries, as the designer or potential user can discover many new positive and negative aspects of the prototype in its simulation 3D environment and thereby contribute to the success of releasing the product into practice.

The complete data stream from CAD system to VR system has various modules. CAD systems are the source of most data. This data is stored in a product data management (PDM) system that also maintains administrative data along with CAD data such as feature ID, version, name, project code, etc. Using the search and conversion tool, this data can be converted, reduced and ready for use in the VR system. (Figure 4). Common problems, in particular with transmission data (i.e. CAD data intended for previous products but reused in new products), are normal orientations, missing geometry and erasing parts or overall undesirable geometry. It is possible to use non-commercial tools available to automatically eliminate these problems. The data preparation process for the VR must therefore interactively enter the CAD system, as shown in Figure 4 by the arrow between the CAD and the Preparation Tool. [7]

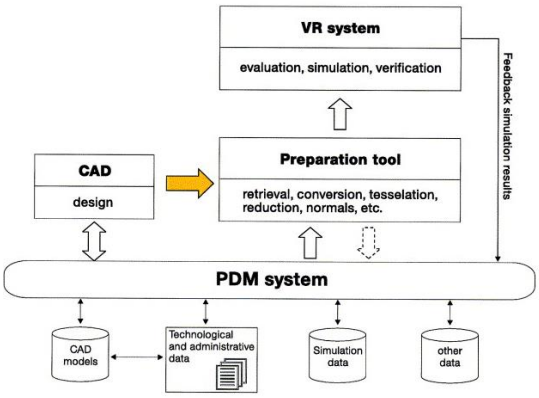

Figure 4 - Data flow between CAD and VR system. [7]

Conclusion

Virtual reality technology contributes significantly to the development of a new product according to individual customer requirements in a virtual environment. The VR has become an important and useful tool in science and technology. Virtual reality applications cover a wide range of industries from product design to analysis, from product prototyping to manufacturing. The virtual model has a central position in a collaborative environment to support the considered integrated VR system, which is also used and enhanced through virtual manufacturing, rapid prototyping, design review, human factor/ergonomic studies, digital assembly, production process simulations, virtual quality control and eventually a virtual reality system. It has been shown that due to the development of IT technologies, software and hardware components, the design and development of engineering, as well as other phases of the product life cycle, can be implemented very successfully with applications in terms of quality, cost and time.

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