Virtual reality in Industry

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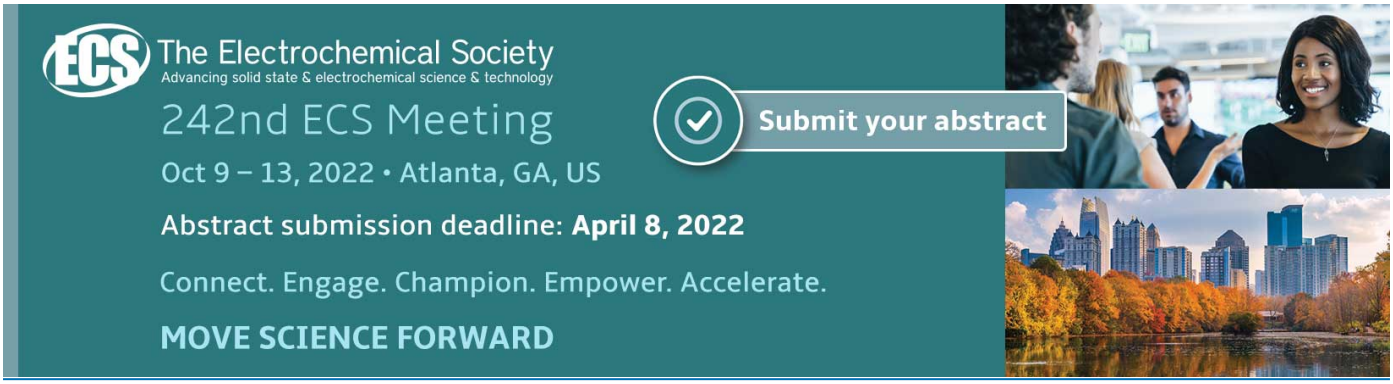

Virtual reality in Industry

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Abstract. The article deals with the issue and overview of the current trends in the field of virtual reality usage in various sectors. The main aim of contribution is an overview of virtual reality and its key components and tools nowadays, especially in areas such as engineering, automotive industry, civil administration, health care and entertainment industry. There are described the basic tools, applications and functions of virtual reality and its interaction with human operator. The main attention is paid to the use of virtual reality in the engineering industry and its division.

Introduction

The development of new technologies is nowadays a part of our daily lives. Part of computing is effective human-computer interaction, and it is in this area that we can see tremendous advances in technology. One of them is virtual reality (VR). The expectations of virtual reality have always been huge, putting on your glasses and going somewhere or being transported anywhere. Forget ordinary things through metaphysical transport into the unknown state of consciousness. This condition occurs when a person connects to a machine. Everything that happens is only in our minds. The virtual world is a digital unreal representation of the real world. Nowadays, virtual reality is no longer just science fiction or fantasy, but is gaining consciousness, in the hands of ordinary people (Fig. 1). Our mind perceives three dimensions (dimensions) through shapes and objects moving in them, which are in a mutual relationship and influence each other. Virtual reality allows you to view everything digitally. This technology allows you to model a digital world or computer environment that simulates reality. It is about creating a visual experience projected on a computer, or through other devices and devices. In more complex cases, other human senses such as hearing, smell and touch are also involved in the interaction with virtual reality.

Fig. 1. Virtual Reality - HTC Vive with Manus VR digital gloves (http://engadget.com)

The use of virtual reality is also in other areas, such as the military and civilian spheres, in the entertainment industry but also in healthcare. Today, virtual reality has many supporters, but also non-partisans, mainly because they do not understand it. In many ways, virtual reality can make hours and hours of hard work and money easier for us. Imagine that you need to replace or repair a part that is somewhere in the machine, whether in common things like a car or a TV, to complex ones like various robots, manipulators or CNC machines. We would be able to find out simply, quickly and easily where the error is, how to fix it and everything without unnecessary disassembly and futile searching, which would take us a lot of time. Virtual reality became known mainly as a media toy for people, in the form of a "helmet and glove", which was intended for the public. Subsequently, the development and sale of systems was focused on the support of economic modeling, where virtual reality systems can be used most often. These are applications based on spatial analysis and visualization of physical dimensions.

1 Virtual reality

Virtual reality is the simulation of a real, or fictional, unreal environment, using a computer and its input and output devices. It is a term used to describe a three-dimensional computer-generated environment that can be explored by humans. A person becomes part of a virtual environment and is able to manipulate objects or perform a variety of actions. We can perceive the environment of virtual reality in all directions in space. We perceive height, width, depth and thus achieve a better interactive experience visually in real time with sound, touch and other forms of feedback. According to Mr. Sobota [4], "a virtual-real estate system represents an interactive computer system, creating the illusion of physical presence in a given time of non-existent mere synthesized space, or more

precisely we can talk about the so-called perfect simulation, in an environment of tightly bound human-computer interaction."

Everyone has already had the opportunity to encounter the phrase virtual reality. We can define this phrase. Virtual, in other words close and the word "reality" is what we experience as humans as beings. So the phrase virtual reality basically means close to reality.

1.1 Division of virtual reality

There is more than just one approach to building virtual worlds. There are many types of digital unreal environments. Some of these systems are less complex to computing, and do not need as many tools to immerse themselves in the virtual world. Others, without add-ons and tools or advanced complex management, cannot provide the user with full immersion in a virtual environment.

The best known from the simplest to the most complex include:

- non-absorbing reality (simple),
- fully absorbing reality,
- collaborative reality,
- augmented reality.

Non-absorbing virtual reality

Between the non-absorbing simple reality, we can include, for example, a flight simulator but also a simulator in a driving school (Fig. 2). These simulators include powerful computer graphics and headphones or surround sound give us a sense of reality. We become part of virtual reality, but we are not completely absorbed in it. Most people would call this an immersive virtual reality, even if it is not true. We do not need and use any headsets, goggles or gloves and controls. In the same way, for example, archaeologists often create engaging 3D reconstructions of long-extinct dinosaurs that we can examine, giving us a better idea of what they once looked like.

Fig.2. Simulator in driving school (www.autoskola-akva.sk)

Fully absorbing reality

Three things are needed to fully immerse yourself in virtual reality. First, we need a quality and highly detailed world that we can explore. In other words, we need a perfect computer model or simulation. Second, it is essential to have a high-performance computer that can decide what we do and adjust the image in real time accordingly. So change what we see or hear as quickly as possible in real time. The third thing is the hardware connected to the computer, which completely draws us into the virtual world. We usually use a headset or glasses that have two LCD displays. The headset also includes headphones that complete the stereo sound. For full and perfect immersion in a fully absorbing reality, it is suitable to supplement the glasses with controls, digital gloves or suits.

Collaborative reality

A collaborative virtual environment is a space in which several people often interact with each other from different places. Collaborative reality can be used in the following sectors:

- marketing - mutual communication with the consumer,
- training in a dangerous, harmful area,
- social entertainment - for example interactivity in board games,
- education - distance learning,
- medicine - surgical simulation.

It is a new form of cooperation and communication. It allows participants to take advantage of new ways of using information, which are then used in the real world. It is a dynamic and innovative way of working that allows people to communicate, change or supplement data in these environments. The main task is to allow a group of people in different places to share information in one place.

Augmented reality

A very close relative of virtual reality is augmented reality. Augmented reality works in the real world, in which digital images, projections and sounds are embedded and projected. Simply put, we are expanding the real world with digital objects. From this we can deduce that many things can be considered as augmented reality. These include, for example, displays on an airplane or in cars, which can provide us with information such as distance to a destination, GPS location, or current speed. The device, ie the glasses, usually focus on a target. It can be anything, but it's usually a 2D image printed on something, like a movie poster. If augmented reality recognizes the target with a camera, image processing follows, and augmented reality provides us with specific information about the thing (Fig. 3).

Fig.3. Augmented reality [2]

The great advantage of augmented reality over fully absorbing virtual reality is that we do not feel as sick with augmented reality as we do with VR. Using intelligent algorithms and other sensors such as accelerometers and gyroscopes, the device provides us with and maintains a balanced image with the real world. Another way of presenting augmented reality is known as projection mapping. Digital images can be projected directly into objects. This technology has extensive use. Projectors are used that provide a 3D digital image projected into the real world. The user does not need to carry any device. Communication with this system is very natural (Fig. 4).

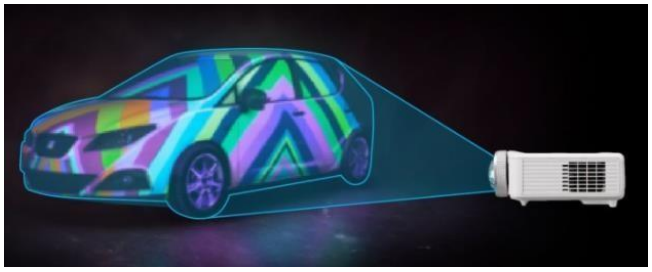

Fig.4. Projection Mapping (projection-mapping.org)

2 Applications of virtual reality

Many people have already come across the term virtual reality, but do not know exactly about its practical use. Playing computer games is one of the most widespread branches of virtual reality. However, there are other areas of its use with varying degrees of difficulty. Even some areas today cannot function without the use of virtual reality. Applying this technology to everyday life is becoming easier and more convenient. Imagine not being able to attend a concert of your favorite band due to health or other problems. With a live broadcast today, you can be there and listen to a concert from the comfort of your home. There are

many areas of virtual reality applications, the best known and most used are applications in:
engineering,
the army,
healthcare,
entertainment industry,
education,
business,
sports.
Virtual reality in Engineering

VR technology allows engineers to view their projects in 3D to gain a better understanding and knowledge of the project [1]. They can detect and prevent errors or potential risks before installing the device. Virtual reality allows a team of engineers to monitor their projects in a safe place without any risk and thus make the necessary changes (Fig. 5). This saves time and especially money. It is important to be able to display the fine details of an engineering product or tool in virtual reality.

Fig.5. Jet engine in virtual environment [6]

Interaction with the CAD model could be completely different than today. We would sit at a table all day and design an object that would exactly resemble a real and real product [2]. Then we could try to install the model in a virtual environment, and thus avoid unnecessary problems and errors that could occur. In the event of errors that would occur during installation or assembly, we would simply change the parameters, dimensions or any discrepancies, and then reassemble it. Everything without losing money, time, material and much more that we would have to put into it.

Virtual reality in the Army

From the beginning in the history of the development of virtual reality, the US Armed Forces have been a major factor and driving force in the use of new

technologies, including virtual reality [3]. The military and entertainment industry, along with medicine, is responsible for the biggest evolutionary leap in virtual reality. The armed forces use virtual reality for almost everything, from learning in a flight simulator to extinguishing a fire on board a ship. Specialized military training can often be very costly, especially when it comes to fighter pilots, and very dangerous when it comes to a real situation. Virtual reality in the military industry has great uses. The most common uses of virtual reality in the military include:

- flight simulator,
- combat ground simulation,
- training of doctors on the battlefield,
- simulation in vehicles.

Obviously, a virtual environment is ideal for military training in that it allows soldiers to get them into a military situation in a controlled environment without endangering life (Fig. 6). Soldiers can also learn to improve their orientation knowledge in a combat environment created by virtual reality [4]. For the military industry, virtual reality is a huge benefit, mainly because of the increased security of soldiers and the saving of large amounts of money.

Fig.6. Military Flight Simulator (www.bbvaopenmind.com)

Virtual reality in Healthcare

We also use the use of virtual reality in healthcare, for example, to determine a patient's diagnosis. We need to find out a lot of data about the patient and his health by the usual method. Virtual reality will determine his diagnosis much faster and more accurately [5]. Finally, it creates a visual output with data information that is easier to read. It is also possible to create different virtual environments and situations. For example, a car accident or other unpleasant situation in which doctors as well as paramedics can improve their skills and learn various situations that may arise (Fig. 7). It is unrealistic to create such situations in the real world, so virtual reality is very important for healthcare.

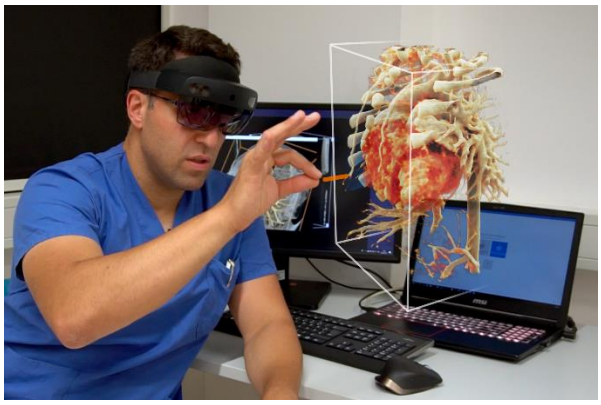

Fig.7. Visualization of the smallest structures of the heart realistically without surgery (https://www.siemens-healthineers.com)

Virtual reality in Entertainment industry

Most virtual reality enthusiasts and supporters are from the entertainment industry, most notably in computer games [6]. Other environments in the virtual reality entertainment industry include museums, galleries, theaters, virtual theme parks and various other resorts. An example could be a historic building that can be walked through to learn information in the immediate vicinity (Fig. 8).

Fig.8. Presentation of a historic building in the Virtual reality background (www.isivista.org)

They are able to do this with glasses that you put on your head and that are connected to a computer. It brings to the glasses a flow of information and images about the place [7]. Many applications are created just for the entertainment industry, for playing computer games, where popularity is growing at a dizzying pace. Players can approach their virtual heroes and move in the virtual environment as they wish and do an almost unlimited number of activities. To do this, it is necessary to have glasses with LCD displays and other devices,

such as digital gloves or controls, which are connected to a computer and thus draw us into the virtual world. These devices allow us to grab objects or manipulate something in a virtual environment (Fig. 9).

Fig.9. Playing games with Virtual reality (www.fluidcastvr.com)

3 Virtual reality in Engineering

Virtual reality allows us to interact with the computer in a way never before. Computers and computer graphics have revolutionized us in the engineering industry in the form of virtual product design and manufacturing [8]. Engineers can transfer their potential and designs to digital virtual environments, such as various production halls, lines, machines and robots [9-10]. Until recently, virtual reality was only available at selected universities and research centers. Today, as virtual reality software becomes more available, companies can begin to build their own applications and solve problems in engineering, mechanical engineering, the automotive industry, or robotics (Figure 10).

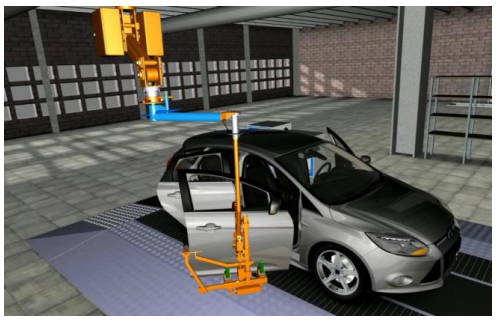

Fig.10. Linking virtual reality and the automotive industry [3]

There are several areas in mechanical engineering where virtual reality can be applied [11]. It is not just the aforementioned automotive industry in which virtual reality is most prevalent.

Programming of CNC machines

The future of CNC (Computer Numerical Control) programming may be completely different from today and may have a manual teaching mode [12]. Scientists working in mechatronics show us how CNC machines could be designed with elements of virtual reality so that a programmer or operator can move the elements manually and the sequences of motion can be stored in the machine program. For easier programming, imagine a CNC that could cooperate with an operator using virtual reality to simplify and speed up programming [13]. CNC machines are equipped with various interfaces, which allows their control and programming using various functions. Operation of mainly 5-axis CNC machines requires highly trained and qualified operators, especially in the knowledge of basic programming. The way in which the control system can be used to control CNC machines is becoming easier and more intuitive.
Programming should be simple and intuitive enough so that even a not very skilled operator does not have problems with programming [14]. A research team from the Mechatronics Center proposed a solution to this problem by introducing a manual control and programming technique for a CNC machine. The operator can operate the CNC machine tool manually using various dedicated elements. These measure the magnitude of the force as a function of its value, thus ensuring the correct speed and smoothness of the machine's movements.

CAD system
Virtual reality, in interaction with the CAD system, allows designers to quickly and easily view, examine and comment on their designed CAD models. Being able to detect errors before a given product is designed and manufactured is a great advantage today [15-16]. Virtual reality is good and useful in a design environment. The reason why it is not so widespread. it is in the complexity of the computing technology that must support it.

Fig.11. Interactivity between virtual reality and CAD system (http://www.perthcadser-vices.com.au)

The great advantage of the cooperation of a fully absorbing virtual reality and CAD system is that it enables cooperation in a virtual space with several clients [17-18]. These clients do not have to be in the same place or in the same country, and yet you can show them your designed CAD model, which they can conveniently check.

Programming of robots

Industrial robots in the past were not as safe as they are today. With a few exceptions and the advent of today's cognitive and collaborative robots, industrial robots were mostly housed in security cages, or various types of hardware and software elements were used, most notably 3D sensors and scanners. [7] If the operator wanted to approach the robot, it was necessary to bring the robot to a safe position and possibly stop it. Everything can change with virtual reality. The interactive robotic laboratory has created an IVRE (Immersive Virtual Robotics Environment) virtual robot environment. [5] This allows the programmer or worker to collaborate or otherwise interact with the robotic system, either in simulation or in real time through a proxy server. The user has access to a large number of working tools for manipulating the robot, displaying information and interacting with the environment [19-21]. The system includes instructions for the virtual robot, monitoring and user-controlled perception.

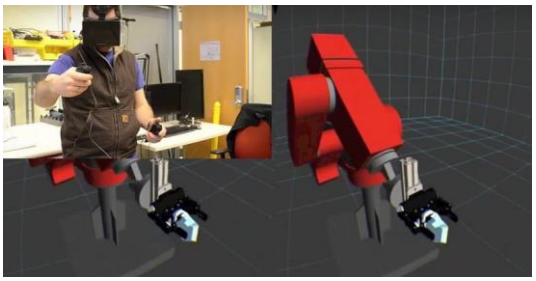

Fig.12. Robot control in IVRE system [5]

4 Conclusion

The content of the article is focused on insight into the history and origin of virtual reality. It explains and introduces the principle on which virtual reality works. How it can monitor the movement of the body, head or eyes, but also the use of wireless smart controls and digital gloves. The individual areas are defined in more detail in the article with examples of use. An important part is

the division of virtual reality according to its application purpose. Gradually, applications of the use of this technology in the most used areas, such as the engineering industry, the military, healthcare and even the entertainment industry, are described and further specified. The main attention is paid to the use of VR in the engineering industry, its application and interactive cooperation in the automotive industry, but also its use in the programming of CNC machines and robots.

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