Introduction to Virtual Reality Concepts and Technologies

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Abstract. Virtual reality is the simulation of actual or fantasized environment which can be experienced visibly in terms of the width, height, and depth. In this paper, the components of virtual reality which are the hardware and software components are studied. An insight is provided on some concepts of virtual reality such as Telepresence, Telexistence, and Cyberspace. We take a look into virtual reality in robot programming which is carried out with the aid of a simulator. Virtual reality is being applied in areas such as Engineering, Sports, Entertainment, Medicine, Architecture and so on and it is being projected that virtual reality would form the backbone of so many industries in a few years to come. The three levels of immersion in virtual reality are the non-immersive systems, semi-immersive systems, and the immersive systems. Finally, we will have a look at some of the challenges facing virtual reality, the advantages and the disadvantages of virtual reality and the concluding section.

Keywords: Virtual Reality · Robot Programming · Hardware Component.

1 Introduction

Virtual reality is a human-machine interface which presents the user with visibly authentic images and several sensorial mediums. Virtual reality is produced by computer graphics alongside depth buffer. The virtual reality technology enables humans to visualize, influence, and relate with a synthetic environment. The synthetic environment is updated in actual-time, based on the programmer inputs [1]. However, when it comes to robot programming in virtual reality, a graphical simulation is the technique that is made use of in robotic systems to produce robot command without risk. The function of the simulator is to teach robot programming.[1] Virtual reality has evolved in so many ways. In the year 1929, the first commercial flight simulator was created by Edward Link. The flight simulator was used in the training of more than 500,000 pilots in the United States [2]. An head mounted gear was produced in 1960 by Morton Heilig. The head mounted gear is not as interactive as what we have today[3]. Further down the line in 1993, Sega created a Sega VR which is a virtual reality headset. That was the first time that a company associated with gaming was really keen on virtual reality[2]. Today, virtual reality has formed the backbone of so many industries. Virtual reality is being applied in Medicine, Engineering, Education, Sports, Gaming and so on. It is being projected that virtual reality will form the backbone of almost every industry in a few years to come. In the coming sections, we will have a look at the components of virtual reality, we will then follow up with the concepts of virtual reality in the section after that. There will be a look at virtual reality in robot programming, the different levels of immersion in virtual reality, virtual reality application areas, and then the concluding part of the paper.

2 Virtual Reality Technologies

The term virtual reality can be described as a hugely interactive, computer-produced multimedia environment whereby, the user turns into a partaker in a computer-produced world[4] [5] [6]. Virtual reality can also be described as the simulation of actual or fantasized environment which can be experienced visibly in terms of the width, height, and depth and which could also give an interactive experience visibly in complete actual-time motion with sound and probably also with tactile and further modes of feedback. Virtual reality is a manner by which humans view, influence, and relate with computer and highly complex data[7]. It is a synthetic environment created with computer hardware and software which is given to the user in a form that it shows and seems like an original environment[8]. A virtual reality is known as a computer-incorporated, three-dimensional environment that several human partakers, accordingly interfaced, could involve and influence simulated natural elements in the environment which could in some manner involve and relate with representations of more humans whether prior, current or imaginary, or with formulated creatures. Virtual reality is a computer-stationed technology which helps in mimicking visual auditory and other sensory portions of compound environments[9]. Virtual reality integrates 3D technologies which offer a true-life illusion. It also produces simulation of true-life situation[10]. As a result of these, virtual reality points to an immersive, associative, multi-sensory, viewer-focused, 3D computer-produced environment and the unification of technologies needed to create the environment[11] [12]. When viewers are immersed in a computer-produced stereoscopic environment, virtual reality technology disintegrates obstacles that exist between the humans and computers. Virtual reality technology does the simulation of usual stereoscopic observatory processes through the use of computer technology to produce the right-eye and left-eye pictures of a supplied 3D object or display. The tip from these two viewpoints is incorporated by the viewer's brain to produce the feeling of 3D space. The deception that on-screen objects have depth and existence above the flat image projected onto the screen is produced by the virtual technology. By making use of virtual reality technology, viewers can sense gap and structural rapport between differing object components more sensibly and precisely in comparison to regular visualization tools[13].

2.1 Virtual Reality Components

The important components that are used for constructing and sensing virtual reality are the hardware and the software components[13].

Hardware Components The hardware components are composed of five subcomponents: computer workstation, sensory displays, process acceleration cards, tracking system, and input devices. 1. Computer workstation: this is a sophisticated microcomputer produced for technical applications. It was meant to be used by one person at a time. Workstations are usually linked to a local area network and run an operating system which is used by several users at a time. The name workstation also specifies a mainframe computer terminal plugged to a network. Workstations provided a greater performance when compared to personal computers, notably in relation to CPU and graphics, memory size, and ability to perform many operations at the same time. Workstations are enhanced for the envisioning and influencing of various kinds of complex data like 3D mechanical design, engineering simulation animation and provision of images, and mathematical plots. Computer workstation is used in regulating many sensory display gadgets to immerse users in 3D environment. 2. Sensory displays: they are used in showing the simulated virtual worlds to the user. The visual display unit of the computer are the most typical sensory displays, the head-mounted display is meant to provide 3D visual and also, the headphones provide the user with 3D audio. i. Head mounted displays: in this, a screen is positioned in front of both eyes of the viewer always. The section of the virtual environment produced and showed is managed by the direction sensors placed on the helmet. The computer notices head movement, and a new viewpoint of the scene is produced. In a lot of situations, view is expanded by a set of optical lens and mirrors[14]. ii. Binocular Omni-Orientation Monitor: it is placed on a united mechanical

Fig. 1. Head Mounted Display
[13]

arm and has tracking sensors situated at the joints. The monitor is made steady through a counterbalance which ensures that the position of the monitor does not change when the user leaves it. The user sees the virtual environment through the monitor. The computer produces a fitting scene depending on the location and direction of the joints on the mechanical arm[11]. A few of the issues related with head mounted displays could be fixed using a binocular omni-orientation monitor display. iii. Visual Display Unit: the computer visual display unit can be splitted into two which are the CRT monitors and the LCD monitors. 3. Process acceleration cards: the process acceleration cards assist in updating the view with the latest sensory report. 3D graphic cards and 3D sound cards are the examples. 4. Tracking system: the system tracks the location and direction of a user in the artificial environment. The tracking system is partitioned into mechanical, electromagnetic, ultrasonic , and infrared trackers. 5. Input devices:

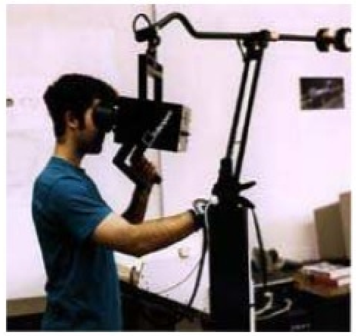

Fig. 2. Binocular Omni-Orientation Monitor
[13]

Fig. 3. Patriot wireless electromagnetic tracker
[13]

the input devices are used in relating with the artificial environment and the objects in the artificial environment. Joystick, instrumented glove, keyboard, and voice recognition are some of the examples.

Software Components The components of software are categorized into four. 3D modeling software, 2D graphics software, digital sound editing software, and VR simulation software. 1. 3D modeling software: they are used in building the math of objects in an artificial world and also indicates the visual characteristics of the objects. 2. 2D graphics software: they are used in shaping the texture to be administered to the objects which improves their visual details. 3. Digital sound editing software: they are used in uniting and editing the sounds which objects produce in the artificial environment. 4. VR simulation software: the VR simulation software unites the components. The behavior and set of rules guiding the objects are programmed with the simulation software[13].

Fig. 4. Nintendo Power Glove
[13]

3 Virtual Reality Concepts

It wasn't until the 1990s that virtual reality became very well-known. Virtual reality became a frequently used term in almost all places. The name virtual reality is famous for a fascinating, interactive, and computer-arbitrated experience whereby a person feels an artificial environment through a unique human-computer interface equipment. Humans relate with simulated objects in the environment in such a way that the simulated object is perceived to be real. A lot of persons are able to see one another and relate in a shared artificial surroundings like the battlefield. Virtual reality is used in illustrating a computer-produced artificial environment which may be maneuvered through and influenced by a user in actual time. A virtual environment could be shown on a head-mounted display, a computer monitor, or a big projection screen. Users can examine, move around, and influence the virtual world through head and hand tracking systems. The major disparity between virtual reality systems and conventional media such as radio, television is in three dimensionality of Virtual Reality format. Immersion, existence, and interactivity are distinct characteristics of virtual reality which pulls it away from the other authentic technologies. Virtual reality does not copy actual reality, and it also does not have an authentic function. Human beings lack the ability to differentiate between feeling, hallucination, and illusions. Virtual reality has developed to be an exceptional area in the world of computing. The benefit of virtual reality has been investigated in car design, robot design, medicine, chemistry, education and so on [15].

3.1 Telepresence

It is the perception of being in a different physical space than the physical space that one is in currently[21]. Even though it could be confused with virtual presence, they are two different things. Virtual presence represents the perception of being in a virtual space rather than a physical space[22]. Telepresence is permitted in a lot of various technologies like the regular video communication such as Skype, immersive video such as 360 degrees camera, drones, telepresence robots and so on. Telepresence robots are movable robots with screen on top and wheels at the base. Telepresence robots give the experience of a video-chat-on-wheels. For telepresence, there are two important preeminent factors which are vividness and interactivity. Vividness is the ability of a technology to produce an environment that is sensorial mediated [24]. Interactivity means the degree to which a user can impact the virtual environment's structure and this can be made moderate through speed, range, and the technology's mapping. Though, the three factors can be hampered by internet speed or device potentials. The technical issues caused by the moderating factors of vividness and interactivity will be solved as the moderating factors get better. Based on these, how humans experience telepresence will get better and it would become more real. [23] Telepresence is being used in the music industry based on the 360 degrees virtual reality. It is also used in treating patients and in education.

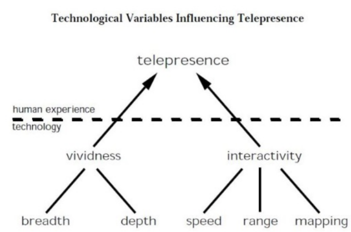

Fig. 5. Technological variables influencing telepresence [23]

3.2 Telexistence

It is a concept which points to the technology that allows a human have a real-time feeling of being in a different place than where he or she actually is. The human can telexist in a computer-produced world or in an original world that the robot is situated. Telexistence can be broken into two groups: telexistence in the original world, and telexistence in a synthetic world. An artificial world is produced by the computer in "telexistence in a synthetic world" while a real remote environment is linked through a robot to the location of the user in "telexistence in the original world". Although, there can also be a combination of both groups. Telexistence can be applied in areas like Medicine, Manufacturing, Education and so on.[25]. However, one problem identified in telexistence is that in the place where the user telexists, only the robot is seen by people and the presence of the human is not felt. That kind of problem can be solved with the use of Retro-reflective Projection Technology. The Retro-reflective Projection Technology helps reveal the human at the remote environment to people. This is very crucial because the users telexisting in a robot must be sure of who they are working with through the network.[26]

3.3 Cyberspace

It is a graphics symbolization of data abstracted from banks of all computers in human system. In the present day, cyberspace is often identified with entertainment systems and the World Wide Web (Internet).[15] Although, cyberspace is usually mistaken to be the Internet, it actually represents the objects and identities that are in the communication network. It details how digital data flows by means of the network of linked computers. However, one downside of cyberspace is computer crime. Unnamed credit cards, bank accounts, fake passports and so on can be acquired by an individual[27].

4 Virtual Reality in Robot Programming

In this, we look at the programming of an industrial robot using a simulator. Graphical simulator is a technique which is used in robotic systems to produce robot command with no risk. A simulator is widely used in teaching robot kinematics and robot programming. One example of the robot simulation software is known as the KUKA robot based simulation software that could be referred to as KUKA SimPro. An industrial robot is programmed to work in the area of manufacturing. The industrial robot could be programmed to carryout tasks repeatedly. There are two ways of achieving robot programming, which are the offline and online programming. The robot's performance need to be studied when it is actively carrying out an assignment. This is done in order to know if the robot is able to carry-out tasks using optimal path, analysis, and so on. Offline programming helps to limit the robot downtime through the generation of a robot program. The robot simulation software is developed through the use of the OpenGL and C/C++ programming. This enables the user to teach the robot without having anything to do with the actual robot. A unique hardware is required in order for this to be carried out. The planned virtual reality based robot programming contains a series of objects that could be seen by the user from any position and also, the objects have some actions tied to them that simulate the real environment. Based on this environment, users are able to choose the suitable sensing modality and programming which relates directly with the real case. The users are able to change the position of the monitor window in the artificial world in real-time through input devices.[28]

4.1 System Architecture

The user is needed to execute a pick-and-place function. To achieve this, the user is needed to shift the workpiece which is on the conveyer to the storage that is in the Virtual Teaching System. The hand movements and fingers flexure will be tracked by the sensor tracker and the data glove as the process path and will be loaded into the simulation program. The simulation program is used in assessing the robot's aspects such as clearances, reaches and so on. The command generator enables the user to produce the robot command when an optimal path has been gotten. After that, the robot command is loaded into the robot system in order to carryout the assignment. A unique program which is referred to as ModGenSTL is utilized in transforming CAD models into ASCII format. The ASCII format can be read by the teaching system and the simulation program.[28]

Tools A virtual teaching system demands a sophisticated computer system to produce stereoscopic images and to update the artificial environment in actual-time with the lowest simulation latency. The sophisticated computer is expressed in terms of high memory capacity and a very high graphic card performance. Another function of the high performance system is to lower the simulation duration of the simulation program. The simulation duration is reduced when

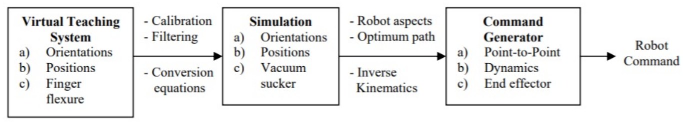

Fig. 6. Data flow
[28]

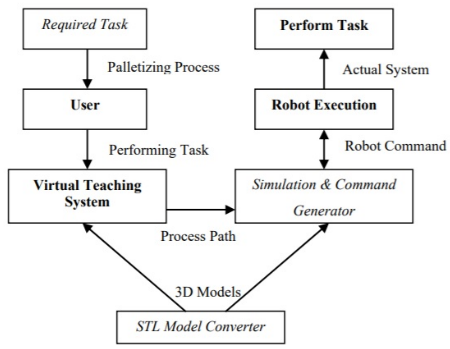

Fig. 7. System architecture for the developed system
[28]

the computer has a great processing speed and huge memory capacity. Quad-buffer assisted graphic card is used in producing stereoscopic images . The virtual reality tools needed are three. They are : data glove, sensor tracker, and 3D glasses. What the right-handed data glove does is to relate with the virtual object after it must have had a three-dimensional sensor tracker added to it. The position and orientation of the user's hand is recorded through the sensor tracker. The function of the 3D glasses is to enable the programmer to see stereoscopic images. The depth buffer of the virtual objects is produced when the 3D glasses is synchronized with the monitor-refreshing rates. The robot command which is produced from the simulator is executed by the industrial robot (Kuka Robot).[28]

4.2 Virtual Objects and Models

An interactive visualization software for a 3D model generator has been formed in order to assist the system. ModGenSTL is a 3D model generator and visualization software which enables a user to see and influence stereolithography (STL) geometry with essential graphical techniques[29]. The 3D models are produced in ProEngineer and transported as stereolithography ASCII file[30]. What odGenSTL does is to import the models and change them into a form that can be read as well as loaded through some more programs in the system. Information regarding the 3D objects as number of facets is stored in the latest format.

Information about the 3D triangles in a compound digital model could also be stored in the latest format. The 3D triangles are utilized for the collision detection algorithms through the use of bounding-boxes approaches. The program

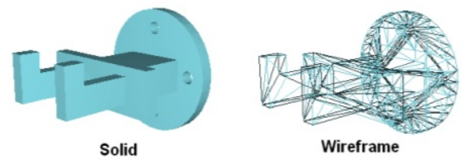

Fig. 8. Different types of object mode
[28]

backs the easy assembly of the model. Transformation, rotation, and rendering characteristics can be carried out in order to check the matching and collisions in two models. Scaling factor can be altered if required.

4.3 Virtual Teaching System

C/C++ with OpenCL was used in developing the virtual teaching system. OpenCL is a generic form of the interface which is made accessible to a broad range of outside vendors in the concern of standardization. OpenCL backs quad buffering to produce stereoscopic images with least possible flickering. OpenCL is also a platform autonomous API (Application Programming Interface) whereby the artificial environment can perform in UNIX or Windows operating system. 1. Co-location Workstation : the virtual teaching system contains an array of objects that can be seen from any location. The programmer perceives himself being part of the artificial environment when stereoscopic images are updated in real-time. The programmer operates alongside the virtual objects in order to finish the craved assignment. A physical environment for simulation workstation is desired in order for the users to perceive, view, and relate with objects in the highest natural position. The simulation workstation should be jointly placed within 3D view, synthetic objects, and user's hand. 2. The Virtual Environment : a strong modeling software is used in producing models, the modeling software copies the real set-up in the laboratory. Models are transformed through ModGenSTL and rendered again through the use of OpenCL API. The computer graphics is used to illustrate the spatial and behavior of synthetic objects in addition to description of the shape and geometry of objects. Synthetic objects are categorized into four types namely; the hand, work pieces, conveyer, and storage table. All information of the 3D models and the synthetic environment are stored in a database. The stored information contains physical properties and the dynamic behavior of the models. Another thing that is also stored in the database is the data gotten from input devices. 3. Enhancing Performance

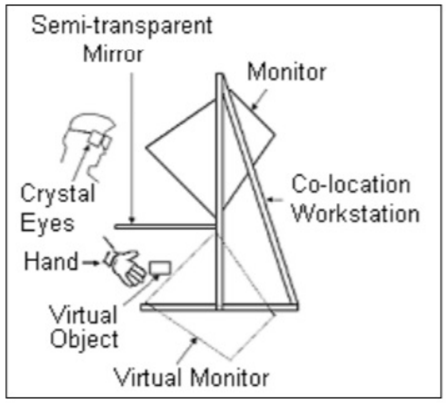

Fig. 9. Co-location workstation
[28]

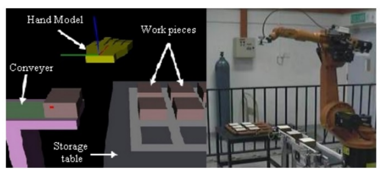

Fig. 10. Virtual objects and actual laboratory set-up
[28]

: the conveyer, alongside the storage table in the synthetic environment are immovable. The only things that can be grasped and taken out with the synthetic hand are the work pieces. The programmer is not equipped with force feedback in the synthetic environment. Grasping can be certified only through visual feedback. When the color changes, grasping is specified. The different color changes are; red, yellow, and green. Red specifies no collision detected, yellow specifies collided and ready to grasp, and green specifies grasped.

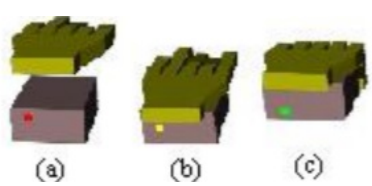

Fig. 11. Grasping signals
[28]

4.4 Data Processing

Sensor tracker and data glove interact with the host computer by means of serial communication ports. The function of the interface is to recapture the data from the equipments and ship the data to the computer system. CSerial, which is a devoted C/C++ class is built to interact and initialize sensor tracker with host computer. Although, the driver does the hardware initialization and serial port interaction of the data glove. The fundamental tasks of the class are to open/close and send/read data for communication port. Calibration is desired so as to boost the precision of the data, and filtering should be done on the data in order to limit the computational load. The raw data of each sensor of the data glove is 12 bit unsigned value. The dynamic range could be different with the differing hand sizes of the glove users.

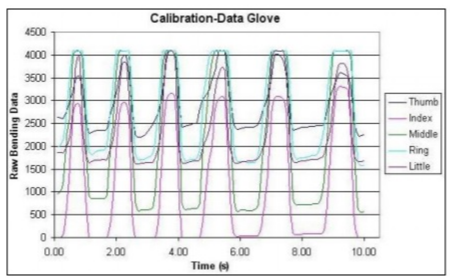

Fig. 12. Calibration data for data glove and sensor tracker [28]

4.5 Simulation and Command Generation

Robot simulation system advancement gives possibly huge and cost-effective rewards. Offline programming helps in limiting the period for which robots are out of production by as much as 85percent [31]. The simulation of the movement of robot manipulators is done on a personal computer before the real operation. The capacity to record and evaluate the manipulations while carrying out an action is given by the simulation program. The evaluation allows users to enhance their know-how, and also to test to see if their manipulative know-how and paths are at an adequate level for a provided assignment. 1. Robot Kinematics : robot movements for industrial robots are explained in two ways. The robot movement could be in form of manipulator joint angles or end-effector location. Robot end position and orientation is decided by forward kinematics. Inverse kinematics weighs the value of each one of the joint variables when the position and orientation of the end-effector is established. 2. The Virtual Robot : a robot simulation system which is dependent on C/C++ programming language with OpenGL has been produced. The recent set of data is transferred to the simulator after filtering takes place. The simulator has the ability of actual-time simulation of a virtual Kuka robot by means of 3D animation which is on a personal computer. The virtual robot can be managed and visualized by the user with mouse or keyboard by means of an easy to use interface window. The robot movement can be simulated a lot of time after the loading of the filtered data. The simulation of the robot is created to: • Have a comparison of the filtered data with the initial data. • Assess the dynamic behavior • Assess robot aspects such as orientations, collision detections and so on. 3. Command Generator : the database can be converted to a Kuka Robot Language over a command generator or a postprocessor once the user is contented with the procedure. The output commands created by the advanced post-processor can only be read by the Kuka Robot model KRC6 controller. The robot languages varies from one to the other. The invention of a generic post-processor is not practicable. Robot movements are carried-out with regular velocity and acceleration.

```
DEF PTP_AXIS()
$VEL_AXIS[1] = 100
$VEL_AXIS[2] = 100
$VEL_AXIS[3] = 100
$VEL_AXIS[4] = 100
$VEL_AXIS[5] = 100
$VEL_AXIS[6] = 100

$ACC_AXIS[1] = 100
$ ACC_AXIS[2] = 100
$ ACC_AXIS[3] = 100
$ ACC_AXIS[4] = 100
$ ACC_AXIS[5] = 100
$ ACC _AXIS[6] = 100

PTP {AXIS:A1 26.5651, A2 3.46629,A3 34.4992, A4 220.355, A5
43.6572, A6 149.288}
PTP {AXIS:A1 -42.605, A2 -10.3901,A3 19.0239, A4 -62.5439, A5
3.33649, A6 45.7593}
PTP {AXIS:A1 37.8414, A2 -8.14868,A3 -2.29048, A4 57.5508, A5 -
7.09465, A6 -42.9173}
END
```

Fig. 13. An example of KRL command
[28]

5 Levels of Immersion in Virtual Reality

When in a virtual environment, sensory feelings are produced by the computer which are fed to the human sense. The nature of the feelings produced by the computer decides the level of immersion in Virtual Reality. There are three levels of immersions: • Non-Immersive systems : this could also be known as desktop virtual reality. The level of immersion in the desktop virtual reality is very low. It does not require any unique device. It can be used in a lot of applications which are at times known as Window on World systems (WoW). It is known to be the easiest of the virtual reality applications. The virtual environment is seen by the user through the computer screen and the user also gets to relate with the virtual environment without being immersed in the virtual environment. A regular monitor is used. • Semi-Immersive systems : it could also be known as fish tank virtual reality. It is an enhanced version of the desktop virtual reality. Head tracking is allowed in the semi-immersive systems and the feeling of presence is enhanced with the help of the motion parallax effect. A regular monitor is used. • Immersive systems : this is the highest form of the virtual reality system. The user is allowed to be completely immersed in the computer produced world through the support of the Head Mounted Devices which gives room for a stereoscopic view of the scene based on the location and direction of the user. The immersive systems can be boosted by the sensory interfaces, audio, and haptic[15].

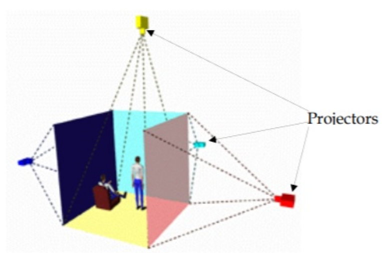

Fig. 14. Schematic representation of a CAVE
[13]

5.1 Characteristics of Immersive Virtual Reality

The rare characteristics of immersive virtual reality are [15]: • Head referenced viewing: this gives a common interface for navigation to take place in three-dimensional area and permits look-around, walk-around, and fly-through abilities to take place in unreal environments. • Stereoscopic viewing allows for the feeling of depth and perception of space. • The virtual environment is given in complete scale and interacts accordingly to the human size. • Practical relations with virtual objects through data glove and related devices give room for manipulation, operation, and regulation of virtual environments. • The fantasy of being totally immersed in an unreal environment can be boosted by auditory, haptic, and further non-visual technologies. • Networked applications give room for common artificial environments.

5.2 Types of Immersion

Immersion can be referred to as the degree to which huge devoted physical inputs like light patterns, and sound waves are assigned to the various sensory modalities like vision, touch, and audition so as to form robust fantasies of reality in each. Immersion can be broken into three types [15]: • Tactical immersion: tactical immersion is felt while implementing tactile operations which requires skill. The players have a sense of being in zone when honing actions which lead to success. • Strategic immersion: strategic immersion is correlated with mental test. Chess players sense strategic immersion when selecting a right solution among a large bunch of prospects. • Narrative immersion: narrative immersion arises when players get devoted to a story, it is related to the experience gotten when watching a movie or reading a book. • Spatial immersion: this happens when a player senses that the simulated environment is perceptually satisfying. The player experiences a feeling of being there and the simulated environment also looks and feels original. • Psychological immersion: this happens when a player mistakes the game with true life. • Sensory immersion: the player feels a harmony of time and space as the player mingles with the image medium and this influences feeling and awareness.

6 Virtual Reality Application Areas

There are more application areas of virtual reality based on the constant improvement of the virtual reality technology. Human-Computer Interaction is being enhanced by virtual reality through the new ways of communication, representation, and visualization of processes and data. Some of the application areas of virtual reality are: • Medicine : virtual reality is used in the area of healthcare when carrying out training of health officers, planning of an operation to be carried out, psychiatric treatment[16] [17] [18] [19], patient diagnosis, reduction of phobia and so on. • Entertainment : virtual reality is applied in the creation of video games. Many industries rose and began to produce virtual reality games. Virtual reality games have so far been created for some sports like football, tennis, basketball and so on. Also, some adventure games have been created. • Engineering : virtual reality has been employed in the area of engineering when it comes to digital prototyping, joint design, maintenance analysis, and so on. • Marketing : these days, a lot of the advertisements done on television were possible due to virtual reality being applied to it. • Archaeology and Arts : image-based modeling and rendering have been generated due to the coming together of computer graphics and computer vision. Virtual reality has made the construction of building prototypes possible for people who are into the field of architecture[20] [13].

6.1 Advantages of Virtual Reality

Virtual reality has largely been used in the treatment of anxiety like the fear of heights, fear of flying in an airplane and so on. It has also been used in treating post traumatic fear disorder. The treatment of anxiety therapy has proved to be useful in academics and it is being proposed to patients suffering from some forms of anxiety. Even though, it was more reasonable to use patients for the training on the treatment of anxiety, the use of computer-based simulation gives more advantages when compared to the use of patients. The aim of the computer-based simulation was to raise the level of exposure to resemble real life emergency situations in order to make decision making and performance better and also, limit mental fatigue in an actual health emergency[15].

6.2 Disadvantages of Virtual Reality

A few psychologists are bothered that being immersed in a virtual world could cause a user to be psychologically influenced. The psychologists think that virtual environment systems which put a user in violent positions could eventually lead to the user not being sensitive. It is being feared that virtual environment systems could lead to antisocial behavior in users and also, users tend to become addicted to the virtual environments. Also, another form of worry is crime. In virtual environments, acts like assassination and sex crimes are sources of concern. Research shows that people could physically and emotionally react to stimuli in a virtual world and this could lead to real emotional trauma[15].

6.3 Virtual Reality Challenges

Some of the challenges in the area of virtual reality are the production of tracking systems which are of good quality, reducing the time needed to create virtual spaces. Tracking system firms which are available are very few. A lot of the virtual reality producers strongly depend on the technology that was developed for other disciplines. Building of a virtual environment usually takes a long time. It often takes a team of programmers as much as one year or more before producing the precise copy of a real room in a virtual space. Building of a system which avoids poor ergonomics is a huge challenge for virtual environment system producers. A lot of systems depend on hardware which hinders a user through physical tethers. If the hardware is not well-laidout, the user could have issues in terms of inertia[15].

7 Conclusion

Virtual Reality is now being utilized in all areas of life and in all industries. It is very difficult to think of what our lives would be without the use of virtual reality technology in this modern day. It is however believed that virtual reality will change the ways through which humans and computers interact by giving new manners for information communication. These days, mail or conference is being employed for the purpose of communication. Virtual reality has been utilized in so many ways like design evaluation, education, engineering, medicine and so on and it would be utilized in so many more ways in the future. Virtual reality is being regarded as a huge uplift in the advancement of technology.

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