Mine Automation and Data Analytics

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Introduction to VR Systems

Welcome back to my course. My course, Mine Automation and Data Analytics. Today, we will discuss on Virtual Reality. And there is a good amount of development of virtual reality in the mining automation and mining industry. And this lesson will devote more on general virtual reality and the theory behind the virtual reality, its hardware. And another lecture will basically devote on how these VR system can be useful in the mining industry.

So, let me discuss in today's discussion about the general introductory VR system. So, in this lesson, we will discuss the following. What is the virtual reality? Then, what is the concept of IQ, of virtual reality? Or many people say 3I. What are the types of virtual reality? Then, the application of virtual reality.

Hardware component of VR systems. Field of view and visuals. Field of view is a very important component of the hardware and its scene that is to be created. And overview of the micro displays. Display system is a very important part.

It related not only to the resolution, that also related with the immersion of the users. And also the user easiness. Benefits of virtual reality. Then, the future of virtual reality. And the technical consideration for virtual reality.

So, what is virtual reality? Virtual reality is basically a use of computer graphics to generate a real scene in the virtual world using different levels of simulation and computation. And also it has the three dimensions, just like same as the real world scenario. And it has an additional part that it has an interactive experience. So, I can touch this is stable. So, in the virtual reality when the table is generated with my display system I can also touch and I can feel yes it is a table.

So, that kind of immersion is very important in the virtual reality. So, it is nothing but a combination of the software and hardware. So, there is a huge amount of use of computational power in the computer. So, computer basically simulate the scene and that scene created up to one after another just like in a real world situation. So, in a virtual reality environment user can interact with the simulated world or simulated environment using a specialized hardware.

There are different kind of hardware's haptics, head mounted display. There are different touch sensors and these basically been realized by using a kind of or specialized softwares. So, the goal of the virtual reality is to create a sense of presence and making user feel as if they are physically present in the virtual space. So, I am sitting in this room. So, in the virtual reality when I will wear those spectacles and head mounted display system and I will take all the hardware's if this particular gallery is been recreated, I will feel that yes, I am inside the gallery.

I can see different features in the gallery. I can also measure, okay, this is about 3 meter distance, it is around 1.5 meter, this side 2 meter, like that I can feel. So, this is basically the principle feature that what the user want to see, what user want to experience, that can be done using the device and softwares sitting in a training center or sitting in a kind of lab. So, what physically you do not have to mimic, you can recreate in the virtual world.

So, this is basically the general feature of the virtual reality. Example. So, here we have tried to demonstrate you an example that an user is basically wearing a head mounted display system and VR headset and in these two hands there is a fly, fly means there is a wing, okay. This wing can be a flap. So, the scene is just like the user is basically flying above the San Francisco city, okay.

So, when you are above the San Francisco city, you can see the aerial view of the city. So, this aerial view of the city is visible to your eye and that is basically, here it is being demonstrated. So, here it is basically demonstrated with the two eye, what kind of picture you are going to get while you are basically flying above San Francisco. So, you are not flying in San Francisco, you are sitting in a lab, you are just with the machine, interacting with the machine and wearing those VR set and you are experiencing the pictures, features of the San Francisco city. So, this is basically a kind of experience, a new kind of experience is required for different kind of purposes and this is nowadays become a very useful tool for imparting training, to impart some kind of entertainment as well and there is a large use of this kind of technology in the entertainment industry as well.

And user also feel that when he or she is flying, there will be some kind of motion, so there are suitable kind of sensory sensing system that will also stimulate those kind of motion so that user can feel yes, he or she can feel the jerk in the vehicle that is he is basically carried through to see the city, San Francisco. So, these are basically integrated in the system. Here there is another example, so this is a mouse running on a freely rotating ball while exploring a virtual maze, virtual maze you know that they are basically there are different path that goes to the goal, so that is basically created by the virtual projection system. So, it is basically around the mouse it is created. So, an experimental setup here it is being used by neurobiologist for different purpose to see what kind of simulation is created on the rodent.

So, it is basically done at LMU monitor, so it is basically done at LMU monitor to present visual stimuli to rodent while they run on a spherical ball that acts as a treadmill. So, this is the optical mouse, this is the mirror projection system, so the real-world scenario is changed when the rodent moves around the ball. Principle of Virtual Reality. The principle of virtual reality is to create a relationship, this relationship is very important between the user, I am the user, you are the user with the virtual environment. Virtual environment may be mines, virtual environment may be building, virtual environment may be a train, virtual environment might be a kind of you are sitting on a drill machine, so there are different kind of virtual environment might be.

So, the relationship is very important that yes, I am sitting what I desire to sit and what I desire to look into, so that interaction and that relationship is very important. If I recreate the virtual environment in such a way that it is very very or closely approximated to the real scenario, so the relationship will be very very strong that will basically give a much and much and higher degree of immersion. So, user will forget where he or she is, he or she will feel that yes, I am inside in that environment. That is basically the goal of this virtual reality system. So, for that, a software technologies that is computer graphics and real time computing as well as hardware technologies, human computer interfaces required.

So, here we have tried to demonstrate here it is the user, and the user is basically wearing some kind of hardware, here you can see in the eye as well as in the hands he is wearing some kind of sensors, so that kind of sensor captures the motion, this sensor captures the motion, so motion is captured in the real world the user is doing the exercise and through that motion he or she is touching something, so image acquired, that is their kind of sound, their kind of movement, so those sensory things are basically captured that is the real world and there is a sensory interface also. So, now using this sensory feedback, there is an animation created of that power that is basically interacted with the virtual environment, ok. And that is basically the similarity is done. So, much and much higher degree of immersion and interactiveness is the desired goal depending upon the target set by the organization, those who are basically manufacturing or depending upon the specific goal. So, this kind of interaction and relationship can be increased or decreased based on the necessity, based on the requirement, so this is basically finally an interaction created for a specific purpose with the real world people with the virtual world and environment.

IQ, so this IQ is a central theme of the virtual reality. So, this IQ is nothing but immersion, ok. A different degree of immersion is feasible within the virtual reality system. Second is interaction, how much you are able to interact with the real world as well as the virtual world and, more specific to, the virtual world. So that, yes, you are getting some amount of information, some kind of feelings, some kind of sensation by interacting with the virtual world.

If those sensations are very very similar, then it will also increase the further level of immersion, ok. Then, the imagination. Imagination is an additional feature of this particular virtual reality that those are basically kind of senses that is generally it is very difficult to imagine. So you are artificially recreating some kind of simulations and you are basically arousing the user to go with those imaginations and you are basically connected those things. So user will experience that he or she has never experienced those kind of situations.

So it is also an artificial stimulus is created. So these I3 or IQ is basically the principle block of the virtual reality system. Immersion, interaction and imagination. So immersion it means that user focus on the experience in virtual scenes and forget about the real world environment and, which is the key to virtual simulation. Interaction: the experiencer participates in the virtual environment and gets information feedback from the virtual environment and, which is the core of human computer interaction.

So user can interact with the virtual object in various forms depending upon what kind of sensors we are basically deploying and using. Imagination, imagination it, is basically the purpose of the virtual simulation that experiencer conceive various sensory effects beyond reality improves rational or perceptual knowledge and expands people's imagination space. With the development and evolution of virtual reality technology, its theory and system are becoming more and more mature, and AI artificial intelligence technology will also be included in the basic characteristics of VR, and its IQ feature will develop into an I4 feature in the future. Types of virtual reality. There are non immersive kind of virtual reality.

There are semi immersive kind of virtual reality and there are fully immersive VR system as well. So these are basically different types of VR system is developed for different purposes and different requirement to fulfill different requirement. So what is non immersive virtual reality? Non immersive VR is also known as desktop 3D VR it is a basic form of virtual reality. And user experience virtual environments through a computer screen or handheld devices like smart phone and tablets. So with non immersive VR user can view the virtual world on a screen while simultaneously observing their real world surrounding.

Example of non immersive VR includes virtual tours 360 degree videos and flight or driving simulator. It is more you can categorize it is a kind of static VR. The user will not feel that he or she is inside that virtual environment. He is also interacting with the general world because it is basically a static kind of pictures in front of the computer or, in the desktop or in the tablets.

Semi immersive. Semi immersive VR provides a more immersive experience than non immersive VR but does not fully immerse user in a virtual environment. User typically wear a head mounted display HMD covering only part of their field of view. The HMD

may include motion tracking, enabling user to look around the virtual space by moving their head. So, this is the user wearing the head-mounted display system. Here it is a scene camera it is a head mounted display here some kind of near IR light illuminator and this frame is flexible based on the user convenience.

He or she will adjust. So these basically include the motion tracking. So this is another kind of system of the semi immersive system. Here is a virtual projection of some buildings surroundings. The user now interacting with those features. So here, body movements are not fully tracked, which may limit the immersion.

Application of semi immersive VR include gaming experiences and training applications where users can interact with virtual environments through head movements. Fully immersive VR system. Fully immersive VR offers the highest level of immersion and presence and providing a realistic and seamless virtual experience. Users wear a special head mounted display and or VR goggles that cover their eye and ear. So it basically isolates the user on the real world.

And these devices allow for a 360 degree view and sound creating a real sense of presence within the virtual world. Highest resolution screen for each eye enhance the depth perception. Now user can interact with the virtual environment using both head and body movement. Additional accessories like motion controller or haptic feedback devices may be included to enhance the experience. Example of fully immersive VR include high end gaming experiences, virtual simulation for medical and pilot training, advance architectural visualization tools allowing user to navigate virtual buildings.

Application of VR. There is a huge amount of use of the VR technology now in the entertainment industry more, particularly in developing different different levels and high degree of immersion games. Augmented reality super imposing display. We'll dedicate a special lecture on augmented reality in the later part. Training. There is a huge amount of scope to use this VR technology for the training of the user for different purposes.

And this kind of training helps the user and the future employee of an organization to better cope up with the organizational structure and different technicalities exist in the organization or specific to some kind of operation. Remote robotics. It has also good applications, distributed collaborations and virtual prototyping. Particularly it is a very good example for large investment industries before creating the real physical structure. They basically build the virtual prototyping so that they can characterize, they can examine what are the flaws in the design or in the actual things.

So that is now it is very much useful and also this kind of virtual prototyping is used in the real estate business as well as to show the user what kind of buildings you are going to see that is you are going to purchase before actually the building was erected. So this is basically a huge market is there for this kind of technology. Application entertainment

games. So these are some examples of different video games are created and what kind of scene it is basically creating.

Augmented reality. This is the Microsoft HoloLens 2016. Uses advanced see-through display technology to superimpose graphical images into the ordinary physical world as perceived by looking through the glass. A flight simulator is used by the US Air Force. The user sits in a physical cockpit while being surrounded by the display that shows the environment. And some of the data shows that in the Delhi metro nowadays, the drivers of the Delhi metro are gone through an extensive amount of training in the VR environment, and they are telling that about 70 percent of the training is being done in the VR environment, and the rest 30 is on the real rack of the Delhi metro.

Remote robotics. Example of the robotic avatars. Dora robots from the University of Pennsylvania mimics the user. Head motions allowing him to look around the remote world while maintaining a stereo view or panoramas are monoscopic. The Plexi drone is a flying robot that is designed for streaming panoramic videos. Health care. Particularly for the medical students and intern in the hospitals these visualizations of different human organs and their functions, their motions is basically helps the students or future doctors or physicians to understand better the interaction of different organs, their functions, identifying what are the faults, what are the kinds of real action might be.

So these basically has a very good advantage and usefulness. So this particular graphics is basically developed by CHAM Training, Simulation and Education Center and it is developed by the University of Ileonesse. Virtual prototyping. So the architecture basically developed the tour about the buildings so that the user, the potential buyer who wants to buy the particular flat so he or she, can see what kind of structure might be, what kind of environment might be, how when you are entering into the building, what kind of surrounding you can look through. So this is basically a very good example of the virtual prototyping.

So this is basically created by Tyhedron, and this is basically IVR nation. Harder components of VR system. There are basically principally three components. There are input, then there are computation and finally the output. So the output basically depends on what kind of output we are basically wants.

So there might be virtual display, virtual rendering, oral renders, oral display, haptic rendering, and haptic display. So these basically depends on the requirement. And these basically, these output basically simulate the scenes and basically it basically interacts with the sense organs so that immersion is better and better. Sensors input device that extract information from the real world scenarios and computers device that process the input and output sequentially. So, based on the requirement, what is the movement, and when there

is a movement, he or she wants to go forward so that forwarding should also be in the virtual world.

So for that, a huge amount of simulation is required. Field of view and visual. Lens distortion. All lenses introduce image distortion. This is a typical image. So whenever there is a lens you are putting before an object and you are observing through the lens, you will observe that certain kind of distortion, at least on the peripheral side of the lens.

And also there are kind of chromatic aberration is also observed. So for a good display system, these errors you need to work on and you have to remove by applying some kind of correction technology. So, this lens distortion is basically a grid seen through the HMD lens. It is a grid, a square grid it is, actually. Now we are observing through the lens and you can observe the distortion at the edge side except at the middle there are large amount of distortion in the grids, square grids.

And lateral XY distortion of the image is observed, lateral side. Chromatic aberration is also observed. And this distortion is basically wavelength dependent. So this is a kind of percussion, pin percussion distortion.

This is an optical range. This is after some kind of digital correction is applied. This is a barrel distortion. And basically in the display panel, you are seeing there is a lens and there is a corrected image to the user. So the user can see a corrected image and that is a requirement of the system. So when you have seen that there is a lateral kind of distortion in the image, so we need to correct the XY of the image.

So, this is the original picture. It should be like this. So XU and YU is the undistorted point. And here, it is distorted. So you see that how far the distorted point, the cross sections are away from the center position of the point. So here we are applying some kind of error correction on the X and Y. So how much amount of distortion is basically depends on how far it is located from the center.

So there is a correction is applied. So that correction is basically implemented in the system, and finally, we will basically get more or less this kind of undistorted image. This is one example of the catalay. There is a kind of stereo rendering with lens distortion correction. This is another example, lens distortion correction example using the stereo rendering. So this is basically done by the computer graphics system by analyzing the center line X and Y and applying and superimposing the real image and how far it is there.

So that kind of correction needs to be accommodated, and finally, you can project the corrected image. So these are basically done at the corners. So, corners are the crossing points. So, if you correct those corner points, then finally undistorted image you can see through.

Overview of the micro-display. Micro-display is a very important part and this micro-display facilitate the user to see the virtual environment through the eye. And there are different kind of development of the micro-display depending upon the immersion, depending upon the resolution and the user easiness different kind of display system being developed. This is one that is LCD, liquid crystal display and there are IPS kind of display system of the LCD. And this is basically LCD there are how these filters are there, color filters, red, green and blue. And this is the pneumatic molecules of the glass layers red, green and blue.

Finally, there are multiple layers in the display system. This is the LCD backlight. Light goes in this direction and then there are kind of error correction in the streamline. So based on that user can see a bright image. Liquid crystal on silicon L-C-O-S and here you can see that there are multiple layers in the display system.

This is the modulated light and the polarized light. So there is a glass layer, transparent layer, alignment layer, liquid crystal layer, reflective layer, C-O-M-S layer and control layer. So, there are different layers. So, these layers have some dedicated purpose. One maybe the image correction, distortion, another maybe the resolution, another maybe the color, another maybe the texture. So everything taken care of by different development of the micro display system.

So basically it is a reflective LCD and standard components in projectors and head mounted display system. In the goggle glass it is been used. Organic light emitting diodes, O-LED. So this is very costly technology though for the high resolution imagery and this kind of display system is basically used. So there is a light emission, glass substrate, transparent conductor, hole transport layer, emitting layer, electron transport layer, and metal cathode.

So, there are multiple layers. So that takes care of all these kind of possible layers that might come. That is when light is going through the lens and the display system.

Digital mirror devices. So, this is the digital mirror. Digital mirror device, DMD. So this is developed by the Texas Instrument. It is a MEMS-based device. This is a binary state, have a plus minus 10 degree resolution. Gray level through the pulse with modulation.

This is the 3D display using the scanning laser projection system. Benefit of virtual reality. It provides high quality visualization with countless sensations. A fully immersive VR can simulate potentially menacing real world situations like flight operation or surgery. As a tourist, the virtual reality technology helps you to decide if any upcoming trip is over.

So you can see the virtual reality technology. This is the virtual reality technology. Virtual reality technology helps you to decide if any upcoming trip is over or not. The types of VR provides consumer with engaging experiences. The virtual reality is a great help to pilots, firefighters, astronaut, police officer to practice in a safe environment before getting

into a jeopardized situations. This technology is handy in day to day activities as well as in the virtual reality.

It makes watching more enjoyable and thereby creating interest. Virtual reality can effectively overcome language barriers. Future of virtual reality. AI and VR integration. Artificial intelligence, that is, AI, will play a significant role in creating dynamic and adaptive VR experiences. AI algorithm can personalize content based on user behavior, preferences and real time interaction, making VR applications more engaging and tailored to individual users.

Expanded applications in education and training. It is likely that VR will find broad applications in education and professional training. It will be used not only for medical situation and pilot training, but also for soft skill development, team building exercise and language learning. Entertainment and gaming. VR gaming will continue to grow and, with more sophisticated and interactive experiences and scenarios becoming available. And game developers are likely to invest in VR titles, pushing the boundaries of storytelling, graphics and gameplay.

Enhance hardware. In terms of the hardware used, future VR devices will probably become more lightweight, comfortable and user friendly. Advancement in display technology may lead to higher resolutions, wider field of view and reduce motion sickness. Technical consideration for the virtual reality. Accuracy. VR application development requires significant attention to detail with respect to stimulus generation, internal calculations and outcome data.

For example, in research, it is necessary to generate a consistent, repeatable stimulus. Additionally, the sequence of when physics, that is the position force, are computed, applied, rendered can vary depending on the applications. Flexibility. Flexibility is a very important feature. These flexible VR architecture for research need to be both modular and scalable and the underlying framework should support further development.

For example, strategic development of base VR features should be a platform agnostic. And though the user interface would need to change based on a final use case, minimizing the need for content adaptation in the future. increases the utility to the same VR application could easily be made for an HMD or a large scale theater. And here I want to mention that for the VR, when it is being used continuously for the training, the user easiness, the hardware that is used, there are kinds of sensations. Those are very difficult for the user to use.

Those are very difficult for the user to carry forward or to go through those kinds of experience. So future VR needs to develop a kind of very, very friendly hardware and software so that users should not feel the jerk. And those jerk might be dangerous for some

of the users. So, future technology will also concentrate on giving user more easiness and, flexibility and comfort to use this kind of technology.

So these are the references.

And let me summarize in a few sentences what we have covered. So we have provided an overview of the concept of virtual reality technology. We have introduced the three main components of the VR that is immersion, interaction and imagination. And then we have the virtual reality technology. We have explored different classification and categories of VR technology based on usage and implementation. We have discussed various practical application of VR technology across different industries and fields.

Examine the essential hardware component required for the VR system, including headset, controllers and sensors. And explore the importance of field of view, visual, visual and visual. And explore the importance of field of view, visual in virtual reality experience. Provided an introduction to micro display and their role in VR technology.

We have discussed the advantages and positive impact of VR technology in various domains. We have explored the potential advancement and development expected in the future VR technology. And we have examined the key technical factors and consideration relevant to the design and implementation of VR system. So in the next lecture, we will basically concentrate on how these VR technology and system will be useful for the mining industry with some case studies that is already been developed in some part of this world. So we will elaborate on that in details in our next lesson.

Thank you.