Mine Automation and Data Analytics

Prof. Radhakanta Koner

Department of Mining Engineering

IIT (ISM) Dhanbad

Week-7

Lecture-32

Augmented Reality Application in Mining

Welcome back to my course, Mine Automation and Data Analytics. Today, in this lesson, we will discuss some of the case studies using the AR augmented reality. You have already seen that there are huge potential in the mining industry for imparting training, developing quality knowledge material for the future engineers and professional across the industry. So augmented reality is basically going in that direction. So in this lesson we will discuss some of the specific case studies that has been developed, that has been practiced and how this is going to benefit the mining engineers and the mining industry in the age of mining 4.0, industry 4.0. So this is under the module 7.

So in this lesson, we will cover the following. We will basically discuss the case study on augmented and virtual reality tools in imparting training to the mining engineers and mining professionals and for that we need to develop VR and AR settings for mining training and we will also exercise the experience that is gathered or experience that is imparted to the engineers and professional using the VR and what is the outcome. And also using the AR what is the outcome of this kind of training and how they feel, it is beneficial for them or not. So those are the aspects we will discuss in this lesson.

So augmented reality and virtual reality basically these two technologies are becoming an integral part at different sector of different industry as well as in the mining industry to implement the industry 4.0 concept in the mining production process and this concept is very very useful in terms of imparting good quality training, good quality experience to the working professional executive and different miners working to be work and to be employed in the mining environment and they are getting a very quality environment, quality data, quality experience that will help to streamline them to integrate them in the production process. So different companies are basically investing a good amount of capital and money for developing different customized product that would be relevant to different different sectors of the mining industry as well as other industry and here to name a few Google and Microsoft are basically developing good quality materials, hardware, softwares and they are not only limiting this market to the common consumer they are also specifically targeting the educational   institute and the different industry sector to be

integrated and to be their customer, future potential customer so that these technology, these people can take advantage of it and impart quality education to the consumer.

So this basically been helping because of the development of the industry 4.0 and the cyber security concept, the IoT and different complex network are basically helping to create new kind of environment and scenarios and complex scenarios that can arise due to the integration of all these complex process chain in the mine automation. So these developments are basically adding new kind of tools, new kind of dashboard, new kind of features into the training program that basically helps the mining engineers to gather and get a good amount of information and training how these are related, how these are working so that they are basically getting a good amount of training and when they will be really employed and really to be deployed at particular site to handle those kind of control situations they have a higher age that yes they have already gone through this so they can accommodate they can work very efficiently under those conditions.

So this is basically the process chain we have already seen in few lectures earlier that due to the advent of the first steam engine in the 18th century now on the 21st century were on the barge of fourth Industrial Revolution that is industry 4.0 and that basically aiming at giving a very high level of productivity compared to this you can see here.

Here the blue is basically the productivity level at the first Industrial Revolution and here this is basically the productivity at the industry 4.0 so very high level of productivity achieved so when high level of productivity achieved it needs a very skilled set of manpower and across the process chain you required skilled manpower and very responsive very fast adaptive employees and workers who can contribute gradually in the

production process so for that you need good quality training as well to aware themselves what are the integrations of different sensors and what will happen if this is operated like in other way so those are the complex situation it is very difficult to simulate in real conditions. So AR and VR provides us a very good opportunity to simulate those kind of complex situations that you are basically underwent that if this basically happens so this kind of situation may arise so you are basically creating a very good awareness amongst the workers and the professionals so it is basically finally helping you to enrich their experience and their expertise and in a cumulative result basically contributing to higher amount of productivity. So this transition from the traditional to smart mining basically has significantly enhanced the mining engineers capability in hazard identification and decision-making process by that we are basically improving the safety notion and the safety overall in the industry.

So this technology basically VR and AR are revolutionizing the practical training of the future mining engineers by offering advanced simulation of production environment that closely resemble real-world scenarios so the mining engineers is well aware of the situation that if these things are run in tandem this much amount of production of this kind of situation is going to arise so that is not possible in a real kind of scenario that you can put them under the training condition because you cannot recreate in an real scene those kind of situations so that VR and AR offer us extra amount of space extra amount of dimension where we can create this kind of situations and we can make our these professional that yes this is this is the kind of situation might be if this is happens parameter 1 parameter 2 parameter 3 there are number of parameters so the role of each and every parameters their influence on the production chain process as well as on the environment as well as on the safety you are well aware you are well informed about those kind of situations so this is basically an advantage side of these VR and AR technology in the mining scenario because mining is basically a very complex process and we are working against the nature so under a very constrained environment constrained condition we are basically working we are exploiting minerals and then producing and basically there by that we are making profit out of it

so AR and VR technology are being utilized in various aspects of training mining engineers okay such as designing industrial line supporting personnel training in repair one of the most important aspect because because of the use of huge amount of machineries sensor control system you record frequent repair as well as monitoring of these kind of things and you record expertise that might not be available at your mine site so AR and VR particularly AR is going to add and augment you in this kind of process yes you can go through this repair process with the help of the expert station geographically distance place or very far away place by that AR system AR camera fitted on the mechanic they can guide the process yes you can do this this that we will basically discuss few slide later so by that we are basically aiming at reducing the risk associated with these operations

and particularly equipment large equipment that is operating 24×7 in the mine site and we are basically well aware of the data generated by these machines yes this machine is required some kind of maintenance right now so we are basically planning beforehand based on the data and in this kind of situation VR and AR going to help a lot.

Collaboration between universities and VR AR manufacturer is a very important thing and many universities are coming forward and we will basically show you some of the examples and this is basically in the need of the day a close cooperation between academics and the industry to develop a good quality material good product that might be and surely helpful for the mining industry for the mining professionals for the mining engineers and other engineers basically working in the in the mining front.

so the primary advantage of using the VR and AR training is lies in the ability to simulate virtual environment and that is very closely resemble with the real one okay and thereby we are going to provide a very immersive experience to the learner to the engineers those who are basically going through this training process and again we should remember that this kind of simulation of a real environment in a real scenario is very difficult and might be risky so we are basically not doing that we are basically now doing in an artificial condition under a very safe other ground parameters and other conditions boundary conditions and keeping the trainer and keeping the training personnels those who are those who are basically going through this process of training we are keeping them with well within the safe limit and they are basically exposed to a kind of a real hazard situation that might arise in the mine site and that might be helpful that under that risky condition what to be done now what to be done next so under those kind of situation under a kind of training we are directing them really helping them yes you can take this route like this direction you can do surely you must do this switch up in this or you must inform like this or you must do that so those are the do and don'ts under those kind of situations we are able to impart those kind of educations and that is not possible under a real case scenario so AR and VR in that context helping a lot so ar and vr training basically necessitate is basically necessitate the development of new teaching method that accommodate the evolving training needs of future mining engineers and the changing role of the educator okay now the education should be more on imparting a real experiences and the kind of situation might arise so that we are basically preparing the engineers ready to move to the mine okay we are basically giving those kind of experience that engineers is basically required to acquire those kind of experience during training so we are basically slowly and slowly VR and AR basically slowly and slowly replacing the need of a a large amount of training or a good period of training and by that we are basically reducing the cost running cost particularly and we are making a ready-made engineers that they can be employed and to be deployed at the mining side or an industrial site.

Advantage of these collaborations we can develop the educational program for the industries and the for the universities we can create specialized training course that is the

need for different kind of courses may be required for ventilations for support needs strata monitoring for deep learning operations for for caving for filling for shaft sinking for drilling for slope stabilization there are number of aspect of the mining that we can we can develop a specialized training courses for those kind of process conducting advanced training courses and professional training of mining engineers that is also the possibility we can do it creating unified method for implementing vr and ar in educational process so that across the globe and different countries under a different kind of mining situation we can impart a quality kind of educations those are the need of the hour we can impart those kind of educations developing those kind of scenarios and scene and the video graph simulations so that the students the engineers those who are now going through an education process they can readily get those experience and that experience would be useful for them when they are employed in the industry and involving the academic community in developing practical tasks based on VR and AR and these practical tasks might be helpful for the industry people as well so that when they are working time to time they are also going through a refresher kind of course and they are basically refreshing their knowledge and the kind of training that will also refresh their mind and kind of knowledge that might they have forgot under different circumstances involving different kind of process so overall again they are going through a new process of training and they refurbish their knowledge and that might be helpful to enhance their productivity their skill to the higher level popularizing the best educational practice of applying VR and AR to training mining engineers at higher educational institution and establishing an international hub to disseminate VR and AR training technology in mining

Developed AR and VR for training: so let us see some of the case studies we will now go through many case studies that is been conducted globally the university of quinceland have developed involving some manufacturers of these AR and VR technology the VR training application with the rig models okay and in strong ucs testing model and the ventilation models so these are the three more module they have developed and we are training applications so this rig model is the university is working on creating VR simulations that replicate rig operations commonly found in mining environment okay how this rig where how this rig function so these are the things the engineers uh does not require the real kind of rig simulation they can see the virtual simulation they can experience what kind of situation might arise under these rig simulations or rig that is working so those are the real experience they can gather out of these modules so these simulations provide training with a virtual platform to familiarize themselves with the rig control process procedures and safety protocols this is the in strong VR and virtual rock samples and the control panel this is basically similar to the real machines and the the control system so everything just simulated so under these conditions how the wire is basically done how control you are establishing what are the safety you must take care so everything is part by part step by step is imparted those who are going through it so they are getting a real practical experience when the same person is going through the training

in a real scenario so this is slowly and slowly AR and VR basically replacing the need of real practical training so in strong ucs rock sample testing model another area of focus is to development of VR application for rock testing using the in strong ucs model the training can engage in virtual rock testing procedures learning how to conduct test accurately and interpret result.

InstronVR and virtual rock samples and control panel
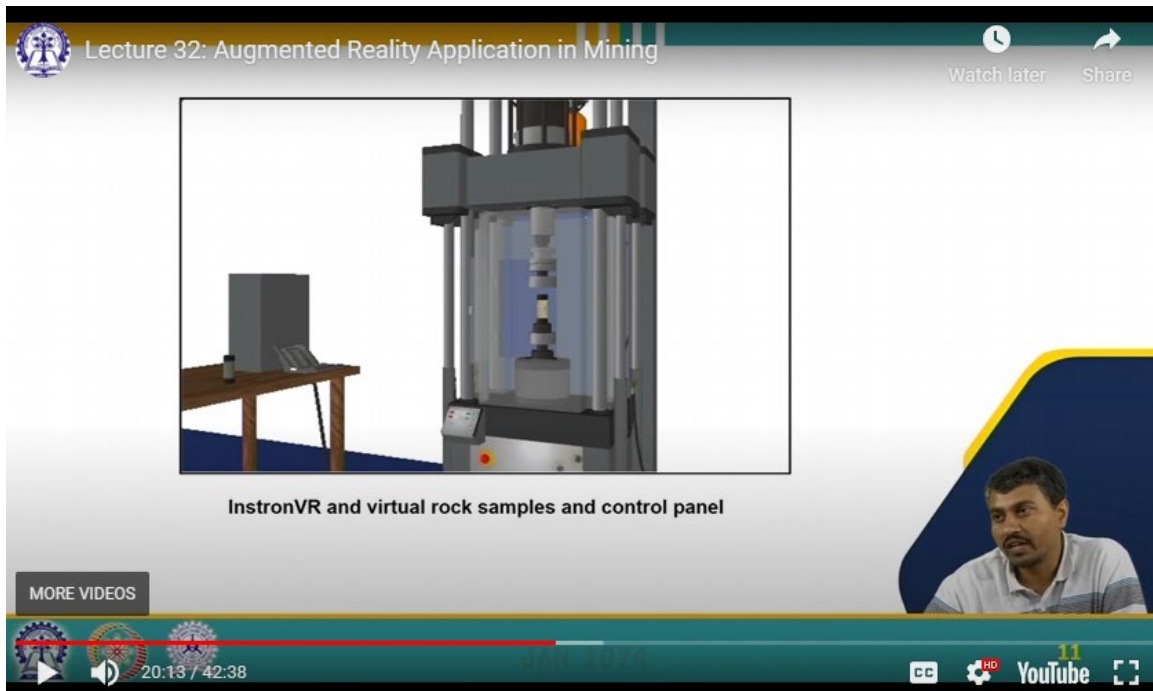
Second is the ventilation model the university is also developing VR models related to ventilation system in mining operations so different kind of ventilation situations you can simulate by changing the fan speed by basically creating a new roughness on the on the on the path or the gallery so different kind of situation that might be risky in a real situation so all these experience you are getting and a good amount of knowledge about overall ventilation system in the mines you are getting through these kind of modules so the training can explore virtual environment representing different ventilation scenarios learning about air flow dynamics and monitoring technique and safety considerations.

Case study two, the university of south wells is implementing i-cinema is a dome kind of a theatery kind of dome separate structure where different scenarios are simulated on the carved screen and that is a 360 screen and that basically consists of 18 modules designed specifically to enhance teaching and learning activity at UNSW so the simulation of difficult work situations i-cinema enables the student to recognize and navigate through difficult work situations commonly encountered in the mining industry and through the realistic simulations students are getting the challenging scenarios under a very controlled and safe virtual environment so this is the typical image of the icnema it is the dome separate structure it is a 360 degree screen when you enter onto this particular theater you

are now under that mining condition that is simulated on the screen of these monitors so here number of kind of situation you can develop you can develop fire situations so which direction to run what to do what do not to do what don't so everything the instruction are given and there are there are kind of sensor to be fitted your motions will be tracked whether you are advancing this direction when where you are retreating in this direction that will also be reflected on the on the sensors and the headset so you can really experience that if you are basically a trap under a this kind of accident in a real scenario you are basically in a same kind of situation in a virtual environment but your safety is assured and your exit is also assured that you are not going you are any no kind of harm is going to be imparted on you so this this has been taken care so this is a very good experience a good kind of technology good kind of facilities that basically helps to expose the miners the engineers the professional under these difficult conditions and they are getting the real relations what to do in this kind of difficult situations.
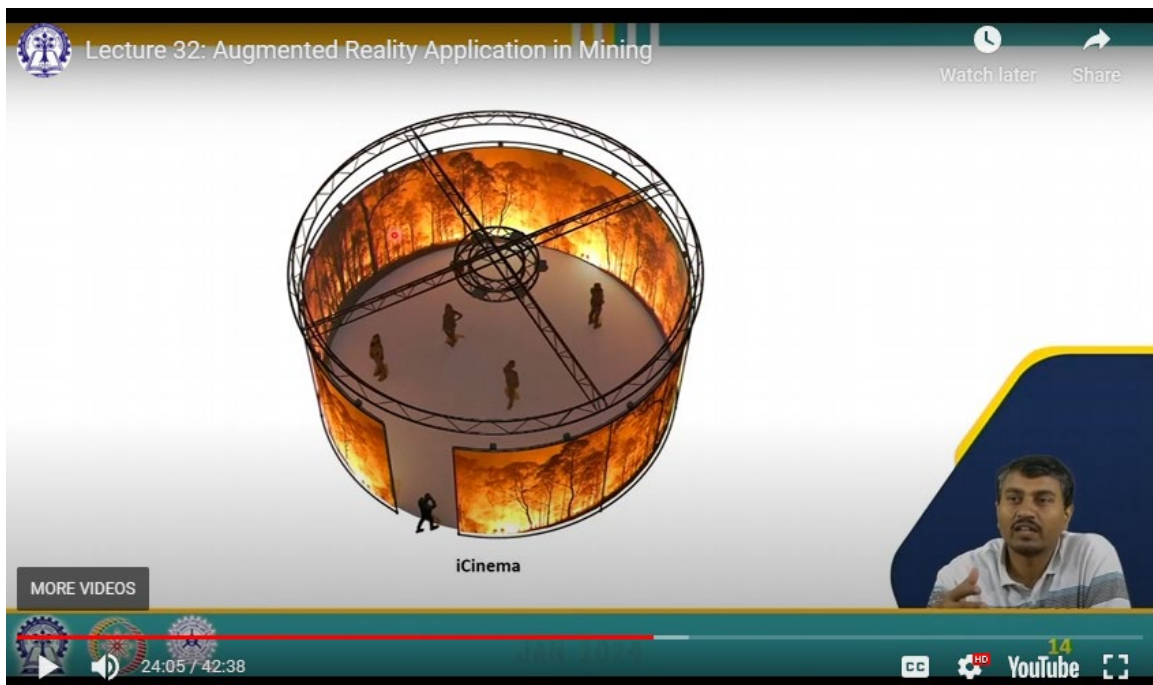
Safe training environment one of the key benefit of the i-Cinema based training is the provision of a safe learning environment and the student now engage in hands-on experience they can change without exposure of a real world risk commonly associated with the mining operations interactive relations and learning i-Cinema facilitate interactive learning by allowing student to actively engage with the VR program student can interact with the virtual object and the environment which respond to their movement and action in real time so it is basically an interactive a good amount of immersion is also there so the people who is undergoing the training or going through this training process they can very well get a good amount of knowledge good amount of experience sensations so those

sensations they will acquire and they that would be a good amount of relation for their lifetime

so iCinema based training allows student to recognize difficult work situations and receive training in a safe environment the technology enables student to interact with the VR program that responds to movement in space and incorporate production situations so this is basically the theater where you are basically under you are basically fitted with different sensor your movement is tracked and now you are under the mining conditions so a real mines is now simulated within that 360 degree theater and you can perform many tasks based on the module developed in this 360 degree screen so this basically give us a very high degree of scope to facilitate a number of or a kind of mining situation that we are basically wants to give a specific instructions or we are want to aware these miners about the safety hazards okay so those kind of situation is very very helpful in this kind of modules.

Case study three, scientists at the US national institute for occupational safety and health have investigated how the mining industry can effectively use gamification and here to learn how to escape fires so the spoken research laboratory has developed fire evacuation training software for the mine safety training course the study notes that we are based training significantly improves uh student skills in determining proper evacuation route in a possible emergencies so this is basically the emergency is simulated so now you have been you are being instructed which route to take what to do now so a real fire situation is simulated so this is not possible under a real situation you cannot ignite a fire situation and imparting that might be risky so these kind of software modules are a very handy tools for

imparting good quality training material so that is basically the untapped potential a good amount of potential here we have and that is why big big companies are investing for giving quality materials and averaging the miners professionals in this industry and to make the industry hazard-free.

Case study four, the expertise of educational institute and mining companies in china includes VR technology applied to teaching safety regulations in rescue operations scientists have developed a cloud-based VR system for training mining engineers so this system include VR hardware a projected panoramic display system a projected panoramic display system a VR headset a monitor a tablet and other devices so now in the classroom itself the engineers the budding engineers are getting those kind of experiences and the animations and the simulations help them to understand what kind of situation might arise in the mining under x y z z or n number of conditions.

Case study five, the lecturers from physics department of Kryvyi Rih National University have developed a AR-based manual for laboratory work in order to provide distance learning for the future mining engineers the future mining engineers will use their smartphone to recognize air marker and actual laboratory installation its use are displayed on the screen so different physics principles particularly maybe light scattering the reflection refraction sound sound wave travel then the resonance those kind of situations might be very well simulated and there are number of physical experiment can be simulated and a good amount of expertise good amount of training can be accommodated and who do not have the real reach to this kind of facilities they can get through in the mobile phone and they can experience yes this kind of test is done and this is basically the conclusion this is basically precaution these are the procedures so what is the science behind it they will learn very well under this kind of technology

AR/VR analysis the latest air here technology for simulating mining production processes expand the boundaries of practical mining training in the educational process it is important to ensure an advanced simulation of the production and production environment perceived by the student as reality professional AR/VR based training of future engineers allow students to participate in production processes of mining enterprise and be engaged in their future professional activities the VR and AR development in mining is based on the automation of technological process in the context of digital transformation of modern society a significant effect of VR/AR technology applied to the practical training of engineers is achieved through forming professional competencies in handling mining equipment.

Experience of using here in the training process of the mining engineers. Mobile communication the internet of thing artificial intelligence and cloud computing provides the information infrastructure needed for smart mining the next generation VR system for underground mining are being created to improve professional adaptation and occupational processes for future mining engineers the study shows that students using the VR application learn four times faster than those learning in a classroom the VR simulators are utilized for training operators and maintenance personnel key virtual reality training program for the mining industry.

These VR system can monitor the training process and provide feedback to student incorporating gamification to enhance learning the map tech in collaboration with LlamaZOO MineLife has developed VR digital tool to visualize production process at mining companies in canada australia and south africa a digital model of an underground mines has been created which has been explored using the VR set or a computer to simulate real life working conditions so this is basically the immersive experience of the real production process that is going on on the mine site and you are interacting with the monitor you are basically monitor all the production process the fleet management system sitting at the head office and that is basically developed by the map tech and the LlamaZOO MineLife all these are monitored in real time the topography of the mindset is visible what are the machines are operating how they are operating what is the current status so they are basically helping a a supervised monitoring from the headquarter for this fleet management system using this technology of VR and AR.

Lecture 32: Augmented Reality Application in Mining

Imagine using virtual reality to monitor the performance of your mining fleet in real-time, from the head office.

Maptek, in collaboration with LlamaZOO

MORE VIDEOS

33:14 / 42:38
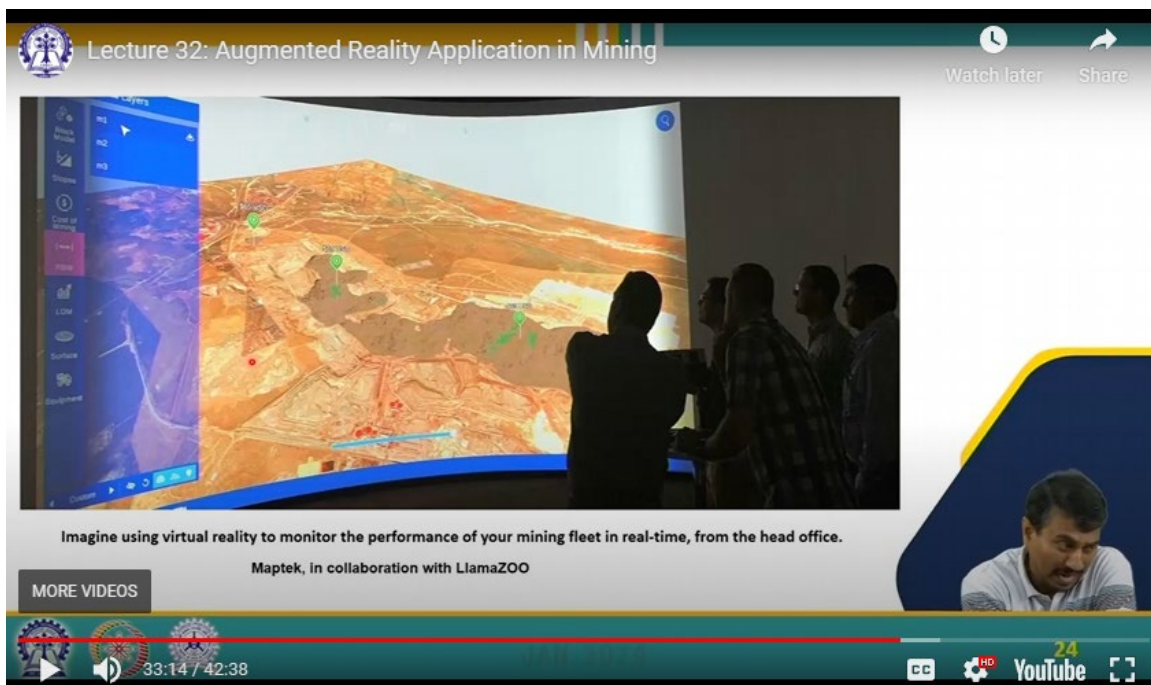
The first quantum mineral company has installed cyber mine five full mission simulator from through tech at its underground mines to training to train mining engineer mining equipment operator simulation booths are replicas of real mining equipment with tool functioning as they would in actual mine transport the simulator enables operator to test and practice skills required in emergencies such as break failure or fire so the two simulator can interact with each other and facilitating teamwork in real production scenarios so this is basically the uh through teach simulator at the underground mines and you are basically operating these machines and you are basically going through the different control process what to do what you should not okay and what are the things you should follow under the cases of emergencies and also you can collaborate with other miners those are operating so these are basically the facilities of this technology.

VR is crucial component of smart mining however they are challenged they are there are challenges associated with integrating this technology into the training of mining engineers. some of these challenge include their high cost and absence of effective methods to assess their effectiveness. Additionally implementing these technologies require prior training for instructor and can be a complex to adapt to varying production condition across different regions.

Experience of using air in the training process of mining engineers. In the mining industry air technology is fast to develop thus contributing to the evolution of training methods and tools for future professionals. when using air digital content is superimposed on the real life production environment and bringing the training process as close to the production conditions as possible. The advantage of the technology is that it is not expensive a smartphone is all that is needed. AR simulators enables preparing future mining engineers to work on the production floor without having to leave for the industrial facilities. AR can be used to create conditions for frontline mining expert to participate in remote consulting for future mining engineers. Developer create an AR platform to simulate unmanned mining in underground mines to simulate unmanned mining in underground mines, revealing good result and stable operation it has been noted that such production has a number of advantage namely high efficiency safety and low cost.

Real wire had developed an ergonomic device like this that feeds under a helmet and does not interfere with the use of goggle in an industrial environment this device help worker to access document instructions drawing etc speed up interaction with other employees and facilitate navigation on the production floor.

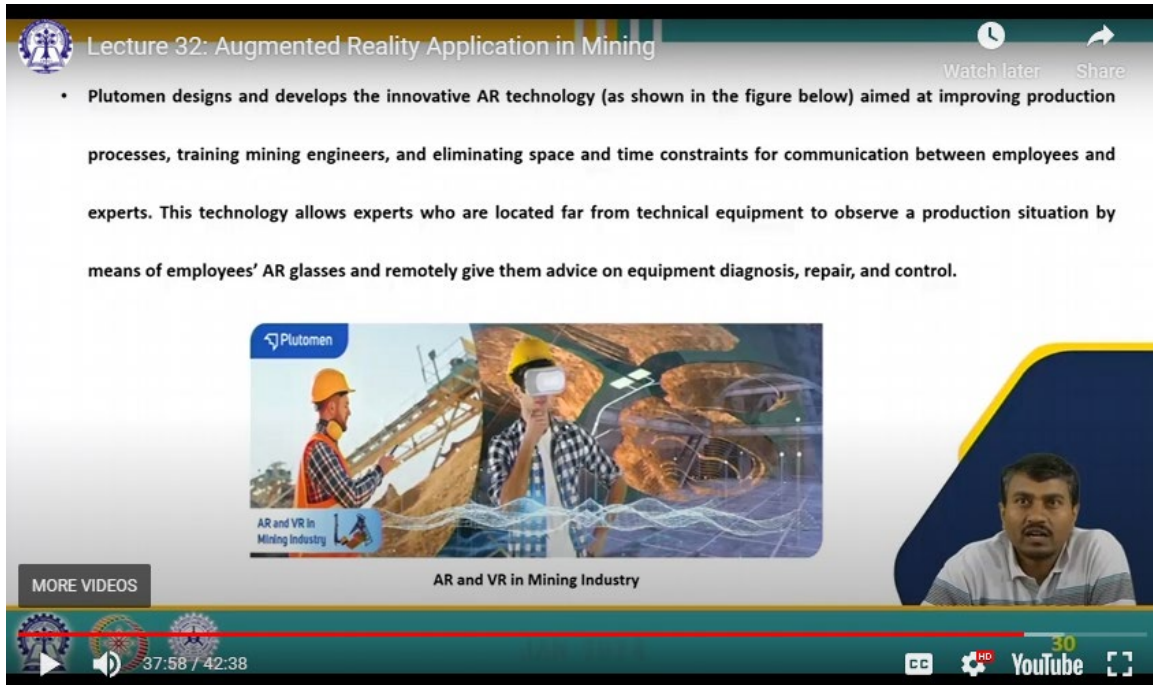- Developer create an AR platform to simulate unmanned mining in underground mines, revealing good results and stable operation. It has been noted that such production has a number of advantages, namely high efficiency, safety and low cost.

- Real Wear has developed an ergonomic device (as shown in figure below) that fits under a helmet and does not interfere with the use of goggles in an industrial environment. The device helps workers to access documents (instructions, drawings, etc.), speeds up interactions with other employees, and facilitates navigation on the production floor.

DAQRI has developed an air headset like this for engineers and the technician particularly for the maintenance so that can be used to repair maintain and inspect industrial equipment while working at the enterprise instructions are displayed on the screen to direct the employee what to do what not to in addition the worker can remotely connect to a mentor or expert to perform the task.

- DAQRI has developed an AR headset (as shown in figure below) for engineers and technicians, that can be used to repair, maintain and inspect industrial equipment. While working at the enterprise, instructions are displayed on the screen to direct the employee. In addition, the worker can remotely connect to a mentor or an expert to perform the task.

The hard AR helmet of DAQRI

Plutomen designed and developed an innovative er technology here this is basically the device aimed at improving production process training mining engineers and eliminating space and time constant for communication between employees and experts these technology allow expert who are located far away from the site from technical equipment to observe a production situation by means of employees AR glass and remotely give them advice on equipment diagnosis repair and control.

VSight developed application based on air technology to provide real-time remote assistance to operator in equipment maintenance and repair drilling as well as in training future specialist

SensPlus Buddy AR tools has developed and it's provided a smartphone communication for remote support of technician at industrial facilities information is exchanged by sending image and text this greatly improved the efficiency of equipment maintenance and reduce the errors.

The TOMRA visual assess assist technology has three types of support telephone email support and real-time monitoring features and remote login to the customer system by TOMRA service engineer.

The use of air technology enhance operational readiness and improve the efficiency of the mining engineers training further research is now necessary to explore the innovative application of virtual and augmented reality-based mining uh learning things AR-based

training effectively immerse future mining engineers in a production environment allowing them to perform tasks on simulator and receive guidance forms remote experts practice-oriented training plays a significant role in shaping the professional competencies required for working in the production environments.

Method of using AR/VR technology in training mining engineers. Multiple methods are there first is the video of the digital training materials. what we want to simulate for example we want to simulate the operations of the bucket wheel excavator so we need a good amount of feed of the video graph or the video material how the bucket wheel excavator operates how different part of the bucket wheel excavator establish control over the process how it interact with other uh vehicle in the mining industry or the mining process so a good amount of video is required for developing the VR AR technology then these various AR applications can be used to visualize the training materials that to be superimposed on the virtual simulations then using the selected application you can create a QR code based project so that whoever scan it they can get the materials so anything we want to simulate we need a good amount of videographic information then we need a simulation based software materials to simulate those situations then under an artificial conditions you have to define the parameters and dimension of those kind of environment and under that you have to simulate the QR code is added to the instruction for a laboratory work on mining with a link for training so this is an one example of SAP boring machine operates and this is the example that you have the QR code so this QR code is available so anyone have the QR code scanner scan it they can go through the material the training that is developed in this module so this is the this is the product that is been developed nowadays so uh that is basically the one of the advantage that this AR technology offers us we do not require a sophisticated tools or a device for going through this training process.

These are the references.

So let me summarize in few sentences what we have covered we have explored the development and implementation of VR and AR technologies specifically tailored for training purposes in the mining industry and we have analyzed the first-hand experience and feedback from mining engineers who have undergone training using VR and AR technology highlighting its effectiveness benefits and challenges

Thank you!