Mine Automation and Data Analytics

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IIT (ISM) Dhanbad

Week-7

Lecture-31

Introduction to Augmented Reality (AR)

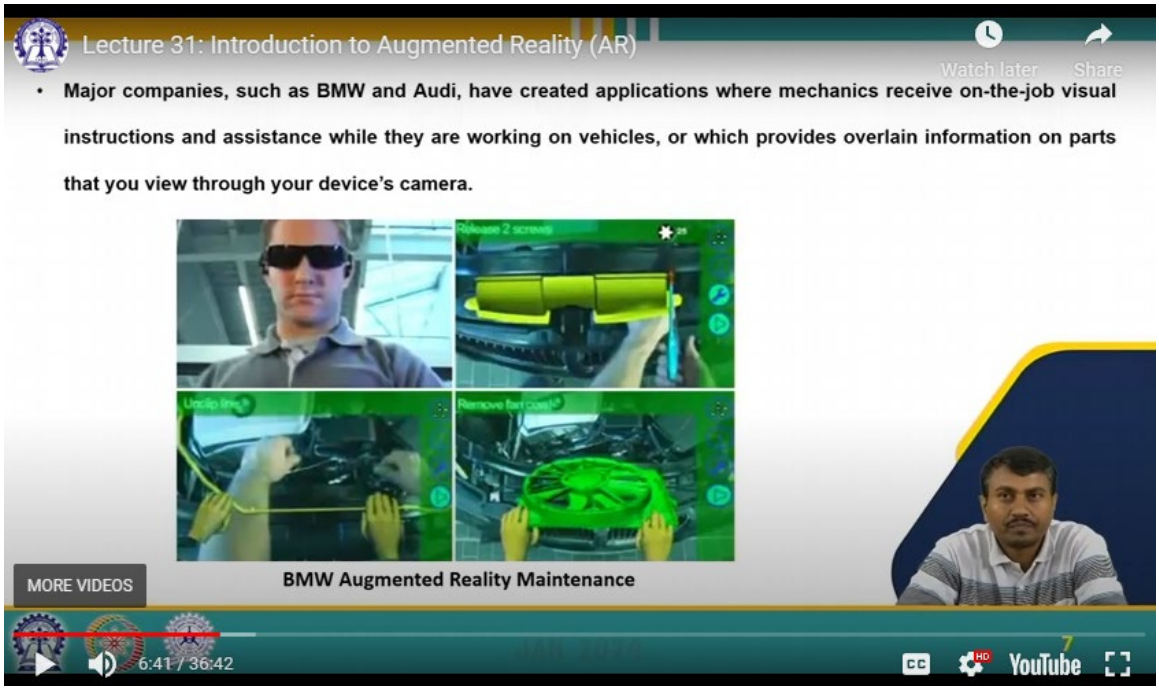
Welcome back to my course mine, automation and data analytics. Today in this lesson we will discuss a new concept that is augmented reality. We have seen in the last two lectures the virtual reality simulator virtual reality system for mining industry and other industry and now we are going to jump into the AR system and there are many applications of AR in the mining industry. So in today's lesson principally we will discuss the theoretical background and different features of the air system with very few use cases in the mining industry.

So in this lesson we will cover the following: introduction to augmented reality or in abbreviation AR then we will briefly compare the different features of AR with the VR and the mixed reality and finally the extended reality XR and different types of AR systems and how augmented reality works, AR use cases, application of AR in the mining industry and finally in this lesson today we will discuss the AR weakness, strength, opportunities and threats.

So what is AR? Augmented reality. The term augmented reality refers to the augmentation or enhancement of the perceived reality of user of this technology. So this is accomplished by influencing the senses of the user through various sensory inputs such as audio inputs, visual inputs or even smell or touch sense simulations and although AR is a sensory based technology that through its core definition utilize any or all of the human senses to augment your perceived reality. It is predominantly only known as a visual technology because many visual information are seen on the screen. So this is due to the visual object having found the most applications in wide variety of applications and environment. For the visual effect and for visual aspect elements such as any object or environment viewed in the real world are augmented supplemented by computer generated sensory input including video, graphical display, sound or global positioning data. The most appropriate description of AR can then be given as a technology which overlays a virtual computer generated element into real-world view of the user. So this virtual element can be in the form of an image, 2D drawing or 3D object or a hologram. The composite view that is then created can be called

the augmented reality space. So within this space the user is often able to interact with and manipulate the virtual elements to achieve a certain goal.

Major companies such as BMW and Audi have created applications where mechanics receive on the job visual instructions and assistance while they are working on vehicle or which provides overland information on parts that they view through their device camera. So here when a user is, a mechanic is basically wearing their device he or she is getting substantial useful information about that part, what to do next, what to proceed which way, which are the sector he or she must look into. So this is a assistance, augmentation, a real assistance to the user and mechanics and that helps. And there are also some camera is fitted here in the system. So there are some other experts are sitting, they are also observing how the mechanics is performing or time to time if it is required through that communication system they will send a specific command information that you must do that, you have already done that so there are other possibilities so you must do that.



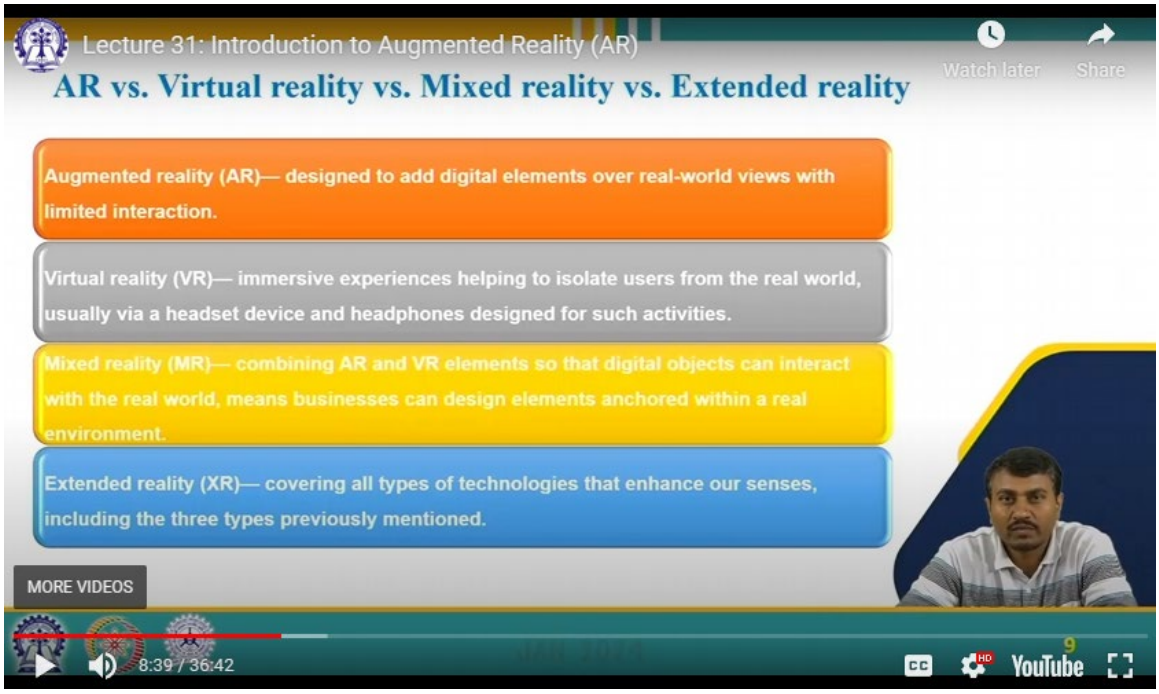
So this is basically video feed is also included and that is attached with the AR system. So whatever the mechanics is doing that is also recorded and transmitted to the supervisor.

The aviation industry has been at the forefront of adoption of AR. Some applications allow pilot to see hidden informations that are fundamental to their decision making process. So in that sense it is a problem. So we will discuss that later part at the end of this particular lecture.

Now let us see the complete picture what these four reality system is all about and their scope. So we have seen the virtual reality. So let us compare with AR the mixed reality

then finally the extended reality that is XR. So AR that is augmented reality designed to add digital elements over real world views with limited introduction.

Virtual reality immersive experience helping to isolate user from the real world usually via headset display and device headphones designed for such activities. The mixed reality it combines the AR and AR elements so that digital objects can interact with the real world means business can design elements anchored within a real environment. Extended reality covering all types of technology that enhance our senses including the three types that is AR, GR and MR. So XR is basically taken about all this technology to better give a stimulus and sense to the user.

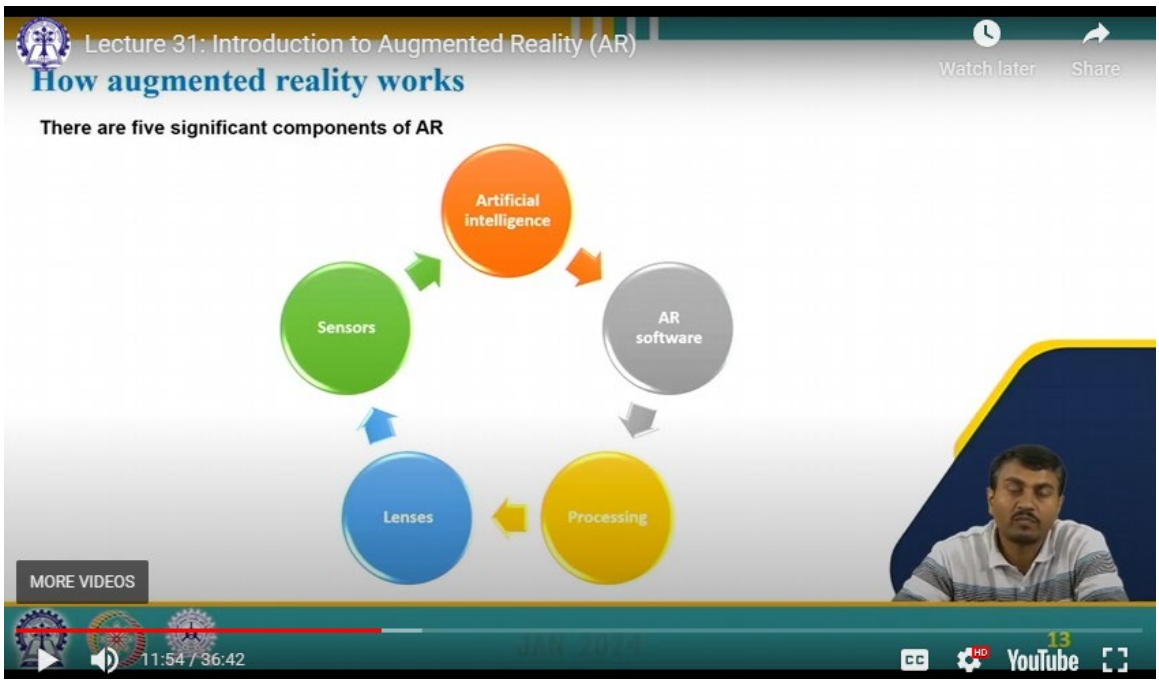


Types of augmented reality. One is the marker based AR another is marker less AR. So what is marker based AR? Marker based that augmented reality utilizes image recognition to identify pre-program object within the AR device or applications. Object placed in view serve as point of reference adding AR device in determining the position and orientation of the camera. So this process typically involves switching the camera to grayscale mode and detecting markers which is then compared with those stored in the device database. When a match is found the device utilizes this data to mathematically calculate the pose and accurately place the AR image in the designed and designated position.

Marker less AR. Marker less augmented reality is more intricate compared to marker based AR because there are no predefined points for the device to focus on. Instead, marker less AR relies on recognition algorithms to identify items as they appear within the device's field of view. The device analyzes colors patterns and other features to determine the identity of objects in view. By utilizing time accelerometer GPS and compass information

the device orientates itself and employ the camera to overlay digital image onto the real-world environment based on the identified objects.

How augmented reality works. So there are five significant components of AR. One is the artificial intelligence. AR use significant amount of AI. Then it has software components simulation purposes AR software. Then processing computational facilities to simulate different conditions changing dynamic conditions. Then lenses to give an overview of the real world and the sensors to get more and more information about the real world and then feed to the system so that a real much helpful information is being retrieved and that is basically help to the trainer and users who is basically using the system.



Artificial intelligence. Most augmented reality solutions need artificial intelligence to work. Allowing user to complete action using voice prompts. AI can also help process information for your AR application.

AR software. These are tools and applications used to access AR and some business can create their own form of AR software based on the necessity and customization required in the industry.

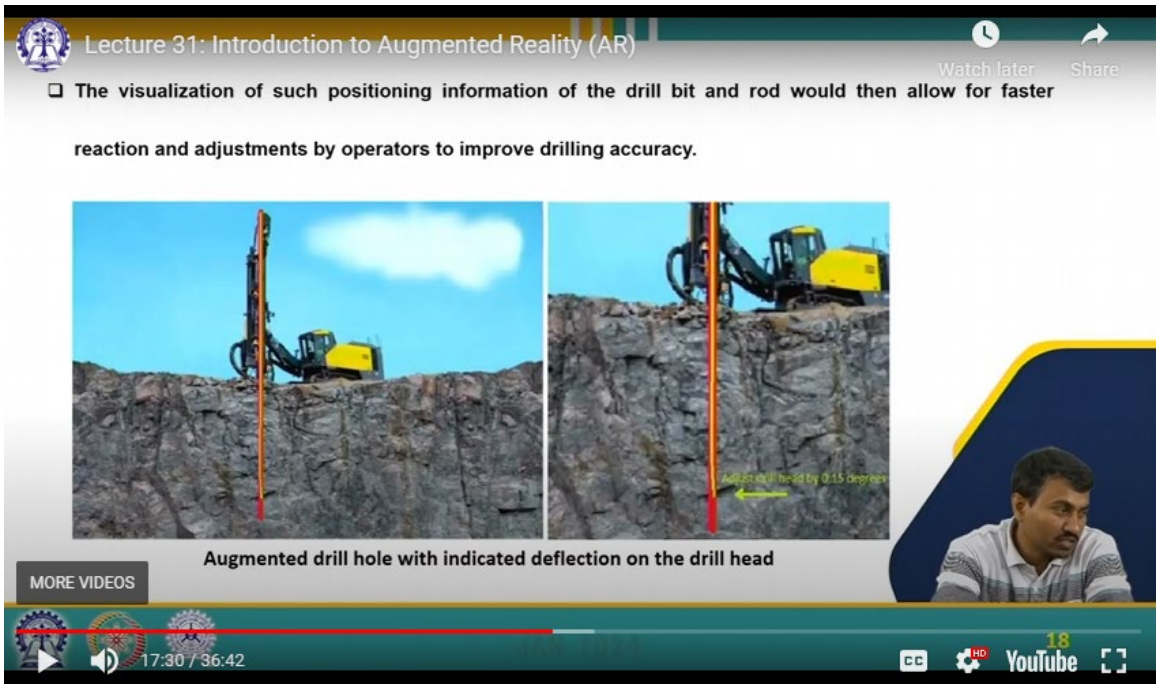
Processing. You will need processing power for your AR technology to work and generally by leveraging your device's internal operating system.

Lenses. You will need a lens or image platform to view your content or images. The better quality your screen is more realistic your image will appear.

Sensors. Your system needs to digest data about their environment to align the real and digital worlds. When your camera captures information it sends it through software for processing.

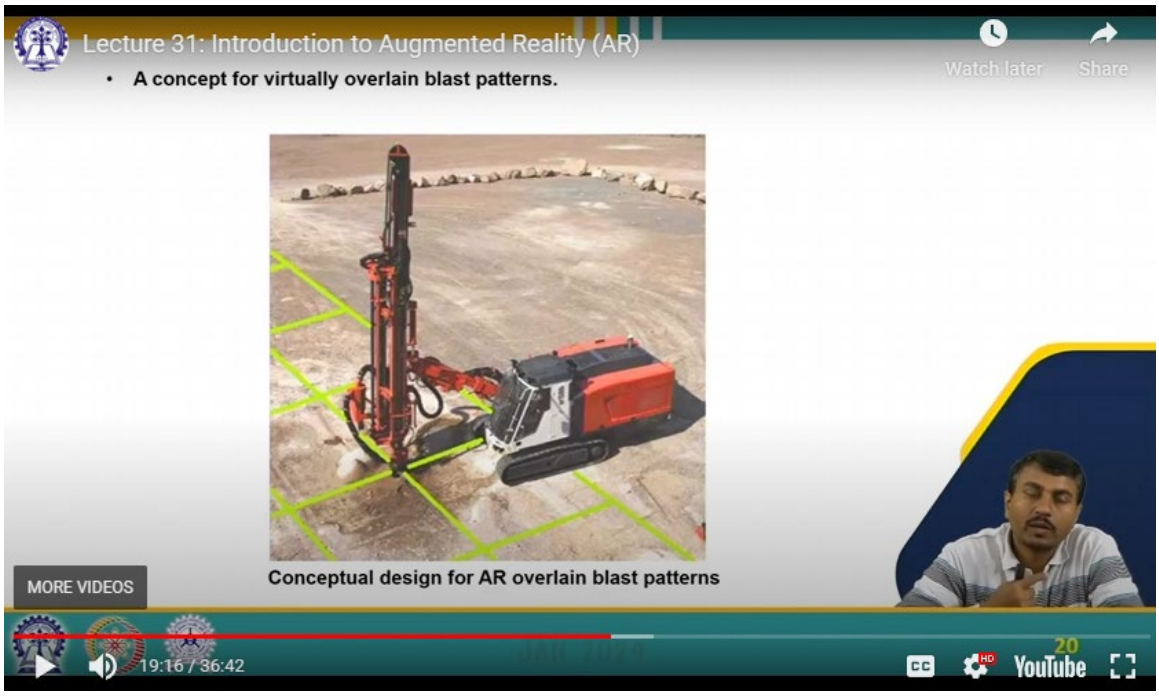
AR can be used in the following ways. Retail business. You scan that product. You see what is the price. What is the rating. So it is basically available to the customer. So that will help customer to quickly choose which product to take and which not based on his particular preference. Entertainment and gaming. There is a huge industry particularly in the video game. Many industries are basically focused on this and there is a good market because interactiveness, different kind of data about the real world and the virtual world. It mixed with so user can feel in a better way in this kind of system. Navigation. So you walk through the road you will get precise information about that particular area. For example in this kind of sector which way to go, which way not to and which are basically important and basically different information that is required when you are basically going through that particular path. Those are basically integrated. So in those kind of industry there is a good amount of use of the technology. Archaeology. Huge usage and basically for the simulations understanding the structures also archaeology is basically using the air. Tools and measurement. Different marking technology you can use it. This is the length. So using the image data you can easily measure. This is the basically the dimension of that particular object. Interactiveness and ease of use. Architecture also. Different building planning, architectural, how the things will be in real conditions. So user, the customer will go through and get the information. If he or she likes it then he will go for the purchase. So in that way it helps the industry to grow and reach in a better way to the potential customer. Military drill operations, training operations and maintenance purposes, air have a good potential.

Application of air in the mining industry. Drilling application. So when applying air to assist with drilling practices through visual guidance on the usage of the drilling equipment or machines, the accuracy and efficiency of drilling could be enhanced. So this application could further be expanded to display the real-time location and orientation of the drill bit below the surface and within the rock face as measured through various tracking technologies such as low frequency, electromagnetic location transmitting system usage used in the oil and gas industry. The visualization of such positioning information of the drill bit rod would then allow for faster reaction and adjustment by operator to improve drilling accuracy. So here basically the augmented reality helps the user to interact to know what is the position of the drill or what is the corrections required in the orientation or not. So, these augmented drill hole with the integrated deflection on the drill heads is basically displayed.



So based on that operator know how much amount of deflection is there and what is the required so that correction can be taken and it goes further to the origin state. When coupled with drilling technology from directional drilling that allows control over the drill head while drilling a hole, the drill head could potentially be steered in real time in order to improve drilling accuracy to nearly 100% that is the need. Improving drilling accuracy lead to measure down the line benefits for production as well as blasting practices and has a corresponding impact on loading and hauling efficiency. So air could also be applied when creating the blast pattern okay which side to take what is the burden to spacing ratio exact location in the rock or plane like that. The pattern along with the intended burden and spacing measurement could be displayed virtually which would eliminate time required for marking of holes.

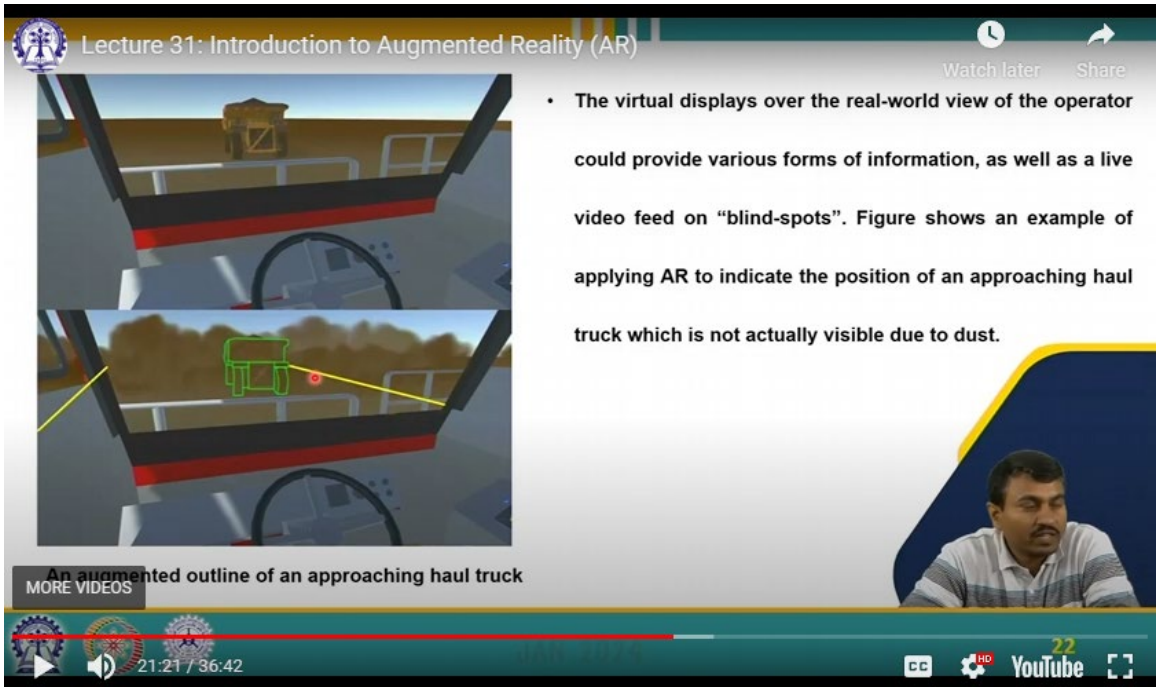
So in the image itself measurement is done as in the measurement industry we have seen that application of air. So that basically save a good amount of time to marking the hole in the mine site. So this is basically virtually the measurement is done with a fixed burden and spacing. So exactly at the cross point drill machine is pointed on the point so that we can achieve a very good efficiency of the drilling operation as well as we can go with the plan what is being planned according to the in the field site.



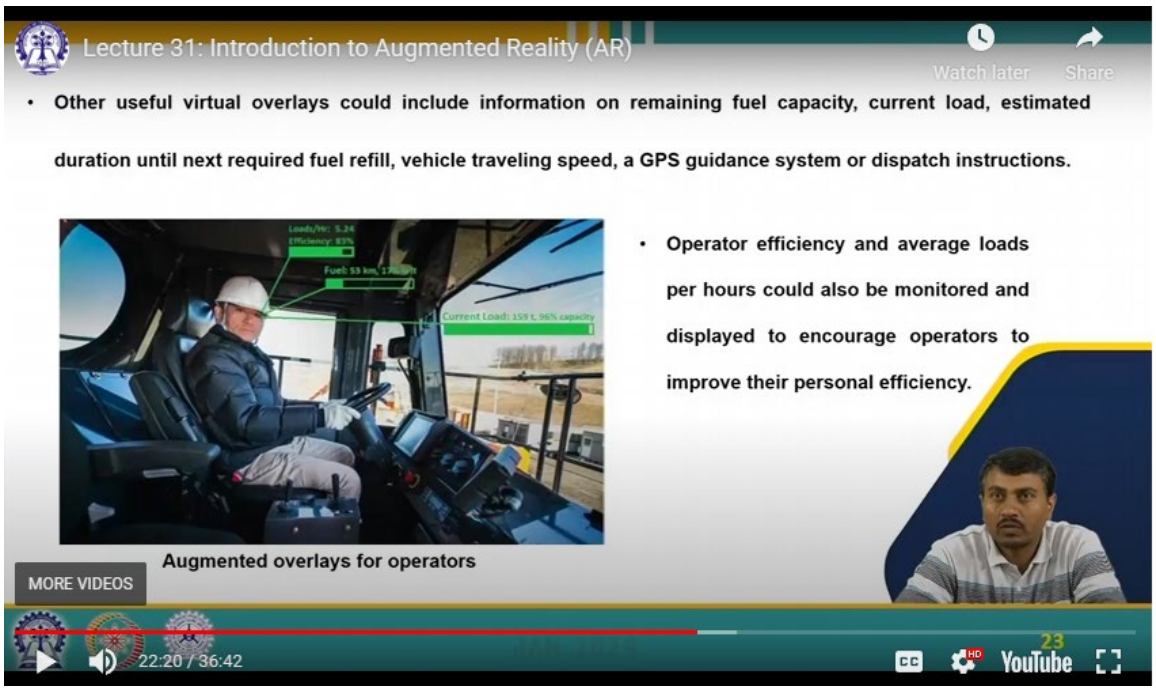
Navigational aid and operator assistance. Surface mining operations with poor visibility due to high amount of dust or rain could greatly benefit from air visuals for safety purpose. This is very important. Many times when some big machines are moving they do not see what is in front of it. So this kind of system will help and assist some vehicle is in front of you 15 meters 20 meters or some vehicle is running in behind so you maintain that speed. So this kind of information sometimes helps the operator to safely maneuver the machines and by that we are averting the accidents and it helps greatly to run the system smoothly.

An air applications could be developed that allows operator to see hazardous scenarios and object such as the road boundaries and this is also very essential. Sometimes due to the dust you cannot see the road boundary so it basically give you a lot here this is the road boundary and some vehicle is approaching the distance to reverse the dumping site or the crusher.

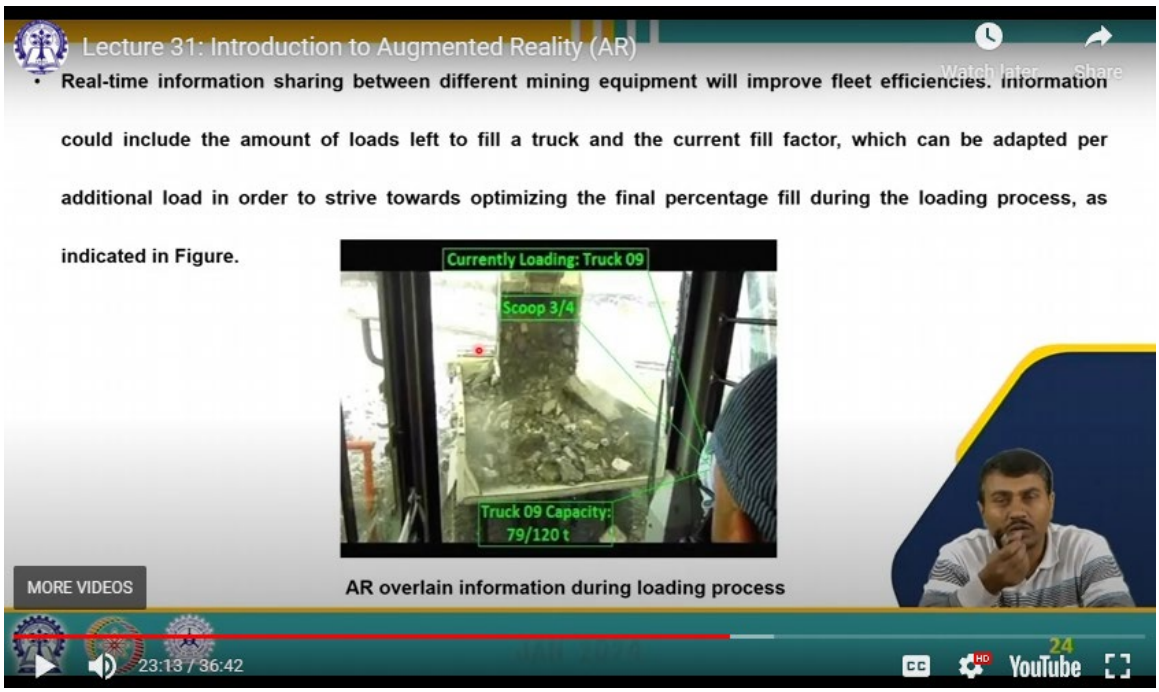
So this is basically the image, an augmented reality outline. So here on the screen it appears that here some vehicle is approaching so it will alert the operator that here some vehicle is coming. So based on that the speed and the direction will be adjusted so that obstacle or collision will be avoided. So the virtual display over the real world view of the operator could provide various forms of informations as well as a live video feed on blind spot and this figure shows an example applying the air to indicate the position of an approaching haul truck which is not actually visible due to the dust.



So other useful virtual display and overlay could include information on remaining fuel capacity, current load, estimated duration until next required of fuel refill, vehicle traveling speed, a GPS guidance system or dispatch instructions. So here if you click you can see all this information at one go so that it will help the user and the operator to understand how much lag this particular dumper is running so that it can speed up to meet the desired target in the next sessions. Operator efficiency and average loads per hour could also be monitored and displayed to encourage operator to improve their personal efficiency.

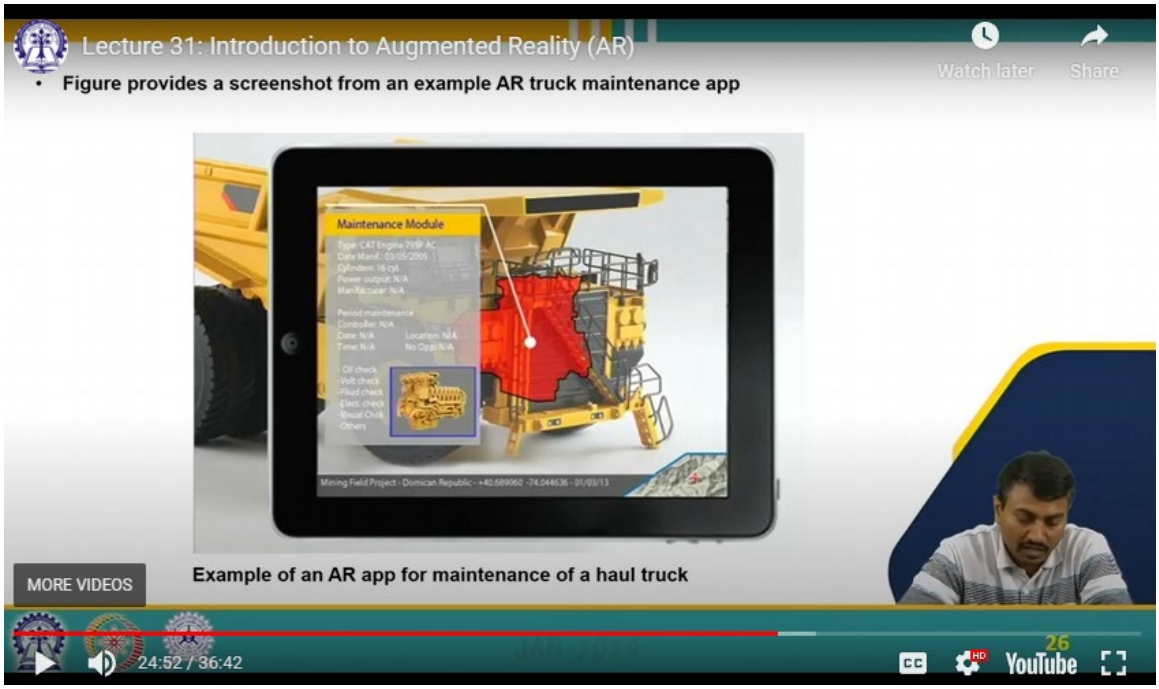


Real-time information sharing between different mining equipment will improve fleet efficiencies. Information could include the amount of load left to fill a truck and the current fill factor which can be adapted per additional load in order to strive towards optimizing the final percentage fill during the loading process as indicated here. So during this process you can see the truck 9 capacity is 79, 79 is basically taking and 120 is the capacity and currently loading truck is 9 numbers so based on that these information will be helpful to the operator to expedite the process and enhancing the efficiency in these operations.



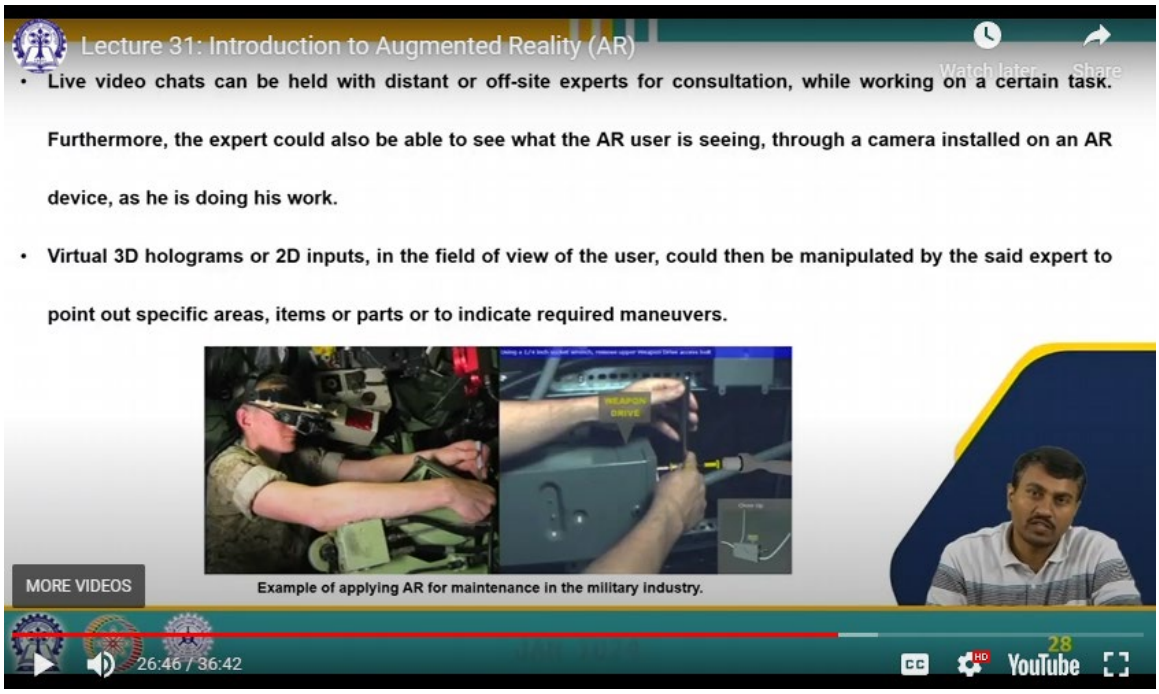
Maintenance and repair. General maintenance and repair task on equipment, machinery and entire system example conveyor belt, entire hoisting system, pipeline etc. can be conducted with greater efficiency through the utilization of air system.

Essential information can be recalled at the working site in real-time displayed by using an air device. This could be done by this could include information on various parts and devices as well as where they are stored or instruction on how to remove or replace them. Other equipment or machinery information could also be displayed such as current air or pneumatic pressure fluid levels or the required torque to fasten or lose an app. So here this is an app so this particular focus on a particular portion of the machine what are the component is there on that particular machine here. This particular app is showing so based on that you will have a good amount of information and data what are the sparsies, what are the conditions, how much duration the checkup is required whether it is done or not so everything is visible. So this basically helps the works of engineer to get through a full-scale checking of the health of this machine so this is basically an app-based system.



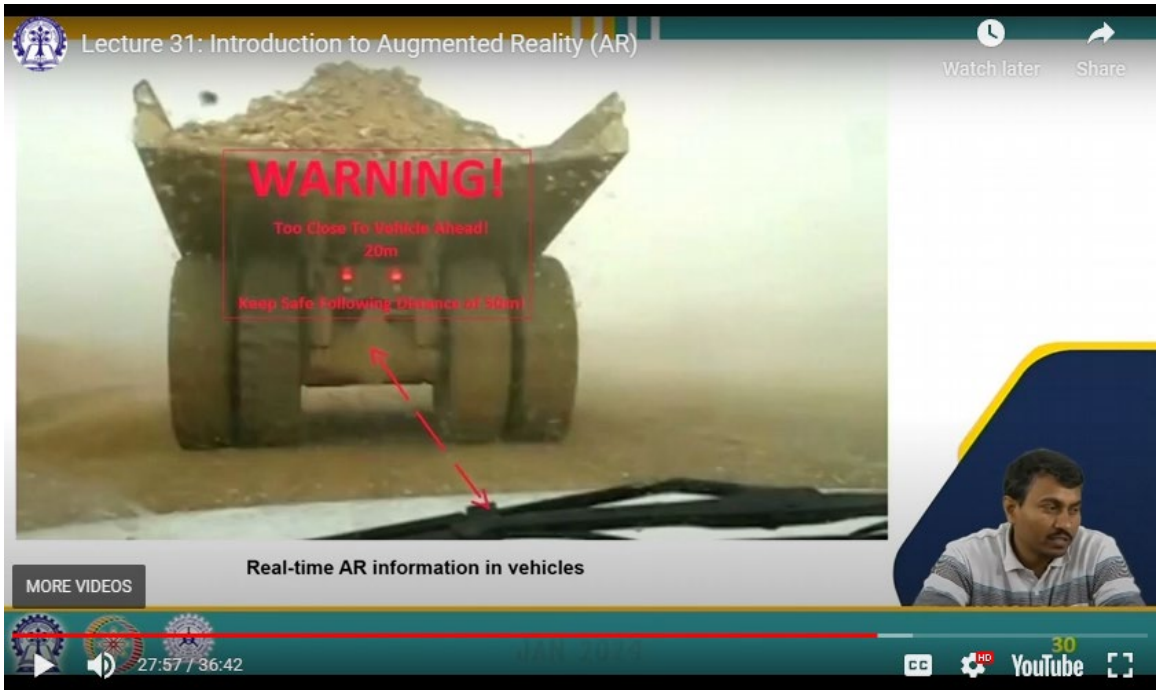
So such an AR application could go further to provide real-time guidance and assistance with step-by-step instruction on how to complete a specified task. Along with the ability to recall virtual equipment manuals or any information required to perform the work such as application could bolster task efficiencies. So here you can see there is an instruction that unscrew and remove so this basically helps the maintenance engineer to complete the task easily, successfully and basically technically guide the operator and mechanics to do the task successfully. It is a supervised kind of help so live video chat can be held with distance or off-site expert for consultation if required while working on a certain task.

Furthermore the expert could also be able to see what AR user is seeing through a camera installed on an AR device as he is doing his work. So it is basically communicating what AR user is seeing so the expert can see. So based on that he or she can direct as you do that next you do that next like that. Virtual 3D hologram or 2D inputs in the field of view of the user could then be manipulated by the said expert to point out specific areas, items or parts or to indicate required maneuvers. So this way the maintenance people will be helped through the expert through the communication technology and to guide to do a difficult task and to complete a difficult task without the presence of the expert.

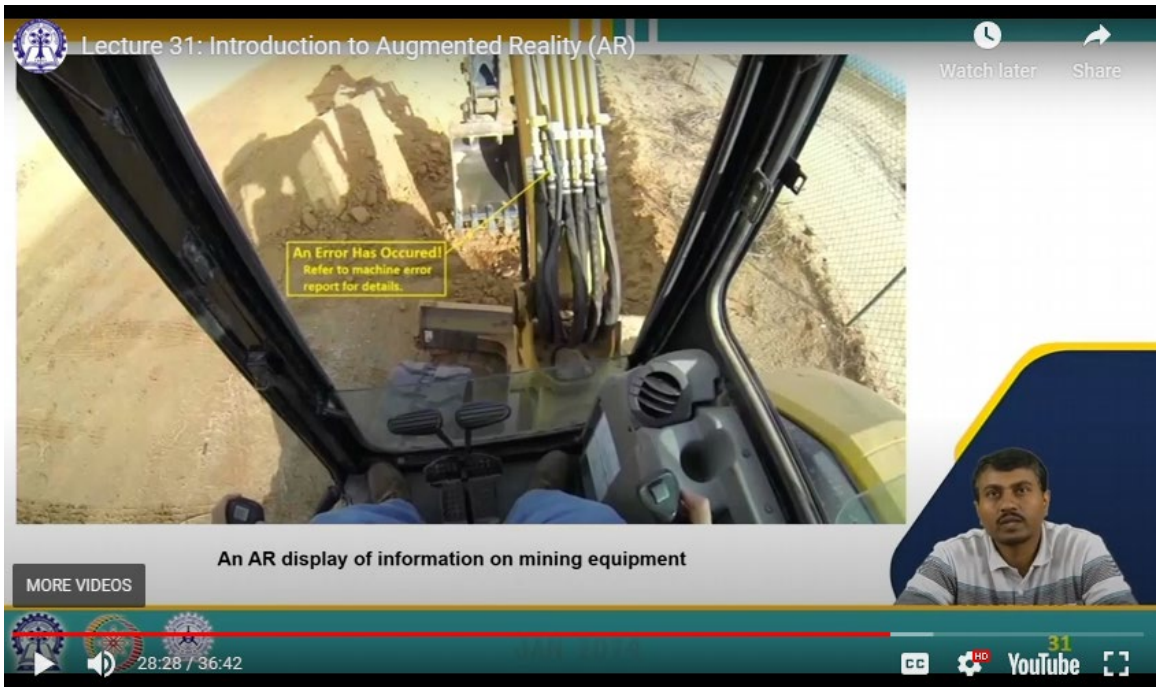


Provision of real-time information. AR could provide helpful and potentially life-saving information. An AR system could be combined with proximity detection technologies to detect dangerous equipment and warn personnel to maintain safe following distance. Another potential application is to combine AR with other software systems to form a new integrated technological system.

An example of this would be where AR based system detects an operational error on a piece of equipment then provides the user with step-by-step guidance on how to troubleshoot or to solve the problem. So this is the warning that it is basically giving the warning to the vehicle that yeah you are too close to the vehicle basically 20 meter so keep a safe distance to avoid the collision and to avoid accident.



So in this way this particular interactive technology and softwares and instruction helps to maintain safety in the mine site. Another display that this basically shows that there are some amount of error occurred in the machines so please do repair that particular thing so that it can do the required amount of action after these basically error is basically removed or the required maintenance is done then the machine will function properly.



Information could also be embedded in individual clock cards or other employed identification system. Higher ranking employees could view this information when looking at an individual in order to determine his or her name, qualification, section of work, medical history, time clock in for work etc. So this information can be retrieved could be dependent on hierarchical difference between the personal job levels. Similarly the historical location data on an employee could be retrieved and retraced for security and efficiency monitoring purposes.

Air application strength. There are many strength one of them is fewer mishaps during task so this is basically one of the advantage.

Faster task completion as the maintenance you have seen that it basically guides what to do next so it smoothly guide the mechanics to do the job successfully and quickly.

Enhanced communication and collaboration over distance. Supervisor is not sitting in real time in the site maybe guide the mechanics from a distance place through this communication medium and he or she will basically detect what are the action required and by that successfully the action can be done smoothly over the system.

Real-time access to information at workplace these are basically visual and displayed so that helps to create a better working ambience and confidence that yes the working going on in tandem and according to the target line.

Integration with various system and technology that facilitate and that helps to integrate all these machines and operations together so that it can communicate between different locations and machines and operators.

Increased task efficiency definitely by these add and augmentation it basically helps to reach the and enhance the efficiency.

Reduce the operating cost because running cost is reduced basically time to time maintenance is a big problem so that guidance is given so it can be done quickly and over a time if it is been analyzed then it can be seen well that runtime or running cost is basically reduced.

Air application weakness. Color blindness factors so those are having the color blindness they have a problem to adapt in this particular system because of the real reason.

Job loss another threat or you can say it is a weakness that yes potentially some of the job will be reduced where in other cases we can see number of job is created for the expert people.

Dependent on other technological system yeah because you are dependent on devices knowledge information source or patent yeah patent is a threat and you have to abide that

patent and if it is required you have to buy that so substantial amount of cost may increase in that case.

Moderately high cost when various technology need to be acquired and combined that is including the patent and new technology and new devices.

Internet or local server is required and it is must for this kind of system and good connection speed is also required.

Additional hardware and software requirement for the site specific cases, customization of the cases it is required and that basically also increase the cost and that is also one of the weakness of this particular system.

Limited visual space in human field of view because it is already in the air system and that view so there is a limited visual space for the human operator or human field of vision.

Air application opportunities, higher task efficiency one of the good advantage of this that you are basically achieving higher task efficiency through this all aided technology and augmentation.

Higher brain functionality you are simultaneously doing multiple jobs and guiding, interacting, knowing so that basically increase the brain functionality and means attachment to the work, increase safety to zero harm because different alerts is there, different information is shown. So, that basically sensitize and basically build awareness with the users to avoid the accidents and hazards so that makes and ensure that you are achieving zero hazard.

The air application threat, it is a new concept so sometimes you might not be able to adapt to that kind of system so that might be a threat. New unknown territory you might enter into an unknown territory that is not your business and that might not be good. Mental health concern is a big concern because a time of engagement on a restricted field of view in the visual space may create a mental fatigue and mental issue with the attachment because prolong your attached to that system so that basically disintegrate you from the real world so that make a real problem with the health of the operator of the system. Navigational hazards because sometimes because you are basically on the virtual environment or in this kind of environment so some alert is been given, some speed limit is been given. So, basically you are basically above you are adapted to that and you are basically having some amount of fatigue because you are engaged in the system you basically avoid so some collision may takes place because of that. So, these have some issues, too much reliance on technology you are basically relying on all technology possible to get all possible kind of information so that somewhere there is a gap. Privacy issue some of the private information about your data that what you are seeing so that is

been retrieved so that is with the higher authority so that might be a privacy issue for the operator as well.

These are the references.

so let me summarize in few sentences. So, we have provide an overview of augmented reality technology which overlay digital information on to the real world environment. We have compared and distinguished between the various immersive technologies including AR, VR, AMR and extended reality XR. We have explore different classification or categories of AR based on usage and implementation. We have introduced the underlying principle and mechanism behind the AR technology. We have discussed various practical application and scenarios where AR technology can be utilized across different industry and domains. We have explored specific example and use cases demonstrating the application of AR technology within the mining industry for tasks such as exploration, training, maintenance and safety protocols.

Thank you!