Mine Automation and Data Analytics

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Week-4

Lecture-18

RFID in Mining Engineering

Welcome back to my course, Mine Automation and Data Analytics. Today, in this lesson, we will discuss on the RFID system that is used in mine automation for establishing control and also monitoring some part of the mining operations. Basically, it is a control technology.

So, in this lesson, we will cover the following. So, we'll cover the following in this lesson. Introduction to RFID technology and how the RFID system works. How smart knowledge works using the RFID system. RFID basics, its working principle, and the main benefits of RFID. Why RFID in the mining industry? RFID application in mining industry. RFID in mine use cases and case study on RFID.

So, RFID basically relies on the wireless technology on the radio frequency spectrum. It use the radio waves to identify and track objects by placing an RFID tag or transponder on them or maybe on the vehicle or particular equipment like that. So, the tag contains a microchip and an antenna that transmit a unique identifier to a reader device when prompted by the readers radio signal. So, this technology allow a non-contact method and also not necessarily in the line of sight and tracking of items by this technology is achieved, and it is very much beneficial for different business applications and, more particularly in mining also. Particularly in the factory level operations and some cases in underground mines we are very much used this technology and for different supply chain involvement, different retail environment, logistic and asset management also this technology are very much in used.

So, combining the RFID with the recent development of Internet of Things, IoT solutions allow for gathering and analyzing massive amounts of information to optimize and improve business processes and reach to a better decision-making process in the overall process. How does these RFID system works? When an RFID reader is activated, it basically transmit a radio frequency signal through the antenna, which then broadcast the signal to the surrounding area, and if an RFID tag is within that particular area or zone, the radio frequency energy emitted by the reader that signal will be absorbed by the tag antenna which powers of the microchip on the tag and the microchip after absorbing the energy it use the energy to transmit the data stored on that particular tag back to the reader and each tag responds with a unique number. So, the data transmission from one tag to the reader is a one-way communication, so here we do not have two-way communication. So, the reader receives the data from the tag and decode it, and typically, using a microprocessor, the data from the tag is process and sent to the host system, which can be a computer or, a mobile device or another type of system. So there are basically two types of RFID tags that is basically is used in different industrial applications one is the passive another is the active.

The passive tag does not have its own power source, and it relies on the energy transmitted by the reader to activate it and transmit its data, so it does not have a source of energy. It basically works on the energy transmitted by the reader and that energy absorbed by the tag and based on that it basically activate its and then transmit the data. The active tag has its own power source, typically a battery, and it can transmit data continuously even when it is not in close proximity to the reader. So, this is a schematic diagram of the RFID system for the underground and the surface mining machineries used with the RFID system for establishing control over the system for monitoring the haulage movement, for monitoring the dump truck movement, their status, and so on and so forth.
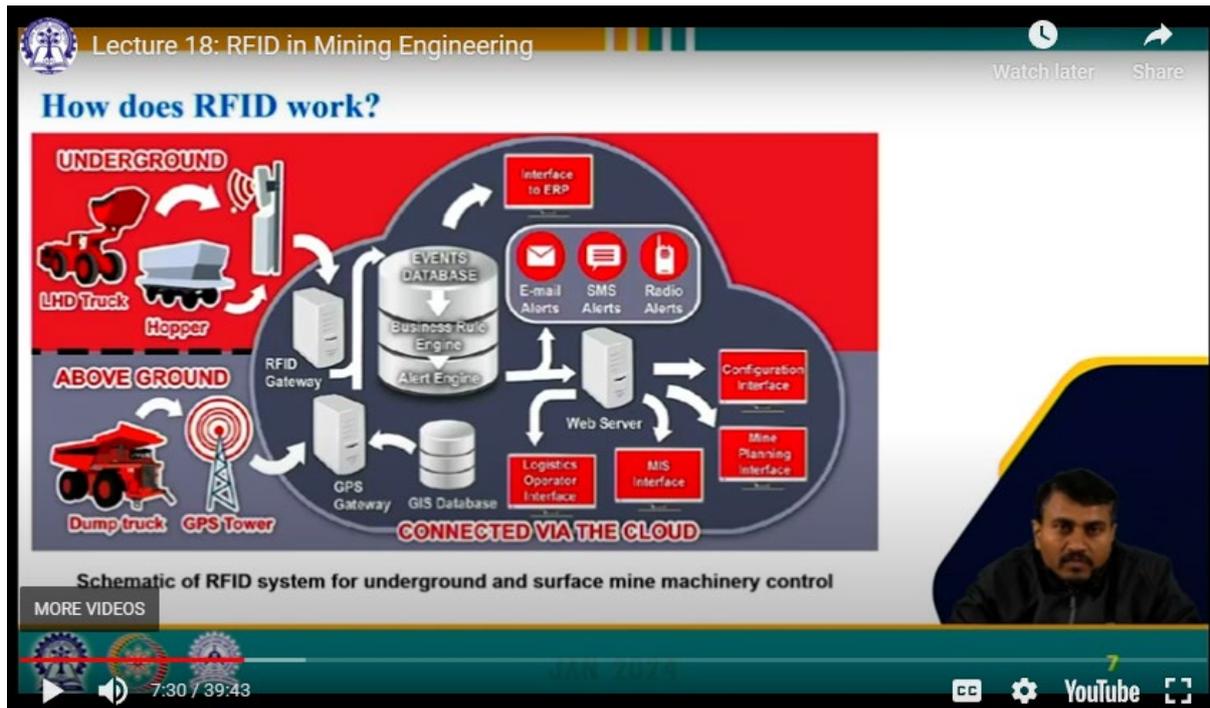
So, this is basically in the underground there is a station that station basically the reader okay and this reader basically broadcasts signal it basically emits the radio frequency so basically that frequency and the radio signal when the equipment come in close proximity that receive that and then it basically send back the information and about the status of the LHD about the status of the hoppers and then that data is continuously in the in the server there is a RFID gateway server for the open pit mines dump truck data GPS tower data there is a GPS gateway and there is also GIS database so in the RFID gateway data you have the business rule engine it basically checks the status and there is a defined business rule for each and every application for each and every mine and there are different event database as well so that basically connect to the interface of the IRP and there is an alert system as well that alert system may be through the email or the SMS or through the radio alerts okay and these basically connected with the web server and that have a module of the MIS interface it has the interface of the mine planner interface it has a configuration interface as well and there are there are also logistic operator interface as well so this is a connected system that system basically use the RFID system for getting the data getting the status of different equipment in the mine site operating in the mine site so this is how the whole database flow is there in an RFID system so the hopper and LHD truck and the dump truck are tagged with rugged RFID tags so we have to understand that mine environments are a very difficult environment so we should use the drug RFID tag that

can work for a good time good period of time efficiently and because there was a possibility of dust there was a possibility of humidity in the in the in the mine here so we should use those specific RFID tag that is very much robust and rugged. The fixed RFID reader are installed at different key points in the mine site the movements of the haulage equipment is detected by the RFID reader and the GPS is used to measure the productivity of each vehicle on a second by second basis this data is sent to the event database this is for the open grid mines so the smart haulage will then compare the event data with the rule established that is business rule engine so this business rule are initially configured for each mining areas or each mining sector as it is specific to the layout of each mine and its operation so the following exception can be a set to trigger alert an alarm route not allowed minimum or maximum travel time between the points minimum and maximum waiting time power point minimum maximum number of visits for shift power point etc so this is a schematic diagram RFID reader are installed at different critical sites of a mine and that basically basically monitor the work of different haulage system and different wagons then their loaders and these basically connected in the way so through the computer or different Android device or mobile device those who have the access to these particular system have the password and ID they can get the status report or in real time the status of different operations using this particular system.
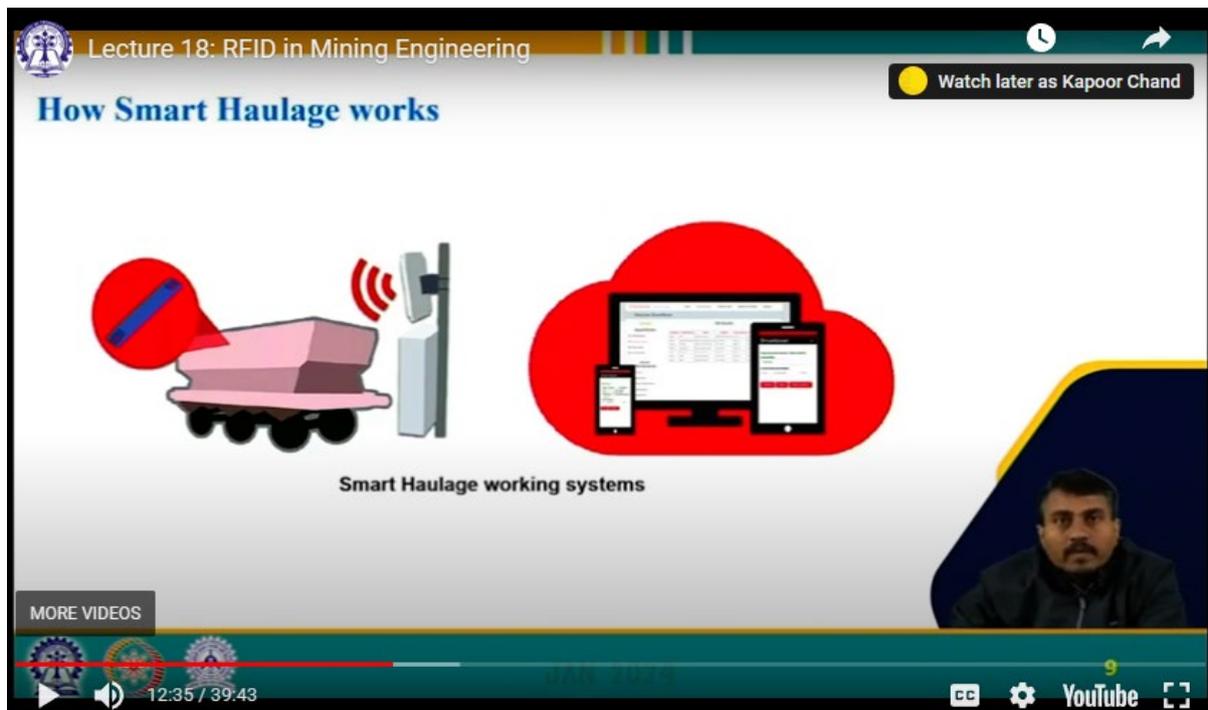

So, when a vehicle movement exceed the parameter set by the business rule, alarms are generated on the screen of the logistic operator interface and can also be sent via email, SMS or radio. The control center then contract the driver and advice the most appropriate action. The MIS interface allow for comprehensive reporting per vehicle perceived with data such as runoff mine tonnage moved, ROM tonnage output and ROM cycle completed, the percentage of the process uptime percentage of process downtime schedule percentage of process downtime on schedule percentage of equipment, and downtime schedule and many more all data captured and produced by the system will be synchronized and uploaded to the cloud in real-time and where authorised employees those who have the password and ID can log in to their smart haulage account to any time to access it and to monitor it.

RFID is basic, so this is basically the RFID reader that basically meets the radio frequency electromagnetic spectrum, and this particular spectrum interacts with the object, and based on that interaction, this object tag is activated, and it's returned the pulse or it basically send a unique number and based on that RFID reader reached a particular decision about the status of this particular object so this is basically the function of the RFID system.
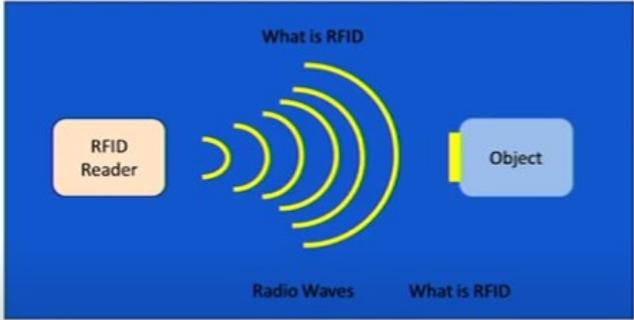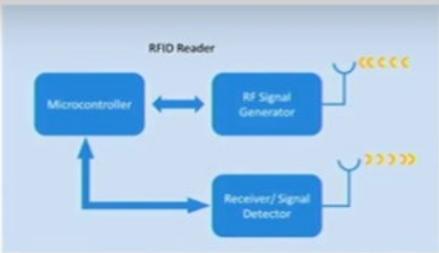

So, there are two component: RFID reader and RFID tag and. Tag are three types: active tag, passive tag, and semi passive tag. So active tab has a power source, passive tag do not have a power source, and semi passive is a combination of these two, so this is basically the module level diagram of the RFID reader

It has a RFID radio frequency signal generator antenna and that basically emits the signal and broadcast it also have the receiver signal detector also have the antenna that basically receive and it both are connected with the microcontroller okay so microcontroller controls the function of these generator as well as the receiver and this is basically the internal part of this RFID reader so here the LR100 is a model it is a rugged long-range ultra-high frequency range RFID reader for outdoor applications with integrated dual linear polarized antenna so this is a high performance industrial class reader and achieves a read range in excess of 30 meters because in mines we need a long range so these LR100 is used for tracking in mining warehousing tolling and parking and access control way bridge automation and many more so it also supports the various cloud platform provided by different technique technical solutions including the RFID access smart asset smart inventory if rate etc.

So, this is a block diagram of the RFID tag. RFID tag also have the controller okay, and there is a rectifier circuit they had some time modulate that sometime works on the coupling principle. There is a transponder, okay, and there is a memory, a very temporary memory, so this is, in particular, an example of Papex for metal asset identification and inventory control. Papex is a tough and rugged waterproof ultra-high-frequency tag for tracking metal items, assets and equipment such as machinery parts, container railway cars trolley trailer, etc. dimension is 150 mm by 25 mm by 12 mm, so it has range read range up to 9 meters.

It's a good range frequency of operation particularly there are generally three frequency range we operates low frequency from 120 kilohertz to 130 kilohertz it's a very small range 10 centimeter high frequency it has a range up to 1-meter ultra-high-frequency range is 10 15 some 10 30 and 35 also so basically in mining applications on the surface we rely more on the ultra-high-frequency RFID system working principle.

So, the low frequency and high frequency RFID tag work on the inductive coupling that is near field coupling and ultra-high frequency tag works on the electromagnetic coupling that is far-field coupling so in inductive coupling near field coupling it induce energy to the tag it induce energy to the tag and it synchronize the clock in the tag and acts as a carrier for the return data from the tag so basically by that it basically works so this is a typical diagram of the load modulation for the near field coupling here are the reader and the tag should be placed in a very close proximity okay to occur the inductive coupling because it is in a very small range in the centimeter level so here they are circuit on the right side of the tag here there is a load circuit rectifier controller and the clock so this clock is basically synchronized so based on that it basically RFID tag is basically reader is basically receive the information particular information about this object for field coupling for a long-range particularly.

Tt relies on the back scatter modulation so energy or the signal or wave is basically scattered from the tag back to the RFID reader so it basically works on the far field coupling so basically RFID technology relies on the radio frequency range and it works on it and we have the two kind of tag basically in general active and passive tags that is used in mining applications and we use various frequency range based on different purpose and different conditions in the mining particularly when there was different bands and age in the underground so in those cases we basically use the low frequency and for the surface level application we basically rely on more on the UHF ultra-high frequency range RFID system so the main benefits of the RFID system it basically improves the efficiency of the system because it is a non-contact method and we are basically getting the data in one way so there is no interference in that sense it basically increase the visibility of the system of the functioning of different machinery within the system it basically reduce the cost because RFID there is a chip that is a tag and the reader these are basically less costly and the micro controller that is used in the reader also not very costly because there is no high level computation is going on in the process so this is the easy solution in that case and in that sense also it basically improves the security as well in the system and it basically improves the consumer engagement in the in the process.

So, they improve efficiency the RFID technology enables fast and efficient data exchange between an RFID reader and RFID tag which can result in improved efficiency and accuracy in various applications such as inventory management supply chain management and asset tracking increase visibility the RFID technology provides real-time data and increase visibility into the movement of goods assets and enabling organizations to make more informed decision and respond quickly to change in demand or other conditions reducing cost by automating the process and reducing the manual labor RFID technology can help organization to reduce cost and improve their bottom line for example RFID can help reduce inventory shrinkage and improve asset utilization both for which can lead to significant cost saving improve security RFID technology can be used to enhance security by controlling access to secure areas and facilities and by helping to prevent theft and shrinkage improve consumer engagement RFID

technology can also be applied to create an engaging shopping experience for consumers by providing personalized recommendations real-time product information and location based marketing the mining industry is one of the most dangerous industry to work on so there are many hazards that workers face on a daily basis including exposure to toxic chemicals heavy machinery and falling debris so in recent year the industry has been looking for a way to improve safety for the workers on way that mining one way that mining companies are doing is this by implementing the RFID technology the RFID stands for radio frequency identification this technology uses radio wave to identify and track object RFID tag is attached to equipment vehicle or even to people as well because we can also use for personal monitoring we can use it in the PP kit how the personnel is moving whether the personnel is within that particular zone or like that so when an RFID reader scans the tag collect information about the object that it is attached many mining companies are using RFID tags to track equipment and vehicles this helps them to keep track of where their assets are and it also helps them to prevent theft in addition RFID tags can be used to monitor equipment maintenance by tracking when equipment is due for servicing mining companies can minimize downtime and keep their operations running smoothly.

RFID technology is still relatively new but has already proven valuable for the mining industry as this technology continues to evolve even more use will likely be found in the mining industry in the future in the mining industry the effective management and control of assets personal and resources are paramount for ensuring both efficiency and safety so radio frequency identification technology has emerged as a powerful tool to address these challenges machinery tracking and control so because we have already seen that in the automated haulage system that we can use the required amount of monitoring how the haulage is moving so there will be a reader that will basically sense the tags that is attached to the haulage so by that it basically tracks the movement of machineries and establish control over these machineries geofencing applications also RFID system can be used human safety and management for enhancing the worker safety and managing the workforce we can use the RFID system and we can use in the PP kit also with the personnels the assessing the material qualities we can use the RFID technology we can also use in the convey maintenance this technology and the machinery maintenance also we can use it asset tracking and management asset identification how RFID used to using the identify and track mining equipment's vehicle and materials real-time location system this implementation of the RLC using RFID for accurate asset location and monitoring maintenance and inventory control using RFID for maintenance scheduling inventory management and reducing downtime personal safety and monitoring RFID based access control RFID enhance the security and access control in the different mining facilities personal tracking using the RFID we can monitor in real time the movement of the personnel and by that we ensure the safety of these personnels and their compliance in the mine site emergency response different role of the RFID system for efficient use in the emergency response system and evacuations we there are different case studies we have found so this is found to be a very efficient technology for this kind of situations RFID can be more costly so whether it is a software or hardware RFID require more costly equipment that needs to be maintained through the life of the solution and additionally tags whether the active passive or sympathetic can be set a business back away and although the price have fallen with RFID upgrade since 1970s business are still taking a pass because of the steep prices there are some trouble with the metals and liquids RFID has long had difficulty relation working among liquids and metals as both make it harder to get proper leads on assets with metal the problem

stems from the radio waves bouncing all over the place with liquid play have up with RFID in that it can absorb signal sent from the tag and we can easily understand for an unknown on the underground mines there is a presence of huge amount of liquid in many places so in those places working with the RFID tag and the reader might be difficult RFID collision course in dealing with the RFID technology workers come across reader and tag collisions often so with reader collision a worker might come across interference from another reader in the field tag collision is a little different in that workers with the reader face issues in reading and abundance of tag at one time it happens when more than one tag reflects a signal and it confuse the reader RFID system can be easily disrupted RFID system that use the electromagnetic spectrum that is Wi-Fi network as well as cell phones leading to a collision when you are working on the same frequency and to a lot of delays and inconvenience to the consumer who want to pay and get out of the store in addition to the card that contains effective battery that can be questions continuous at a low level of the battery if no answer.

RFID in mining controlling access to mine site RFID can control access to mine site by tagging employees ID batch with the RFID tags companies can track which employees are entering and exiting the site and this information can be used to improve safety by ensuring that only authorized personnel are on the site logistic distribution of supplies RFID tag have many benefits over other tracking methods such as barcodes for example they are more durable can withstand harsh condition do not require a line of sight to be read and can store more data than barcode this makes them ideal for tracking products in the mining industry RFID tags can provide a wide range of information about the product they are affixed to making them ideal for tracking in the mining industry there are two main ways that RFID tags are being used in the mining operations open circuit the same RFID tag that the suppliers use is reused by the mining operation to track the product inside the mine closed-circuit mining company puts new RFID tag on the product distributed in the mine environment this allow them to track the product easily and prevent mix-up tracking personnel RFID tags are used in the mining industry for people localization as each worker is given an RFID tag the RFID reader are located at strategic points throughout the mine the antennas are located based on readers range and spacing the goal is to decrease the personal location uncertainty areas this allows the rescuer and the first aid team to know exactly where everyone is in case of an emergency evacuation and rescue safety is one of the utmost importance in underground mining so radio frequency identification technology plays an increasingly important role in helping to keep miners safe it is vital monitoring it is vital monitoring miners to know each workers exact location and where the rescue where to rescue and the first aid teams are in an accident RFID can help first responder locate individuals who may be trapped it is possible to activate alarms immediately and implement evacuation protocols monitor and guide rescue teams do the same with workers and conduct them to safe places or operating lifts stop truck traffic and stop work affected directly or indirectly by accident managing explosive RFID can also be used to track the location of explosive in a mine this information can improve safety by ensuring that explosive are only used when and where they are supposed to detection areas RFID is used in the mining industry for proximity warning systems these systems use RFID tags to track the location of workers and equipment and then warn the vehicle driver if someone or something is in his proximity so this helps prevent accident by ensuring the drivers driver is our office surrounding these systems can also be used to track the location of assets and inventory.

which can help improve efficiency and productivity in the mining industry. So this is a typical case study that is used in the marble mines, so each marble is attached with the RFID tag so the manufacturer are in a better position to assess the quality of the marble, which marbles need some action, and which marble to be seen in a particular location and which marble needs a particular cutting by these RFID tag system so these basically smoothen the overall process in a big marble industry.

So, this is basically the block diagram of this particular system. There is an RFID reader and, there is a module connection, and there is a power supply to make use of the power, and this basically connected with different Ethernet system, and it is basically connected with the computer as well, so then based on that it basically connected with the virtual cutting machine system so based on that it basically decides which marble to cut and which size like that so basically this smoothen the process and this is basically one of the applications of the RFID technology in the mining.

So, these are the references

So, let me conclude in a few sentences, so we have provide a new overview of radio frequency identification technology. We have explored the operational principle behind the RFID technology, we have examined the application of RFID in the context of smart haulage systems, we have introduced the fundamental concept and explained the working principle of RFID. We have discussed the key advantages associated with the use of RFID technology. We have explored the specific reason for implementing RFID technology in the mining industry. We have examined the diverse application of RFID technology within the mining operations. We have discussed practical use cases showcasing the application of RFID technology in mining, and we have examined a real-world case study illustrating the implementation and outcome of RFID technology.

Thank you