Computer Integrated Manufacturing
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Lecture 34
Automatic Identification and Data Captures

Welcome back to the course, computer integrated manufacturing. We have discussed FMS, flexible manufacturing system. Then robotics, then PLC.

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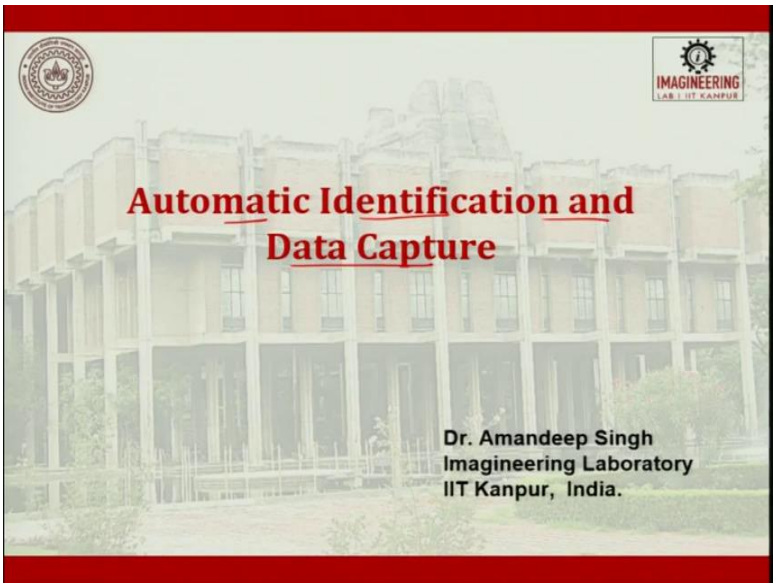

In this lecture, I would like to discuss the automatic identification and data capture that is an important topic to be discussed. What is automatic identification? What is automatic data capture? Now, you all might be conversant of using QR codes. What is QR? QR is a quick response, as the name suggests, it is a quick answer, a quick solution to what you want to do.

You like to use your WhatsApp on the Windows platform, it will put, okay WhatsApp web then scan this code. Then you will have to scan the code. There are certain QR scanners available, QR Scanner is one, then Cam Scanner is one, certain android applications, iOS applications are there that are used to scan the codes, and immediately you can do the transactions or immediately you can just connect to the system. You can use your debit cards, credit cards to make the transactions with the bank. This is all automatic identifications.

Now, what is happening here? The data that was to be entered manually, when I say manually here, manually means, entering the computer manually using the keyboard or mouse. In place of that, you are just using an automatic system so that the data can be identified by the computer itself. There has to be some identification mode in your hand like a credit card or a scanner and there has to be some reader that scans. So, what are these, we will discuss this in this lecture.

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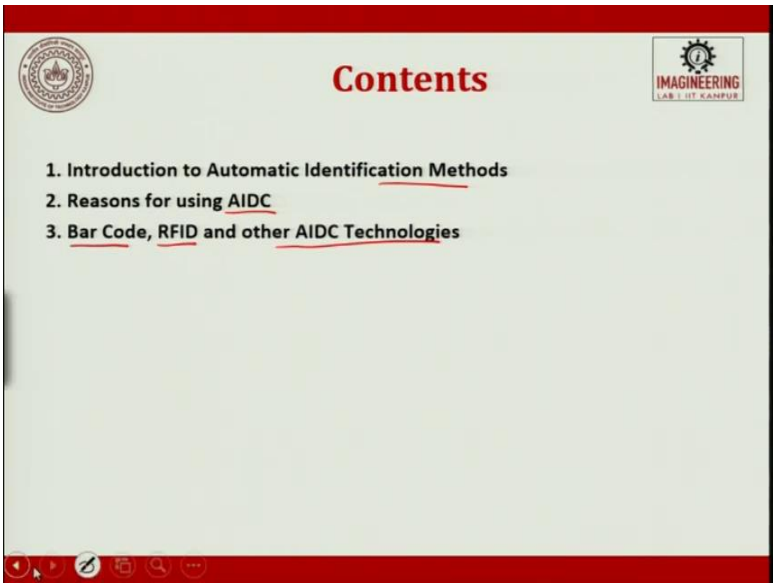

So, the contents would go like this, introduction to automatic Identification methods. Then, the reasons for using AIDC. AIDC is an automatic identification and data capture. Major AIDC technologies are bar code and RFID. These are very widely used and other AIDC technologies we will discuss.

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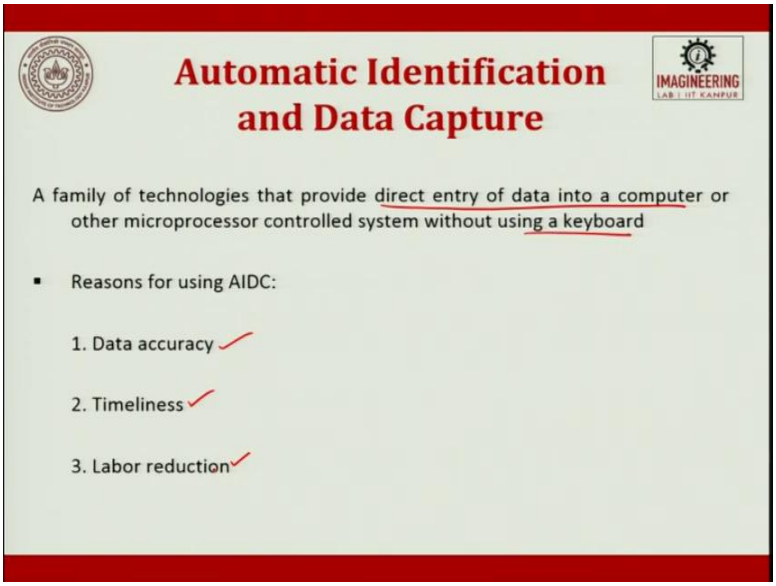

Now, automatic identification and data capture, what is this? This is a family of technologies that provide direct entry of data into a computer or other microprocessor-controlled system without using a keyboard. Now, many of these technologies require no human involvement at all, the data capture entry is completely automatic. It is an automatic identification system, which is being used increasingly to collect data in material handling, in manufacturing applications. In material handling, if I say, that could be applications in shipping and receiving, storage, then sorting, then order picking, knitting, and so on.

In manufacturing, the application includes monitoring the status of order processing, WOP, inventory, work in progress, machine utilization, worker attendance like biometric is very commonly used these days, biometrical, but that is it identifies the pattern of the thumb or any of the finger impressions that you use. And even, the biometrics are used for the eye scan or voice scan. So those kinds of identification systems are there.

So, these are very widely used these days. So, what are the advantages or what are the reasons we use AIDC is- number one is data accuracy. Number two is timeliness, number three is labor reduction. Now, what is the accuracy of data? Now, errors occur in both data collection and data entry. There are certain sources of error when it is done manually. So, an average rate of error for the manual keyboard entry is one error per 300 characters. So, this technology, AIDC helps to ignore or get rid of this kind of error that is there because of the manual data entry.

Then, the time factor, as QR, I just said, quick response. So, manual methods are inherently more time consuming than automatic methods. So, when manual methods are used, there is a

time delay between the activities and events occurred or where the data or the status are entered in the computer.

So, there is a big difference like making the entry manually in a bank register. The time you made your transaction and the time when the clerk made the entry in the evening, that had been happening twenty years past. Now the computers enter the data instantly. The moment you go to the clerk, the moment you go to the transaction officer, he enters the data and your transaction can be immediately seen in your account. So, this is point number two, timeliness, it is a quick response.

The third is labor reduction. Now, the full attention of human workers is required in manual data collection entry. So, this is again associated with labor costs and so many things. So, these drawbacks are virtually eliminated when AIDC is used that is, data on activities, events, and conditions are required at the location and the time of the occurrence is entered in the computer immediately, shortly thereafter.

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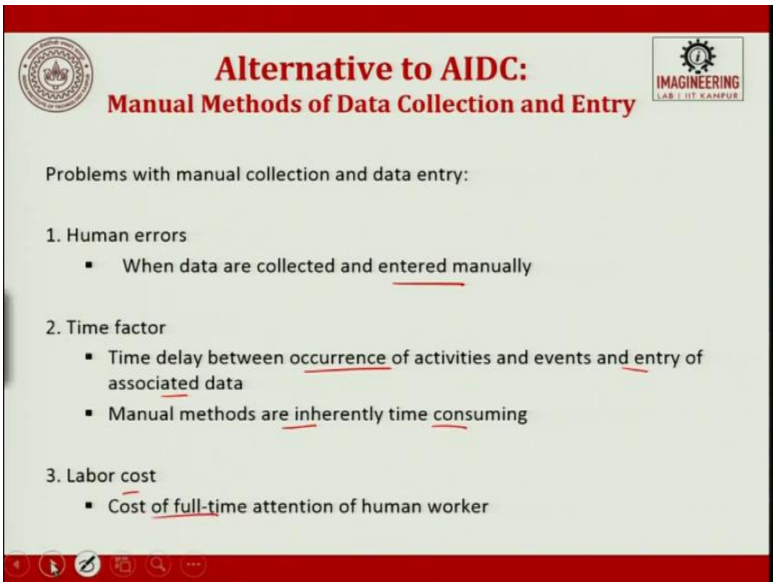

So, these are a few—I would say the benefits of using AIDC. Now, the problem with manual data collection, we have just discussed, there are human errors when data is collected. Time factor- the time between occurrence of activities and events of entry-associated data. Manual methods are inherently time-consuming. Then labor cost is there, this is already discussed.

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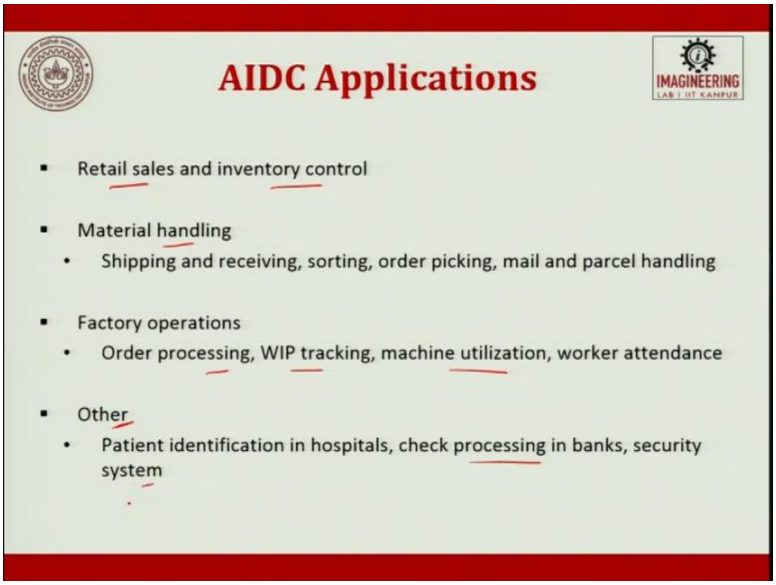

Application of AIDC. Automatic identification has a wide range of applications starting from retail sales and inventory control. Then, material handling is shipping and receiving, sorting and order picking, and so on. Then, in factory operations like order processing, work in progress, machine utilization then other applications like I just took the example of bank transaction and also in hospitals, patient's identification in hospitals. Cheque processing in banks, security systems and so on, there are certain applications.

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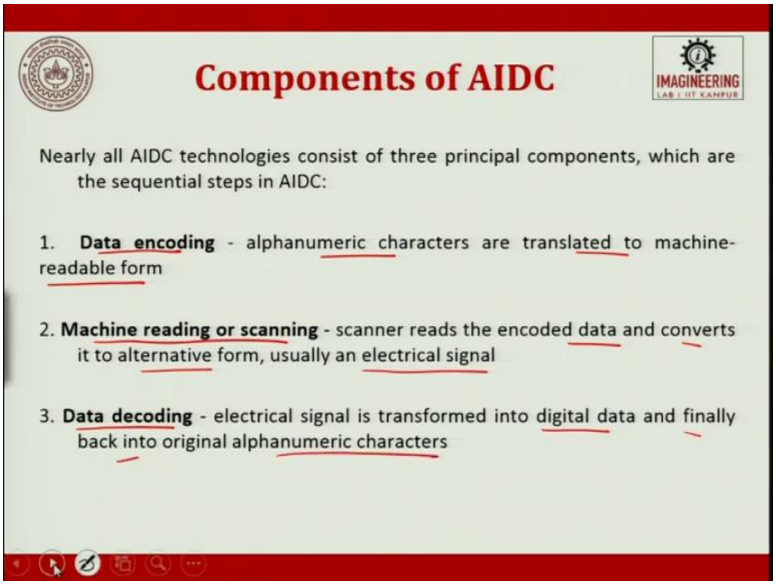

Now, components of AIDC. An AIDC system typically consists of three major components. Data encoding, machine-reading and scanning, and data decoding. What is data encoding? So, data encoding here implies that data has to be used by the computer, it has to be readable by

the computer wherever it is being stored. So, what are these? These are alphanumeric characters that are translated into machine-readable form.

So, what is the code? Code is a set of symbols of signals that usually represent these characters. So, a label or tag containing the encoded data is attached to the item that is to be identified like, I would discuss the bar code and RFID in detail and other technologies, I will give you an introduction to that. For an instant, if you purchase any items in the big shopping center, there are certain codes, the QR codes; the scan, etc. are the codes that are there. Some codes, you might have seen, straight bars are there.

Some codes, you might have seen, there are kinds of dots. So kind of the QR codes that I just mentioned regarding the WhatsApp using on the Windows that is a matrix or two-dimensional bar code. The simple straight bars are actually one-dimensional bar code. So, these are the data encoding.

So, data is transferred to alphanumeric characters, then machine reading or scanning is the second part. The scanner reads the encoded data and converts it into an alternative form, usually an electric signal. So, then is the data decoder, the electrical signal is then transformed into digital data and finally back into alphanumeric characters.

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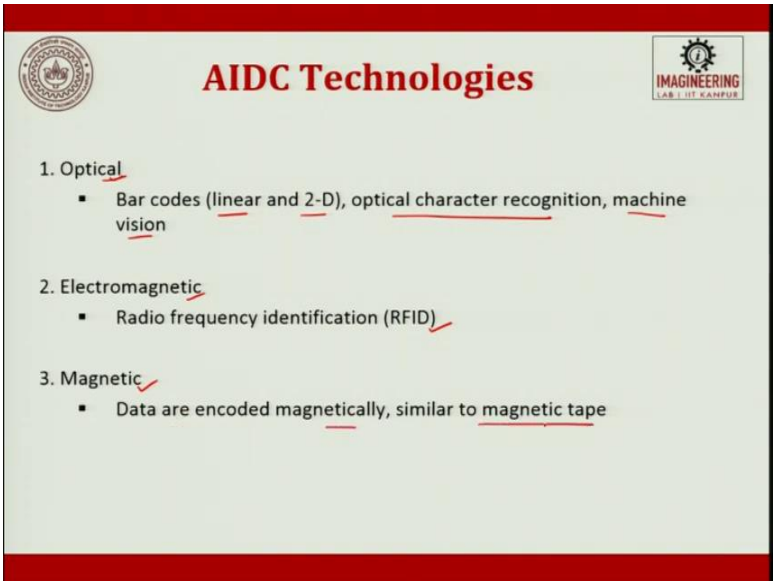

These are the major components of an automatic identification system. So, these systems can be optical, electromagnetic, magnetic, and so on. In the optical system, we have generally the

barcodes. Bar codes can be linear of two dimensional, optical character recognition (OCR) and machine vision. These are optical characters. I will discuss about these.

Then electromagnetic. RFID- radio frequency identification is one of the major electromagnetic types of technology. Then magnetic, magnetic, as I took the example of credit cards or any magnetic tape wherever it is used, data are encoded magnetically, similar to magnetic tape.

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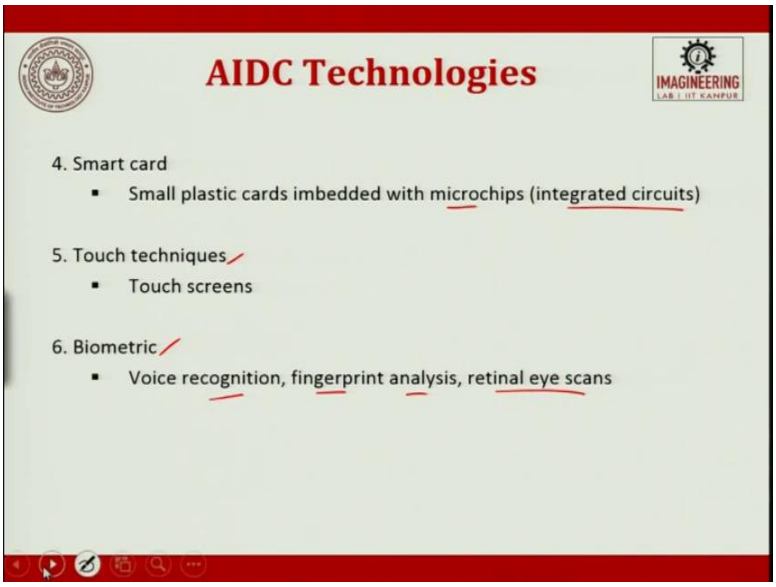

Next is smart card. These are the plastic cards those are embedded with microchips, integrated chips. So, integrated circuits are there. So, these integrated circuits have more data than what magnetic tape could carry. Then touch techniques. And touch techniques are also there like there are touch screens there which can identify—which can put the data into their memory, the touch button memories are there. Then biometric voice recognition, fingerprint analysis, retinal eye scans. So, these are the major technologies.

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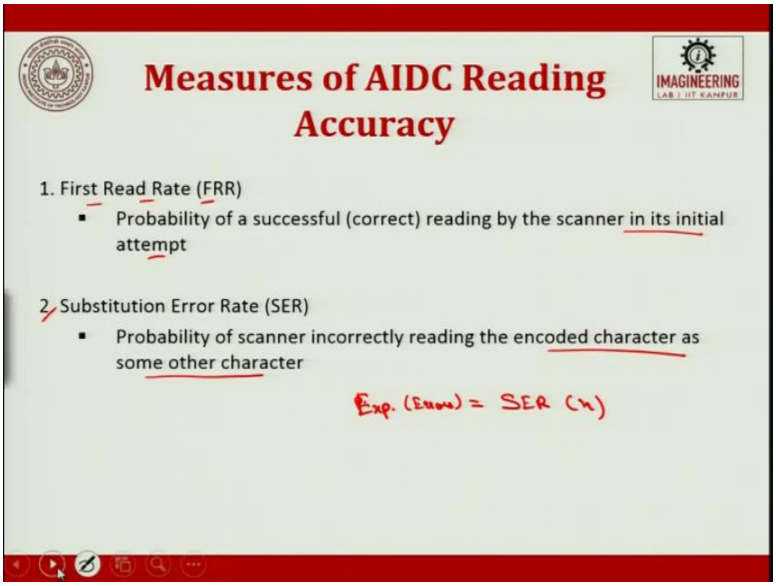

Now, measures of AIDC reading accuracy. The accuracy of the data that is represented there has to be high. There are two major measures for that. First is the 'first character reading'. Next is that if the first character is not read properly then what is the subsequent error in the further characters.

So, first is the FRR- first read rate. It is probability of a successful correct reading by the scanner in its initial attempt. Now, these are all characters, these characters could be read, write or could be read with an error. Like, it could identify bar which has to be coded may be as a number nine, it could have identified that as maybe number six. So, this is an error. So, if this error happens for the first time then this comes into play, substitution error rate.

What is SER? It is a probability of scanner incorrectly reading the encoded character as some other character. So, how is it calculated? The expected number of error is given by—expected number of; I would say error that is equal to SER, substitution error rate multiplied by n. Now, n here is the data set with the number of characters n is the number of characters in the data set and SER is the substitution error rate. So, this is how this error is calculated here.

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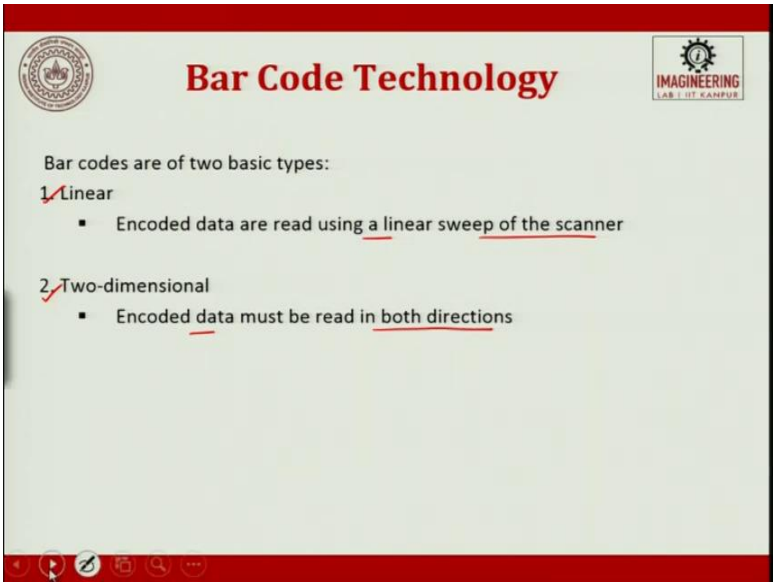

So, I am not going into the detail of this. This is just an overview of how the AIDC system works. Next is bar code technology. So, no the error rate in bar code technology is approximately ten thousand times lower than in manual keyboard data entry. The error rates of the most of other technologies are not as low as bar codes but are still better than manual methods. So, the bar code is also too economical to use.

The cost of using the RFID technologies is around ten times of what bar codes are. They are widely used in certain applications. So, there two major kinds of bar codes. Number one is linear, number two is two-dimensional. In linear bar code, encoded data are read using a linear sweep of the scanner. In two dimensional, encoded data must be read in both directions. Both directions, as the name just ratifies that linear and two dimensional, what does it just mean.

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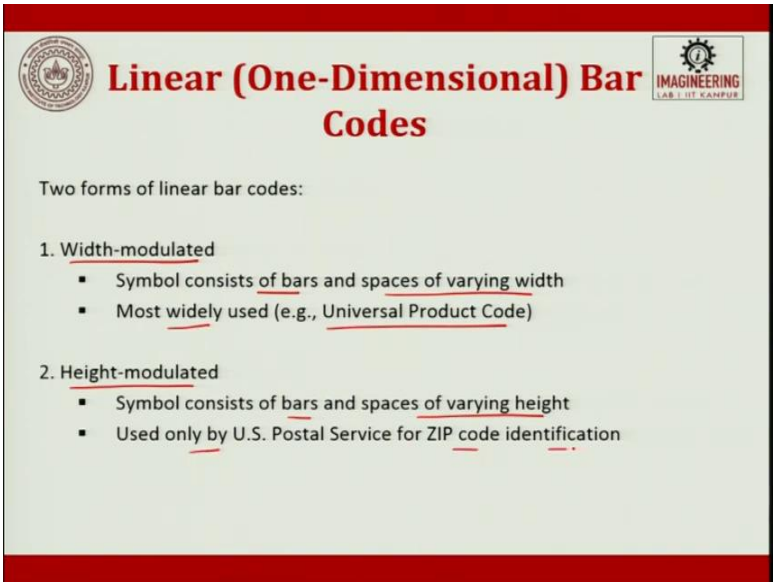

Now, what are the major kinds of linear bar codes? One is width-modulated and the other is height-modulated. Now, width-modulated bar codes are a symbol that consists of bars and spaces of varying width. These are the most widely used that is UPC. I will discuss what is UPC and core-39. Height-modulated. This symbol consists of bars and spaces of varying heights. These are majorly used in U.S Postal service or zipcode identification.

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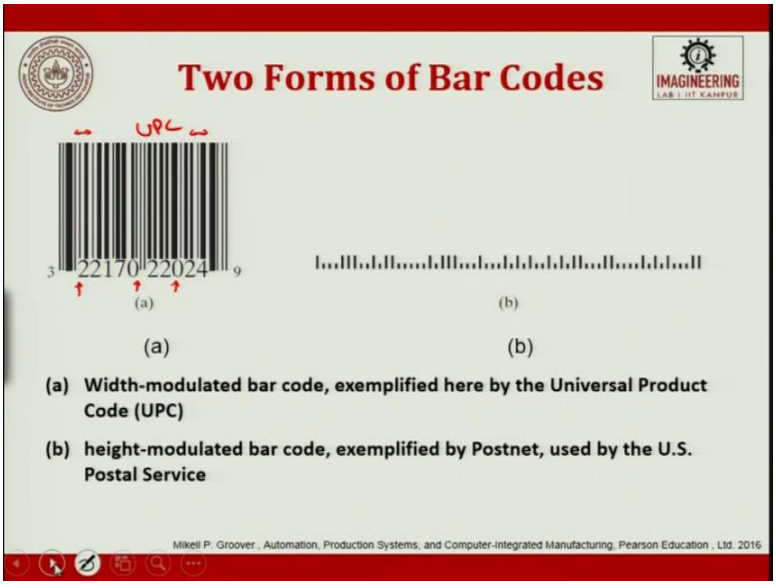

Now, what are these? These are the kinds of width-modulated and height-modulated linear bar codes. So, this is a width-modulated bar code that is a UPC. This is a height-modulated bar code that is a, used by Postnet in U.S Postal service. So, what are these? In a width-modulated

bar code, these are used in retail or manufacturing. The bar code consists of bars and spaces with varying width, with bars and spaces being highly contrasting in colors.

The widths vary here. These contrasting colors are normally black and white. The pattern of bars and spaces is coded to represent numeric or alphanumeric characters. So, these characters these bars might be representing these characters. These are numeric or alphanumeric; in this case, these are all numeric. It could be also alphabets.

So, this code is subsequently interpreted by a bar code reader. This reading action is done by scanning and decoding the sequence in which the bar falls. The bar code reader itself consists of the scanner and decoder. The scanner emits a beam of light that is either automatically or manually swept over the bar code reader, so this beam can be fixed, this beam of light can also be moving.

So, if the beam of the light is fixed, that is known as a fixed beam, otherwise, it is known as moving beam. So, if the bar code—suppose this is the bar code, this is the bar code—so the light is fixed. Generally, in shops or big malls, the bar code reader that you use or that you see is kind of a fixed beam. The beam does not move. When the light is also moving, then it is known as moving beam those are generally used when the product is also moving like in conveyers. We have taught you, the material handling systems when the material is going in conveyers or it is being held on the hoist or so. So, the moving kind of scanners is also used.

So, these are the major bar codes. This is the height-modulated height here tells a different kind of characters here. So, these are, both, the linear bar codes for single dimensions.

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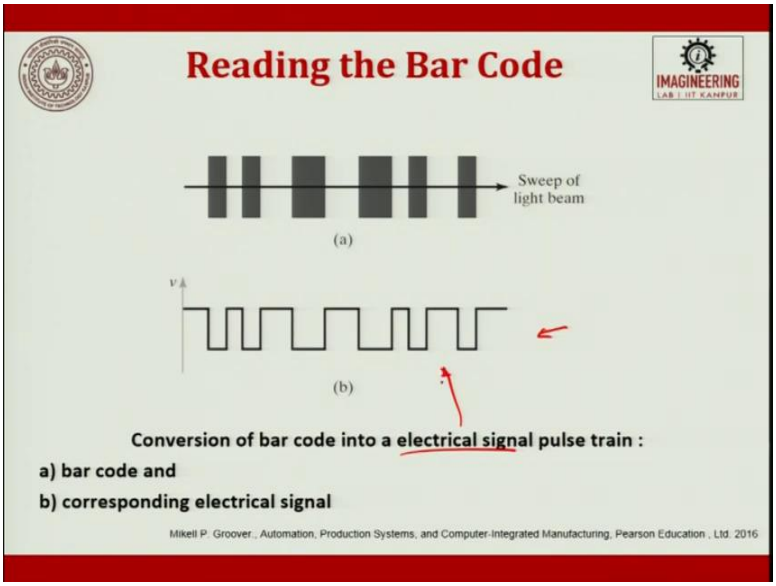

Now, conversion of bar code into an electrical signal, how do we read bar code? Reading means, the bar code is decoded here. So, this is a sweep of light beam. The light beam travels here. It is converted into an electrical signal here, this is an electrical signal. So, this signal gives the information or transfer information to the next step.

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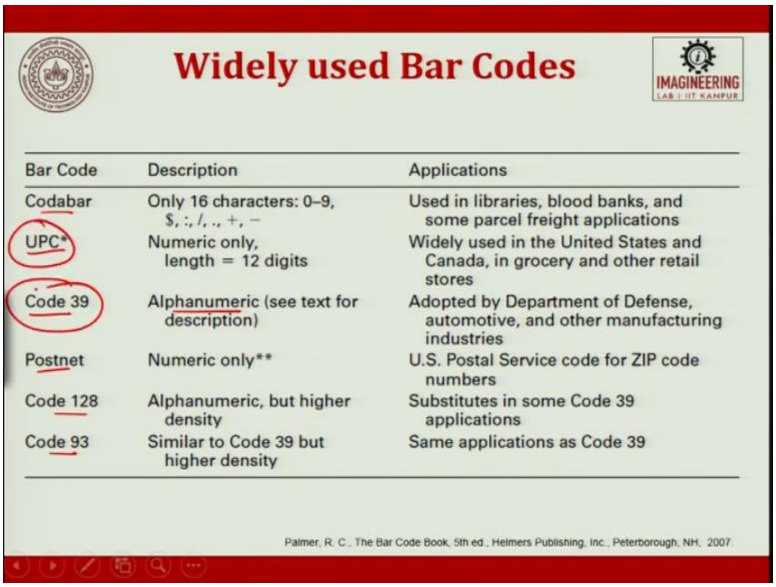

Now, widely used bar codes, these are general barcodes, which are being used in the industries these days as it was just mentioned UPC before. UPC is a universal product code. So, that is numeric only and length is 12 digits. It is widely used in U.S, Canada in grocery and other

retail stores. So, this kind of bar code as I said. This is a UPC bar code. Other than that, majorly used bar code with alphanumeric kind of description is code 39.

So, it is adopted by DOD, automotive, and other manufacturing industries. There are certain other bar codes Postnet, code 128, code 93, coda bar. So, some are numeric, some are alphanumeric. So, code 93 is also very similar to code 39 but, two majorly used here are UPC and code 39.

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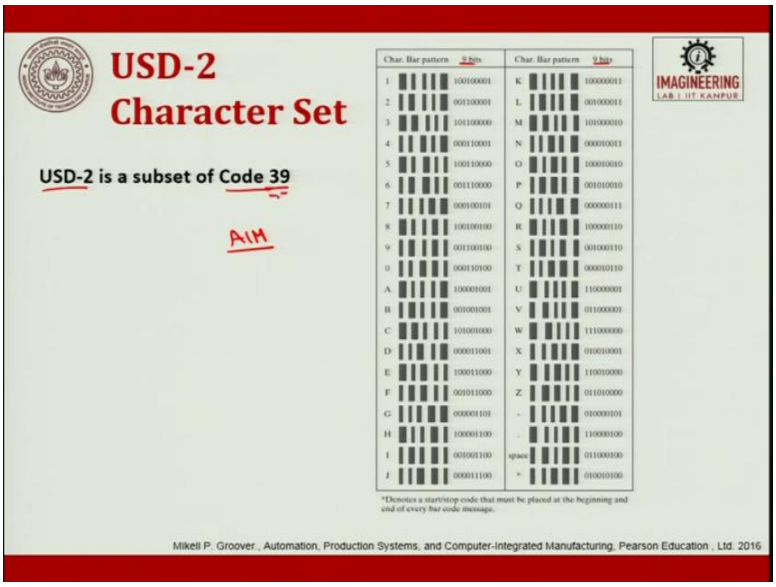

Now, this is a subset of code 39. How does it look like? This is just an example here. So, this is USD-2. Now, the reason this code 39 name given to it is that it has nine elements that is bars and spaces, which are used in each character and three of the elements are wide. The placement of wide spaces and bars in the code uniquely designates the character. Each code begins and ends with either a wide or a narrow bar.

The code is sometimes referred to as ‘code 3 of 9’. In addition to the character set in the bar code, there must also be called quite zone that is both preceding and following the barcode in which there is no print, this might confuse the decoder. So, this is the major bar code. This USD-2 is a major AIM—AIM is an automatic identification manufacturing association, so this is a majorly used bar code by AIM. So, these are the few examples of the nine bits. That is why it is known as code 39. I would better say code 39.

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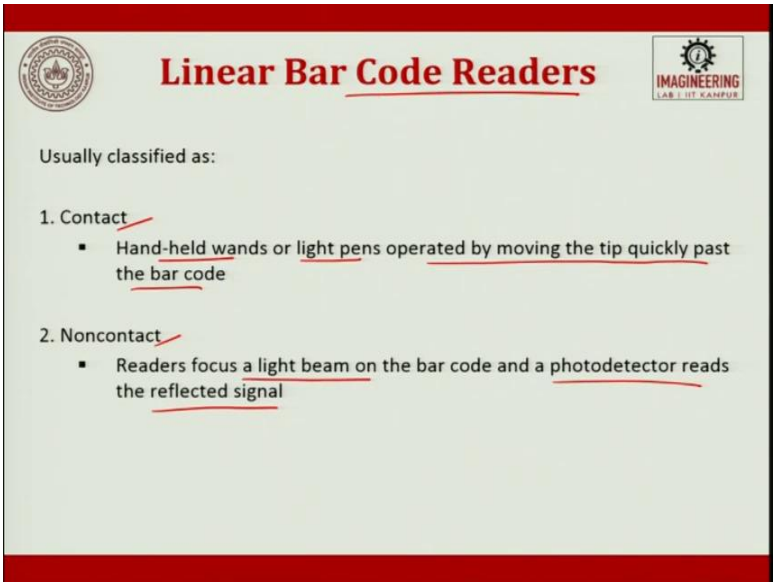

Now, next comes the bar code readers. The bar code readers come in various configurations. Some need humans to operate them. Another is just stand-alone and completely automatic units. These are usually classified as contact and non-contact. Contact readers are handheld wands or light pens or operated by moving the tip quickly past the bar code. Non-contact readers focus a light beam on the bar code and their photodetector reads the reflected signal. So, the contact bar code as the name suggests, it has to make a contact.

The non-contact does not make any contact. The wand must be in contact when we use the contact kind of bar code. The contact bar code reader is also available as portables units that can be carried around a factory or warehouse by the worker. They are battery-powered and includes solid-state memory device, which is capable of storing data quite during the operation. So, data can be transferred to the computer subsequently. It can be transferred using cloud computing or maybe using some physical transfer method like the data card, the memory card or pen drive or so.

The portable bar code readers often include keypads that can be used by the operator that cannot be entered via bar code. So, non-contact bar code readers, I will discuss about them.

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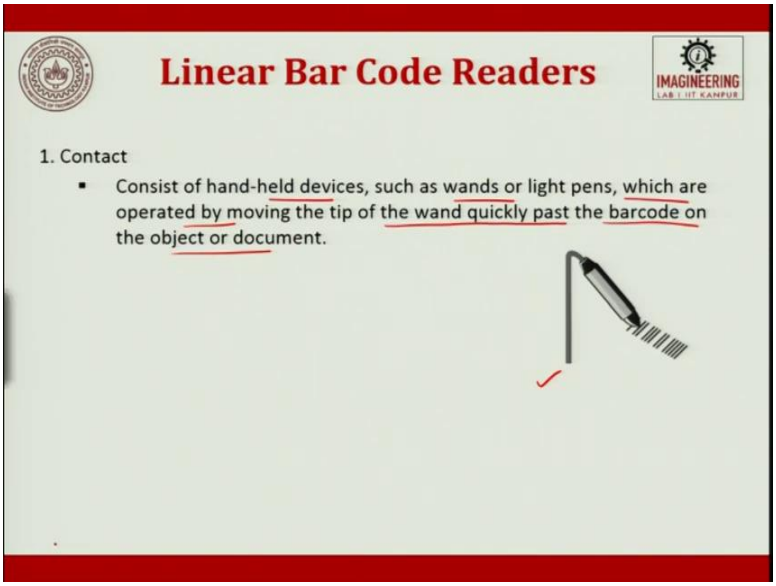

So, what are the contact bar codes again? It consists of handheld devices such as wands and light pens, which are operated by moving the tip of the wand quickly past the barcode on the object or document. This is the kind of contact bar code reader.

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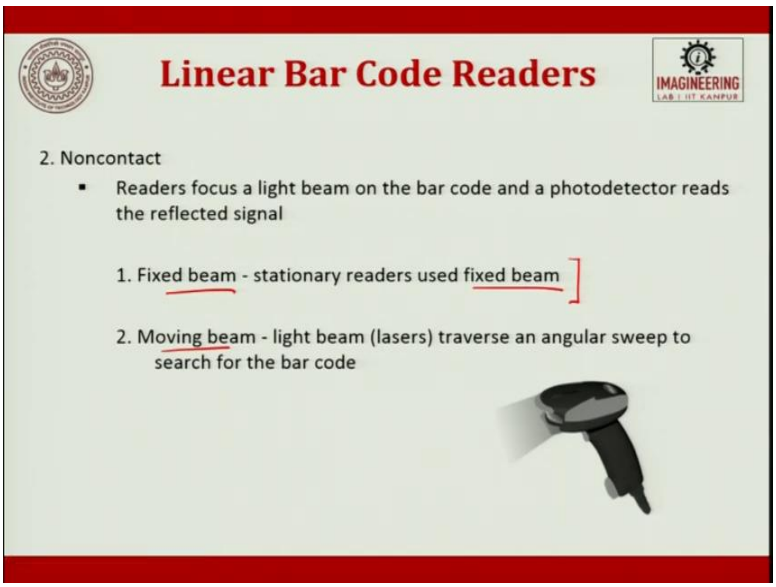

So, next is a non-contact bar code reader. So, in these readers, focused light of beam on the bar and the photodetectors reads the reflected signal, it is kind of a fixed beam and moving beam. So, this is non-contact or stationary readers used fixed beam. As I just mentioned, like in the big shopping centers, moving beam, the light beam (lasers) transverse an angular sweep to search for the bar code.

So these focus the fixed beam reader or stationary units that use a fixed beam of light and they can be mounted beside a conveyer to scan items as they pass.

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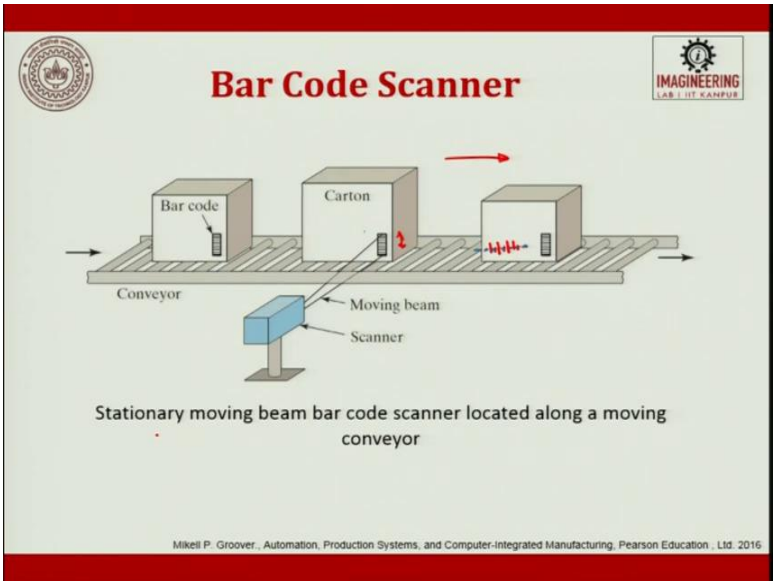

Like this is the conveyer that is going. This is the kind of a moving beam because beam is moving up and down. Suppose if the beam is also fixed if the bars are like this. The fixed beam can also sometimes read that. Whenever the beam—supposed this is the beam, if it covers—I will put beam with some other colour. So, this is the beam, if it covers this whole code, it might be able to read that.

So, in the moving beam, it has to move up and down in an angle. Up and down to read the complete bar. Okay, the conveyer is going in this direction as it is mentioned here, from left to right and this moving beam scanner is reading the barcode. In the fixed beam bar code, I have just – about the fixed beam bar code, I have just explained the typical moving beam reader, usually high focused beam of light to search for the bar code upon an object. The particular scan is defined as a single sweep of light beam through an angular pass specified by rotating the mirror used to project the beam on the object.

Typically, the mirror rotates at a very high scan rate. So, up to 1500 scans per second. Thus, when a bar code is located, it may be read more than once permitting verification of the reading. The typical applications including mounting alongside the conveyer or as it is just portrayed here. So, just like fixed beam readers, as the portable devices that use point of at objects in the same manner as a pistol, this can be used. These are applications that are conveyer, warehousing and material handling operations.

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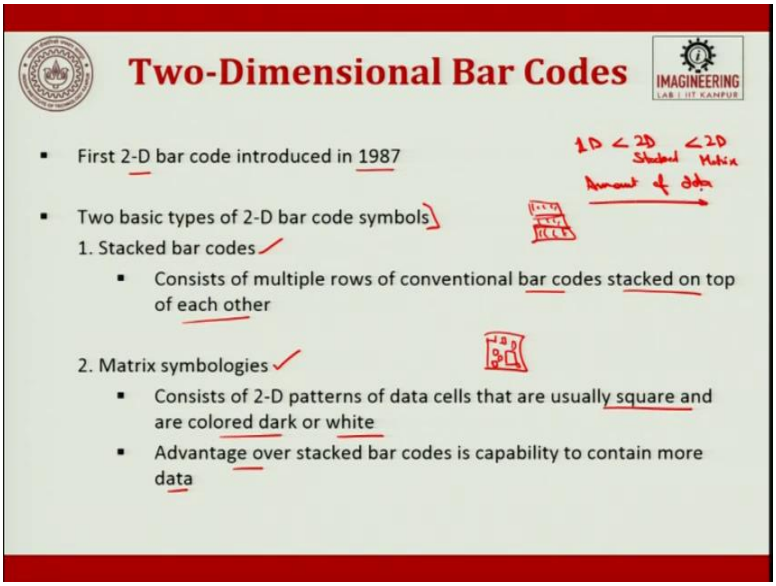

So, next is a two-dimensional bar code. The two-dimensional bar code was first introduced in 1987. The two basic types of them, number one is stacked bar codes. Number two is matrix bar code. Matrix bar code, as I took the example of the QR code in general that is matrix—QR code for WhatsApp when I picked that is a matrix kind of a bar code. So, this stacked bar code, what are they? These consist of multiple rows of conventional bar codes stacked on top of each other.

That is kind of one barcode, second barcode then third barcode, and so on. So, these are just stacked. Now, matrix barcode, it consists of 2D patterns of data cells that are usually square and are colored dark white. So it is the general barcode that we generally see, it is this kind of barcode. The different squares of different sizes and the two colors, obviously, dark and white.

Dark or white is generally black and white. The advantage over these stacked bar codes is the capability to contain more data. So, obviously, first is one-dimensional. More than this data can be taken in this stacked bar code, two dimensional, stacked, and more than this information can be carried by two-dimensional matrix. So, this is the amount of data that they can carry from left to right.

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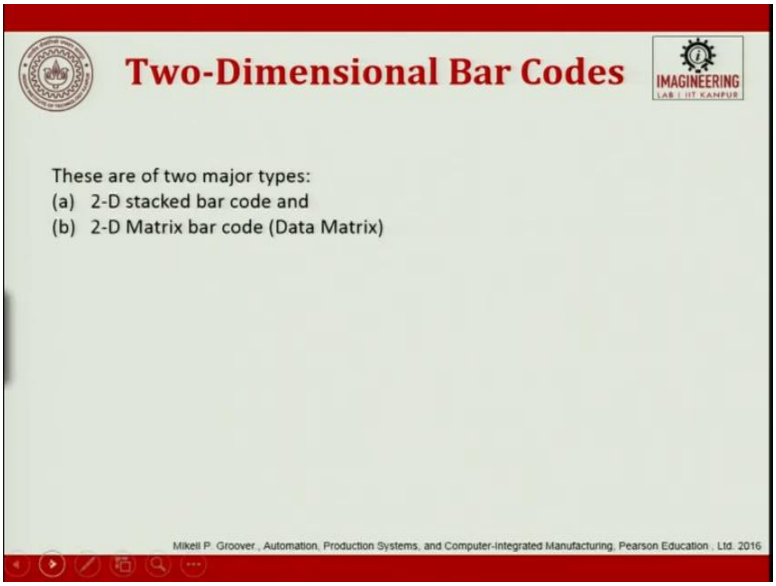

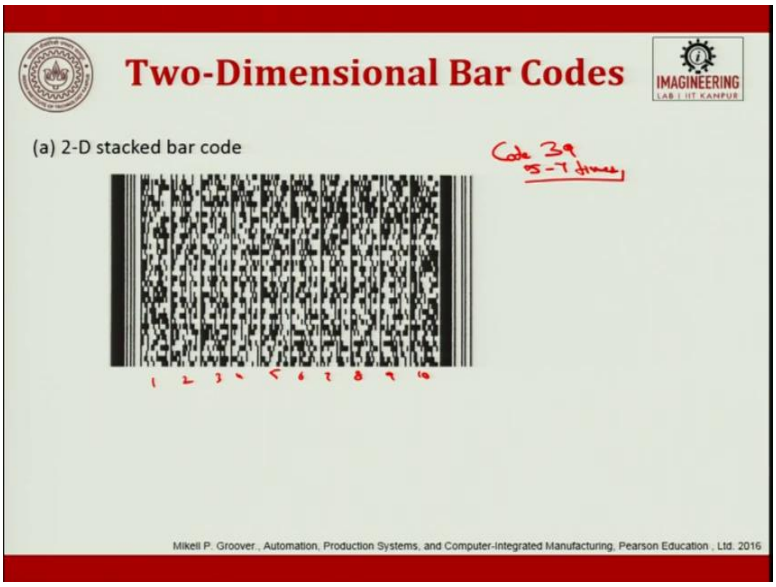

The 2D barcodes stacked and matrix. This is how a stacked bar code looks like. It is 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. Ten barcodes stacked horizontally here. So, it typically consists of the multiple rows of conventional bar codes stacked on top of each other or just stacked side by side. The data's density of stacked bar codes typically five to seven times, here it is ten times. For linear barcode 39, it is five to seven times. Generally, five to seven times, the bar code is repeated.

So, various techniques schemes may be applied to achieve the built-up of bar codes on the top of each other and still allow them to read. The decoding in a stacked bar code is done by a laser type of scanner that reads the lines sequentially. So, now some issues with barcode reading include keeping the track of the front rows during scanning, dealing with the scanning swats that cross between rows. So swats means the—this quite period or the silent period are also

there sometime. Then detecting and correcting the localised errors that can also be printing defects, may be similar to one-dimensional bar codes. So, there can be certain issues in this.

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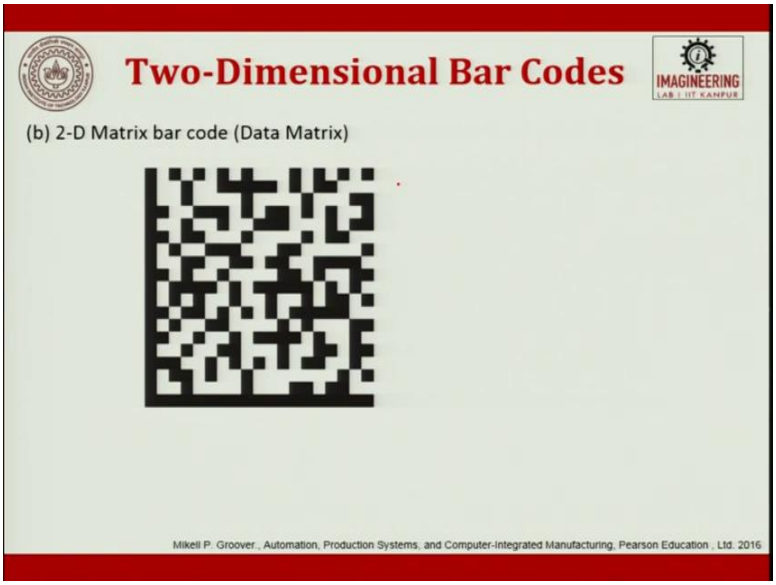

Next is matrix bar code, this is how matrix bar code looks like. So, it consists of 2D patterns of data cells that are usually square and colored dark and white. These are up to thirty times denser than code 39. Code 39 is before; this is around thirty times more than a code 39 can create. However, there are more complex type bar codes and they require more sophisticated printing and reading equipment.

The symbols must be produced and interpreted both horizontally and vertically in matrix kind of bar code because this is an area that symbolizes the whole information. Recent advances have seen considerable improvement in matrix kind of readers, which are easier to set up and use as well as being more robust and reliably operating under a range of conditions. So, these were the bar codes.

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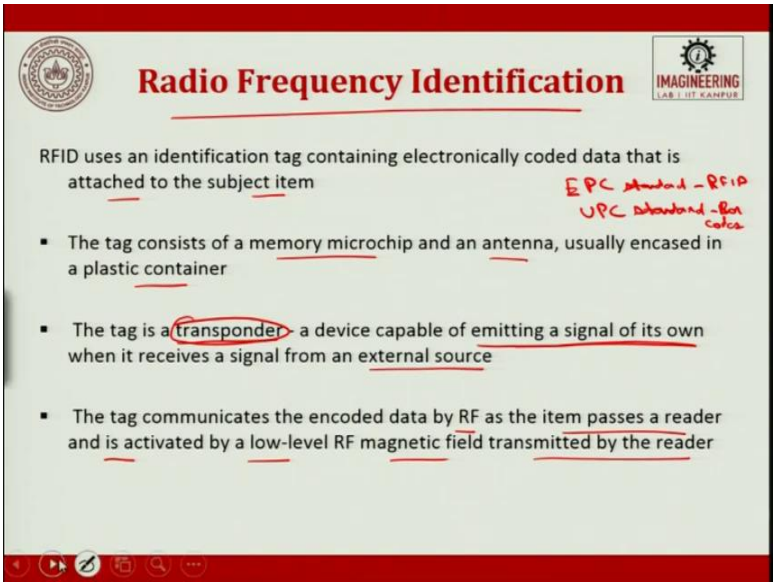

Next major kind of automatic identification and data capture method is RFID- radio frequency identification. Now, what is RFID? RFID tags at their associative RFI technology is currently a much-discussed concept and represent the great threat to the conventional bar code dominance. The only thing is that it is a little expensive but the expense or the cost is not too heavy. The bar code—typically the bar code cost is suppose, ten barcode of size one square inch each can be printed in maybe ten rupees, the cost of one RFID tag might be five rupees or so.

So, the cost difference is around ten times or so, but the applications is quite bigger because generally what bar code does is they do not store information much. They just transform one kind of information to the other. Major information is stored in the computer. But, RFID can also store information up to some extent. To some extent, but majorly information is stored in the computer itself.

So, RFID uses an identification tag containing electronically coded data that is attached to the subject item. The tag consists of a memory microchip and an antenna, usually encased in a plastic container. Then tag is a transponder, so, what is a transponder? That is a device capable of emitting a signal of its own when it receives a signal from an external source. What is this? I will just explain. The tag communicates the encoded data by radiofrequency as the item passes a reader and is activated by a low-level RF magnetic field transmitted by the reader.

Now, what happens? So, this tag has to satisfy the EPC standards that is an electronic product code. EPC standard—now, which is RFID counterpart of UPC used in barcodes. UPC, those

are there in bar code. UPC is again a standard. This is for bar codes. EPC is for RFID. So, the tag communicates the encoded data to radio frequency to a reader as the item is brought close to the proximity the reader can be a portable or stationary. It decodes and confirms the radio frequency signals before transmitting the associated data to the computer.

So, what is happening actually? RFID is completely silent unless it comes close to a data stimulator. What happens? It come close to the reader. The reader emits some of the frequency, some radio frequency and when this frequency is taken by the RFID gadget, it then transfer the information to the reader. It is how it happens.

So now, RFI signals are similar to those used in wireless radio or television transmissions. But the difference is that the intensity of signal radio or television is quite high and RFID is quite low and also one difference is that in the radio communication, the information is in one dimension and in this case, the information is in two-dimensional. Now, what happens? Now here comes the user transponder. The transponder is a device that is capable of emitting the signal of its own when it receives signals from an external source.

What happens? The external source here is the reader, RFID that is to activate the RFID; the reader transmits a low-level RF magnetic field that serves as a powered source for the transponder when they come near each other. So, this transponder then helps the RFID to provide information to the reader.

Okay, another difference between the wireless radio-television transmission and the RFID is that the signal power is substantially lower in RFID applications that is a milliwatt of several watts. That is—in RFID it is in the order of milliwatts. In television transmission, it is in the order of several watts or so. So, the difference is in allowable frequencies that can also be used RFID versus radio and commercial military users can use the television radio frequency but RFID cannot be used here.

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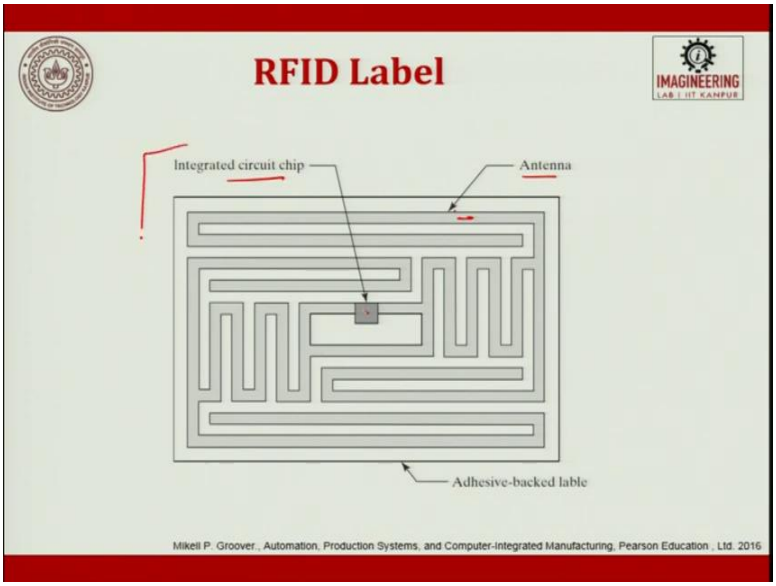

However, RFID are generally two types that is active and passive. This is an integrated circuit chip and antenna. This is an RFID label. This also has to be printed. Now, before talking about these things, an important factor is printing. Printing of bar codes, the printing of RFID. In many applications, the labels are printed from medium to large quantities for product packages and for carton used to ship or packaged box in case of bar codes.

Then, RFID are also to be printed and also sometimes RFID are printed—they are put in key rings or so they are put in a band or so. So, the printing that happens has to be flexible. Sometimes, flexible electronics also play an important role here, in the printing of RFID labels. So, this is the integrated chip that is there. This is an antenna. This is had as if the black label on which this is fixed and this is a chip. This is how typically an RFID label looks like.

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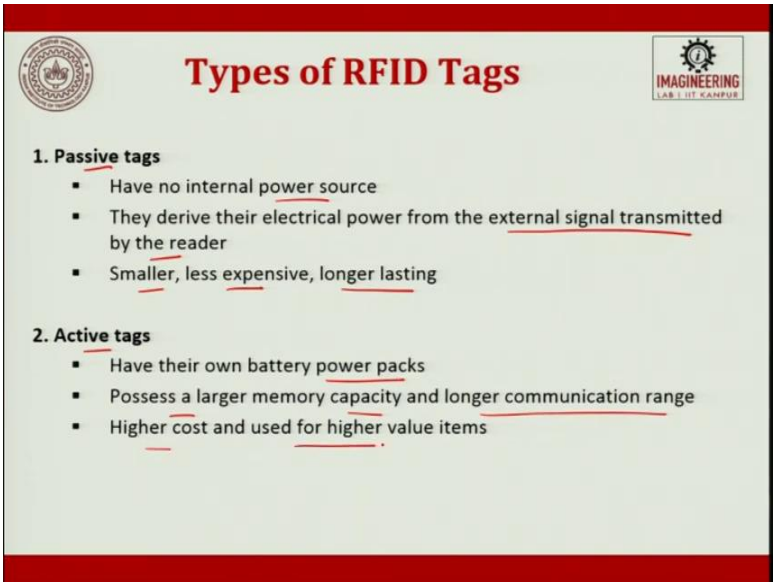

The two major types of tags are there. Passive tags and active tags. The passive tags are the ones that have no internal power source. They derive their electrical power from the external signal transmitted by the reader. So, these are passive. These are smaller and less expensive and longer-lasting. Active tags are the one, which has a transponder in them, they have their own battery power packs.

They possess a larger memory capacity and a longer communication range. Their cost is a little higher and it is used for high-value items.

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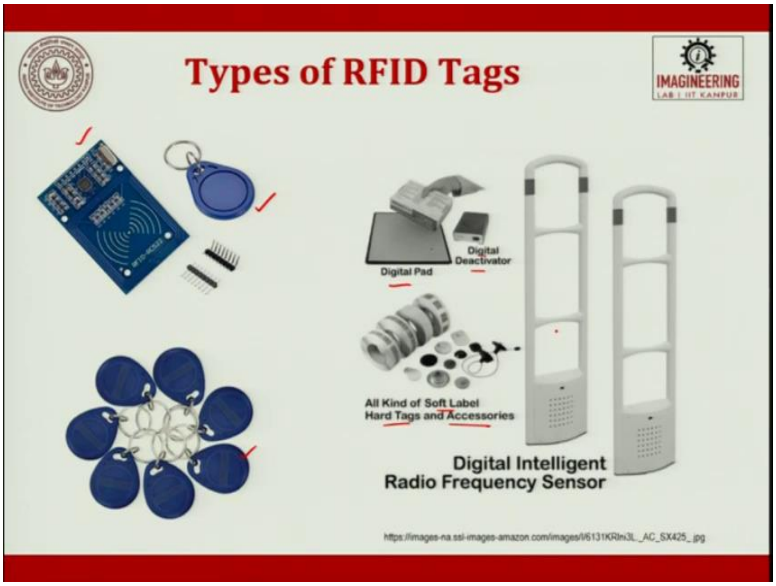

So, these are a few kinds of typical RFID tags. So, the tags are in the keyring. Here we have this reader circuit and this is one set of it. So, this is the digital pad, digital deactivator. These are the kind of soft label hard tag than accessories. So, this is a radio frequency sensors like the antenna is there that helps to emit and then get the information.

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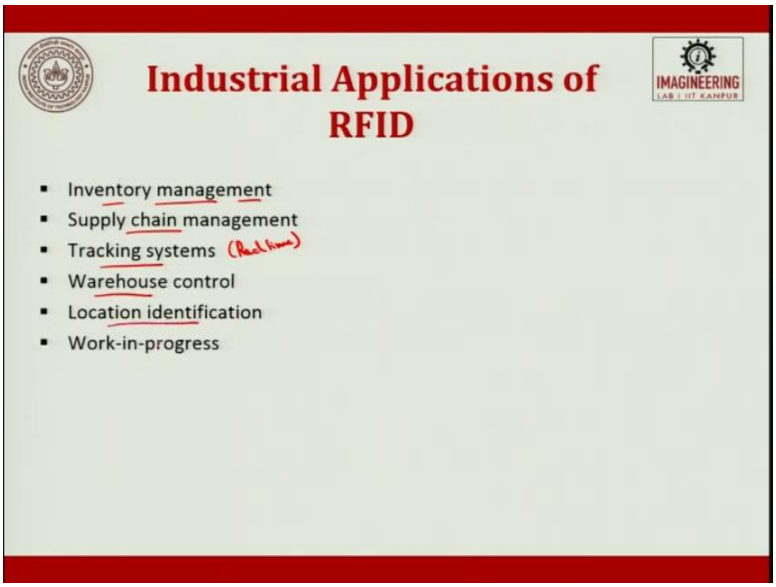

So industrial applications are inventory management. In inventory, RFID codes are put when the cartons are packed and the whole information like what is there in the carton. Whom the carton is to be supplied? When—what is it packed? Certain pieces of information could be put

here. Then supply chain management is similar to that in the tracking system that it is actually, real-time tracking system that where is my package now, this is real-time sometimes.

So, the warehouse control, obviously, comes in inventory management. Then location identification, it again comes in tracking system itself. Then work in progress.

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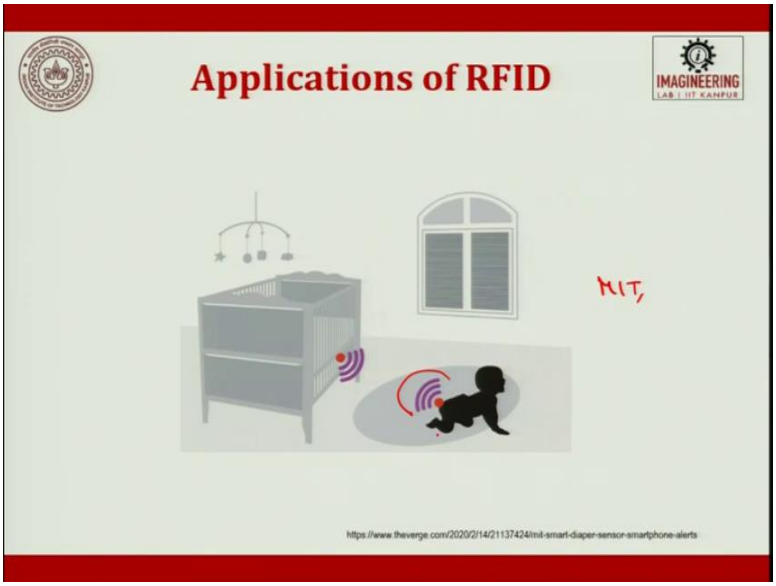

An interesting application of RFID that I would like to show is that this is the diaper. When the diaper gets wet and it come close to the cradle, the cradle emits a signal and it tells that it is the wet. This is one of the applications that is produced by MIT, Michigan Institute of Technology. By the people in MIT, the scientist have made this kind of application where RFID sensor detect the diaper moisture.

So, the signal then can be send to the caregivers as an alert. So, the researchers here say that sensors can be manufactured in less than two cents, making it suitable for disposable diapers without adding bulk. So, these kinds of very low-cost applications are there.

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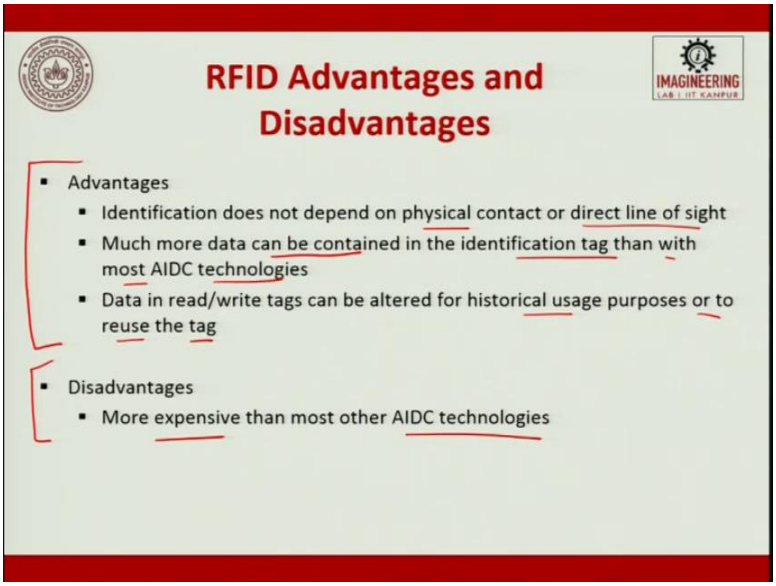

So, advantages and disadvantages. The advantages are the identification does not depend upon physical contact or direct line of sight. Much more data can be contained in the identification tag than with most AIDC technologies. The data in read/write tags can be altered for historical usage purposes or to reuse the tag. So, the data can be reused. The larger number of data can be put in here and identification does not depend upon the physical contact.

This are the major advantages of RFID. The only disadvantage is its cost. So disadvantages, it is more expensive than the other AIDC technologies but still, it is widely used because of the benefits or the advantages or the merits or the usages that it gives against the cost that is invested in it.

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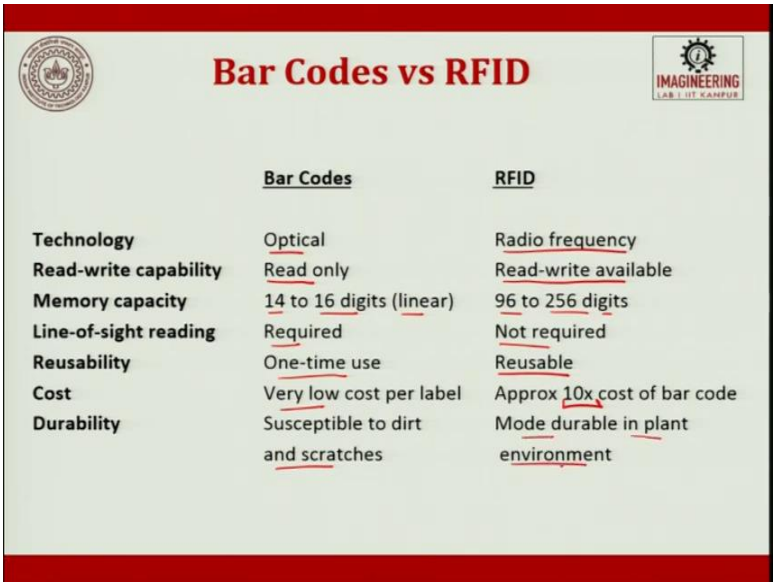

Now, a few major differences between bar codes and RFID. The technology for bar code is optical. The technology here is RF, radiofrequency. Read and write capability, the QR codes can read-only. RFID can write as well. Memory capacity is 14 to 16 digits. For linear it is 96 to 256 digits.

Line of sight-reading, it is required, not required. Reusability, QR codes are one-time use. Once the data is put in the code, the data cannot be erased, the memory cannot be erased and reused in case of barcode but in RFID, it can be reused. The cost is very low cost per label here. It is approximated ten times the cost of the bar code, RFID. Durability, barcodes are susceptible to dirt and scratches. RFID is more durable in-plant environments.

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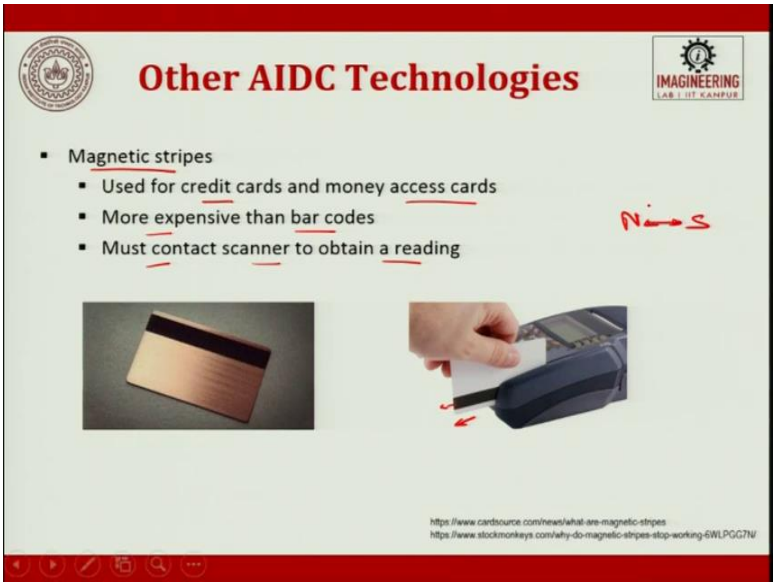

Next, other kinds of AIDC technologies. I will quickly just go with them. Magnetic strips. Now, we generally swipe the cards, what happens? This is the magnetic strips that carries data used for credit cards and money access cards. Some more expensive than bar codes. Must contact the scanner to obtain a reading. The general characteristics of these. These applications, I think you do know and the magnetic strip technology has been around for more than 40 years now and more magnetic strip cards are produced today than ever before.

However, there are still widespread misunderstanding about magnetic strips and their role in bank and gifts. So, what are these magnetic strips? These are thin layers of ferrous oxide that is applied to the surface of the card. Each oxide particle has a magnetic north and magnetic south pole. When first applied to the surface of the card, the arrangement of these particles are totally random. The strip is magnetically neutral and said to be uncoded or blank.

Now, when it is coded or when we add information to the magnetic stripe, the oxide particles are forced to align their magnetic poles in the same direction. By periodically reversing the direction of the alignment, this encoding creates a pattern of transitions between north and south of the magnetic fields. It is the transitions between the north and south pole that are read as the data. So, it is read and it is interpreted as data.

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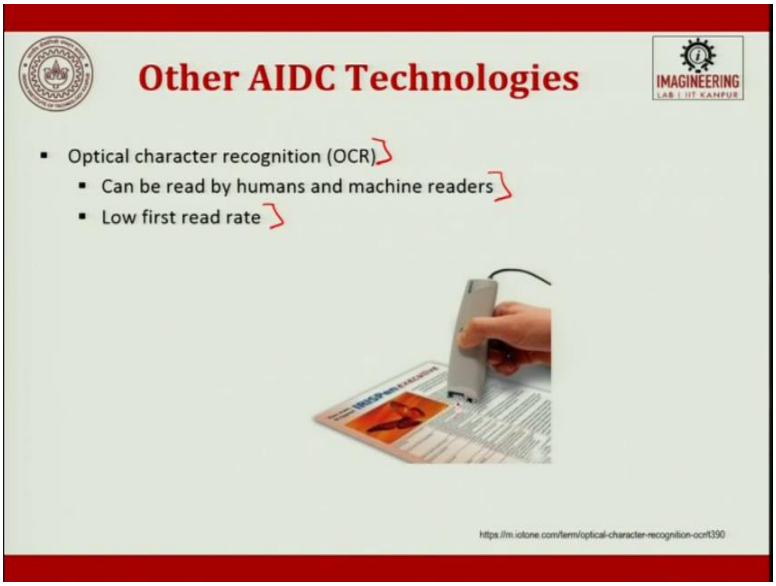

Similar to magnetic tapes, we have optical character recognition. It can be read by humans and machine readers, so it is a low first read rate. So, it is just used to read the data by humans and the data is then converted, the characters are recognized and data is converted into the soft form.

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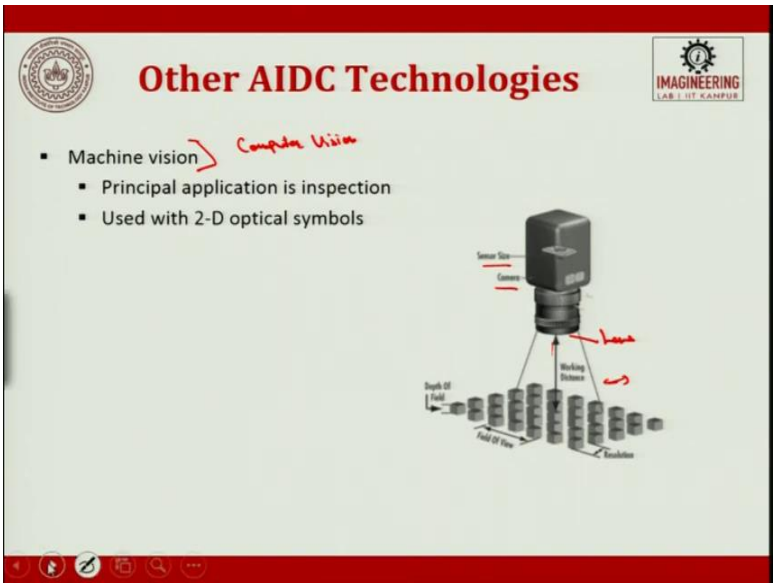

Similar to that is machine vision. Machine vision is a very wide or big topic. Similar to machine vision, we have computer vision. When we talk about robotic or artificial intelligence, computer visions come into play. Machine vision principle applications is in inspection that is what is the distance between them? What are the number of components those are there?

Then it is used with 2D optical symbols. So, machine visions also has these kinds of applications. So, there is camera and sensor that is there. Then, the machine vision system has some software algorithms, speed interfaces are higher, the lens is there. This is a lens here. So, this is a focal length and the resolutions of the length also determine what kind of data means, what kind of range does it have. Then illumination also has to be there. Then a machine environment that is cycle time, feeding system, required spaces. All those things have to be considered. So, this is just a quick view of what are these major technologies.

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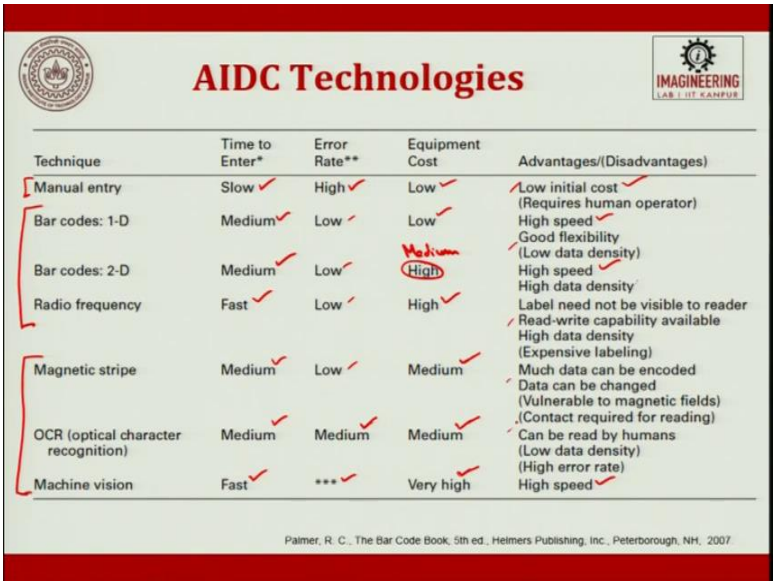

Now, a quick comparison between the technologies those are discussed. The two major technologies, which I discussed, are barcodes and radiofrequency. Other than that, we have magnetic stripes, OCR- optical character recognition, and machine vision. This is manual data entry. Obviously, this would be a slow error rate is high, the equipment cost is very low. Barcodes, if I put into a categorical form and out them in low, medium, and high, a barcode can be put as the medium in comparison to the radio frequency.

The time for radio frequency to enter data is fast. So, the time to enter data for magnetic and OCR kind of the system is also medium but machine vision is very fast. The error rate for barcodes and radiofrequency are low. For OCR, it could be medium. For machine vision, we cannot say, it depends upon the kind of the machine system that is developed. Now, the cost of the barcodes is low.

The barcode two-dimensional could be higher, it is better if I put medium here and for radio frequency, it is comparatively higher. Magnetic stripes are medium. OCR are medium.

Machine vision are very high because the complete set up has to be development and machine visions are generally used in a flexible manufacturing system or in smart manufacturing system where the whole system is controlled by the machines—by the different sets of setups, those huge machines. I will discuss this smart manufacturing when I will discuss about the plant simulation software.

Now, the advantages and disadvantages are listed. You can just have a quick look at them. So, the majorly manual entry is a low cost, these are high speed and these are also high speed. So, you can just have a quick look at this.

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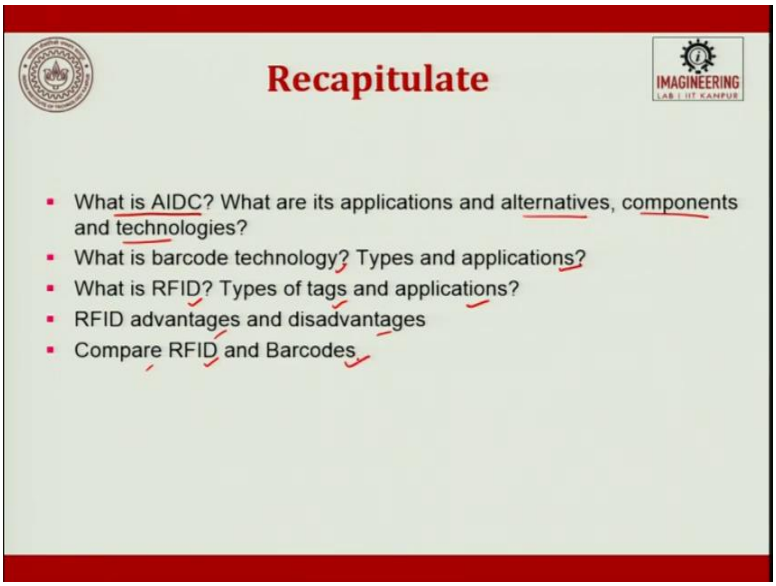

Now, to recapitulate, what we discussed in this lecture is, what are automatic identification and data capture? What are its applications and alternatives, components, and technologies? What is barcode technology and their applications? What is radio frequency identification? The types of tags and applications.

Radiofrequency identification advantages and disadvantages. Then we compared radio frequency identification and bar codes. Also, we discussed about the other technologies such as magnetic stripes, OCR, and machine vision. So this is all about automatic identification. We will meet in the next week and discuss more on the course, Computer Integrated Manufacturing. Thank you.