INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NPTEL
NPTEL ONLINE CERTIFICATION COURES

Digital Image Processing of Remote Sensing Data

Lecture – 04
Image Characteristics and Different Resolutions in Remote Sensing

Dr. Arun K. Saraf
Department of Earth Sciences
Indian Institute of Technology Roorkee

Hello everyone and welcome to this fourth lecture on the course digital image processing of remote sensing data. In this lecture we will be mainly discussing the image characteristics and different resolutions in remote sensing very briefly these things we have already discuss but in this particular topic I will be going in much detail and this slide you have already seen in very first lecture a picture tells 1000 words and a satellite image tells 10,000 words.

(Refer Slide Time: 00:53)

So after going this and the lecture that is digital image processing the introduction now you might have realize that yes, a satellite image can tell 1000 words after the processing analysis

and interpretations and inferences, so lot of inferences can be made so that is why I am repeating this particular slide and new few more slides, because now we know that what we are going to do and digital image processing in very brief I have discussed in previous lecture.

But in later lectures we will be discussing so a picture tell 1000 words and satellite image can tell 10,000 words which we will be realizing one after another throughout this course and because digital image processing through digital image processing we can improve the images to a very large extend and this is happening. Also we have and there are two things which I want to re-emphasis here.

One first, one has to understand what is basically an image and second is the unit of an image in brief we have discussed this things in very first lecture that image is a pictorial representation but it is fine now let us considered mainly the image which is being a quite by a satellite sensor or a sensor on board of a satellite. So we are now not just built it, not discuss any other source of image except the satellite based.

So you know that there are various types of scanning process or non scanning process or various aquagestions system are there and that is why in this particular lecture many slides will we repeated but because it was very much required so that the in between the lectures which we have covered now we can go and focus mainly on the satellite based and digital image processing.

Because digital image processing are in different fields in electronics digital image processing meaning one together different in medical science digital image processing is all together different whereas in this remote sensing and digital image processing or remote sensing data is different. Though fundamentally our from the background in the mathematics which is in the background might be same but the purposes are different and therefore the sequence of image processing and the handling and different steps are all together different.

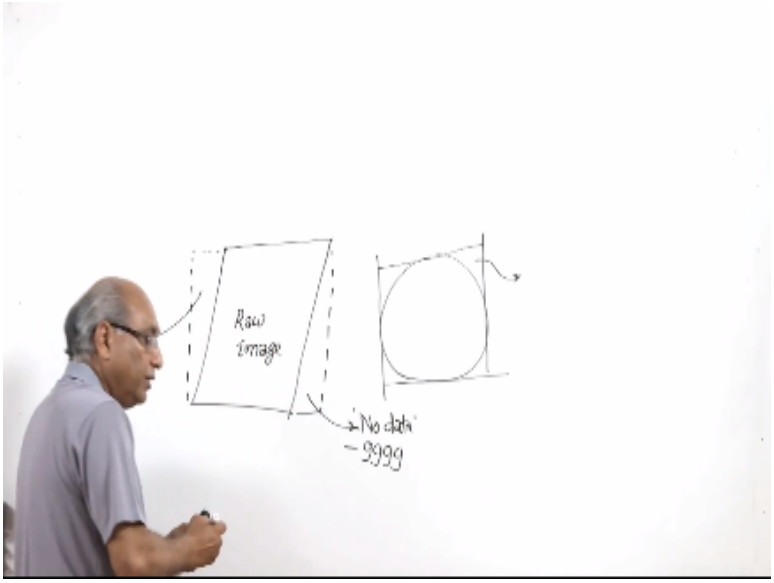
Like in may be in image classification may not be required in electronics or in medical imaging but image classification is very much required in remote sensing application so that is why we would like to discuss this thing. So one say satellite has acquired an image of any resolution let us take example of 80m resolution from land side MSS and when it has a quite why the sensor

transmitted by the satellite has reached to a system then you must understand that image is a two dimensional matrix and each cell of this matrix which we call as pixel will have one pixel value.

And depending on the radiometric resolution these pixel values will vary and also these pixel values will vary because they depends on the, if we are talking about the visible channel data then they will depend on the reflectivity of the objects in the sun solar lights or solar illumination. So and unit of an image just a pixel, so these things have to be remembered and again I am repeating that this will make things very clear that the overall shape of an image can be either rectangular or a square.

But the unit is always a square that means pixel will represent a square part of the land and let me show you one example here.

(Refer Slide Time: 05:21)



That if you see raw satellite image what you would find that it is having something like this kind of appearance. Now you might say that you told me that an image overall shape of an image either can be rectangular or a square but this image is appearing not exactly like a square or rectangular. But in computers the image will always as I have mentioned the image will always be stored either rectangular or a square.

So rest of the areas these areas will have the no data, no data is also a data but it is the data which is note that kind of pixel value will not exist within that image, so the system or the program the image processing program can identify this thing very easily. So that is why an image on your

screen a raw image on your might appear like this but actually the image in the computer is stored in a rectangular or a square fashion.

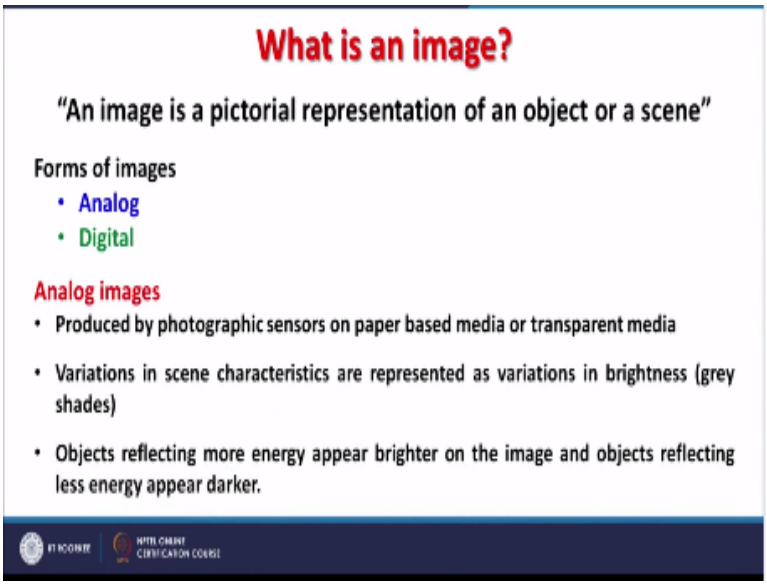
So this one should make very clear, the same scenario I can take an image might be appearing like this but if you see very carefully you will find that image has been stored as a square, so this area will go as no data and no data is a very good concept to represent the areas where basically the pixel values are there which, but they are very different then what within the images are so no data values might be, can be declared to the system that if the system and counters any pixel value say for example -9999.

Then consider as any no data, and do not include an image processing so this is how that is why we see different because the screen generally is having the black back ground and if we assign to no data values the 0 or the bad value then we do not see this area rectangular this area we only see the image part. So but overall shape of an image can only be square or rectangular this is very important one to understand.

And second is that the unit of an image will always be square, so this will be always be squared in the mean if I enlarge it this is always square, now when we say space resolution say if I took the example of lens certain masses say 80 m resolution we only mention only the one side of this we do not mention that 80 m Y 80 m is a 80 m, if it is a 10 m wide 10 m we say 10 m resolution.

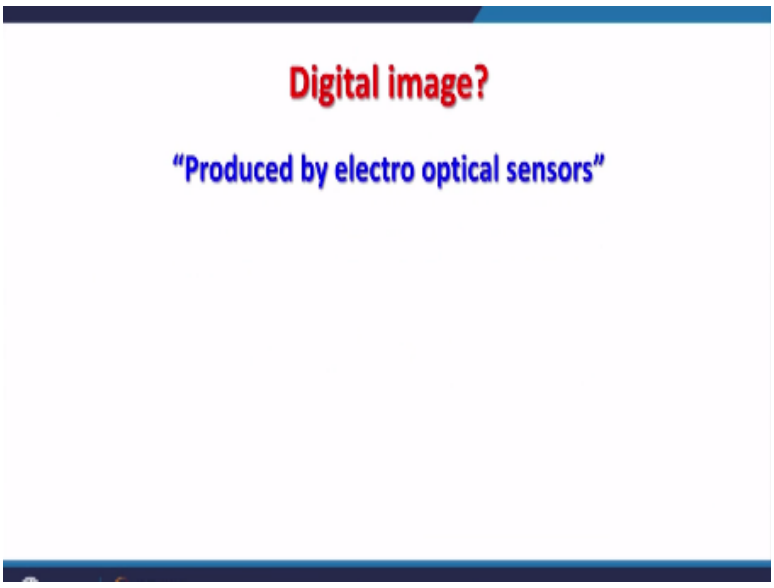
But what it is representing basically see in this example 10 m wide, 10 m it is representing 100^2 m area but in sing we say 10 m resolution so we because we assume or underrated I have understood that the over a shape of a unit that is pixel will always square so only one value while telling about this spatial resolution is very much sufficient. We have also discus.

(Refer Slide Time: 09:09)



The different images analog and digital now we are only we will talk only the digital images note we will not talk the analog images.

(Refer Slide Time: 09:17)



And digital images we have seen now we have discussed different type of sensors so may be electro optical sensors or may be just simple CCT's at area of CCT's which we have seen through in some scanners along track across track scanners they acquire the data there are now lot of innovations are happening, in scanning system as well especially which are going onboard of different certain lights so that so that the better quality digital image with the minimum signal to noise ratio or can be acquired so that the processing is reduced and things can be this I have already discussed and which I have already read now in what we have find in different literature on different discussions people call different things different numbers.

Somebody would like to pixel value they call as digital numbers somebody like to mention a brightness value so depending on the type of you know type of a image or a bend bay of bitch a it is representing the EM part the electromagnetic part of spectrum, so if I am talking a say for example a thermal image then the pixel value becomes my brightness temperature but if I am talking a visible image or image belongs to the visual part of EMS spectrum then I am talking about the reflectivity.

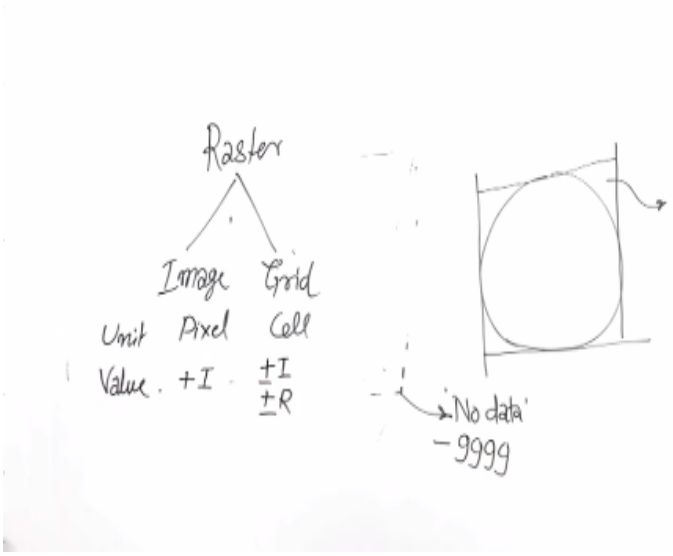
So brightness value can be there or overall people say is a digital number or very common address to this can be pixel value some people use grey levels but grey levels restrict us only for black and white images but when we go for color then this term grey label cannot be used, so therefore one as to be careful why I mentioning this things, same with our pixel because if we look from computer concept point of view.

A raster will have a cell value and in image we call the unit of raster is a cell whereas in case of image the unit of an image is a pixel so once we say pixel that means I am talking about an image not a simple raster they are it is whenever we say raster or we say cell value that means I am talking about a grade or some other type of raster note it and a certain light image, so pixel always is associated with an image.

Where pixel value will be always positive integer value this one has to remember the pixel value or digital number or brightness value or brightness temperature or grey level any name you give but the value it will have always a positive integer values so these are the mind details one has to remember to better understand the different steps in digital image processing, I have been mentioning digital image so this is raster.

Because raster can have two types of raster basically and one raster which we are having is which raster we can.

(Refer Slide Time: 12:44)



Have two types so one is image which we are discussing a digital image of course and then another is the grid, so in case of image the unit is pixel but in case of grid we call as cell, here the values the cell values the pixel values only positive integers whereas in case of a grid that means the cell values of a grid can vary we can have positive and negative integers as well as positive and negative real value.

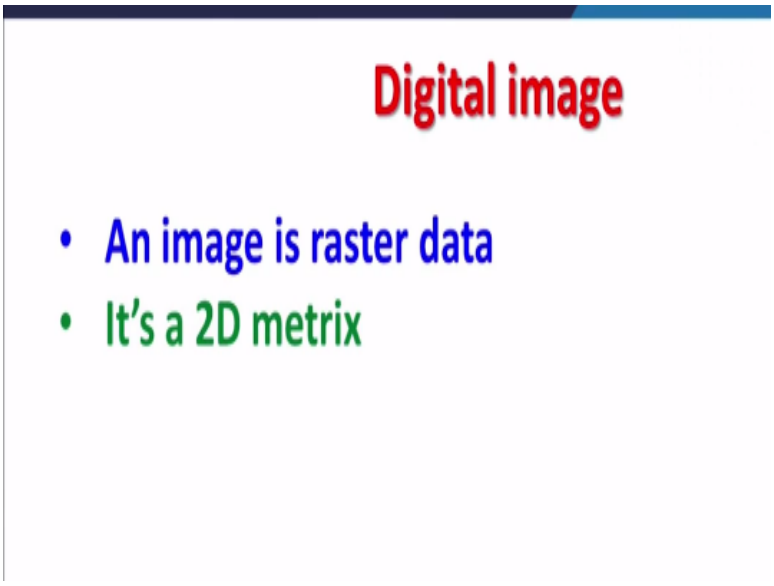
So that means the range which is provide by the grid overall raster is much bigger there but here but it is deliberate because an image cannot have any that value and it becomes much easier o process such data whereas if you want to have a grid and a both is raster and we want to process

the lot of theory is required in the digital image processing program, so this is another important thing which one has to remember is a that grid can have.

And the best example of a the most common data which we use in remote sensing or in GIS domain is digital elevation model. Because in digital elevation model if the digital elevation model belongs to a coastal area where the cell values can have you in minus values because they may be below c level and there will be values in coastal areas which are positive barriers and if we restrict only two integer values.
Then you are having problem in case of a digital elevation model or in case of grid that mean we I cannot go for higher position and that means I cannot have a elevation value of 1.5 m or 100.25 m so if because that we know that our pixel values can have only a positive integer so no decimal or no procedure is required in this case but in case of grid the procedure is required so therefore the entire storage processing.

Everything is different in case of grid as comparably but remember both are raster so that is why it is important to discuss here it is a 2 dimensional matrix.

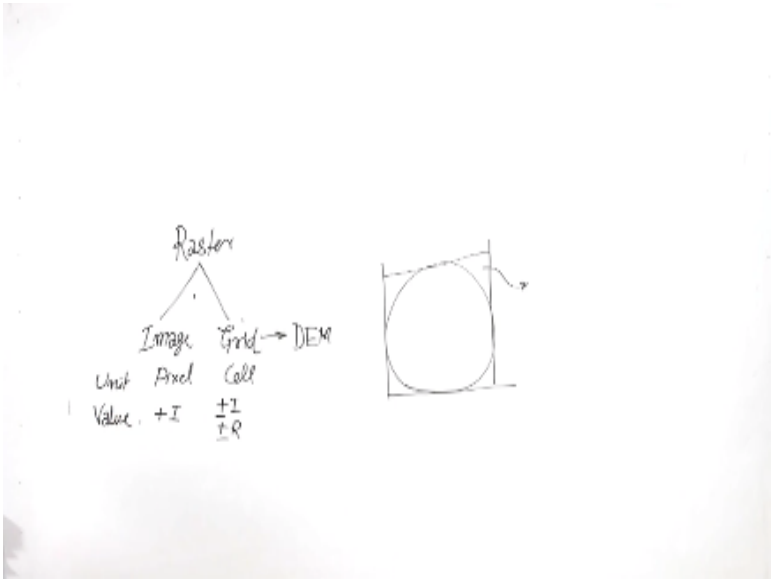
(Refer Slide Time: 15:28)



The side again has appeared in the first lecture but I am taking again because now I say different kind of discussion may be in the topics or the lines which we are appearing is the same, is it two dimensional matrix you know by in this is a matrix is a branch of mathematics or part of mathematics now this 2 dimensional matrix so whatever the processing techniques which exists

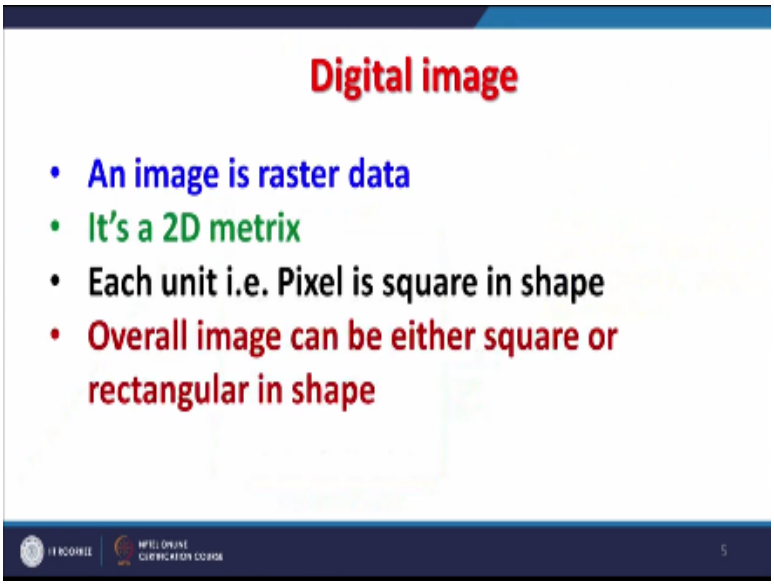
in mathematical domain it is very easy to import in digital image processing and that is why and if we are handling only positive integer values in case of our satellite images.

(Refer Slide Time: 16:10)



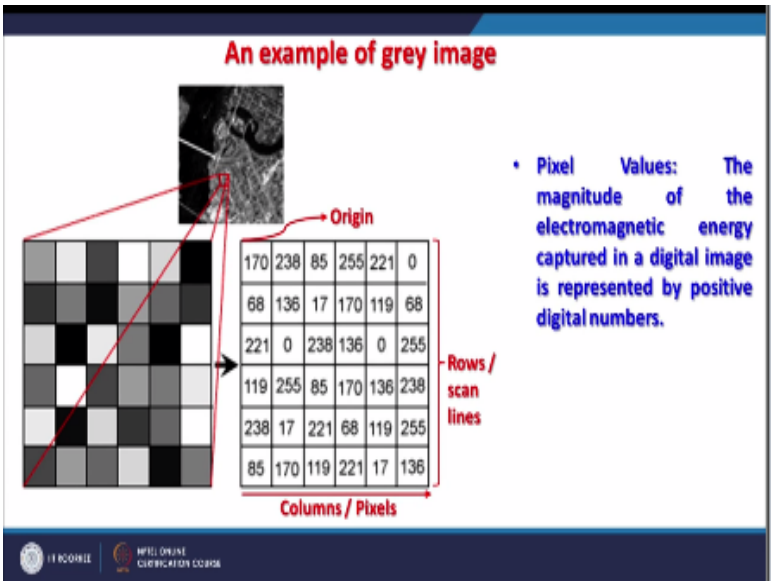
It becomes little easier rather than and the great values so two dimensional handling of two dimensional matrix is a relatively now a day's easier through software and therefore it is employed here now we have already we will discuss this thing that inch and the unit here is pixel and always it is square in sheet overall.

(Refer Slide Time: 16:36)



We have also discuss that can be square or rectangular and this slide is again appearing as I because one has to remember that the pixel values.

(Refer Slide Time: 16:45)

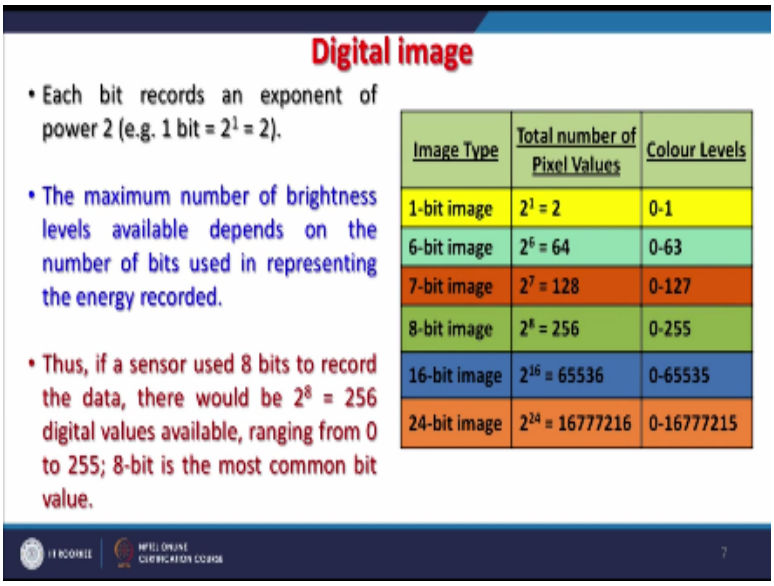


Also that here for demonstration they are shown here but basically when you display and image neither the pixel values are shown they are on inside the computer only that the great that and the pixels are shown and they are all though for they these are shown into dimensional matrix if you are having a Panchromatic image and then only then they will appear in the black and white if it is 8 bit then the maximum shades of grade you can have an image is a R256 that means the values can vary between o to 255 and rest to in fall in between and no lines will appear no lines will be appear just simple image.

As you can see here but for just demonstration and better understanding these lines or these grade by a line grid that been over late to understand things of course the values are no displayed but values are the back bone so they basically through a concept of LUT look up Tin these values are converted to shades of grade or colors so to the concept LUT in which we will discuss later and that this is a digital numbers will or the pixel values or shades or colors will come according to what is the metric resolution of an image if it is 8 bit image then as I mentioning here that you might have the shade one.

One shade out of that pallet of 256 colors or shades in case of a 24 bits image we can have very large number of colors.

(Refer Slide Time: 18:35)

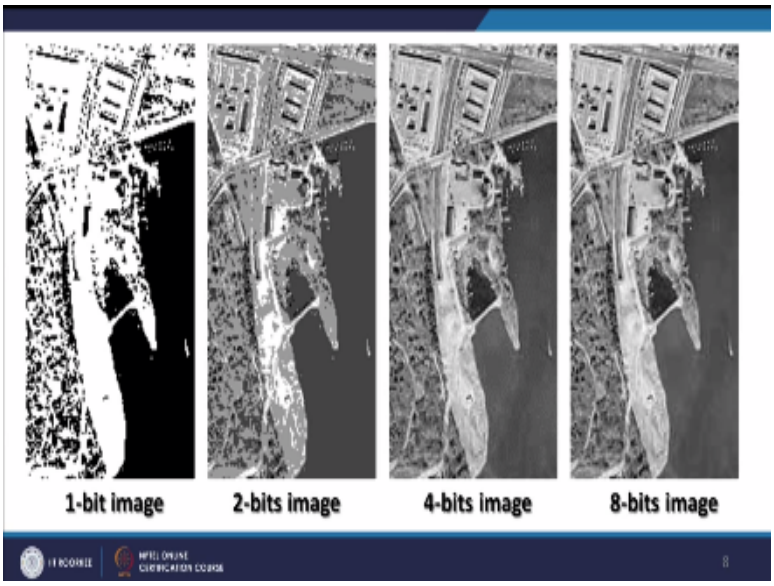


And a that day comes from about a you know 65000 and a 500 sorry this we can have for 8 but 256 for 24 bits 1.6 within colors and our standard falls color composite image is which we prepare using three bands out of a multi spectral data shades carry a large pallet that does not that if single image will always have all these colors present in the single image not at all the pallet is available and this valid through look up to we will depending on the pixel values will be picked up different colors and are displayed on your screen.

So this is another important thing is that depending on the bit size or the radio metric resolution and this is done as you that this radio metric resolution is improving at a quite nicely or very highlight there is a space resolution of remote sensing data but there are constrains with other resolutions which we will be discussing little later so this is the pallet is available that depending on the image and the objects which are present reflectivity or imensitivity in any color for a particular pixel can be picked up out of this pallet.

So it is more than say I am repeating is not necessary that each image in a 24 bit image it will have 1.6 million colors not at all the pallet is available it will pick up as for depending on the pixel values and this is the example earlier also we have discuss.

(Refer Slide Time: 20:26)



That a one bit image is just having black and white two extreme numbers and nothing in between where is in two you are having something in the fore few more have been added and a standard 8 bit you are having a pallet available of 256 rates here and image quality as improved tremendously this 8 bit is more or less standard in various digital image processing software's as well as with your satellite it one other important thing I want to bring here and your discussion that like a when we started getting from higher rays.

The higher rays one you when the panchromatic data which was in 6 bits if you recall this one then we had a only 6 bit data that our digital image processing are have been design to handle of 8 bits data so it is very easily to always a scale up or a scale down like here in this example the scale down has been happen but remember if I reasonably if I am having just one bit image I cannot convert that image the own computers I will store as 8 bits image but the quality will not be improved.

So from higher bits I can always go for lower bits but from lower bits image I can never go to higher bits image so this one has to remember but in digital image processing when the handled the images in 8 bits so the same 6 bits image is handled as a 8 bit image but the image quality is not improved but in case of image quality can be due rate it much is here but image quality cannot be improved and same discussion we can also have related with the special resolution what I am trying to say is that.

Suppose I am having an image which is representing 1km resolution no heavier are the best example 1.1km that means the 1100m 1 pixel is representing 100m / 1100m of the area of the

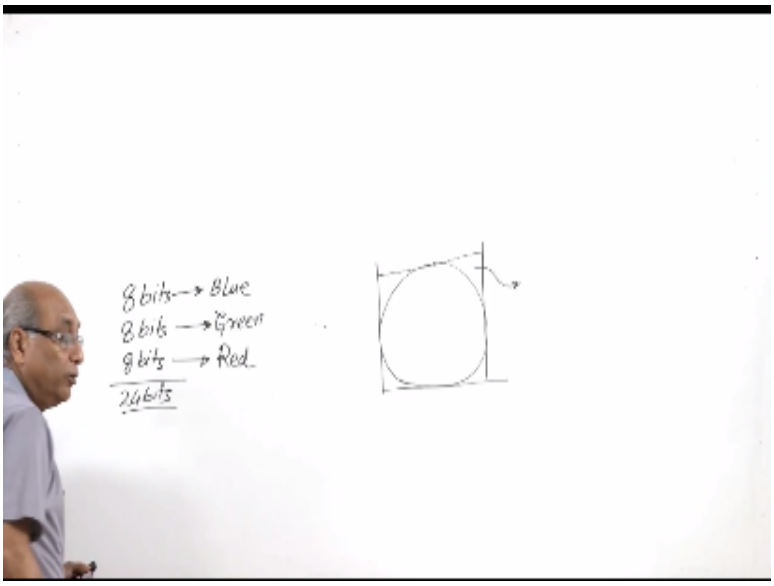
ground or surface of the earth now using this data and using any types of digital image processing techniques either based on artificial intelligence or neuron network or fuzzy lossy I cannot improve the special resolution that means just taking a roughly 1km resolution data that is 100m resolution data.

And I cannot convert or bring that image at 1m resolution however reverse is possible so resolutions once the image has been required any kind of resolution cannot be improved to duration can be done as per our requirements or the handling which is done by the image processing system but improvements on a special resolution on radio metric resolution on temporal resolutions or a spectral resolution cannot be done at all spo this is a just one way process that is why this image is being repeated again in our discussion and they saying that this was the original image.

Was used to create these images that does not mean that first one that this image was used to create this 8 bit image no this way have to write we cannot go but write to right to left we can always go. So we can derivate the quality of the image but we cannot improve the quality of an image in terms of bit and in terms of special resolution once the image has been required by the satellites, this has to be remembered very carefully, because otherwise people will claim that they have improved the special resolution.

Once the area has been required by the device then the special resolution by no means can be improved. Otherwise there would not been a need of launch of many satellites and then there 1km special resolution data which is coming from the nova hrr can be used to create a 100m resolution data or even 10cm special resolution data not possible. So only there is one way that you can diorite the quality you can do the sub sampling but you cannot improve the quality. Now I am coming to the color composite for here to make further clear on this 24 bit concept because basically it adds a single image and one single image in a bit.

(Refer Slide Time: 25:29)



When you a single image is a 8 bit and say I have assigned blue color to this one as in the slide also shown. Another band which is also showing 8 bits I assigned green color to this and then the third one I am having the 8 bits again this channel might be my infrared channel. Here the vegetation is having healthy vegetation might have very good reflection and I assigned the red color. Now I add this it becomes 24bits. One can argue why are we adding why do not we multiply because remember these three color shown here these three color are shown just shown for our better understanding.

The word is additive color synthesis. This is very important for creating color composites because here we are adding 8 bits +bits+8bits that become 24c bits. We do not go for multiplication, so remember this is because we are following a additive color scheme, no one can say there can be subtractive color scheme. Subtractive color scheme also exists for displayed devices subtractive color scheme is not used. Always we use 3 primary color and additive color is used. Subtractive color scheme is used for printing devices and there for example if you are having a color raiser printer or a inkjet color printer you might notice that there are four cottages.

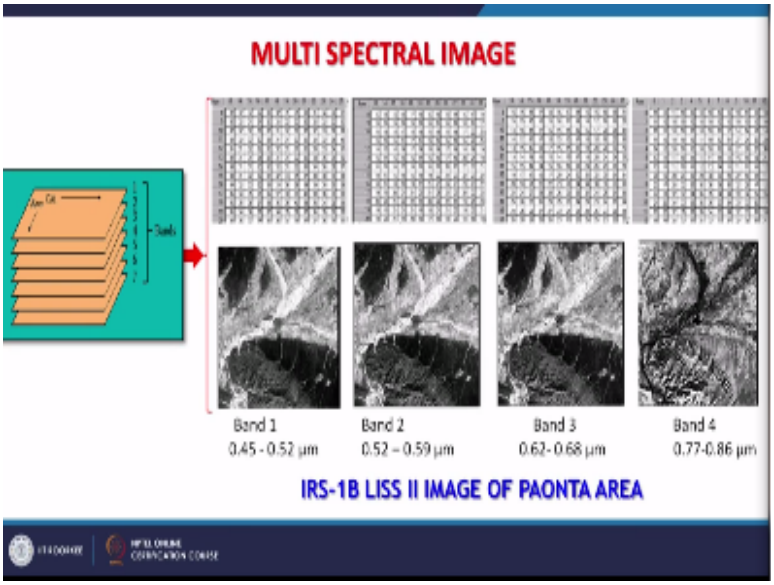
One sign, magenta, yellow, and black, so that means three secondary color are important the forth one kept as black if you subtract these color from each other you will end up with black, so why to waste these tree color if the black lines or black things need to be printed , so directly the black color will be used. Two different schemes are used additive color schemes are used for display purposes and subtractive color used for printing devices.

You might notice in news paper at the bottom either in the left corner or right corner you will notice 4 dots in 4 different colors. Why they print that anybody can change the quality of printing. If all four colors are appearing properly then the automatically it means the quality of printing I quite good, if any one color is missing then you will not see a poorer color image. So there for printing you use subtractive color scheme you have used additive color scheme.

We add this 8+8+8 otherwise one can think why not multiply or subtract. Subtraction color scheme is used for different purposes but in the digital processing except for printing in this case we always use color scheme. So that is why there is a repetition of slide. Now because we are going for higher and higher spectral resolution and therefore number of channels are increasing. However at the same time that width of the channel is reducing and this is very important.

That we are having more choices to pick them bands by making a color composite and which one top pick might require a better understanding about the spectral of different objects for which we are targeting. I am focusing on vegetation point then I have to remember the spectral vegetation and accordingly I will choose a channel. An example here the

(Refer Slide Time: 29:50)



They are seven channels are there that means the same area has been scanned using different parts and different bands spectrum and therefore the objects in the spectrum might appear

differently, so only 4 are shown here and not the seven are shown here but first three you might not notice much difference, because they are belonging to more visible or digital part of spectrum and in panchromatic censor combined all three, so it is a broad and band censor where as in multi spectrum we have three or four bands within the visible part of spectrum.

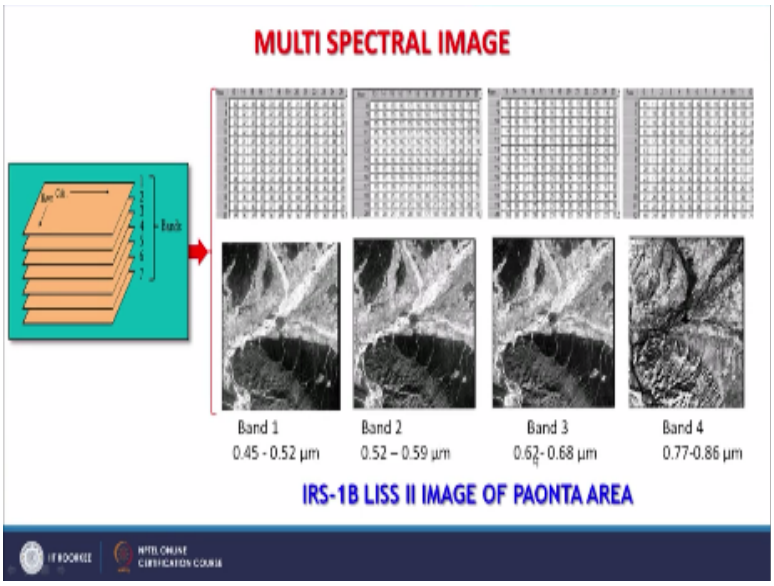
The example is given over here that 4.52 and .52 .59 and .62 to .68 and another important thing is it is not necessary the width of the each band within the censor has to be same. Depending on of which part of spectrum is been covered the breath will varied it depends on the sensitivity remember it depends on the sensitivity in the thermal part the sensitivity is less that means the energy is which is reaching to the sensor is known not sufficient and therefore we need to the throughout bend so that it can detected by the sensor so depending were we the sensitivity highs less and when it thermally designed now.

In the earlier case is case says the I am giving the example of length side Male speaker: and where the bends were and 0. 045b to 0.55 so that means that only the difference of the point and in the one point micrometer was there but you are tell we see it is not like this so people learned through the expel through the first launch of its salaried and lens settle is not equal and the next bend was not 2.5 65 and so on.

So the bend was kept equal the bend was behave the such instrmatically manner therefore letter is on the realize that depending on the their sensitivity it should design our bend with therefore thing be developed which is hyper aspect so in the case of hyper aspect spectral the spectrum of me spectrum a large pawed ware seeing different bends on the different bend even in the case of seven bends.

But now a days it is a one different field of emotions being covered in the continuous the massive affection that means you don’t have segmental expectations from like one bend and another bend and so on so far like here between the bends there is a gap as well as you can notice the highest value is0.59 the net is there is gap and this gap is know that in the case hyper aspect.

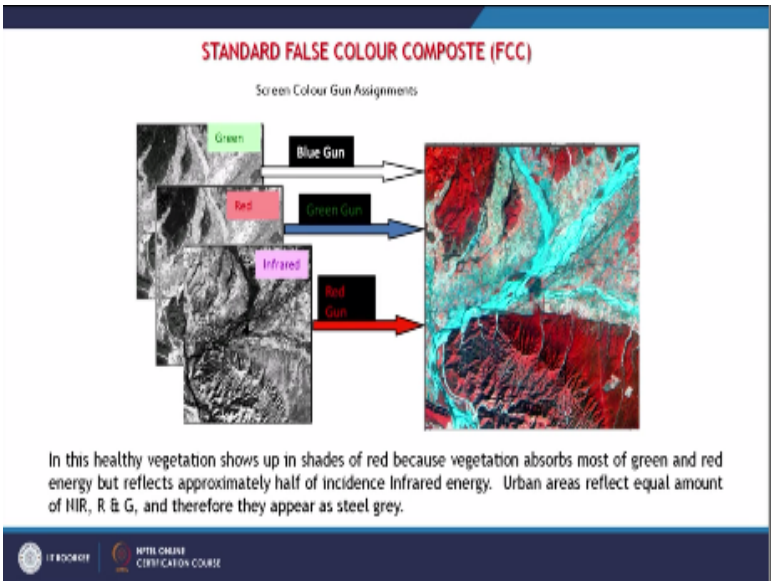
(Refer Slide Time: 33:36)



And this gap is not in the hyper it is continuous which we are continued infra red channel in colored the green which belongs to the spectrum and red so the red part green collogue are assigned blue color now one can urge what happen to the blue color s very close to the ultra violet and since in the three color we can give red channels the earth.

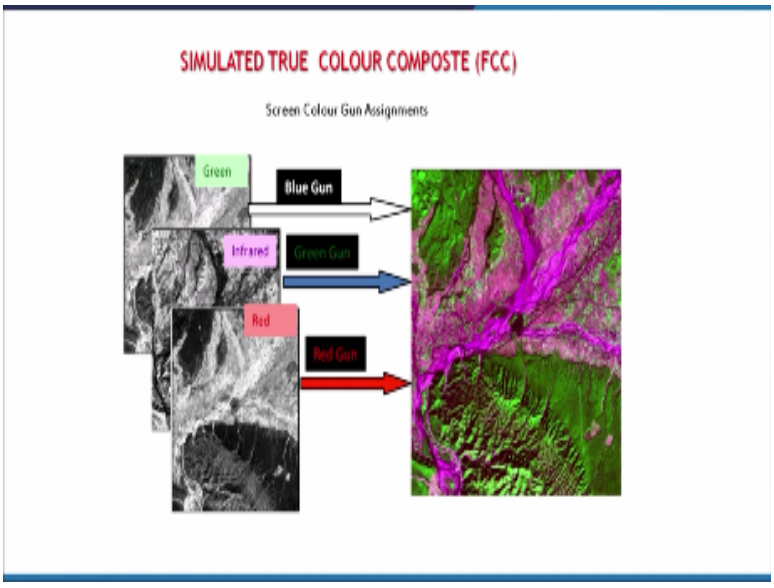
We have a standard color composer it which as followed and I when writes and it compose t automatically compose it is the green and red which is belongs to the visible part of the spectrum assigned blue color is a signed as well as me spectrum a signed and in infra redcaps a sighed red color and therefore the vegetation health vegetation will appear in bright red and people explode this thing.

(Refer Slide Time: 35:28)



If the vegetation is not healthy because of some reason the shortage of water and some disease and for fire as things then the this color will change the vegetation in the infrared change and that can be used in the understand all this thing so this is very another in is that is simulated through color composite it here will see.

(Refer Slide Time: 35:56)



And it is tried to true color to compose it also the false color and in the true color we compose it the great the first one is the same that the green bend assigned in blue color we us instead of the red when we are infra red which we are signed in the red cooler red cooler and the green color there is a inter change and that inter change we will bring there is a vegetation is appearing as a green for vegetation it is alright.

The rest of the object therefore in the true cooler green there is you know hyper to create a true color image in the in the India such a own image there is no infra red our eyes are not send we see the geek kind of image green brown and many kind of image and the part of the land but even the vegetation will appear in the green health in the settled image because here a know me is there the infra red channel if bringing many changes in your image.

This resolution parts we have discussed already so that it is basically bring to now end of this presentation the image has to be understood one and the unit of the image as to underestimate these are two important things which will help us when we discuss the digital image processing thank you very much.

For Further Derails Contact

Coordinator, Educational technology cell
Indian Institute of Technology Roorkee
Roorkee- 247 667
E Mai: etcell.iitrke@gamil.com, etcell@iitr.ernet.in
Website: www.iitr.ac.in/centers/ETC, www.nptel.ac.in

Web operations
Dr. Nibediata Bisoyi
Neetesh Kumar
Jitender Kumar
Vivek Kumar
Production Team
Sarath.K
Pamkaj Saini
Arun.S

Camera
Mohan Raj
Online Editing
Jithin. K
Video editing
Jithin. K
Graphics
Binoy. V. P

NPTEL Coordinator
Prof. B. K. Gandhi