Remote Sensing essentials
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Lecture-24
Image Enhancement Techniques-1

Hello everyone and welcome to this new discussion on this remote sensing essential course which is image enhancement techniques 1. Some of the slides which you might see are being repeated here but it was essential to have those slides again and we will have now discussion because we have seen some demonstration and we have also seen some image enhancement technique, colour space and other things.

So now we can understand these things in much better way therefore this repetition might be there of the slides.

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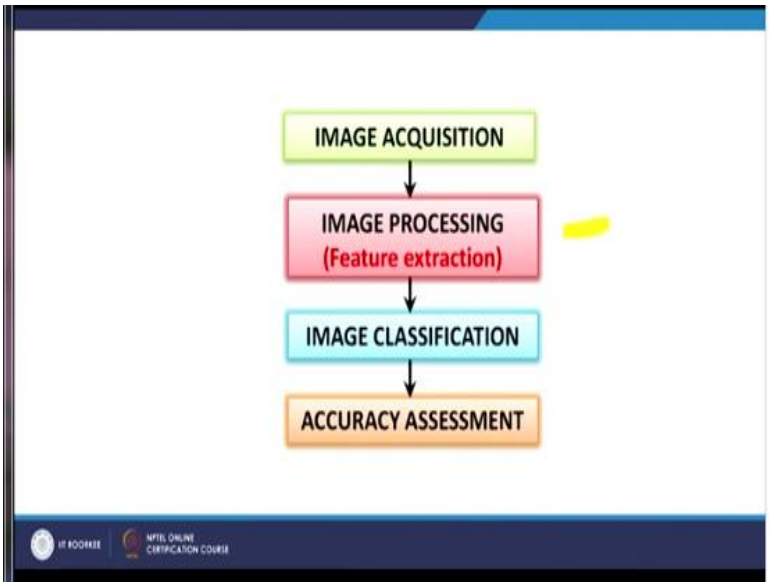

But note the content or discussion part, as you know that after image acquisition the main focus here is now image processing. Ultimately we are interested in feature extraction through classification and then we go for accuracy assessments also.

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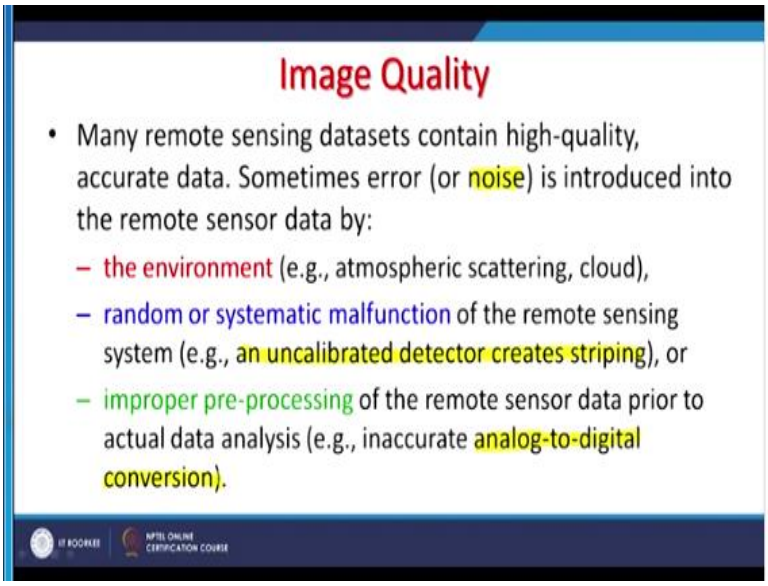

Now image quality when we say image quality there are many aspects in it not only the noise which is present in the data in the previous demonstration of the software of the DIPS digital image processing simulator. We have seen 2 types of noises, one is complete line being dropped and another noise which we saw in our data. In that example data was a salt and pepper kind of that one pixel is having 0 value, the next pixel in the same line is having 255 value and likewise you are having.

You know these are electronic devices though before launching putting on the satellite and launching all kinds of testing goes on. But sometimes because of when they are in a space in the environment is completely different. Then what you are having on earth and therefore, sometimes because of some other reasons they may go bad and may start giving some data.

Sometimes these noises are not permanent only for few scenes, few days you are having noises in the data, errors in the data and later on it is corrected also. But sometimes it does not happen I remember a scenario especially it happens in case of thermal infrared channels that when it is over passing a very high temperature feature of the ground. Like for example, over a volcano it is very high temperature values and that the sensor it you know itself saturates for some time and a start giving noise after that.

And once it cool down after some time it starts again functioning well. So it is not necessary that these sensors will have noise errors permanently. Sometimes these errors comes and goes that is why they are put in sometimes in the none systematic errors and sometime systematic error**.** Systematic errors are easier rather easier to remove them routines can be developed, softwares can be developed and these can be removed.

But none systematic errors have to be dealt separately completely separately. So when we say image quality, the quality data that means say it is not only the accuracy part that may come through either geographic or georeferencing or geometric corrections or that might be because of noise or less noise in the data or high quality data or distortions introduced by the atmosphere, that is the biggest problem in the remote sensing data.

And so these kind of if these are less then we can expect a high quality accurate remote sensing data. I also in the previous discussion one day I told you that there are chances that in a very highly polluted environment atmospheric conditions once there is a rain and then suddenly things becomes very clear and if that time the data has been acquired by over passing satellite.

Then that image is very, very clean generally because all these atmospheric constituents or timing have been settled because of rain and sky is clear. So then things the atmosphere is clear and then we get a very high quality data from even the same sensor which was earlier giving you know the poor quality data. So sometimes these are not permanent sometimes these keep changing.

And the environment or the atmosphere between sensor and earth plays very, very important role. There are scattering phenomena, there are absorption phenomena, clouds, water droplets, gases which creates a absorption, reflection, scattering in different part of EM spectrum and may create a noises. Random or systematic malfunctions are there, random or difficult and sometimes for example uncalibrated detected creates striping.

Generally it used to happen in earlier sensor technology but now these calibrations have improved very significantly and it is not very common now to see this striping effects. But

anytime the some sensors within a airy can go bad and then you start seeing the stripping. So everything is not all the time reliable in that sense also when we discuss about pre processing of the remote sensing data.

Then there might be some errors might be introduced at during that stage also. So like for example because sometimes the images are converted easily from analogue to digital format conversion. And there might be some error introduced during that time and few more things affects the image quality. So if almost all these things have been removed then the image becomes of very high quality.

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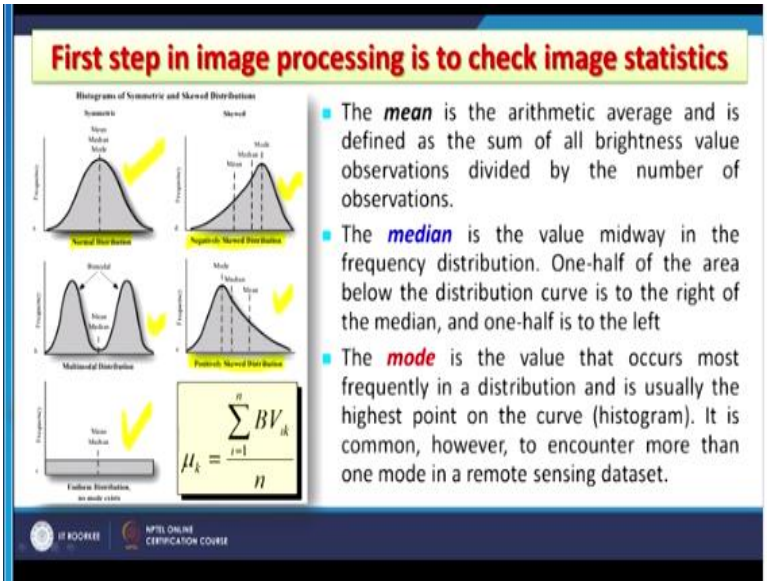

But it is not so easy to do it, again this part we have already seen these slides. But as I have said that whenever you are looking for quality image how you can assess that image is having quality is by going through the histogram. If the distribution is normal distribution, a Gaussian distribution, well shaped throughout the dynamic range say 8 bit scenario 0 to 255, if that is there.

Then definitely that image seems to be of very high quality but if you get other scenarios which are shown like this one or this one**.** Then maybe the image is not of very high quality. So one has to see the histogram is not direct indicator of the quality but the distribution of pixel values on this by scale between 0 to 255 can tell something about the quality.

Also the position of median, mode and mean will also give you some indications about the quality of an image where they are concentrated. Like for example, here negatively skewed distribution we are seeing. Here we are seeing the positively skewed distribution. So the pixel values because of absorption or a scattering the pixel values are shifting where there should not have been.

And they are changing the position it is not a normal distribution and we can guess that probably image quality is not good. So we expect most of the time we expect that there should be a normal proper distribution and the position of mean, median and mode in this histogram should be in like in the first example. But it is not necessary all the time though image can have the quality data but a still the histogram may different.

So it is not the sole indicator of image quality, there are some other parameters on which image quality is assessed.

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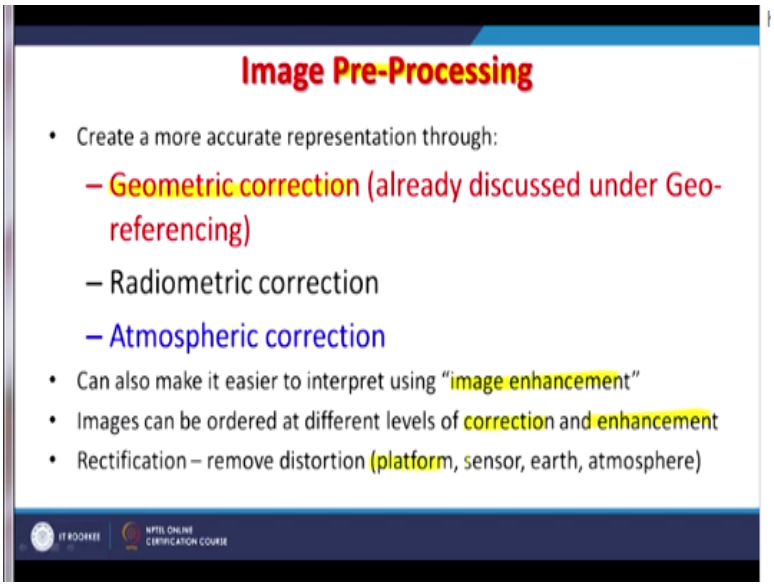

Now how to you know accurately represent these images once we get the data in a pre processing stage. Today previous to previous discussion about geometric corrections that come under the image pre processing step which we have already discussed. As you know that better

and accurate the geo referencing is done that will be better in further processing or further utilization of that image or datasets.

So the geometric corrections or geo referencing plays very, very important role in remote sensing as well as in GIS. So when one is doing these things, one has to take all care, so that we achieve a very good geo referencing. There might be some question that when we say the geo referencing is very good. So that root mean square error the sum of root mean square error which we discussed in the geo referencing discussion should be within pixel.

So if your spatial resolution of the satellite image on which you are performing geo referencing is having 10 meter spatial resolution. Then your sum of root mean square RMS should be less than 10. If you can achieve by iteration process that you identify GCPS and you find that it is giving high error you delete it, recollected, change the location again identify a new GCP.

And if keep doing and spend some time one and collect more GCPS then minimum required. Then probably you can achieve a high geo referencing within one pixel and within of course, pixel is the unit of an image it is individual you cannot see inside, you cannot do anything. So within one pixel if the root mean square error, some of root mean square error is coming like that, then it is very good geo referencing can be considered as a very standard one.

So while doing a geometric corrections or georeferencing utmost care must be done because that image will be used later on with other data sets, which are also geo referenced. And if there are some mismatches wrong geometric corrections have been done wrong geo referencing has been done, then you may end up with the wrong results. Because a error propagates in digital image processing as well like in GIS.

So one has to control these errors, so that results remain highly reliable. Another thing is radiometric corrections, radiometric correction generally are not done by the user these are done by the agencies who acquire the data. And they know that how the different sensors in an area are working, which one is under performing, which is over performing and that they, you know the correct the images doing the radiometric correction.

But again as a user and especially when you are going to use these images for quantitative analysis. For qualitative analysis one may still you know give a less emphasis on radiometric or atmospheric corrections. But if somebody is going for quantitative analysis then one must know that whether radiometric corrections have been performed on your input images or not.

Similarly atmospheric corrections have been performed or not that we have also seen earlier. And this makes a this is easier the image enhancement and then of course, once you have improved the quality of an image by going through these processes and plus some enhancement. And then the image becomes much more interpretable much more usable.

And as also you know sometimes we ourselves may not be having capabilities or only for in a certain project we require once or twice the images. Then our selves may not be doing corrections enhancement, we can ask the supplying agency. Like in India, NDC of an RSA and to do these corrections, do the geo referencing, do the radiometric correction do the atmospheric correction and give the product well.

Of course that product is going to be very expensive but nonetheless such things can also be done by the rectifications. Of course removed distortions and either because of platform movement due to might be sensor earth rotation or atmospheric distortions. So as far as possible all these errors must be removed before we go for any quantitative or qualitative analysis.

Especially I am talking about quantitative analysis a de-striping, noise removal, we have just seen the demonstration through the DIP software. So very quickly I will go that radiometric corrections or de-stripping is done.

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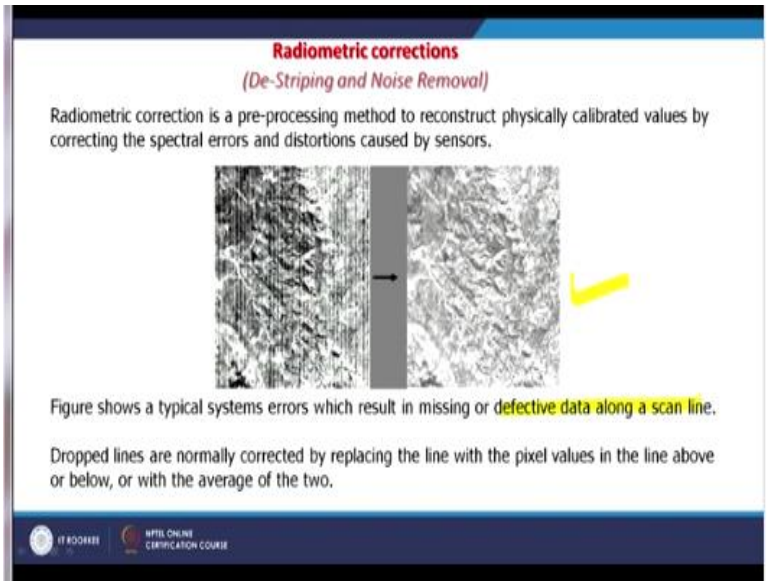

Like here the line which we saw was horizontal in the software here. The stripes are in the vertical direction but the technique would be same that adjacent pixels average value is taken and given to that drop line and you get a corrected image. Though, if we would not have the striping effect then the image would be different completely then what we are seeing here. But since we do not have any choice.

We have to use that data and therefore by this adjacent pixels average replacing with that drop pixel can solve our problem for certain applications. But if I am to use this say right image for some quantitative analysis then probably that would not to be good approach to have. So images which have been corrected because of de-stripping or noise should not be considered for a serious quantitative analysis. So this drop line or defective data line scanning maybe a problem and these values can be replaced.

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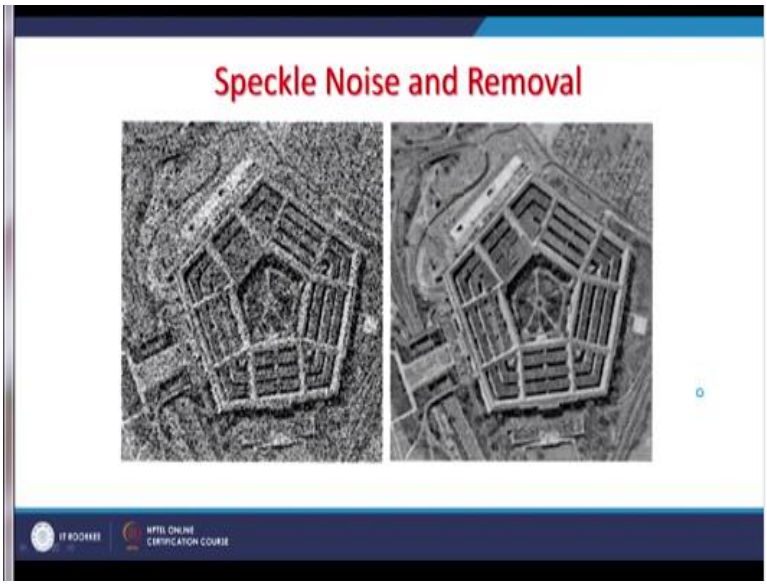

A noise I have also that salt and pepper noise what you are seeing here, salt pepper noise has been removed. And it is more or less is a manual method a surgical kind of method and it is done like this. Because we do not know whether it is a real object or a say noise, so that is why manually it can be done these speckle noise or salt and pepper noise you generally see in the radar data.

But there are different processing step filtering techniques are there by which these a noises can be removed.

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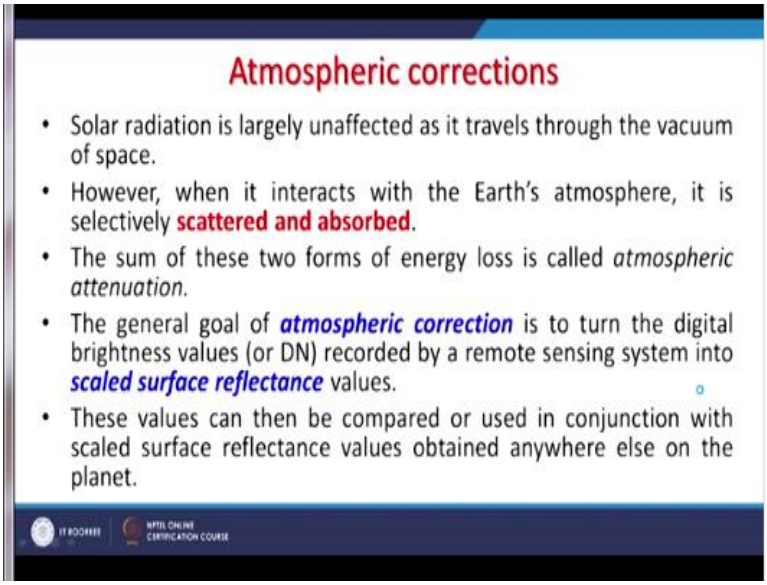

So that we are not here discussing when we will come on the radar data micro data then we would be discussing. Atmospheric corrections, we have already discuss and have done a separate treatment mean 2 problems in atmosphere scattering and absorptions and these can be **a** sometimes can be, you know can change the quality of an image very badly because of these phenomena.

But you know the choosing the right image especially of right season of a particular location is very, very important. And generally what we do, for serious applications we first try to think what kind of which is the best time of the year for a particular application. So suppose if I have to identify some vegetation and I want that atmospheric affects especially scattering and absorptions will be minimum.

Then say we say like month of February or March in India, especially in central India or in south India can be very good months to acquire the remote sensing data. There you will get good discrimination between vegetation and other objects and these affects, scattering and absorptions affects are generally minimum during those months. But contrary to this if I go and acquire the data of say May or June or in northern part maybe of November when lot of this burning is taking place of after this paddy crop.

Then there will be lot of absorption phenomena and maybe scattering also and your image quality is going to be very, very bad. So choosing a right season that will depend on the location is very, very important. So date of the scene one has to be very careful, if there is a choice, that I can choose an image of any time of the year knowing very well that this is my target. So as I told you, that if I am working on vegetation part.

And I do not want just after the post monsoon because just post monsoon, you may have a very healthy vegetation. So I want to discriminate between healthy vegetation and less healthy vegetation then maybe January, February, March when a sky is clear, less scattering and absorption affects are there, I may go for that, no clouds generally at that time also. So you know choosing a right time for image acquisition is very, very important.

Because nowadays this one can assess also by himself if you go in the Google earth and you may find for a particular location images are available of different season. And you would find say if I give you example of central India or south India. And in month of January February you would find images are very, very clear and when images are clear then we can say that they are having good image quality.

And when images are not clear like in northern India in month of November lot of pollution absorbs on the scattering is happening or in during fog season then one should not use those images for serious applications. So these are the things one have to remember, important thing is these are the things which are not mentioned generally in books or manuals or by the software these things you learn only through your experience.

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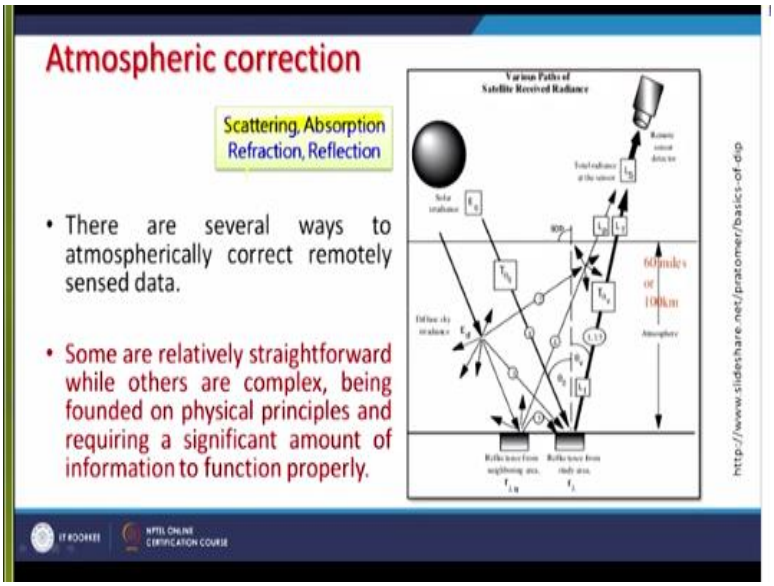

So because you cannot avoid atmosphere that will be there but for a particular location you can assess through some other datasets. Then, when this is scattering and absorption are minimum for that particular area. And a like from either from metrology department or some other sources. And once you are sure that these months are better for me then acquire the image of those months.

And those images would be of high quality and if you produce certain results, they would be also of very high quality. So this one has to remember because we cannot get rid of atmosphere

but we can definitely acquire the images of that particular time when atmospheric distortions are minimum for that location, that is in our hand and that we can do it.

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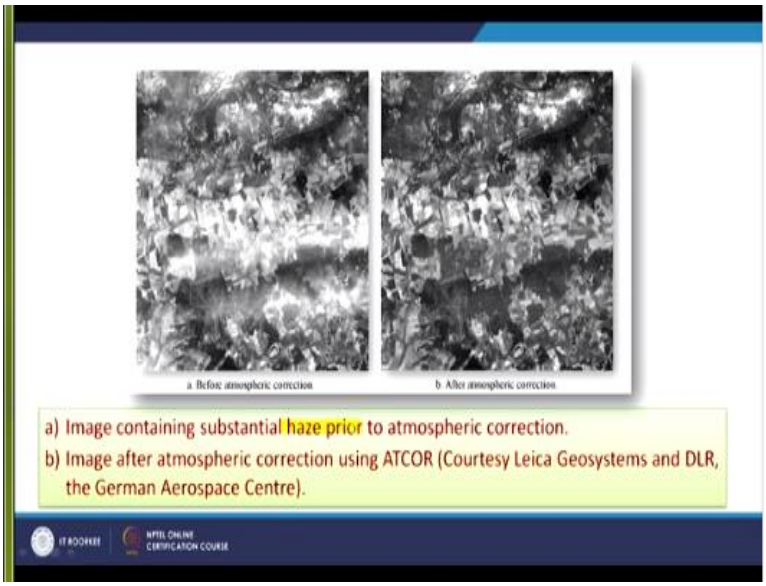

After you know that if possible then you still you can perform atmospheric corrections even on those images which are as per initial assessment of good quality. So if that is done then still images can be improved he is a another problem in northern part of India because of pollution and dust particle is another things. So again, if I see lot of you know previews from these suppliers side I and a same time I see the rainfall data.

I can know that when rain has occurred and just after that if I get an image I may not be seeing much is in the satellite image that is the image one should acquire. So just after the rain, if possible, when clouds are less image is very clear atmosphere is distortions are minimum, that is the time to acquire the image or take the image or buy the image, download the image of that particular time.

As you know that through that software also DIPS software, I have also demonstrated through simple linear contrast stretch that how image can be improved and what goes in the background.

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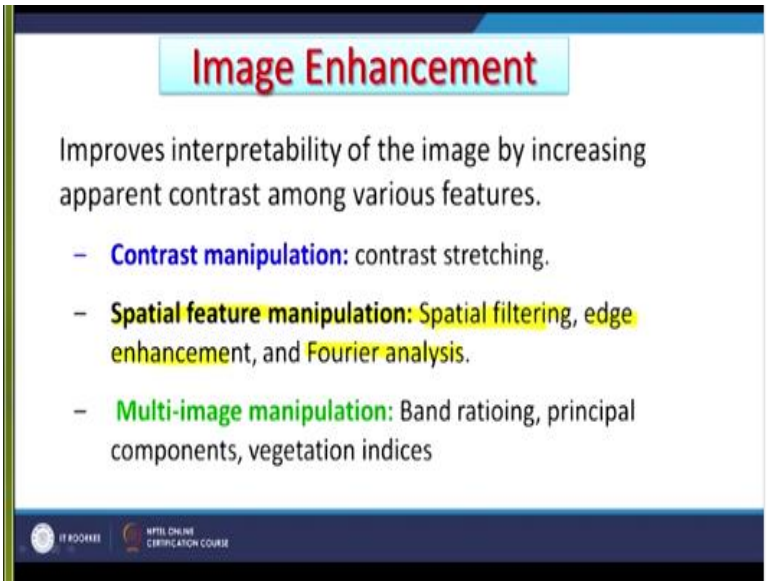

And the example which we took is the linear contrast stretch and the calculation very simple calculation goes on behind the scene though in that software it is not in behind it is in the front. We will be in future discussions we will be also discussing now, filter a spatial filtering also enhance cement. So in a spatial filtering, high pass filters, low pass filters or directional filters we will be discussing.

Also we will be discussing Fourier analysis and other things in image enhancement 2 or some spatial filtering techniques also. In the DIP softwares I stopped in the previous discussion I stopped when the filtering thing came. So now when we will be discussing filtering, I will be also showing through that software, when we go for a spatial filtering, what kind of modifications in the pixel values goes on that you can see through that demonstration of that particular software.

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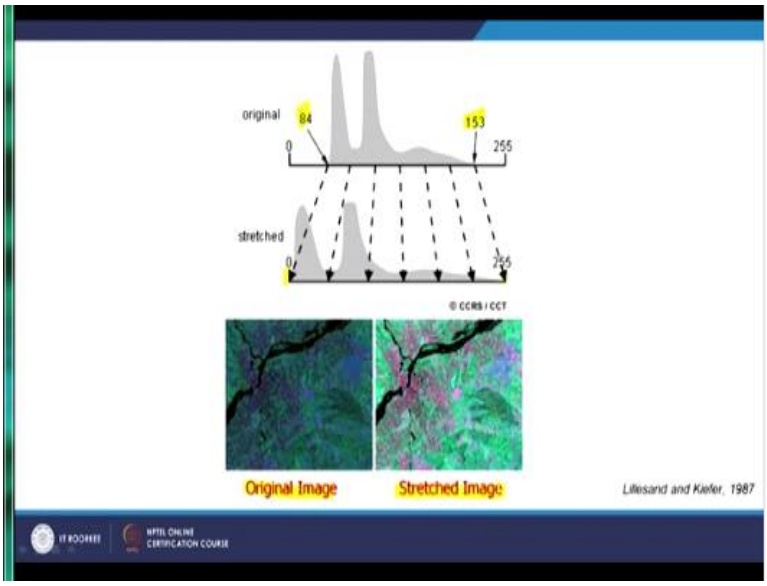

So whoever is interested for image enhancement techniques and would like to learn the inside of image enhancement, image processing, the best thing first thing download that DIPS software since it is not commercial. So I can repeat many times and request you to download install on your machine and then try to, you know learn the things maximum from that software.

It will give you a real good understanding we are also regularly using in our classes as well. Now multispectral image manipulations when we will go the same also through the DIPS we will be seeing band ratio in principal component. Of course digital there are vegetation indices which might not be through that software. As we have seen in that software that how pixel values are enhanced or changed when we choose the linear contrast stretch.

Now you can realize that how it is done because when we use the full dynamic range then the contrast in the image is automatically increase as shown here and also so to you through that software. Here in this example, the values were between 84 and 153 these had been stretch to full range that is 0 to 255 and original image was having a low contrast and this is having high contrast.

Now interpretability uses of this image is much more higher, so simple linear contrast stretch sometimes works very well.

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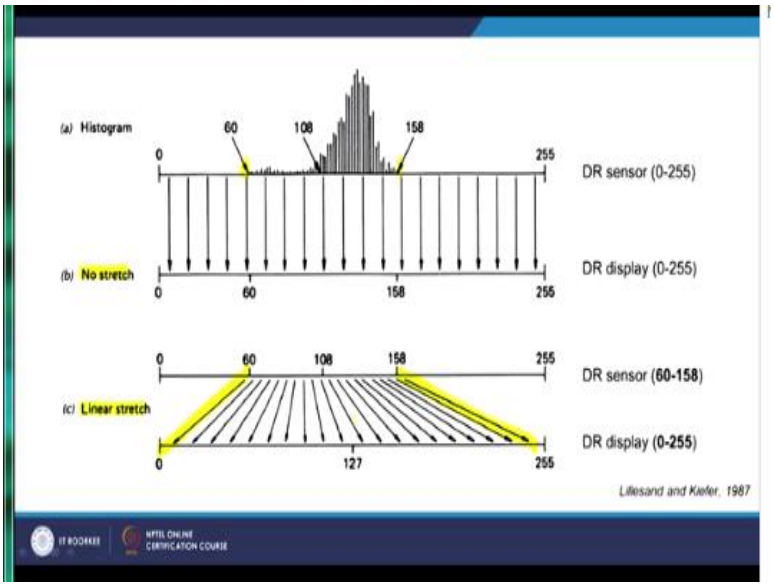

There are some other you know the same way I am showing here that here the values are between 0 to 158. And when you go for contrast stretch the 60 values goes to 0, 158 goes to 0 and rest are spread there.

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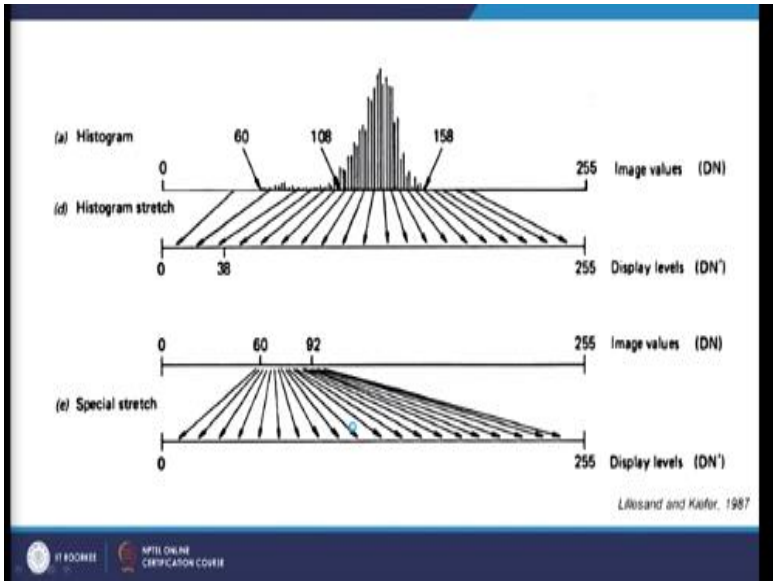

This is histogram equalization that we will be also seeing. So in histogram equalization, wherever the more frequency of pixels are there, they are more spread is there likewise.

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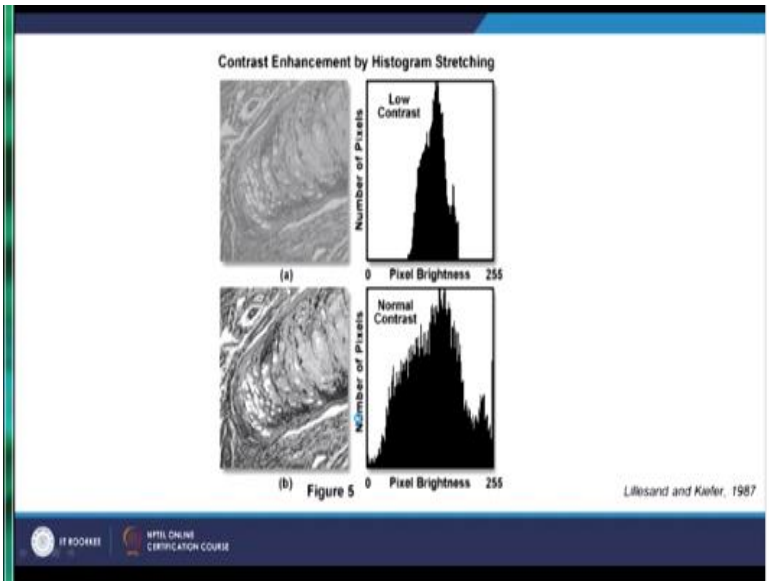

These slides we have already seen, so I am not going to spend much time here but you can realize that what goes in the background when we choose these stretching steps or routines and what kind of improvement we can bring in our images.

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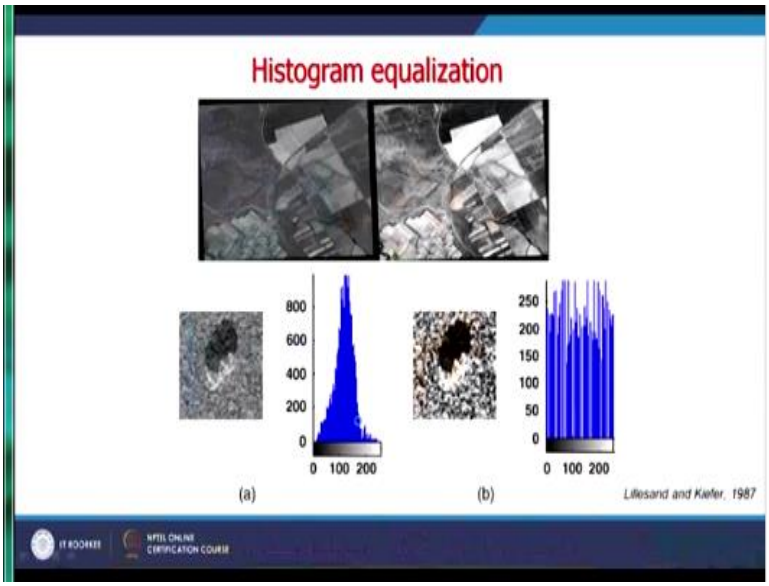

Histogram equalization can create a large contrast in your image compared to simple linear contrast. But which one would be best for your image for of that particular location of that particular day nobody can tell. So this is really one has to judiciously choose a right contrast stretch routine or you know tool. And then do it and try and see and assess how best the results are there.

And if it is not there you go back to original image do the another way of stretching because there is no standard that every image has to be linearly contrast stretch no. There is a nobody can say that every image has to be histogram equalized, no. It depends on the image, it depends on the contrast which is present in the image. If suppose you get an image which is already having distribution of pixel values in 8 bit scenario between 0 to 255.

Then you do not have much space for contrast stretching or any kind of stretching but still you can perform, you can still improve the contrast but not much spaces left. But if you are having a narrow distribution of pixel values that means your image is having very poor contrast then definitely any of these contrast will improve your image very significantly. So you know choosing a correct contrast stretching technique or maybe histogram equalization or nonlinear contrast stretching is up to the image which you are it depends on the input image basically.

So this brings to the end of this discussion and definitely 2 main points I have mentioned here. One is that choosing a right time for image or right date for the image that is very, very important. And second day, choosing a right contrast enhancement technique for your image. Both will depend on your judgment depending on the local area and the location of which you are working and accordingly you would choose a right date for your image, right season for your image.

And also accordingly you would choose a right stretching techniques, this brings to end off this discussion thank you very much.