**INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**

**NPTEL**
**NPTEL ONLINE CERTIFICATION COURES**

# Digital Image Processing of Remote Sensing Data

## Lecture – 03
## Why is Digital Image Processing Important?

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Hello everyone and this is the third lecture in the course digital image processing of remote sensing data and in this particular topic we are going to discuss why digital image processing is important in the previous lecture you have we have discussed about how data can be acquired and that especially about the remote sensing data and also we have learned how images of different part of electromagnetic spectrum using different types of sensors active-passive and scanning, non scanning.

Various types of these in scanning and non-scanning sensors we have discussed so now let us discuss and discuss about why digital image processing important? Basically if we start looking the definition of digital image processing the digital image processing focuses or the purpose of digital image processing of two folds one is the improvement of pictorial information for human interpretation remember that the ultimate aim of satellite remote sensing and data is to interpret make the interpretation on the data.

So that we can make inferences in later in this course we I will be showing some examples how an image satellite image can we can make interpretations after processing and then how inferences can be made.

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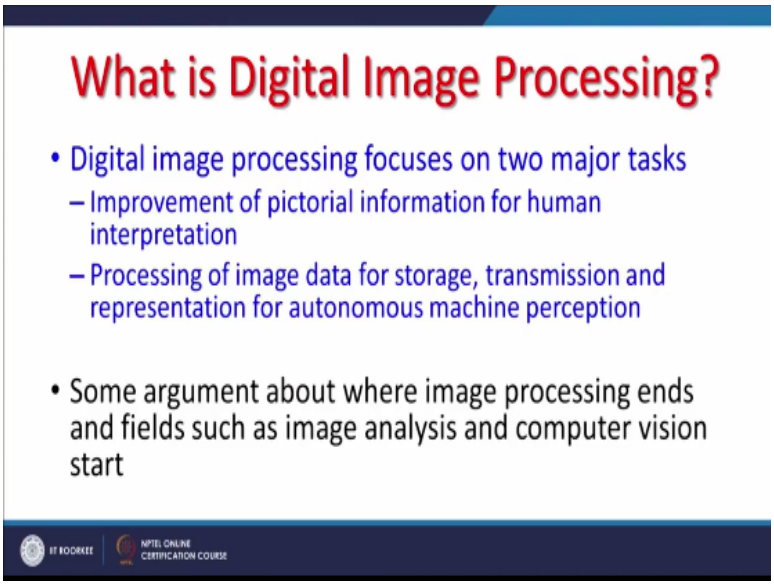


And the processing of image data for storage transmission and representation for autonomous machine perception another aim is nowadays which is really a hot topic is that how we can involve machine machines mean see basically here computers so that everything or most of the things becomes automatic and you might have heard about this Google card and others so there image processing at very high speed is going on.

So ultimately detect the identify the objects and accordingly receive the instructions and drive the car and other and there are some you see image processing digital image processing is a kind of trade off so you lose some you use some information but you get some other information so there are some argument about where image processing ends the fields such as image analysis and computer vision starts but this is one way of logging the things.

If we look the little history about digital image processing what we find that somewhere early in 1920s one of the first applications of digital imaging was in the newspaper industry the photographs which we are of note that quality which printers of newspapers wanted so they wanted some announcement so that engage improves and when photograph here is given.

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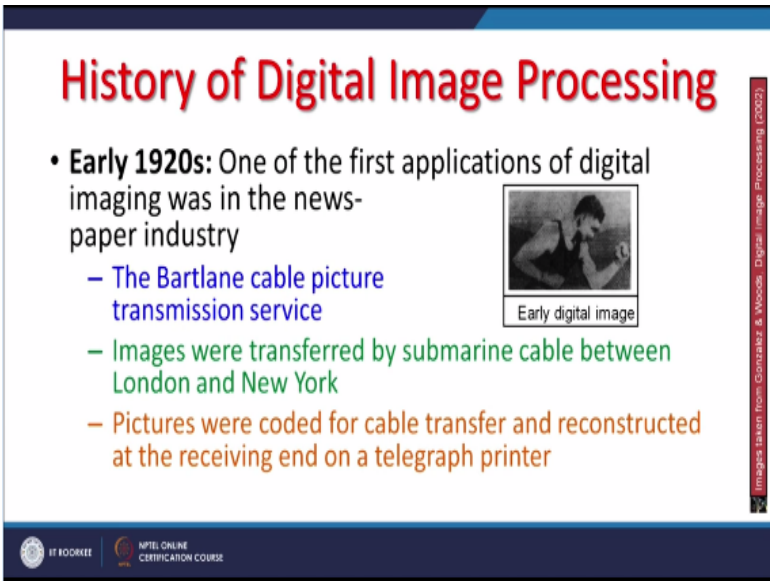


And that kind of quality that to in black-and-white and was available for newspaper industry somewhere in 1920s and this is Bartalane cable picture transmission service the example here given images were transferred by submarine cable between London and in Newark and there were no wireless technology and pictures were coded for cable transfer and reconstructed at the receiving end on a telegraph printer this sake and you know cable and for the transmission nowadays we use zipping and unzipping and there are some other methods also for better transmission but most of the transmissions now is happening wireless or through satellites and if at long distances are involved or towers and another thing.

So the technology has change but this is what we had in somewhere in 1920s there a later on we made to late 1920s the improvements to Bartlane system.

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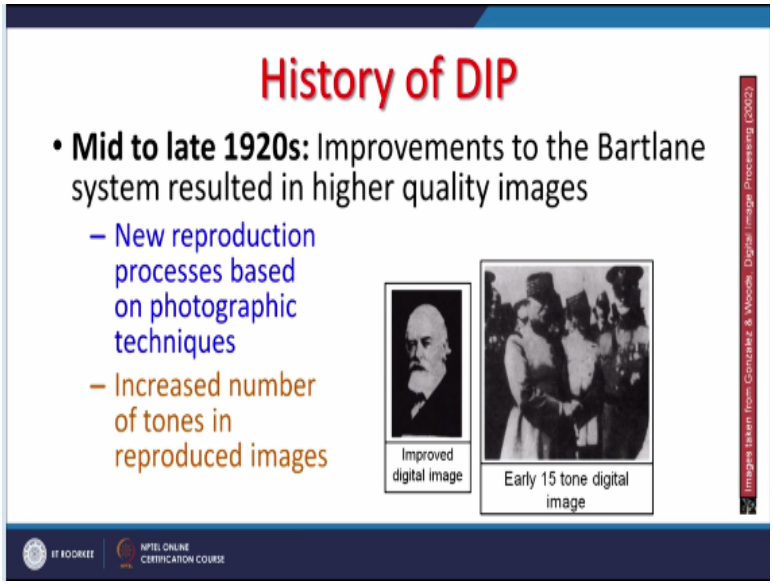


Resulted in higher quality images and they improve digital images and image you can see here and at that time only 15 that mean the 16 shades of colors we are there zero is also there and new reproduction process is based on photographic techniques and where developed increased number of tones in reproduced images tones means here the number of seats available for printing so instead of just simple black and white that is binary you move to up to at least 16 and then later on these are the moon pictures taken by as Center ranger 7 probe minutes before the landing and that time lot of improvements have taken place as compared to 1920s and improvements in computer technology.

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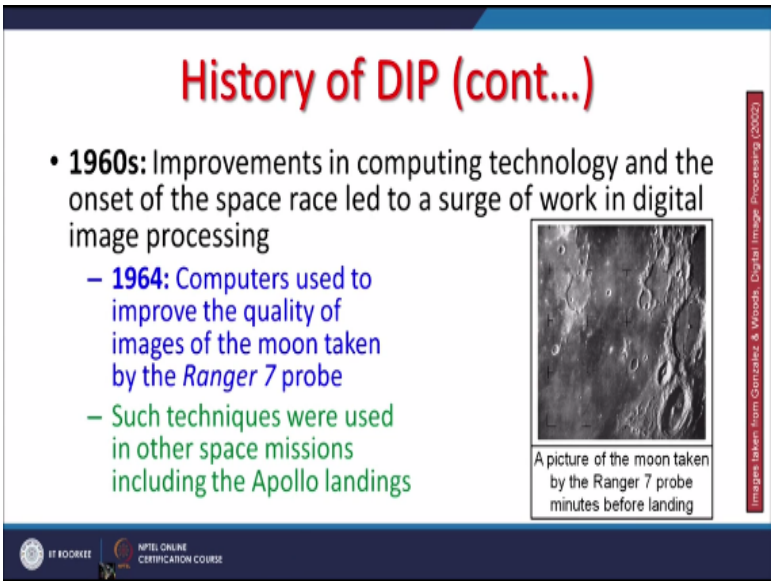


And the onset of space race led to surge of work in digital image processing and that to the transmission started before that the wireless transmission in 1964 computer used to improve the quality of images of Moon taken by Ranger 7 probe so that stage came very quickly and such techniques were used in other space missions including Apollo landings and of course in 1972 later on we had our Land side dimensions and lot of new image processing techniques or it became digital image processing became very easy and they still it is improving but they in somewhere in 80's or till today.

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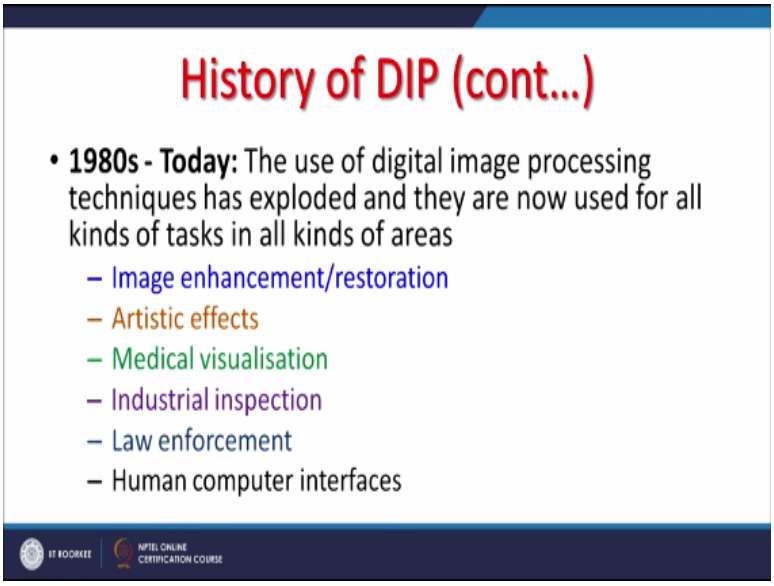


The use of digital image processing techniques have exploded as I have just mentioned they are now used for all kinds of tasks in all kinds of areas so there are different fields where digital image processing are happening even nowadays in our own small smart mobiles we can improve a little bit our images taken by the mobile camera and can transmit as well but when we handle large images acquired by the satellite sensors then the most scientific methods have to be evolved and the main purpose here image enhancement or respiration of the image the quality of image.

So that it looks soothing to the viewer and we get much depends and I mean rather than just few gray shades artistic effects should be there so we began now by bringing digital image processing and some fancy filtering techniques and other things we can bring artistic effects and much use of digital image processing is now in medical visualization whether it is ultra sound image or x-ray or there are various imaging systems in medical sciences are being used there also image processing plays very important role.

Industrial inspections and where thermal cameras and other cameras are used and such images are also improved and law enforcement especially night time the images are acquired by CCTV and others those two can be improved so that the person can be detected human-computer interfaces this is another field where things are happening lot that most of the things we want that computers will do it and then less influence or less interventions by human and so that the task becomes faster if these are the routine tasks.

Some examples are given here about a major enhancement but one of the most common uses of digital image techniques to improve quality remove noise etc…

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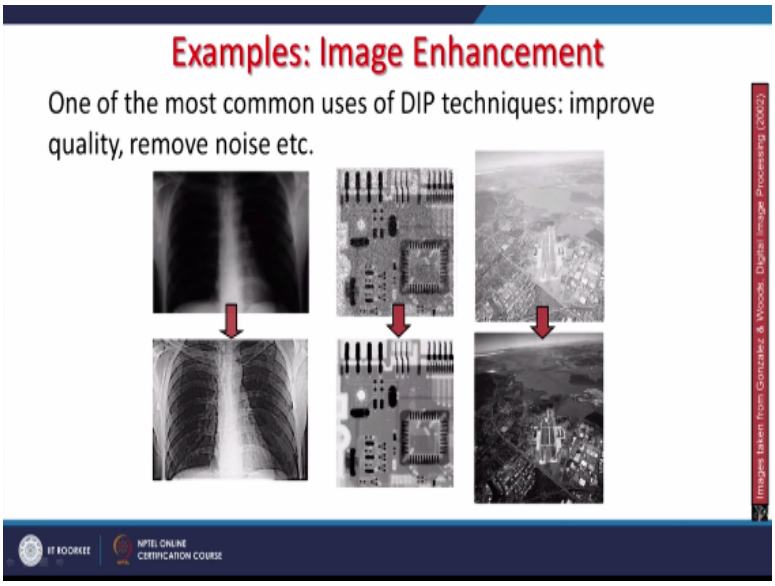


And two examples are here rather three examples the first one is you can see in a row scan x-ray image this is this was the situation but when it was enhance now you get much better detail and interpretation by doctors can be much easier and second is about micrograph photograph taken for some electronic circuits as you can see that there were a lot of noise once the noise the speckle they removed the image becomes much easier to understand similarly for the this is a public photograph taken by some aircraft and this is what you can see that a lot of now improvement in the image and better interpretations can be made.

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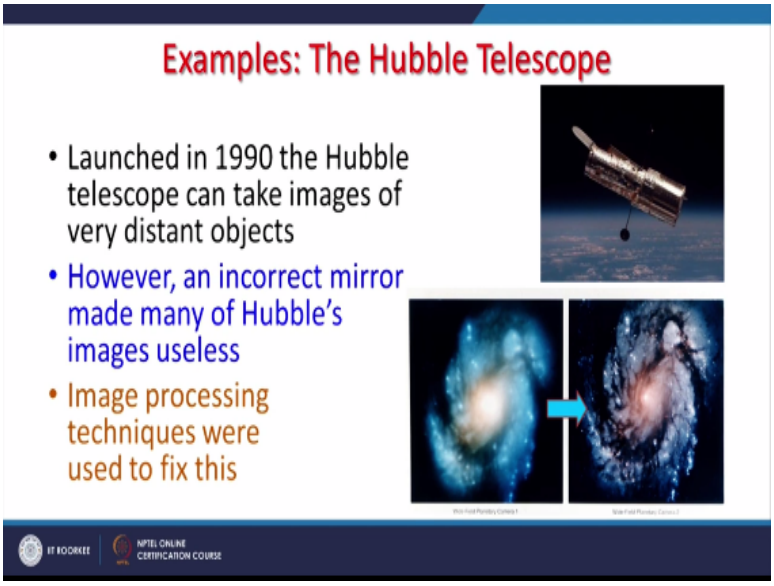


And similarly examples the best example because in 1990s the Hubble telescope was launched and could take images or very distinct objects but somehow because of problems I mean optics they were out of focus and the problem is that you cannot bring and repair so now it was a challenge for and for the digital image processing and it was done and as you can see here this is a Hubble telescope these are the images which it was it was acquiring after image processing these images where much improved and interpretation could be made.

So how ever an incorrectly mirror which bit and later on will people realize which while on board of Hubble's images or Hubble's telescope created problem and as I mentioned that image processing techniques could fix this problem to some extent and there are examples from remote sensing fields one example I we have already seen many more are here the digital image processing techniques.

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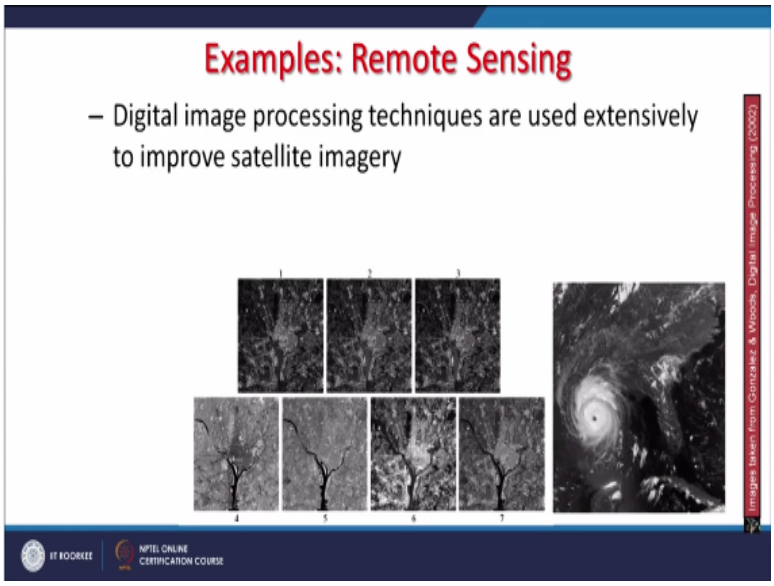


To use extensively to move and improve satellite images the one of the major regions because between satellite and earth there is the atmosphere and generally atmosphere did you read the quality of enemy it brings the distortions in the image and therefore the once the image quality is not up to the marked and image interpretations can be also affected so in order to improve our image interpretation analysis the first thing is to improve our image by implying digital image processing technique.

And here for because ultimately the images may go for pattern recognitions or terrain classifications another thing so for that purpose and the image processing is required may be our images might be coming from meteorological satellites or geostationary satellite which will use directly meteorology for forecasting or productions there also the improvements might be required. So that can be done there and sometimes when we acquired night time images.

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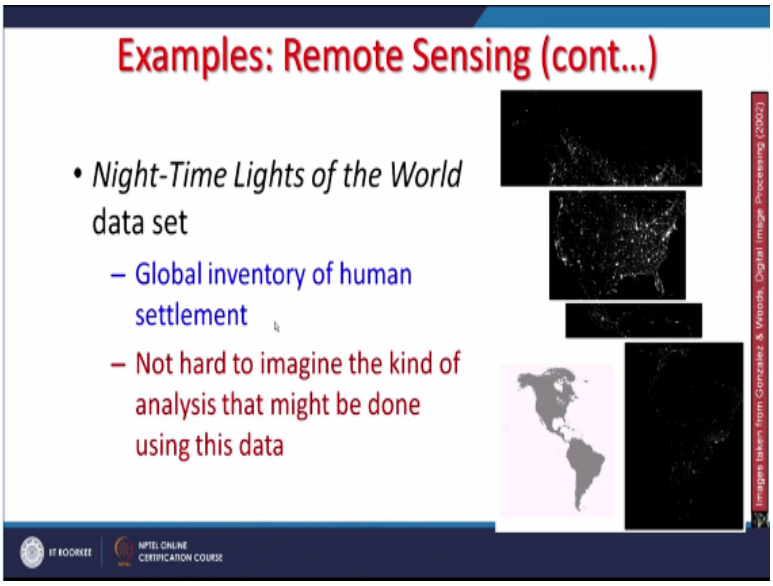


Maybe of like night lights or of the world the example here then again digital image processing and can be done this is useful to know quickly the global inventory of human settlements and not hard to imagine the kind of analysis that might be done by using the data people have employed these images and in case of some disaster like suppose an earthquake has occurred, so the neutrally the power supply gets affected.

So if you compare an image before the earthquake and after the earth quake immediately you know which are the affected areas so in that way a lot of usefulness is there about such images there are various stages various step processing steps of digital image processing and these are though in this flow chart and they are they are given.

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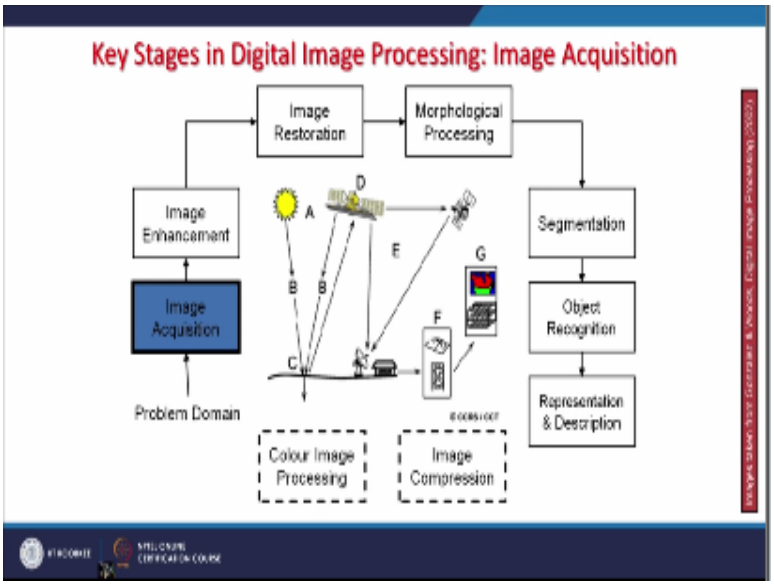


But you know that there is no exactly not any starting point from that point of view but if we start the problem booming from here immediate cognition is the first thing and then image announcement some major announcements some improvements and the quality and is done immediately on once the image has been acquired by the satellite and we might be going for image restoration these things we will see in much detail morphological processing and for further enhancement then segmentations in the image object recognitions might be in image classification.

Then representation and description in this one we also go for image compression one of the topics say in this course we are having on image compression and the color image processing is nowadays very much required that is also done. So if you start from here you may end up like this but for as I have mentioned that directly one can go from image enhancement to object recognition means for classification it depends for the purpose for which purpose for which application you are going to apply remote sensing images accordingly you would use different image processing techniques.

And now as I have already mentioned that image is digital image processing a trade-off you lose something you gain something so one has to be careful while doing image processing that what ultimate aim is and accordingly different image processing techniques would be implied now these are the like email acquisition we have already discussed in the previous lecture that the

satellite sense that and you transmit the data towards art and the examples are given here and the satellites are there they are transmitting data towards the earth.

You should have a antenna and tracking antenna for polar orbiting satellites and then there has to be a system recording system means hard disk software and other things and then you can make the archive of such images and as you know that this all happened because of in day time because of the Sun and there are you know the energy has to reach to the surface and then go back to the satellite so these are the things this is the first step is an image acquisition and we were if once the image is required then real image processing starts. So this is the first step in that one.

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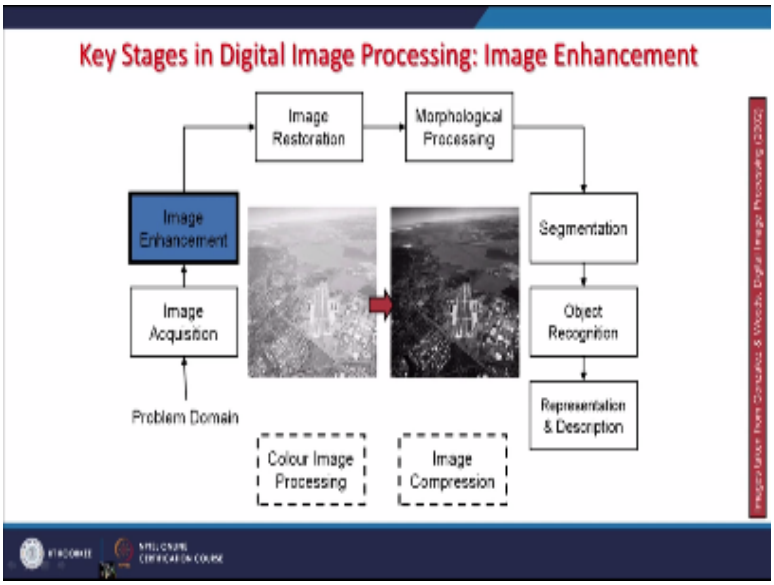


Then image enhancement as the example is giving here and they say that and the raw image after some enhancement you can see the improvement in the quality of image for the interpretation.
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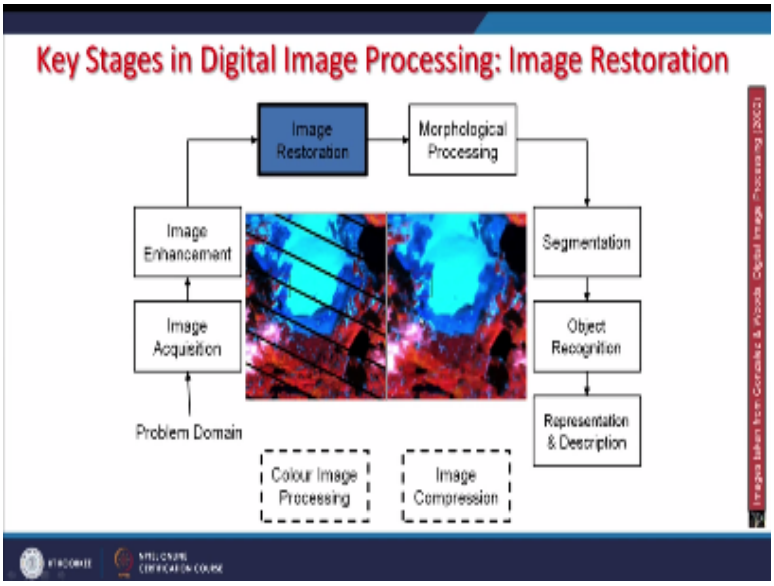


Image restoration sometimes what happens that a satellite has acquired an image there might be some problem on the sensors and like here one example is soon about different lines which are appearing and do that effects you have to be removed if we want to use a page very serious for serious purposes and therefore if there are systemic errors like here the length is and some is missing a scan line scenario then by employing digital image processing and it is easy to remove and systematic errors and one of the systematic errors is missing scan line.

An example here so that those have been removed but of course the data which is lost cannot be recovered on the surface of the earth by any processing rules but through some and interpolation of nearby pixels we can improve so that the visualization of that image becomes a more comfortable. So this is in that case is the third step in digital image processing which is the image restoration the next one is morphological for processing here we employed different types of special filters may be special filters or maybe frequency based filters again the main purpose is to improve the quality of image or hide certain frequency features or an uncertain frequency feature.

And so that morphological and processing is employed and this is the input image on the left side.

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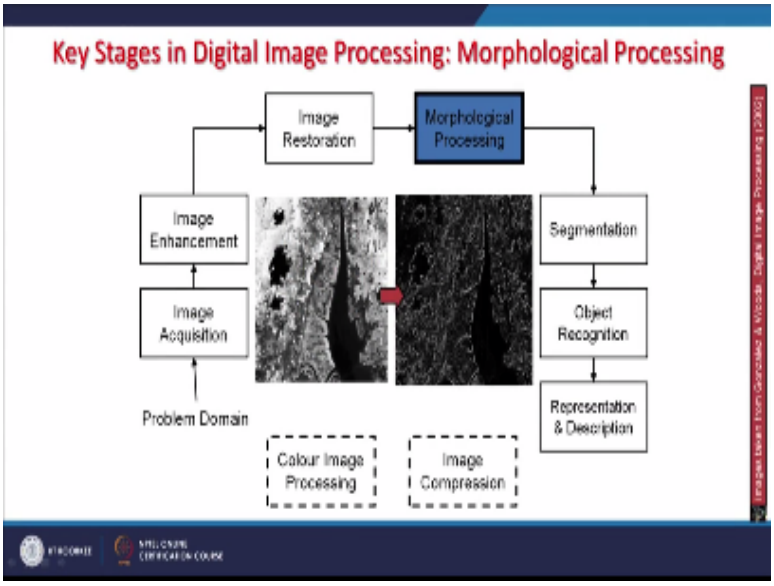


And they after this filtering or morphological processing and what of the details this is basically edge announcement and so the details which were present on the edges, edges means here of two objects like here water body and land part and those and then this contact between butter in cord what about in and part has been highlighted and through the filtering techniques rest of the details and have disappeared from them it says from the continuous image it has become more or less a binary line image.

But for certain applications this might be very useful and therefore people go for such kind of morphological processing the next way in this digital image processing step is the segmentation where because you know image is a continuous data and the digital values are also continuous this is since if I take example if the 24bits image means the three channels of 8bit each the resultant image is 24 bits and lot of details are available even it within the vegetation.

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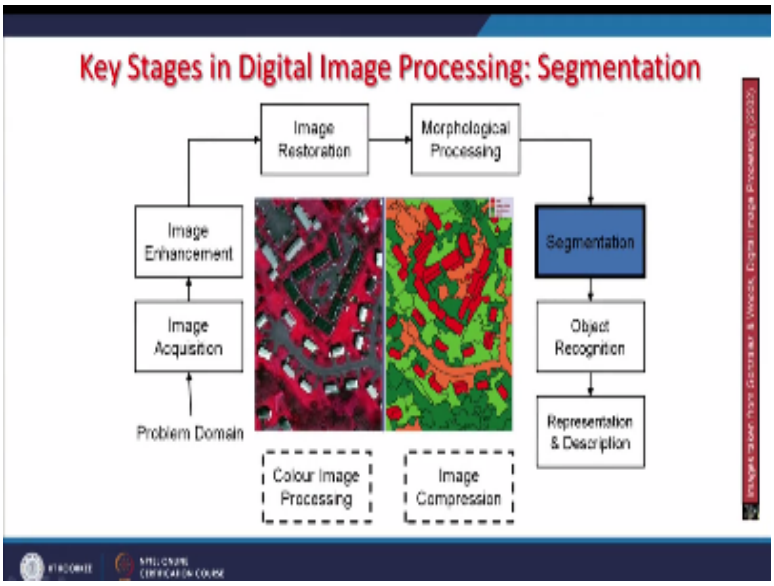


But I know all this vegetation and my I want to use this image to procure a classified image that means I have to segment it and for that all built-up land has been given a red color their boundaries have been restored through filtering and other things and also and like a green color for the healthy vegetation. So no more built up land some other color and likewise the legend is given here and I can segment a continuous image into say just four or five classes and or maybe land use land cover and so on.

So this is another step all these stuffs we will be seeing in subsequent lectures in much detail but just there I am giving you the beams of what digital image processing can do and then next is the object recognition which is little advanced technique that we I think we would like to identify a pattern or an object and using our digital image processing techniques inclined fast computing and other things like here and the building is there.

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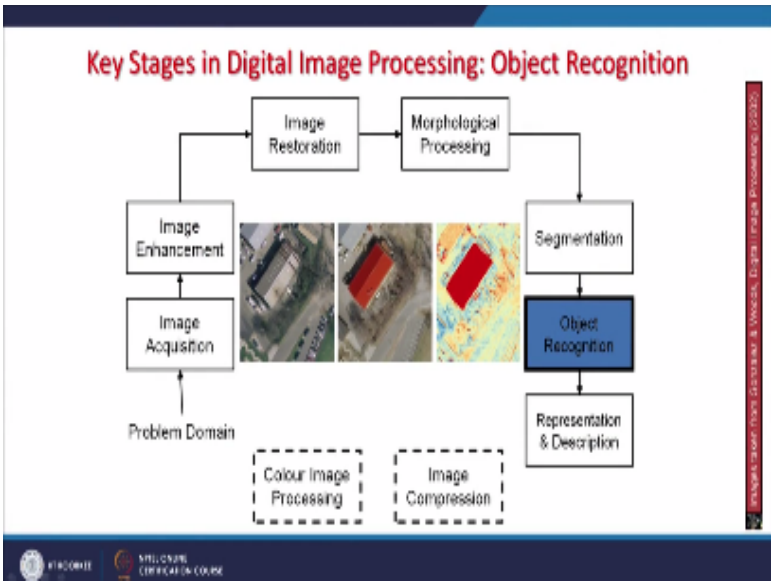


The shed which has got the shade and by putting certain conditions it can be further marked and then finally rest of the details might be removed from here and only the building is detected so that object has been recognized here that it is a building with shades as a roof as having shade and then next step or in that case you can call as a last step in conventional digital image processing is the presentation and description. That means that now light here lot of details are here.

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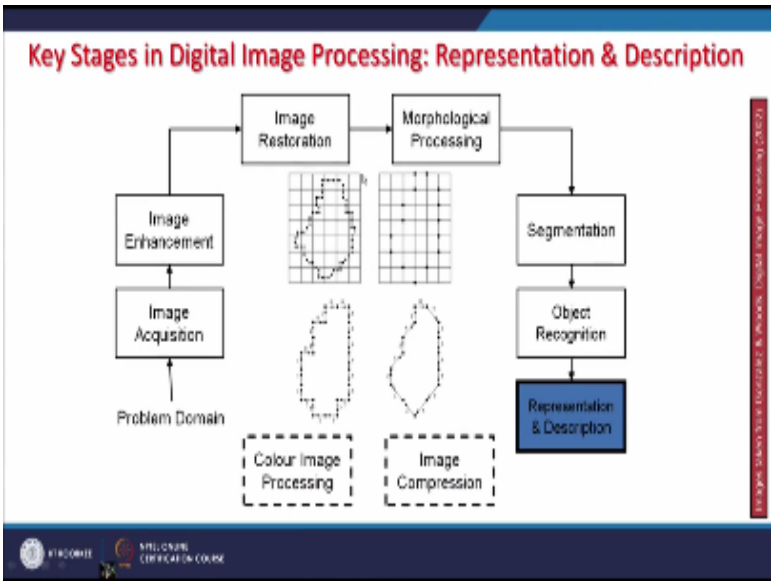


Now I want to really present this image only through some points or some pixels and likewise here maybe from cluster 2 vector conversions and so on those things can also be done through digital image processing as and two examples are shown here.

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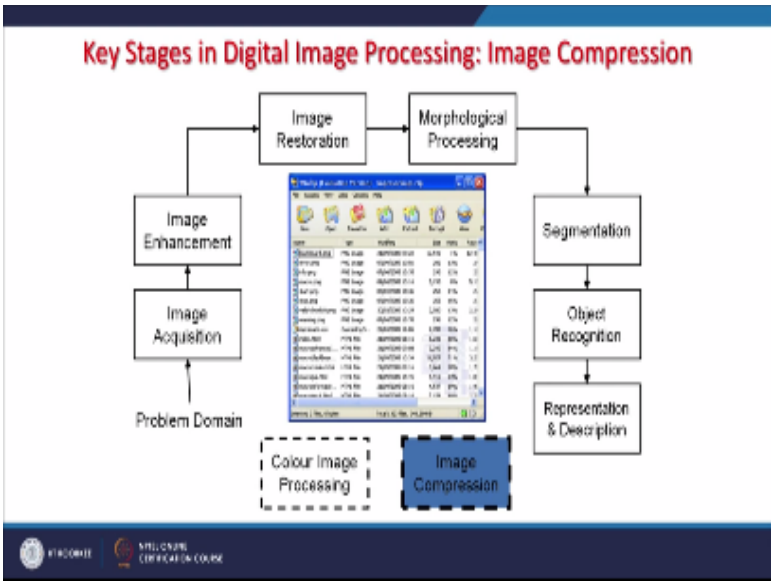


There is another as I have said that it not directly connected at any stage one can imply image compression and then color image processing generally it is in the start and generally this is in at the time of storing the image so that it occupy less space on hard disk image compression is employed but nowadays there are image compression techniques initially you can compress the images and many processing steps can be taken without decompressing it.

So that that is very image compression is very important one of the most common thing which be nowadays and use is this G program which will compress but in these it programs everything is compressed there is a text file or your image file or audio file that kind of thing but here we will be discussing in image compression techniques mainly the satellite images or raster data how it can be compressed and the size can be reduced and as you know there are two major types of compression techniques and one is non-destructive another one is destructive means you cannot and go back to the original that is the destructive.

So those kind of constraints are there which we which will be discussed in this one in image compression, now the last in this series is that is in that is color image processing and this figure has already appeared in previous lectures that because say you know the black and white image is not as good or soothing to the eyes as to a color image and therefore when once we are having multispectral data then we always prefer to go for colored images because our interpretations becomes much easier we can draw the good inferences out of but if it is simple black and white

then it is not possible and like many sensors are having panchromatic and pen chromatic cameras or sensor on board and they are broadband.

So though for certain purposes they might be useful but for certain purposes they are not useful because ultimately the image which you get is in black and white however at some implying certain image processing techniques like image fusion you can exploit the best quality of your panchromatic images which generally are in high resolution and best quality of your multi spectral images which are having your colors in it and then you can fuse these two images to get is new output.

So that technique those techniques are also here we will be discussing in this course so this brings to the end of this different types of digital image processing which we will be employing in this course thank you very much.

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