Biometrics

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Lecture No. # 17

Offline Signature Recognition

We we want to start with that one biometric system, which is offline signature verification system. Now, the signature itself is a difficult problem. If I tell you to sign a paper, try to sign on a paper, you will be thinking always for what reason you are signing, right. Say for example, I want to withdraw money from the bank, then the signature generally I give is a very long signature. But, if I want to write a letter to my friend and there my signature is different and if, I want to keep a copy of a letter in a folder, my signature is completely different.

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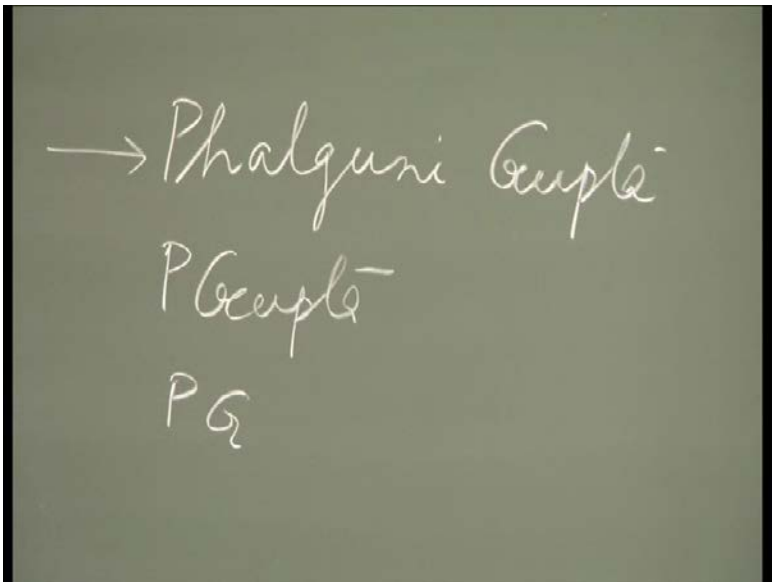

So generally Say, let us consider my case, after that you will find the other case. So, these are the common way I sign, and this signature first signature is more critical one. Wherever you have the critical operations, we use this type of signature. Say for example, you also do same thing when you have joined the institute, we told you to sign.

So, if when you are doing the critical operations, where money involves or your entity involves, generally you are right the full form, right.

Now, I write a letter for my official purpose. I write a letter to my director or dean or then I write this way. You also would be doing same thing or you are doing. And, this is the very common way of signing, common way of signing means, wherever the importance is less nobody by forgery (()) cannot gain much but, it is helpful. For example, earlier days in our time, all students m tech and p h d, they have to sign on the resister. Nowadays, (()) here you put the card (())all those things. So, in in the resister and they had the idea that, you have to complete the process by 9 30, this is a common practice And the door will be open at 8 45, it is not that whenever you come and sign the (()) 8 45 and 9 30, that will be closed and then, resister will move to the head of the department and head of the department use generally uses red ink to mark absent. That absent will be used for your scholarship purpose that was the standard formula for across the institute.

Here also, it was there. Nowadays, you know we have this very difficult to manage such a big class and other thing. So, sometimes we use to tell our friend that today I am late, not most of the time sometimes, I am not going you and why do not you do and you have to write in such a way, that other person can sign on your behalf.

So, generally we use to write the capital letter sign. Same thing happen, same thing happened with you also, one of you or two of you or some of you have done, same mistakes same thing you have done. That student candidate is in quota and father has filled the form and in the form, the father has signed, the father does not know the signature of the candidate. Most of them, they sign on capital letter.

So, after that, I remember in 2003 we decided that we should be in running letter, we wrote same thing happen again, they are writing the same thing. Then, we thought that we will reject some of the candidate. We took the legal help. In that process, I got a signature, which is the signature of (()). A (()) has a signature, have you seen that (()) chocolate. It is there (()) chocolate has a signature. So, same signature candidate (()) given. So, I asked him, this is not your signature. You give your signature. He is telling that, it is my signature. So, all those issues came up and we took the legal help and legal is telling that, no no you cannot tell or cannot dictate somebody, that you have to sign on

this only, who as there is no nothing is written that I cannot sign using capital letter. But, if I use the capital letter, my identity is problem in problem.

So, if the candidate wants to take risk of his identity, what where is your problem? So, we did not proceed further, we accepted. After that, we have observed that quite a good number of people starting giving the capital letter right. Now, capital issue is nothing wrong but, point is that you have to show again the similar way, you are type writing. So, the student they start writing the only his first two characters. So, it is safe mode to character identifying is not a very difficult problem.

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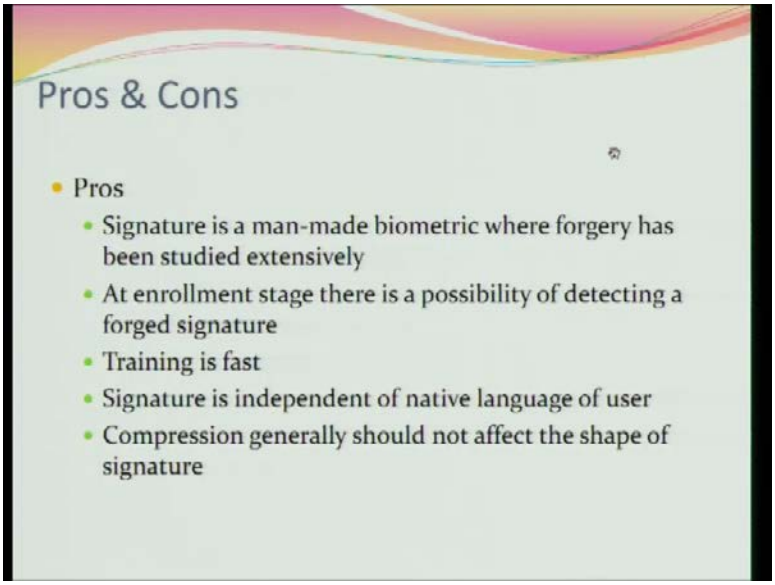

So, if you see there, what are the advantages you have, using the signature? Now, the word I use offline, offline means the through pen and paper or you are giving your signature or you are proving your identity, not on digital image. So, once you sign it, I have to scan it. After scanning, you will be doing certain operations to get the features. Next time again, you have to get the signature and again, you do the same process and so on.

Now the problem what we face, that if I tell you to sign three times, three at continuously, you will find that there is a variation. If I tell you to sign in the morning and after your hard work, if I sign tell you to sign again, there is a variation. So, this variation is a big issue and that has created problem for us. So, it is a manmade biometric

system. It is not that, you are carrying with you, that is you know or you have been told how to sign, you have learnt that. So, it is a manmade biometric system.

Not only that, forgery part also has been studied well. Now, how this forgery is helping you or I am telling you, that it is an advantage. Forgery started means or has been studied well means, that it is very easy to learn false acceptance, right. Early days, if I what I did do in the case of phase forgery is not much because, you you know, you have to put some mask to prove that you are Mr. x, right. But, that has, that is not too many cases you will find but, here the signature, you have you are in to force somebody, it is inherent in our idea, that if you see that Mr. x has sign this way. Then, you also try to learn, how to you will (())intentionally, like to see whether you can copy his signature or not, right.

And this is habit, this is the so forgery on signatures has been studied very well and that is help us to understand, what is the false acceptance right and right in more critically. Though at the enrolment stage, that if I am an expert (()) the time of enrolment you will be coming I am an expert to see whether, you have forged since, forgery has been studied well, so it is easy for us to detect whether, signature is forged or not. And since it is a simple character type thing and training does not take much time it is fast.

Signature is independent of anything that whether anything means, that there is no language dependent. In the case of face, it depends upon the occlusion or reflection all those properties. Even here, it is not the case, it is it is free from any other such type of things. And most important thing is that, if you reduce, compress the data, the pattern of the signature retains. See this is not the case with the finger print, if I suppose I have a finger print and if I reduce the size, then there is a possibility that, you will be missing some of the miniature points, right. Some of the termination points may be me but, this will not be the case of, in the case of signature. Is it clear.

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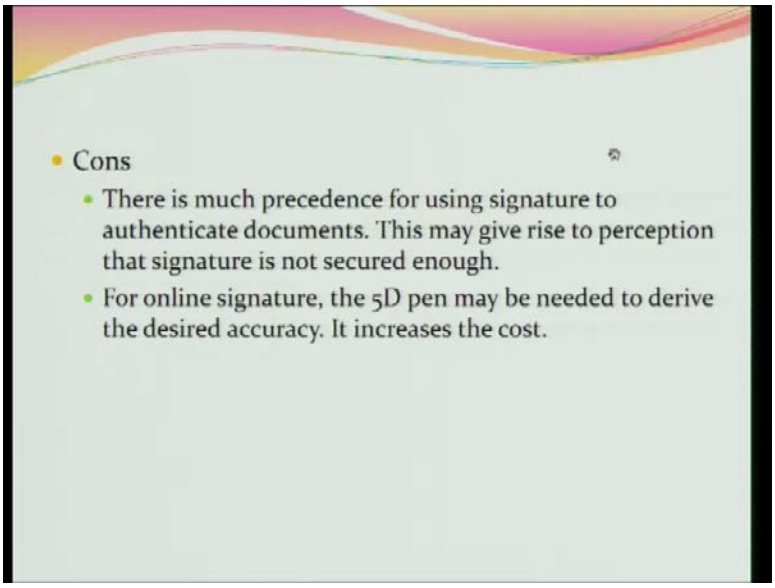

Now, what are the disadvantages? There are several people, several people (()) working on forgery, right. And by if you and there are we have the habit of earning the something without doing much work, that is also (())in our system. So, if you if I tell you that if you can forge a signature, possibly you will be getting big amount of money. So, you will put your more effort to forge somebody's signature, so that you can get more money. So this and by any means, you are through or you have been accepted by your forge signature, then you you are becoming very rich right. So, this has created a problem and this problem has been well studied. So as a result, government or any (()) they are not considering, this as a biometric system. So, in the case of say for example, in the case of (()) card, we are not considering signature. We are considering fingerprints or ID's.

Now, further in India scenario is different. In India, 30 percent above 30 percent people, they do not know how to sign. So, this is another big problem, right. And, your signature is available everywhere. So, there is a possibility that people can misuse because of, you know if I have the your signature, I can do lot many digital work on it, right and I can prove that it is your signature. You put it on some page, which is actually you have not done in reality. Now, there are online signature pad, where you can sign the paper. Now, in the online signature pad, issue is it is a very fast, it has different dimensions. But, it has it is very costly, the pad is very costly and moreover, that once your are signing on the pad, you are not seeing what you are signing on the pad. You will be seeing that display monitor, what you are signing. We are not habituated with that, what we have the

habit? We have the habit that, wherever I am writing, I am seeing also what I am writing. So, you will be writing the here and seeing there, that it that creates formula, that is the issue. So, all this are disadvantages in the case of signature.

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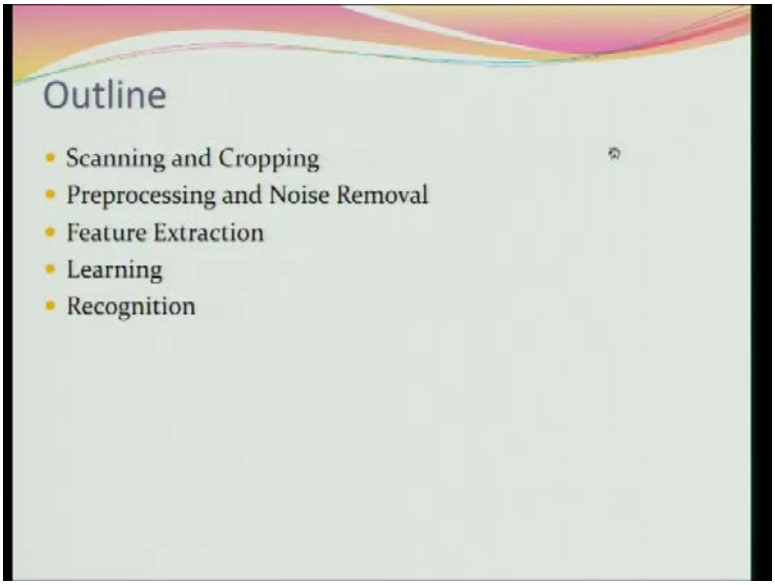

Now, what are the things, steps involved in signature biometric system? First one is that, you have to it is an offline signature, so you have to scan it. And then, from the scanned, it is a page from the scan, you have to extract the certain area, where or otherwise where you have your desired signature.

Now, the signature has lot many you will find that it has lot of noises and other issues will come because, it may be used you have may be you have used the color paint, you may used thick pen and there are several issues. There is a question of normalization will be coming because, sometimes if I give you the bigger space, your signature will be big and sometimes if I very small space, same signature you can write in the small page. Because as per example, in the case of passport form, you will find a very small area, where you have to sign. But, if I give you a an plain paper, your signature will be of your size, whatever you want that too, he stay each and so on.

So, there is need of normalization is becoming and you have to noise will be there, the noise has to be removed and after that it will be extracting the features. And once, features is there, there is a concept of learning as I told you, that your signature is varying right. Because, if I tell you that, you check your forty years back signature and

current today's signature, there is a vast difference. So, that learning is required. So, that most recent query signature can be used to identify yourself. Finally, you have the recognition.

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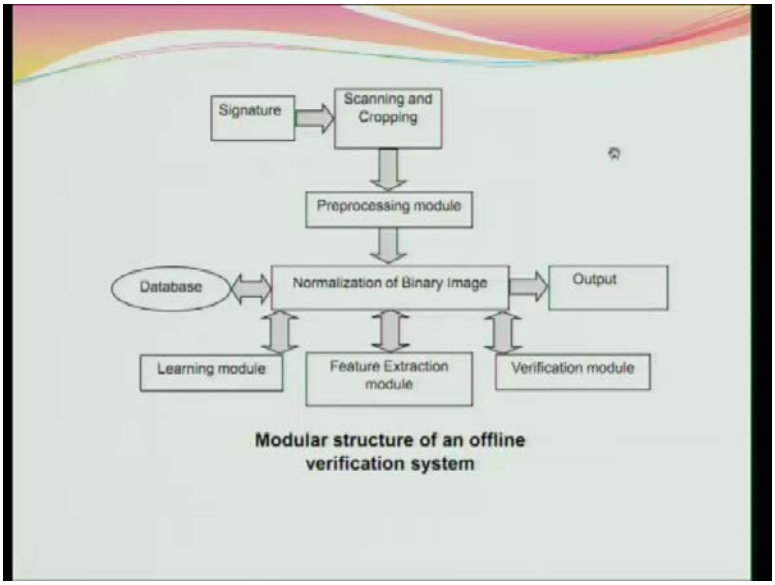

So, this is the block diagram, the signature you have and then scanning and copying preprocessing module. Now, (()) since signature may be in colourish space or the gray-scale, if there is a need of creating the binary image and normalize it. There is a learning module feature, extraction module and verification module. Finally, you will be giving the output.

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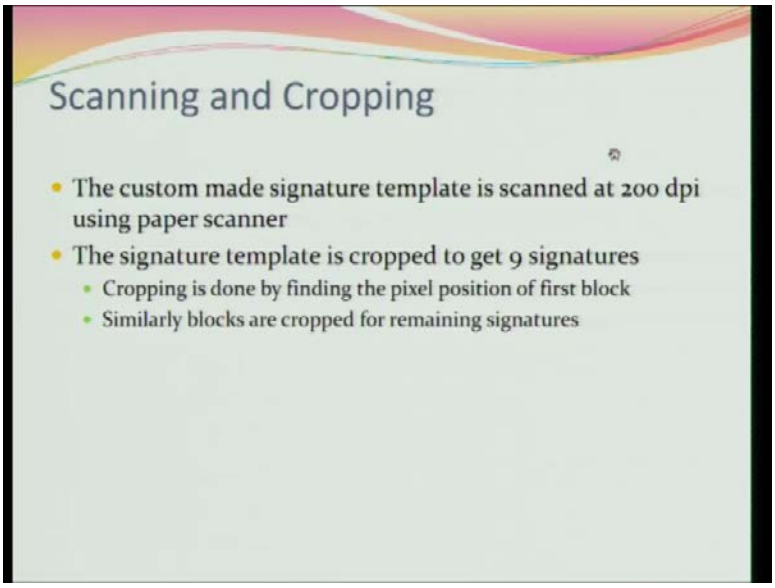

Here, we will be discussing what we have done, right. But, there are other ways also we can take. We have taken your signature on a page, there is a box of 9, 3 cross 3. So, in 9 places you have signed and that page has been scanned using the simple 200 dpi scanner. So, you have an image, which contains the 9 signatures and that image has been scanned using 200 dpi flat bed scanner. So, this scanners, this scanned image, you have to use and then you will copying the signature, 9 signatures, right.

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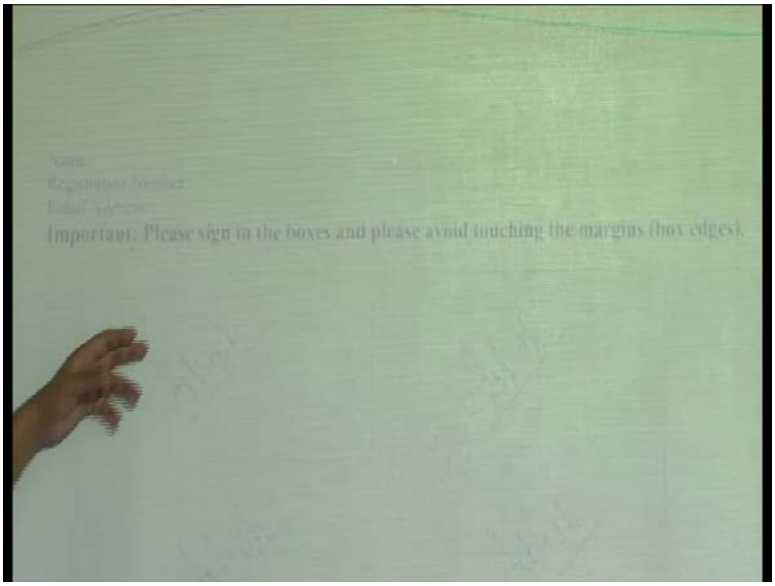

And, at this copying image you will be using, so let us see, it is there, it is visible, right. Some signature is there. So, this type of page was there and here your name, registration numbers all those things you have filled. And then, you have collected the signature. The problem is, that you have to know this point, this starting point of the image, scanned image and then you have to extract this signature, right. It looks simple, I if I know (()) my image, then I can easily go to this coordinate and from there, I will be looking for where I am getting the black line, black dots and that is your starting image. That line onwards, you go till this one. But, it cannot exceed this dots are known to you, where this is this 9, 3 cross 3 image you have created. So, it is easy to crop that image. But, you know in reality, it is not the case.

What happens? I have collected your signature and I have put it on the flat bed scanner. Now, it is not guaranteed that you have put it in exactly in the same place, it may be shifted, it may be tilted little. So, this image will be tilted and as a result this starting point may be in problem. That it does the raster scanning method, it is done through raster scanning method. Even, I faced or we faced the problem, if I use it that blank page, where nine signature box is there and I scanned it or through Xerox machine and then, I give it to you to sign. The Xerox machine is also having some problem; because it is not necessary the page will come exactly, the first page format. So, there may be some shift, shifting operations. So, photocopy did not work, what we have to do we have to take the print out and that is the safe mode. You have to take original printout and there we use to collect the data, this nine signature and in that case, this coordinate is registered. This coordinate is available, exactly it is available, then you scan it.

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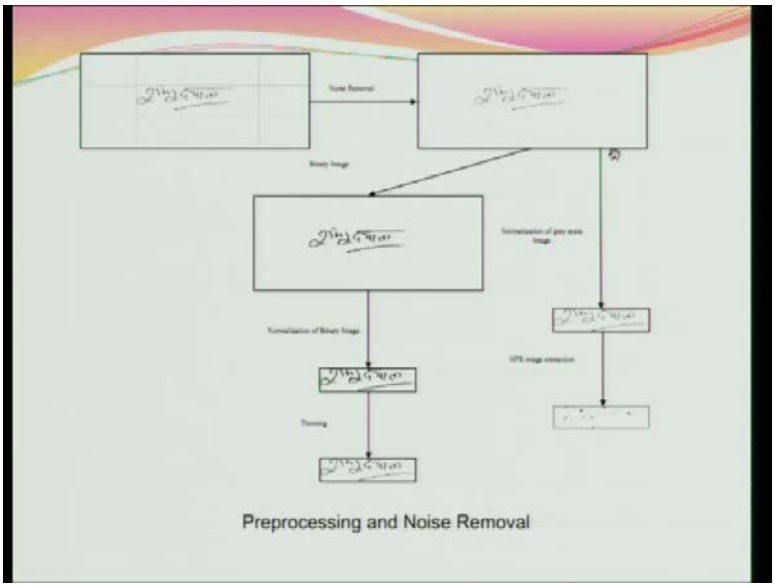

So, we go those cropped image, this is the cropped image initially, this is the this is the noise vocal algorithm. How know, what noise how you will be using very well known technique, we will discuss later on.

Now, the two components, one is that binary image, another one is the gray-scale image. So, binary image from there, I can easily convert into that binary image, that one is if it is using some threshold value, we will discuss what and then if it is below threshold value, you put very dark, 0 and above threshold value, you put 255. So, you get a binary image to color image and then you need you need to get the appropriate areas only and this should be normalized also. Because, signature as we have told that, even if you compress it, the structure will be same. So, you need to normalize it and after normalization, there is a scope of training. So, you get the thinned image.

The other side I have written that, whatever image you have it is in the gray-scale and from the gray-scale; you determine what is the high pressure area.

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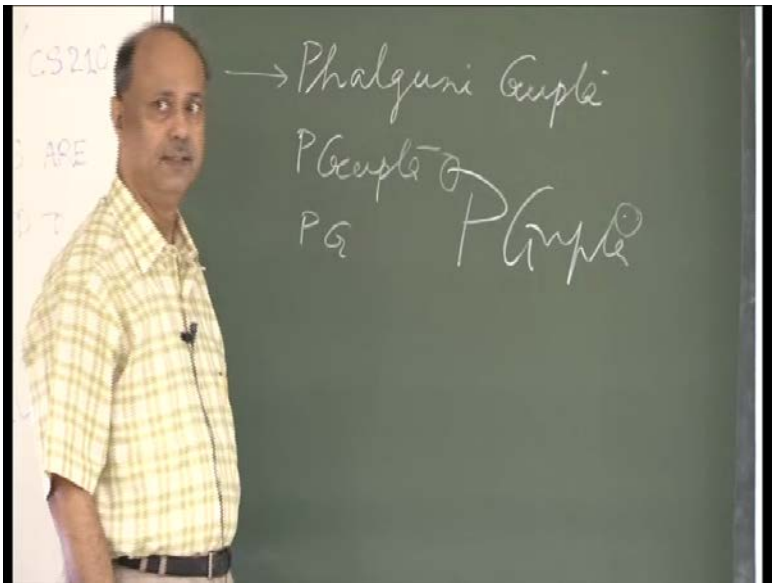

Everybody, who signs on a paper, he has 7 peculiar characteristics. Say for example, I sign, when I sign the paper right, this is the one way. So, you observe, this is a pressure I have given here, here I have given another pressure. So, extra pressure is there, on your signature. Those extra pressure point is important because, this cannot be copied by forgery. Wherever you give the pressure that is you only will be giving the pressure.

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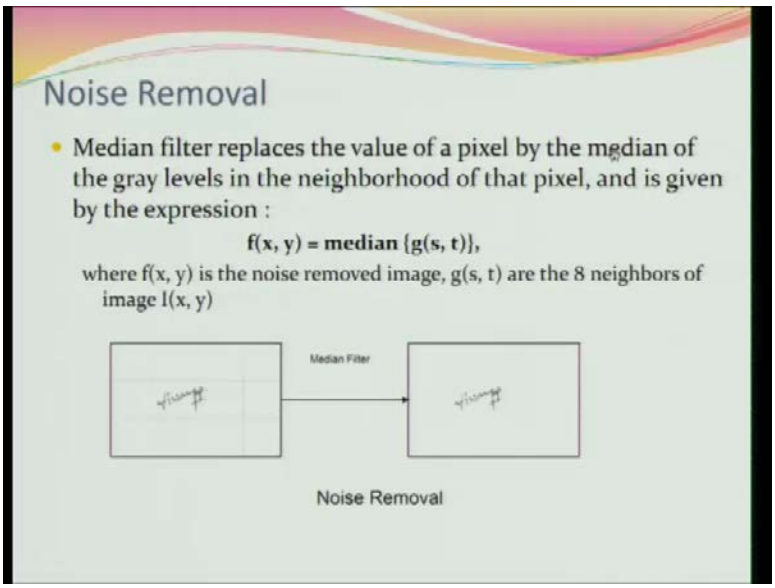

Now, let us think about how to remove the noise? Simple one is the median filtering technique. By now, you know what is median filtering? You take the 3 cross 3 and you

obtain the median and that positions value will be replaced by the median value, right. So, that will remove your noise.

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Once it is a noise free image, you need now from that the block diagram I have told, that you need to obtain binary image, thinned image and high pressure region image. Binary image conversion is very simple. You first obtain a threshold value and all the above threshold value you put the white and below this will be put it dark, right.

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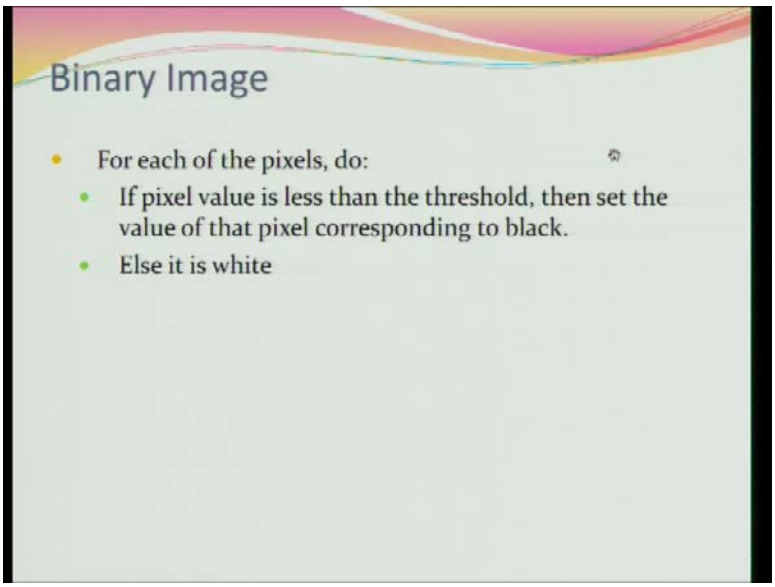

Now, this threshold value obtaining is based on the based on the gray gray-scale image right. You have to know that, what should be the appropriate way of but, one thing here, I can tell you that once you your threshold value you have decided, that threshold value you have to use for everybody. Otherwise, you are in problem.

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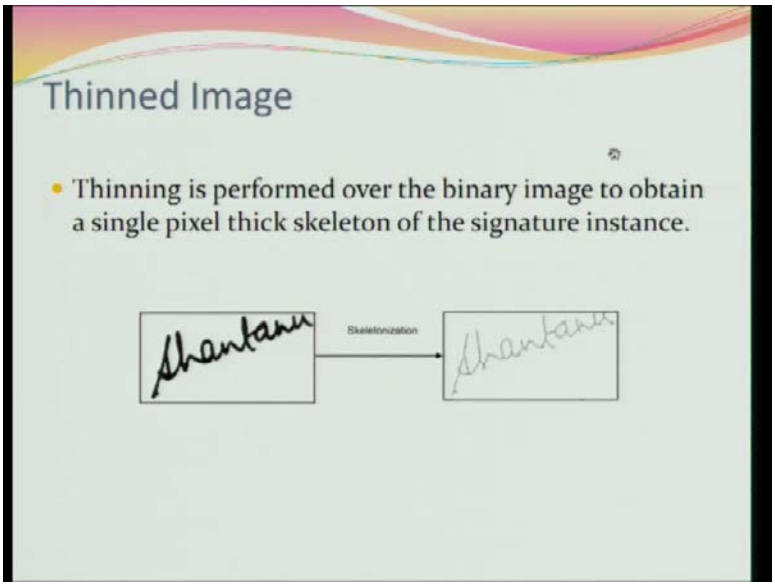

Now, this is your binary image. Now, I need a simple single line signature. How can I do it? So, what technique is, there are different various technique available, one technique is known as the you move a mask, right. And, if you get the neighboring pixel black, you put that instead of 2 blacks, you put 1 black, like that, you iterate it. Finally, you will be getting this type of signature and this will give you a single line signature.

So, if you get the, see you are moving 2 scale, 2 black you make it 1 black, again 2 black make it 1 black, 2 black make it, so what happens signature will move becoming a thin one, right. Now, it is one dimension I have told but, thickness can be this direction also, you have to do similar operations to get it.

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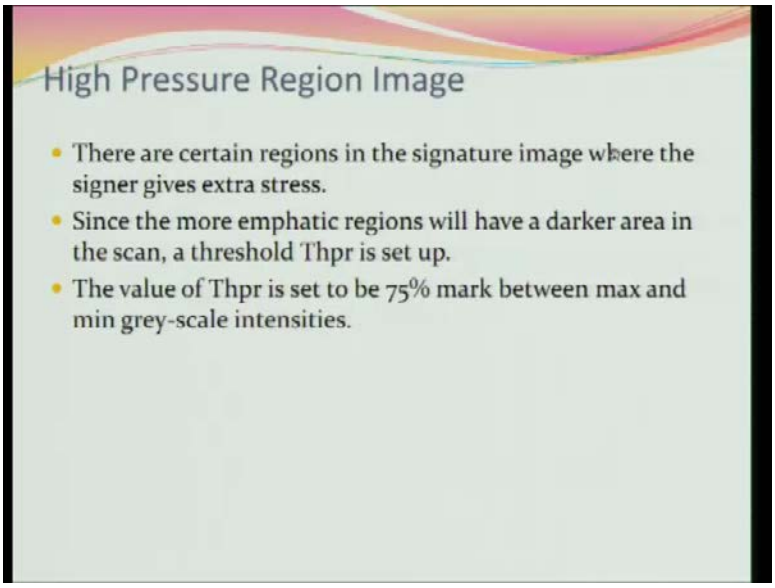

In that process, you may find out the signature may not be like this form, it may be like that. It may come staircase format but, single line. So, high pressure region as I told you there exist some regions, some area, where you have given extra pressure, that pressure you have to obtain. How to obtain that pressure? So, what I we are thinking that, suppose I have an image and then I reduce one layer, that I decrease the gray value by one, then I decrease again another by one, another by one. So, what happen? The dark values, very dark values will be retain after sometime and other soft values will be gone.

So, in order to make it, that only the very dark values you want to retain and all soft dark value you want to remove, what we have done? We have obtain another threshold value, this threshold value is dependent upon the minimum and maximum of gray values, right of the signature area. So, what we did? The value of threshold is is said 70 percent 75 percent (()) between the mean and max gray average, right. We obtain the minimum value and the maximum value, other than the background value, min and max and then max minus min and if 75 percent, that is your threshold value. If it is above that, they are not considered as the pressure point.

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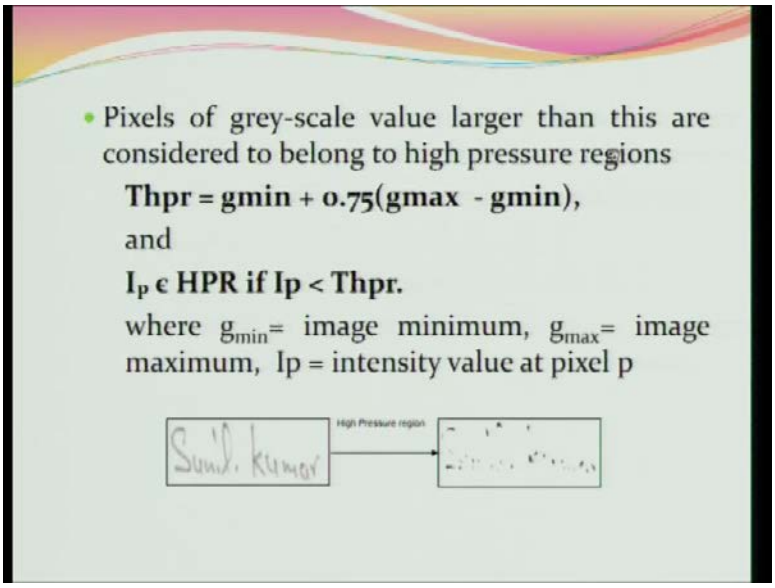

Now formula is, I know the minimum; I know the maximum from the image. So, threshold value is nothing but, minimum plus 75 percent of max minus min and that will be give you a threshold value. If it is less than that, you assume that this is a high pressure area otherwise; it is not. So, you have introduced now skeleton image and high pressure regions.

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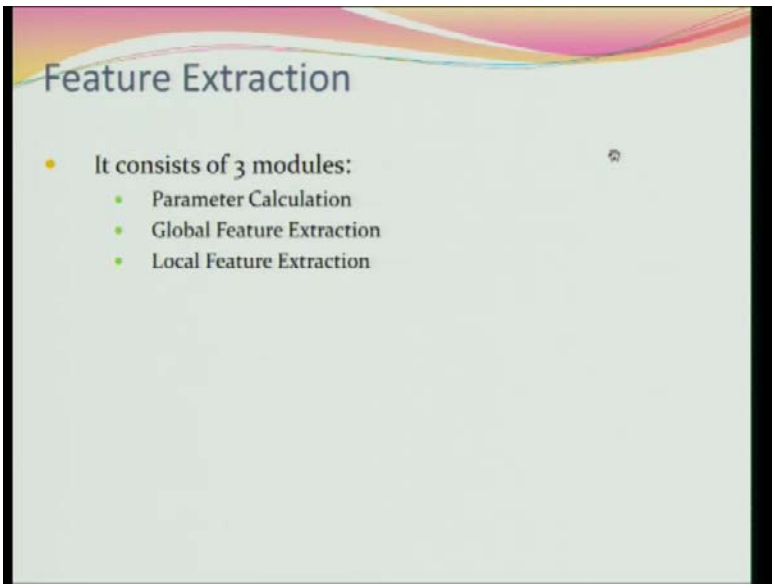

Now, from these two images, you have to obtain the various parameters. These parameters will be defined, there are 27 parameters and also the two (()) we obtain global

feature extraction; from those parameters you will be using the features from the global image and features from the local image. Then, what is global? Global is the whole image, you will be considering and local means, the local some grids will be computing on that grids, you be computing the features.

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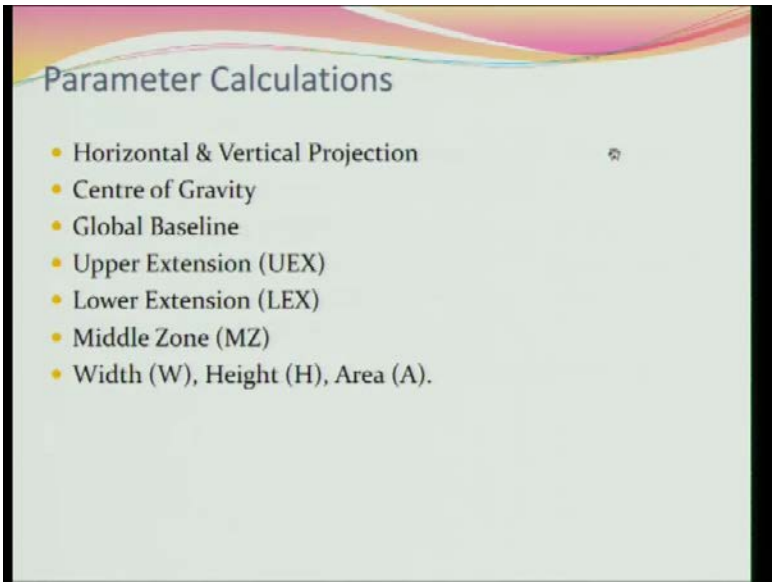

What are the parameters? So, one is horizontal projection, another one is vertical projection nothing but, horizontal histogram and vertical histogram. You have the black and white image, I can easily obtain the what is the horizontal histogram and I can also have the verticals suppose, I have this signatures, I can find out, I can have an histogram, how many pixels are here, how many pixels are here here and so on, right.

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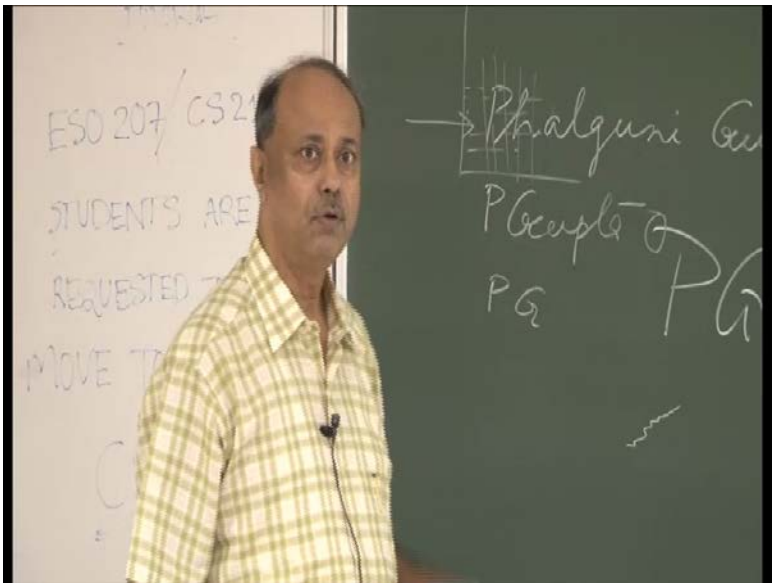

Similarly, vertically we can also find out how many dark pixels are there. So, I get the 2 histograms. Then, we can obtain, what is the centre of gravity of your signed area, that is also we can easily obtain, we can discuss what is the formula? Then, global base line, global base line means the line under, which that most of the pixels are lying. And upper extension line, lower extension line, middle zone, width and height of the image and also corresponding area.

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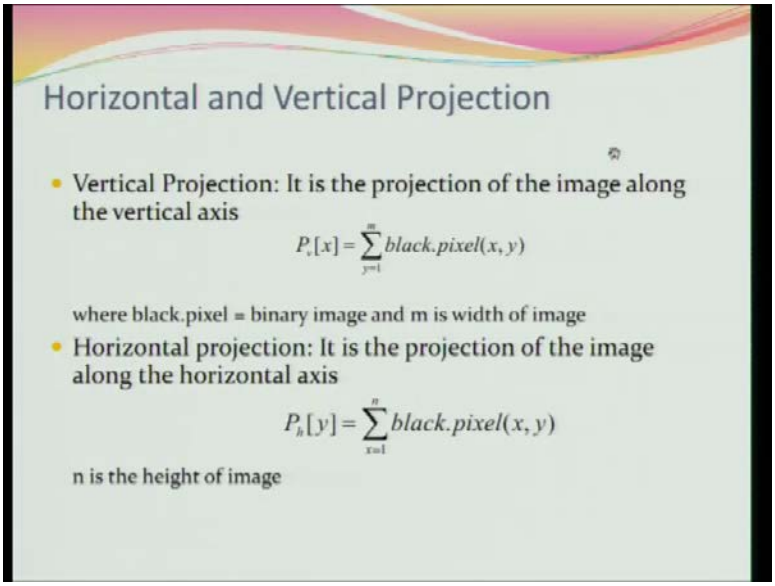

So, let us see is one by one, how to obtain horizontal and vertical projections. This is nothing but, the simple histogram competition am I right.

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Just horizontally compute, so you will be getting like that and so, where you will be getting another one, if I project it this way. So, one is horizontal, another one is vertical.

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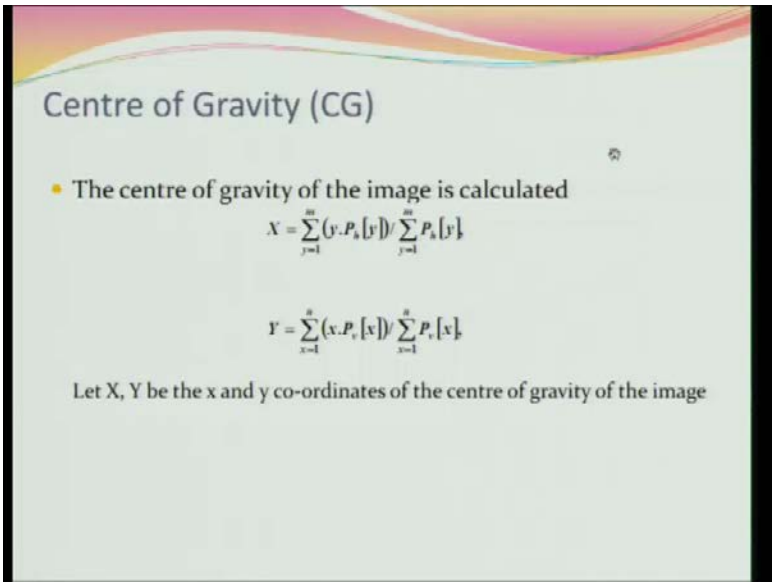

Now, if I know this one, I can find out very easily centre of the centre of gravity. It is nothing but, the x and y coordinate, which is the weighted average of this and this one. So, you know the centre of gravity is it.

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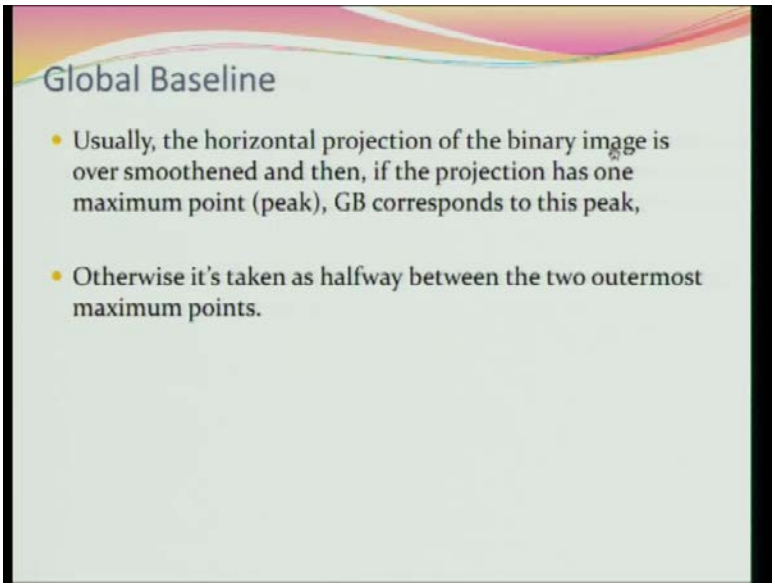

Now, Global Baseline. Global baseline is nothing but, which line is having the maximum frequency, that is the thing right. Because every single, you will find that in my signature there will be line here, it will maximum. Maximum one black (()) that is your global baseline. Now, there are possibility, you may get the two, very two large may be you may find this another one this, like the two horizontal value containing very large values. In that case, you take the average of this two points and that becomes your global baseline, right.

So, global baseline is the baseline, you you write any Hindi character or English character, there is a base line. So, that is your above one is upper extension and below one is the lower extension. Yes yes angle will come, angle whatever angle but, baseline cannot be angle. Baseline is nothing but, suppose I sign not this way, there are people they sign this way, right.

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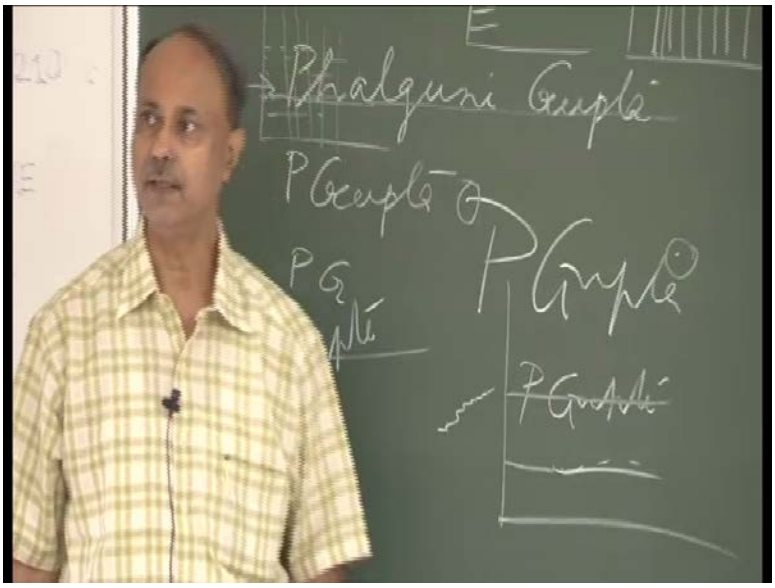

Now, the baseline is that containing the maximum dark points right. That line rotationally fixed. (()). If I, there are people, they write this is not the baseline, no you have to find out, which area which if I draw the histogram horizontally then, how many points are there, that will be a line. How many points are there? Need not be need not be need not be need not be. See generally, such a long line very few gives and even that long line is that that will be tilted one. So, you will not get, am I right. Generally, people give dot dot dot. So, dot dot that will come as a high pressure region.

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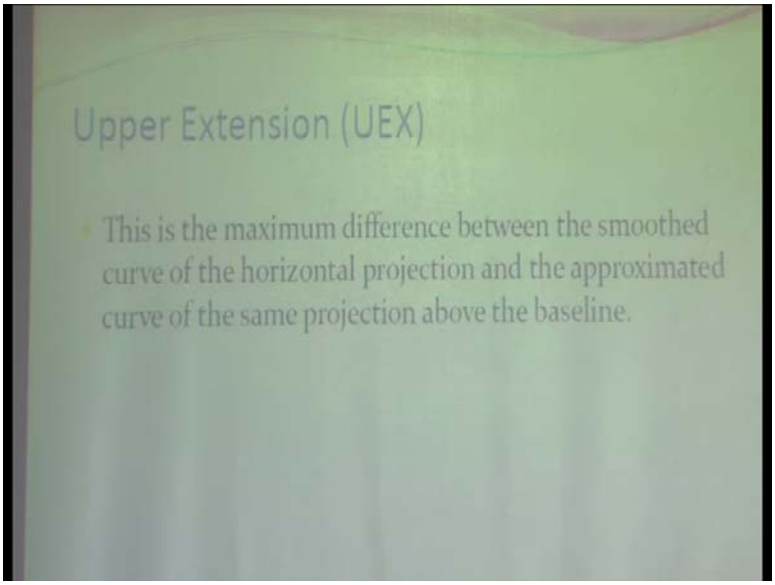

So, the upper extension is nothing but, you have the histogram, you got the base line. You got the base line and you get the, if I draw the something like this, this will be getting, you will be getting like this.

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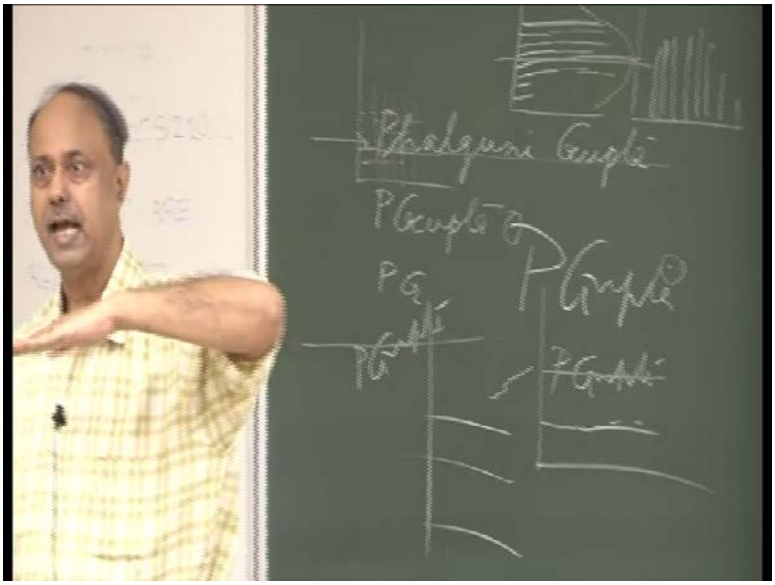

If I do the approximate curve and and you have the curve of the horizontal projection and approximate curve of the same projection of the baseline.

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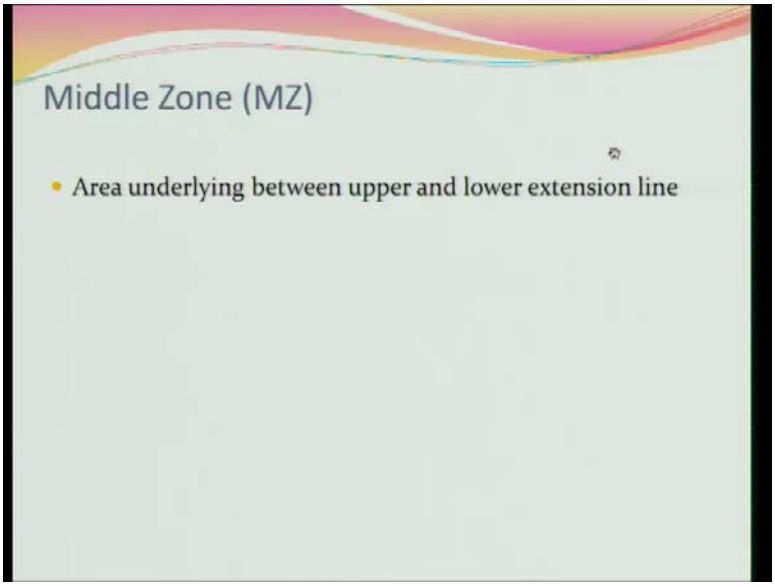

So, you have to get that, this is your upper extension line, this is a base line. So, if you draw the curve, you will get a line, here it is coming. So, this is upper extension, this is

your lower extension line. So, if I note this upper extension line, these 3 lines you can, in the in Hindi characters, you have the (()) right above one is upper disable line and this is other line below also there are some dots are there, right. So, that is the baseline is the centre one and then upper extension line and and lower extension line. So, that is the things we defined. Same idea, we have considered.

And, this zone is known as the middle zone. Between the two upper extension line and lower extension line, whatever area is there that is your middle zone. This middle zone contains most of your signature, am I right. Now, this middle zone will give you several information.

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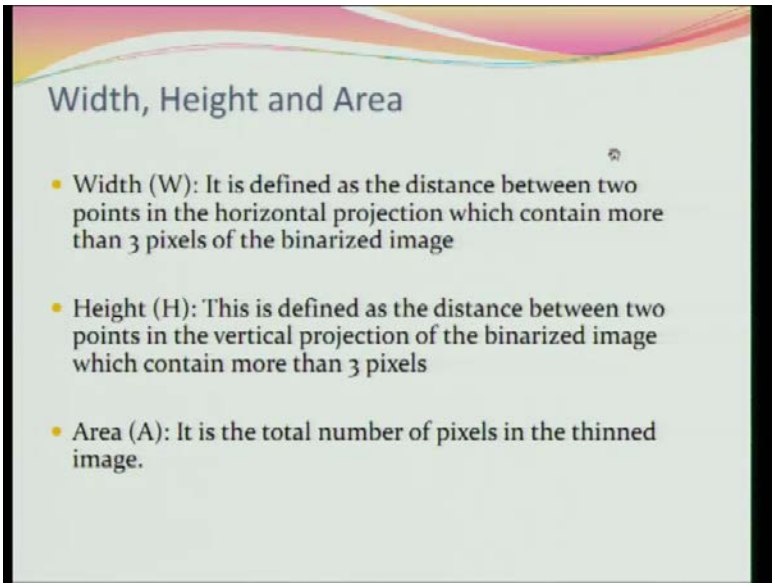

Now, can I find out width and height of your signature? You have the histogram, from this histogram, I can obtain the width, I can obtain the height, am I right.

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Now, there may be some noise, you may find out in yours histogram, you may find the histogram is like this. So, these are may be noise right. So, in order to obtain the width, I do not need this information. I suppress that some number, some here it is considered 3 pixels but, some small number if you find then you do not consider that, you consider this is your width. Similarly, you have the height sorry this is height, this is width. So, you do not have to consider this one and this one right. So, width and height is known to you.

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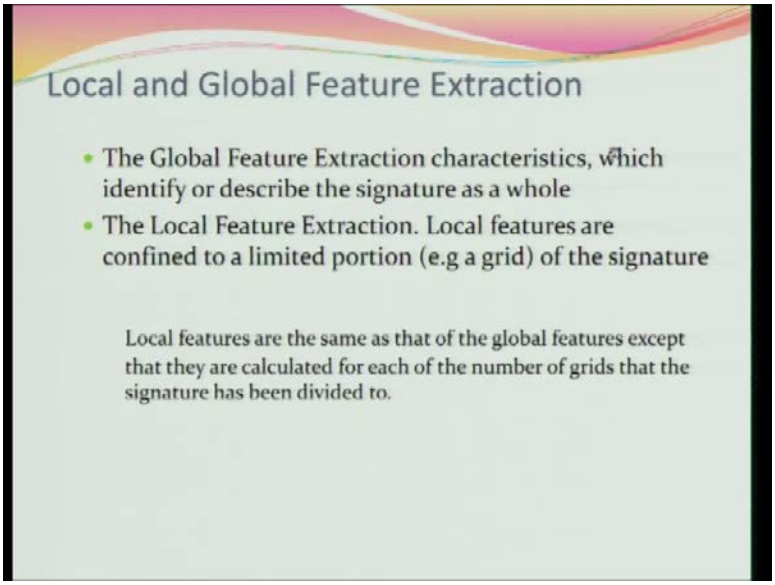

If I note the width and height, I know the area. How many black pixels are there right, which has not considered those three three pixels, two pixels, those noises. Now, the you have obtained the feature points. What are the feature points? Global baseline, baseline upper extension, lowers extension, width, height and area right. Now, these parameters are used to obtain the features on the whole image and also on the local area. Local area is nothing but, that grids we have created, one is with above extension line, below extension line, below above baseline and so on.

So, I have the three parts. One is upper extension line above, another one is lower extension and another one is the middle zone. These 3 regions are there. For these 3 regions, also local feature point I can extract.

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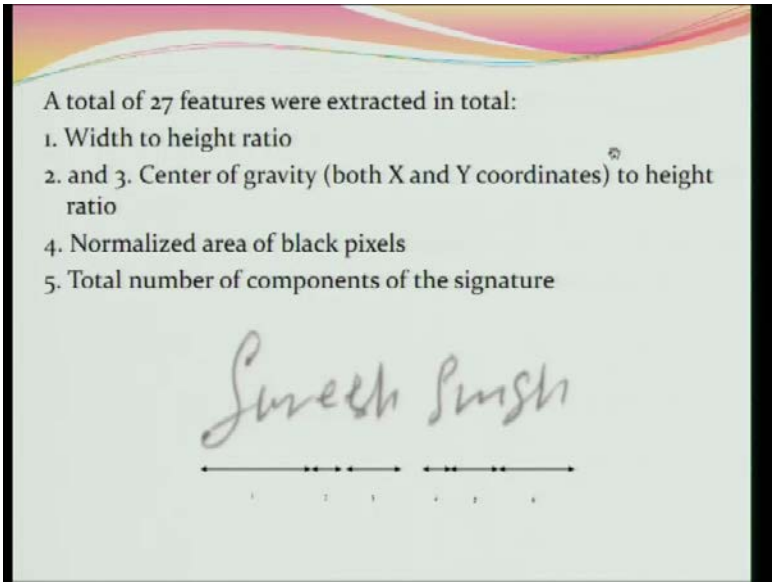

Now, what are the feature (()) feature points? So, there are total 27 feature points. I know width, I know height. I can obtain the ratio, why I am obtaining the ratio? I have to normalize, remember one thing. The signature sign may vary, right. So, that is why to normalize this, we have done the ratio between the width and height. Then, we can obtain, we have the centre of gravity and X and Y and we know the height, we just obtain the ratio X by height and Y by height. They normalize area black pixel means, width and height is there but, what is the image size? Based on that, you can find out the normalized area, normalized area black pixels. Then, this can be considered as a graph.

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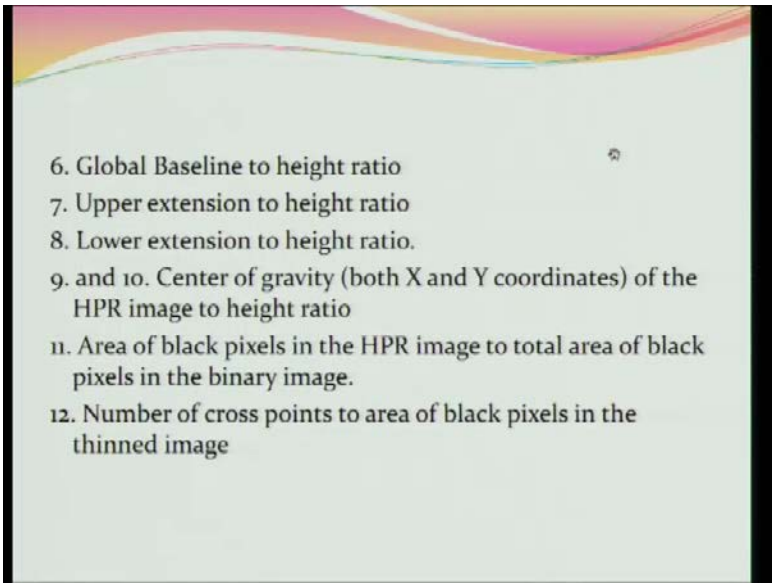

I can find out the number of connected components. Consider this signature, you observe that this is one component, this is another component and this is the third component right, So, number of connected component is also important. If I you start forging somebody else, you will find that the connected components or number of connected components is different. So, I can easily find out the number of connected components.

You have the global baseline, you know the height. So, I can obtain the global baseline by height ratio, upper extension line to and height ratio, lower extension to height ratio, centre of gravity. Now, I am considering that high pressure region. So, you can obtain the centre of gravity of the high pressure image to the height ratio and area of the black pixel in the high pressure region to the total area of the black pixel that also you can obtain and number of cross points of the black pixel, this is another thing what we will be discussing, that you have to find out the number of cross points to area of the black pixel in the theme image, that is also ratio.

Now, what does it mean, number of cross points. If you see the signature, there are some crossing points. Say for example, in my signature, so there is a crossing point here, there is a crossing point. Similarly, you will find there is a crossing point, there is a crossing points right, crossing points and so on. So, this how many crossing points are there? So, in any signature, you will get the several such crossing points right. And, also you can

find out the number of end points in your signature, there is an end point, here one, here one, here one, here one, here one, one right there are several end points.

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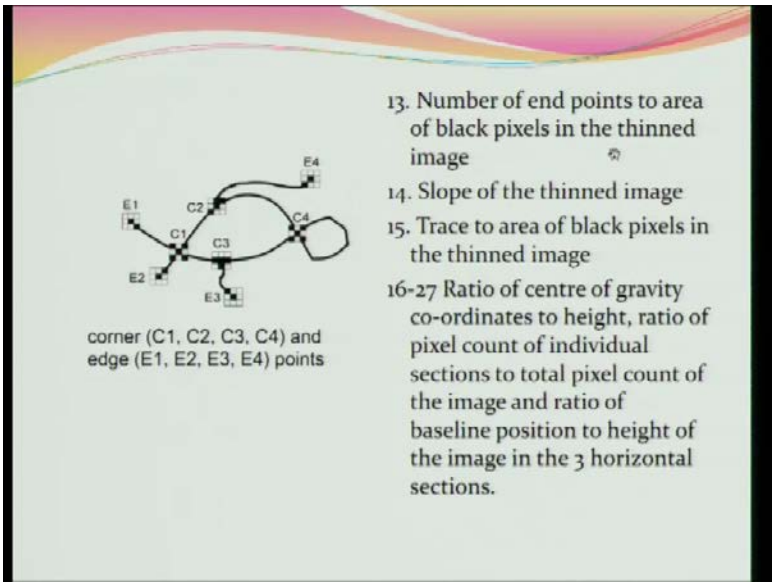

So, number of end points also you can find out. So, number of end points to the area of the black again the question of every time, we are considering the area is my best thing. Because, I have to control my size. So, that is why and then slope of the thin image, you have the thin image, can I find out the slope of the image, slope of the image you have to find out because, the person who signs always signs tilted manner, he always will sign in the tilted manner, only that is the regular practice.

Trace, then trace to area of black pixel in the theme image. So, exactly thin image also you can find out, what is the total number of black points right. Same, whatever things we have considered that also for the three regions up above upper extension, below lower extension and the middle zone. You can find out the coordinates centre of gravity (()) ratio of centre of gravity, coordinates to height ratio of pixel count of individual section or to the pixel, total pixel count of the image ratio of the baseline positions to height means, in the 3 horizontal sections because, first upper extension lower extension and middle regions. So those ratio you can obtain.

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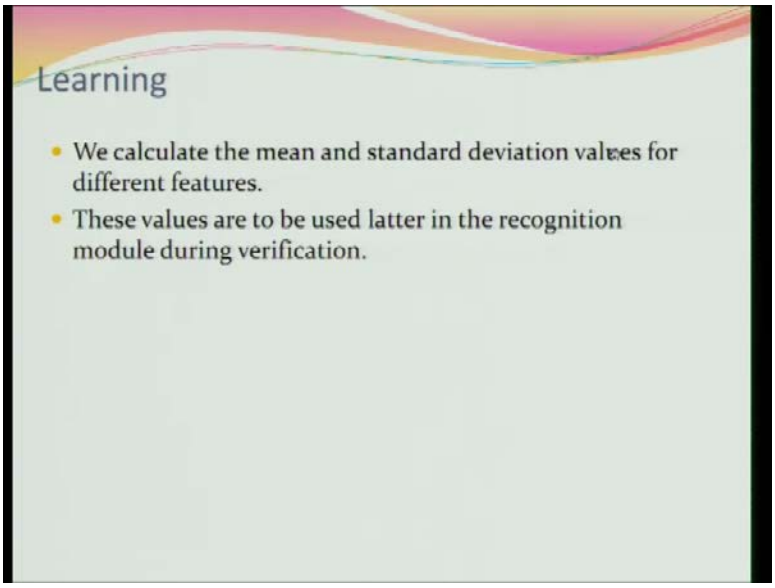

So, you got the 27 feature part. Now, these feature points would be used for your matching purpose or decision purpose, right. As I told you, the signature is vary right. So, can I use this 27 features constantly, that will be a risky environment. So, what we do? We have to learn every time. Whenever you sign, we obtain the mean and standard deviation with respect to the, whatever knowledge you have.

So, given the previous 9 signatures mean and standard deviation of your signatures of different features for against these features, I will keep the mean and standard deviations. You have come and I and new signature you have given, I will modify my mean and my standard deviations, I retain it. So, whenever you give a signature, I check this feature points, whether your feature, each feature points is lying between that X bar plus minus two sigma or three sigma. If it lies between that, you tell that features are matched right.

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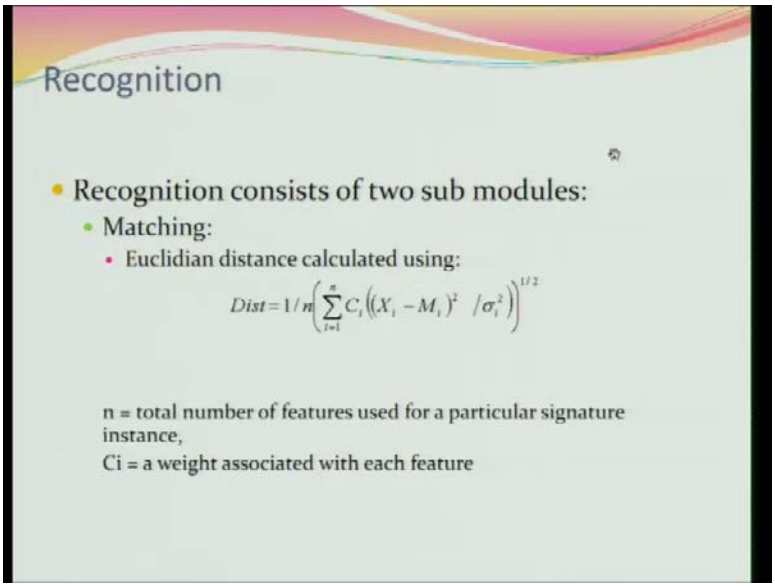

So, with this idea, we can have the distance formula. One by n summation C i X i minus m i square divide by root means square basically sigma square and then you take how right, where n is the total number of features, which is 27. C i is the weight you want to give on the i-th features because, all features are not equally important, equally important. Some features are having more power, more dominant power, compare to the other one. So, some ways you have to assign against each feature points. X i is the i-th feature point, you whatever you got, m i is the mean of i-th feature point obtain from your previous data's and sigma i is square is a variance of your your validity of i-th feature points from your old or training set.

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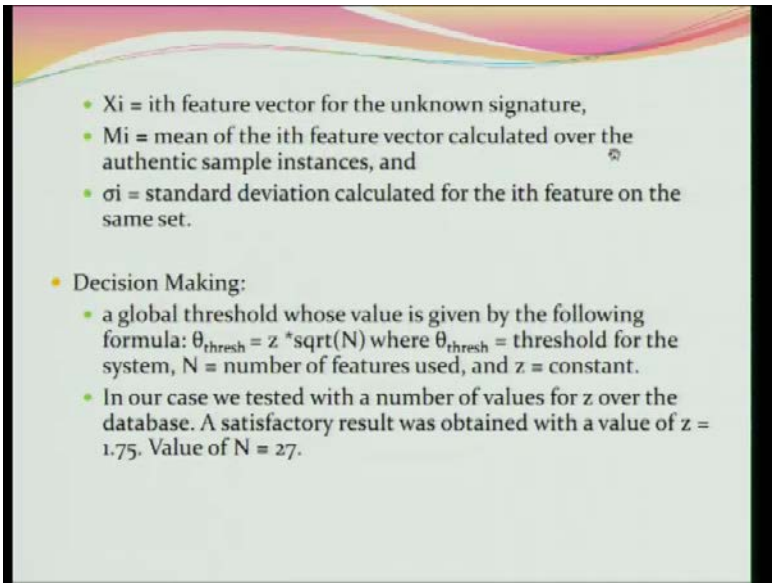

So, this is the definitions. So, once you know this one, so can I take the decision. Obviously, this after that what will happen, that you get some value because, because what you will be getting distance is equals to root mean square, some value you will get. Now, this value, if this value is less than some threshold value, you would be telling that is matched. Otherwise, you will tell it is not match.

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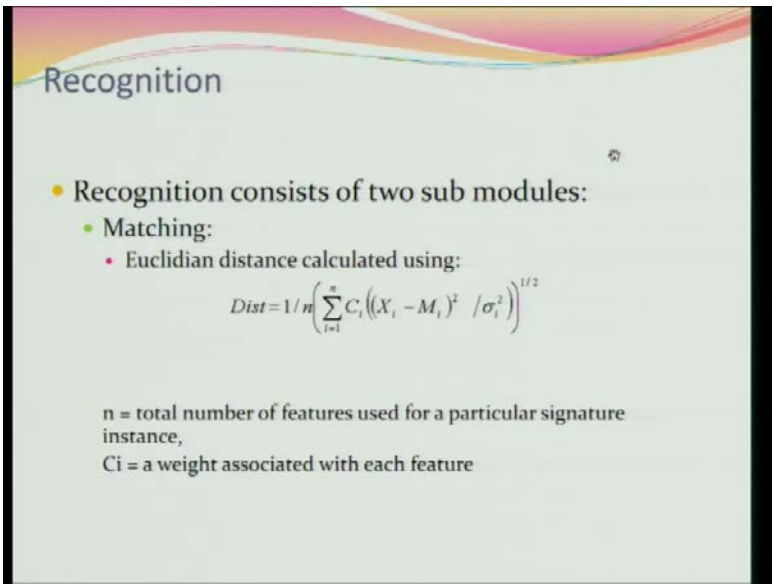

Now, what is the threshold value? How to compute the threshold value? Threshold value, we have to obtain z into square root of n. Square root of n is the number of threshold value, n is known. Now, number of feature values, feature points which is 27.

So, square of 27 into z, z is some constant. Here, in our case, what we observe or in Indian what we observe that, we have put z is equal to 1.75. So, 1.75 into square root of n is your threshold value. If, it is less than that value, you tell accept the distance match. Otherwise, you tell distance is very large so, you are rejected right.

This is all about, I think this is all about, how to estimate the value of C i? Yes, C i is the weight assigned to each of the parameters. Now, you will be observing this C i values, C i values will be come because, sum of C i will be one, let it be clear right. Now, you may not get you may not get all the features on your (()) on your signatures. Some features is, you will find that it is say high pressure regions right. Now, less number of high pressure regions will have the poor poverty of matching, am I right. If, I more from your signature, if I get too many pressures, high pressure region, high pressure dots.

So, you get extra parameters but, if I have only two dots, two high pressure dots, I will not get. So, those issues you have to take into account, is it okay. So, what happens that some of the (()) feature points, you will find that they are presents or they gives always (()). Some of them are you will find that they are routine every so, you give little less weights. So, this C i will be computed based on that idea, right. So, these are all through training only you have to gain knowledge, is it clear.