Biometrics

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Lecture No. # 01

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So, let us start. See this is C S 698 X, and the study of the course is multimodal biometric systems. And I am the instructor in charge and I am Phalguni Gupta. So, very often you will be thinking of that, what that biometrics? Whether I will be able to understand the course or something like that?

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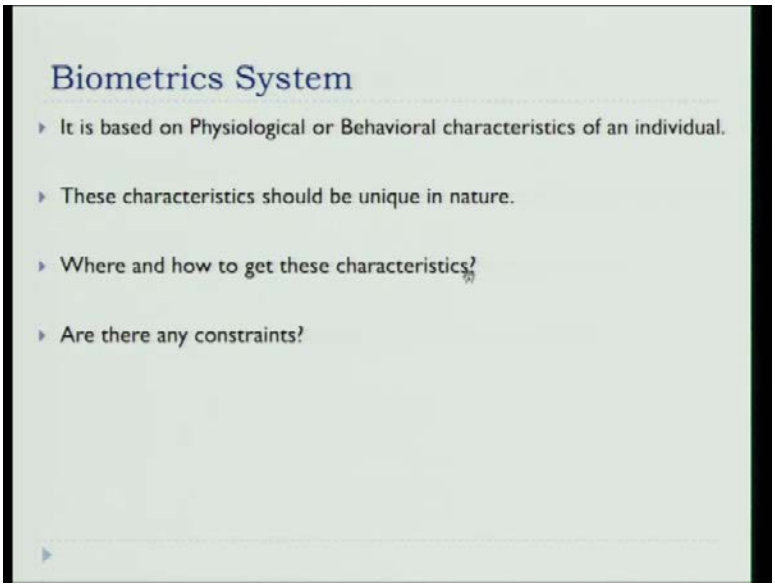

It is nothing like that the biometric system is generally develop based on your physiological or behavioral characteristics. Now, what do you mean by physiological characteristics? Every individual has certain characteristics which he is maintaining with himself; say for example, your face is a physiological characteristic. By seeing your face you can identify yourself. You may feel no this is not my photograph, maybe I was not in a good mood or my the camera did not take my photograph properly. That is differ, but at least you will understand that this is my face. Similarly, your finger print or palm print or foot print iris, and so on.

There are several physiological characteristics, you are continuing yourself. Similarly, the behavioral characteristics the way you walk from the backside, when you are walking from the behind also I can understand that he is going. The way you make the sound while walking. So, that is also unique in characteristic or the way you press the keyboard the way you speak and so on. Now, these there are several other characteristics, but you cannot consider all the characteristics as your biometrics characteristics. You can select only those characteristics as biometrics characteristic which are unique in nature. Suppose I consider that this is my biometrics characteristics, but you will not be able to identify the individual by seeing only this arm part

So, this is not unique in nature, but if I tell that the face is a biometrics characteristic, you will accept it. Because every face look different except some few cases like a twin

brothers, twin sisters, but there also there are certain indication is there through which the parents understand, he is mister x and he is mister y, even though they are twins. Now, where to get these characteristics, that is with the individual himself it is not outside.

And it should be taken in such way that you should feel that it is unique in nature that feeling must be there. And there are certain other parameters you have to understand that not only uniqueness, it must exist to everybody. It is only you are telling no no I have only one finger and others do not have. Let us consider this is the biometrics character it is not allowed, that it should be available to every individuals. Then next one is that it should be permanent, it should not be like that today it is available to know tomorrow it is not there.

So, those issues characteristics will be there of any biometric state and how to get it? Next question is how to get biometric characteristics? So, obviously, that camera is one source or sensor is one source. Through any sensor you will be able to get the biometrics characteristics, and once you get that image or the sensor data you need to process it. That through processing you have to get certain features, those features should be used for your identification or the recognitions. Are there any constraints? There are many constraints while you are collecting the data. First constraint is the atmosphere, for example, we decide to take the finger print image through some sensor.

And most of us we take food using hand. So, after lunch I fix that time and I have decided to collect your thumb impression, right hand thumb impression .So, you have curbed up the food, and you will find even though you put your lot much soap water or other things, you will find some greased materials are in your fingers. So, one you give up a your impression possibly your data will be able to get it data correctly there will not be any problem much problem. But the next person once he comes, he will find the finger; reason is that you have given your finger print impression on the scanner which is still there.

So, collecting data is different, atmosphere creates problem, because weather suppose it is a sweaty weather. Now if I take your photograph your photograph will be different if I take at this point, if I take your photograph outside the building. Because your face will change right the light source the way we take the photograph. If we see that the light may

come from this side, that side and so on. But if I take your photograph outside this building in the sun sunny weather, your face will be different or the background. In the background if you find that there is a red crops or a green crops, and I take your photograph then the light will be reflected on your face from the crops also.

Similarly, is the case with the suppose I decided to take your palm print and in the palm print if it is on the sand. Palm print you know only possible palm print means this is the palm I want to take the is only possible when you touch something. So, if it is on the sand area I get it I take the photograph, but that will have different type of noises. Lot of lot many noise will be there, but if I take the your palm information from the glass of where you have taken using that you have taken water, then that you will be you know some different format. So, projection as it will come in between to project something on the plane. So, there are several such constraints on each image on each sensor or each type of each such type of data and these constraints has to be minimized.

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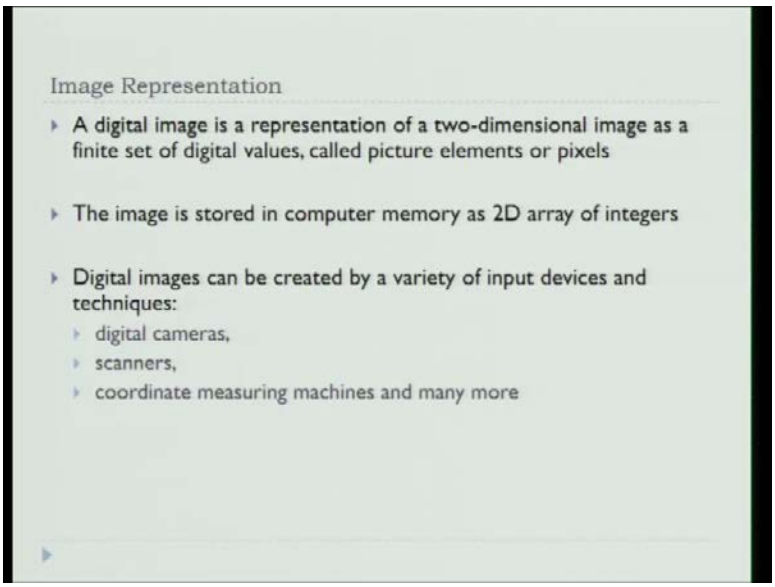

Now, biometrics itself is not a course that I cannot tell that biometric is a course and biometrics is has been see this is being defined using mainly this three parameters. One is image processing another one is pattern recognition and the statistics. So, they are we will take the help of these three courses to explain how to design a biometric system? Now, obviously, you will be telling or thinking that do I have to have the pre knowledge or pre requisite of image processing pattern recognition or statistics. Answer is no, you

do not need any such type of background, because all of this will be covered as and when you require.

But, I assume that you have the little knowledge on statistics that is the only thing my requirement, that if I have you have to start that property a b equals to property a plus property b minus property a b then I am in problem. So, I assume that knowledge you have or what do you mean by two variables are independent? Those knowledge I am assuming that you have. But image and pattern recognition I assume that you do not have any knowledge because our we generally do have any knowledge in image processing. Who is having little knowledge in image processing? So, we will do not worry about that, but you know what is image? I suppose you know the word pixel. What is the pixel unit of an image? And it represents what?

So, if I tell a 5 mega pixel what it means? 5 mega pixels means what? In your one cross one. So, five billion points are there each point is a pixel. Now if I know that from the camera if I take a photograph and if I know the area it has covered. That image has that area and that many pixels is there. So, you know what is the area of each pixel, it may be 1 1 nanometer or something like that, you can easily compute that one.

Yes. So, the pixels it gives represent some area of your face or of your finger print or something like that. And that means, image can be represented by a two dimensional array, it does not have the concept of the depth. It is the only two dimensional array and it may be 100 cross 100 or 128 cross 64 and each of them has certain represent certain length or width of the face or finger prints and so on. And, that image through certain processing that the image has to be manipulated. So, that it can be used for your identification.

Now, one easy question is that sir, what is the problem? You have a, I have a photograph and another photograph. You just check it, match it and tell take the decision, whether it is matched or not. I have taken your photograph and in my database your photograph is there, the two photograph take the and I take the decision whether it matched or not, yes or no. So, image by image matching could have been done.

But the problem here, that if I take the image by image matching, say if it is a 512 cross 512 rupees that is 512 cross 512 diff operation is required, which is very costly. Because I am not thinking about only the one person you have to think about 1 or 100 millions

people. Second thing is that, just now I have taken your photograph at a distance of one meter and may be previous photograph is having the distance of two meters. So, there will be sudden changes or the angle may be a different, all those issues would come into in pictures.

So, even by image matching is not a possible solution, also the quality of image, also you may find that light source is different. And all those things color may be different today you have come in front of camera without putting any talcum powder and after time t you have come with lots many cosmetic materials. So, you know intensity value of each pixel be different. So, difference will not give you the proper solution. So, what we do through image processing? We try to enhance the image that is the only thing we do. We enhance the image and retain with us, now from that enhanced image, we try to extract certain features. So, what is that features?

So, in the case of finger print you check there exist several lines which are known as ridges or valleys. Now, under these ridges there you will see it that in some cases the ridges suddenly end or it has bifurcated. It has from one ridge then you will find the two ridges come have come out and so on. So, these bifurcated point is a feature point, similar is the case with the palm print if you see the palm there are certain lines are there these are known as principle lines. These principle lines are certain properties along with that you will find there are certain ridges here are also there. So, these ridges also do have those properties and all such type of characteristics, you we need to extract those features through certain techniques

Once, I get that features I retain that features and this feature size is not very big. So, that I retain it as in the form of vector, now in the form of vector each element may be three triples or five triples or some things. Now, once you get again that features from another image I can have any distance matrix or I can use any distance matrix to obtain how much it is deviating from the original one. And, if it is less than some threshold or if it is greater than some threshold, you can take that decision, yes; these two are matched or not matched right. So, this is the pattern recognition, rules of pattern recognition and finally, the statistics where I need to draw the conclusion based on some threshold.

I have told you in the current pattern recognition, you have to tell that if the difference is or distance between these two vectors is less than some threshold, you are telling, I

accept otherwise I reject. So, once you decide that way then there is a chance that one day, you may not have a good biometrics day. You could not give your biometrics data properly and as a result say I for example that today weather is very bad, full of sweat on your face and if I take your photograph.

And also you fought at home, when you discuss or you did something outside your hostel and you created nuisance there. And you have come, then your face will be different and then u wants to match with this face with your database face, where you have come with a suit and other things. And your beautiful face is there and I will find that it is different difficult for us to match it, that is not that will tell that your biometrics is not good.

In that case, what will happen? It will exceed the threshold and you will be thrown out. You will be told that did not match similarly, is the case that there exist for any system there exist forger group also for anything. You know always we like to bypass the system or we like to see how I can make the full system, all of you have the habit. So, there exist by you will first day you will be caught, second day you will be caught, third day you will try to find out that. How I can bypass the system? So, that I can enter into the system. So, once you do some possibly by some method you will be finding that your difference distance between the two vectors becomes less than threshold and you have been accepted that may occur.

So, if it occurs, that means, you have been falsely accepted. So, there this method comes under this category that there are certain statistical parameters. You have to consider to rob the final decision whether I am accepting or rejecting .So, there in pattern recognition, you will find that there exits two types of error will be discussing in detail later on. One is known as type one error and the other one is known as type two error. Now, in our case we have one is falsely accepted and another one is falsely rejected.

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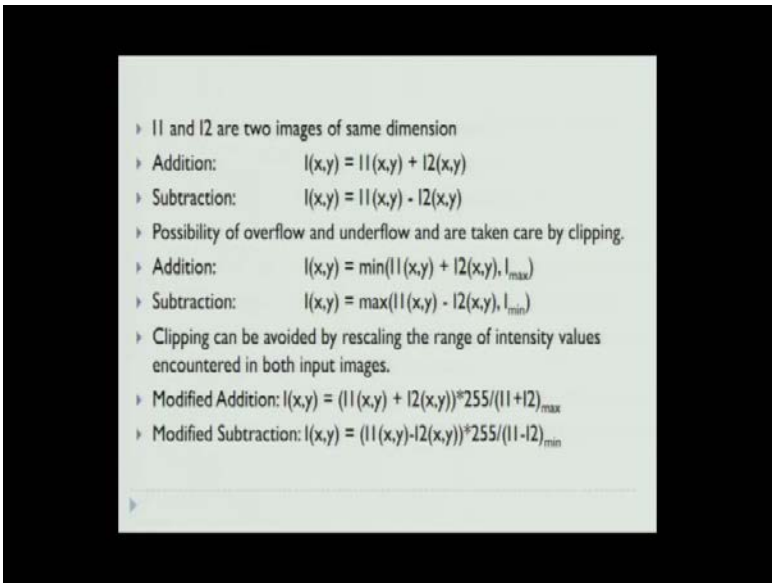

So, these two types of error and this to measure this type error we need to take the help of statistics. So, these are the three subjects we may need to use. So, in the image processing what are the things we need to discuss? Or we will be discussing in our course. First one is that how to represent an image? Because that is important thing because until and unless you know how to represent image you cannot proceed further.

Then different types of images are there we will discuss. So, for example, one is known as color image then, what type of operations I can perform on any image? So, different types of operations filtering this is the most important one we will be very we will be using it very regularly. Is not it? edge detection, smothering, sharpening, erosion dilution threading and certain enhancement techniques.

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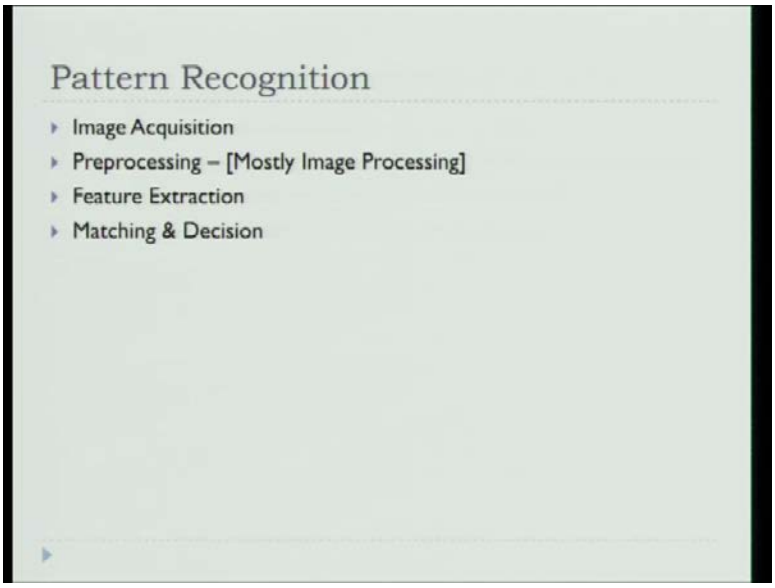

In the case of pattern recognition first problem is coming image acquisition. So, what do you mean by image acquisition? That see there is a sensor and you have to come and give your data .And I have to collect the data in such a way that this data is useful, what do you mean by useful? The data would be useful only when that I get the data very good quality, if the quality is poor, it is very difficult for us to identify something. So the data image acquisition system should be such that it should be useful for us or for us to determine something. Say for example, in today's if you see that yesterday night there was a bomb blast in pune city they have the CCTV, but they could not get anything out of it. So, that is image acquisition system is used is basically.

So, the system should be such that I must get the photograph or footage as and when I need and in the proper format. So, not only you, who are putting the camera? you should ensure that you are putting a camera in such way that most of us will give the data in data format. So, for example, in the airport I want to take your photograph. So, always since I told you that we have the habit to bypass the system I will put my face little tilted or I will put something on my face say a cushion or some paper here or something like that. So, that I want to see how much I can make the system.

Say, the general tendency what we can do? Suppose at the time of entry I put some a beautiful picture. So obviously, everybody will like to see the picture and at that time I can capture your photograph. So, or I will put my path such a narrow way that only one

person can go. So, that there is concept of occlusion comes in between. There are several ways you can tackle, but this image acquisition plays an important role, because you know if I do not get the good quality image, I will not get the good acquisition. So, there is a two terms we will be using, one is known as control environment, another one is known as non control environment.

In the control environment means that I fix my environment, the light source is this is my camera specification and I want that you should be able to give me the data in that format, say background there should not be light background all those things, I am fixing it. So, that is known as control environment and non control environment. Suppose in the football ground I want to take your photograph or I have a gallery of photographs and then I want to identify somebody. So, that is not under my control that general photograph I got it and we are trying to do something.

Now, once image is there, I told you that we need to do certain processing. This is known as preprocessing and that should be done through certain image processing algorithms. What we will be covering? You know during our courses and from that image, we have to accept the features. The feature extraction techniques should be discussed and finally, matching and decision will come in between.

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So, once I know all these things. So, you are ready to know or start your work on biometrics. So, I have to define, what is biometrics? At that time once you define a

biometrics, now how good is a biometrics? Say everybody can design a biometric system. First one is that, if you declare something as a biometrics, you have to tell that it obeys certain properties like example it obeys the cubicness or permanence. So, once it passes through certain parameters then only you can tell this is a possible biometrics.

Now, once you declare that this is a biometric straight you have to tell that how good is your biometrics system? So, performance has to measured, now performance is to measure means that it is not only with respect to the accuracy rate, it is not only with respect to that it will fade. We expect that it should be near real time. So, that we can take the decision on the as early as possible about his identification. Then also it should be, it should not be very costly. Because, if cost goes up then nobody will purchase your system. So, those measures will be discussed.

Then we will be discussing different biometric system as I have told you. Your face is a biometric system, everybody has face that the universality property obeys and similarly, other characters also obey to some extent. So, different types of biometric system, we will be discussing then applications where are you going to use it? Suppose you decide in some institutes they are planning. Or they are also want to do that finger print system is a class room attendance, in your class it is there in your school finger print system. No. So, they decided that no finger print system will be there in the class room a cost of a finger print is coming say 5000 rupees. And, if I purchase on mass scale may be 4000 rupees as I have a class of size say 100 students and I decided that at entry point I put the two finger prints one is this side and the other is that side.

So, what will happen that and all of you have the intension to come to the class at 9:01 not 8:59 and that is a generally our habit. So, once you come at 9:01 and 100 students will be entering through the two gates. So, I assume that they are equally likely that they will use, but generally you will find that this gate will be used more compared to the other one. So, it is a long queue and when you stand in the queue and we are human being, our mouth will not be stopped it will be continuing like this with your friends and about the previous night story.

So, by that process when you enter you already spent ten minutes. It is fact ten minutes is nothing even if you take ten seconds per individual I lost ten minutes. So, from my class hours ten minutes gone. What I achieve? I achieve that your attendance. What I lose?

Ten minutes from my class. And what student gains? Nothing. See for example, I am sure nobody will come to my class if he has not registered. So, this is the concept of or I do not care about the false acceptors. If anybody wants to come falsely in my class, no problem, he sits here, he sleeps, whatever he wants to do, let him do. I do not care.

And, now is coming the falsely rejected that personally a genuine student, he wants to come to my class and I am still no my finger print is still there, he is saying no you are not a genuine person. So, falsely suppose I am rejecting. So, false acceptance false rejection will treat a problem for me. Because a genuine student he wants to come in my class anyway the student are not coming to my class no somebody wants to come and you are not. So, this would be a big problem for me. So, I do not want such a system where my genuine student wants to come and I am rejecting him.

And not only that I am spending money also for that. So, this is not a good proposition. Same thing in the case of let us understand in the case of nuclear flats, there it is different, where I do not want someone enters falsely. Then that will be havoc, there will be chaos, but at the same time false rejection should be there. Because you know, if you want to get some good thing, you have to bear some bad thing also. So, it is like that that if I put my system very tight not to allow any person falsely. So, there are some genuine personnel's will be stopped. Because that day his biometrics data was not correct or he could not provide the biometric data correctly.

So, you are telling that sorry I am not able to recognize you he may have to give several time his data to get the socket. So, there exist some other applications for that. For example another example I can give you application is how come then another application is say airport security which nowadays is a very very common problem. So, there we decide that even though the CRPF is a tough man they are helpful, if you go there they do not tell no that your photograph is not matching or you have not taken out your shoe. And that is why I am not allowing why do remove your shoe and go inside nothing wrong in that. So, the security level you have to understand.

What level of security you are expecting? How much flexibility you want to give on your system? Say for example, in ATM what happens if I give falsely? Except more there people will take money, but if I tell no no falsely accept I will not allow false rejection. May be allowed then you will be unhappy. I have kept my money in the bank and now

you are not allowing me to draw my money. So, there is a need of compromise between these two factors. So, this would be coming here.

Next one is that what are the issues you have? Because for every system you will realize there is certain issues, critical issues. For example, in our country most of us are cultivated, you may not worry. Are you cultivated? No. Have you seen the structure the way they work? No, what is this? You are from which place? Maharashtra. There is no cultivation in Maharashtra, you have not visited those sides is too bad, you must go and see how they cultivate? This is different atmosphere they do not care, see they do not listen the radio or T V to know whether rain will be there or not.

By seeing the atmosphere they realize that tomorrow there will be rain, see most of them is cultivated seventy percent of India is cultivated or hard worker. So, most of these people, they do not have the finger print, they are plain nothing is there. 15 percent of our population they do not have the finger prints. And now, suppose I introduce that your finger print is my source through which I will identify. So, 15 percent of the people I will able to tell whether they are genuine person or not, see in the case of the government has certain policy like schemes the poor people will get two hundred rupees at the end of the month. And, this poor person comes from that cultivation, hard work and other group.

And, then their finger print is not there, how you can give the money now? So, you have to have certain alternatives, now this alternative, whatever you will be thinking, suppose I introduce what adhar card have you given? Your adhar card, have you got your adhar card? Some of you got it. So, in the adhar card they have taken not only your finger prints he has considered the ten finger prints and also there is your iris data, the eye ball detail.

Now, again if I introduce there iris data, iris camera cost something like that between minimum costs is eighty thousand and maximum cost is something 3 lakh rupees. Now, if I this the village area in each village, I have to at least give one camera and then the camera will have some failure rate also. But the amount I am spending eighty thousand rupees and most of the village people they have the problem with the eyes is not that they are only having the problem. With the somebody may have the problem with the finger, somebody may have problem with the eye, they have cataract problem, some problem on

the eye also. So, again rejection will be there, but there should be certain way you have to think that how can we minimize those issues?

Then is coming system security How safe is my system? What example what for example? I had given the biometrics data. I have given ten fingers data that 4 4 then 2 that is the thing that you have given also. I have given iris data are they safe what is the guarantee that you have taken? my four this one his four and his two fingers. And you generated another finger print data nobody knows what you will be doing? How you will be doing? How you are making it? How safe is my system?

That government of India can tell anytime or government would tell that you are collected the data, but what is the guarantee? That his data you have not merged with his demographic data to generate another data. Because once I am collecting the data that data has to be used for something to open my bank account or to draw three hundred rupees per month something like that.

So, the system must be secured enough, the system errors, there are different types of errors. You will find one as I told you, false acceptance rate, and false rejection rate. This is one type of error, another one is that data acquisition system is there is an error; the data system is not able to collect your data. The sensor is having a different type that he is not able to collect the data; he is not able to perform anything. Every system hardware have certain error; say for example, have you taken any photocopy anytime photocopy of a page.

So, you have one original page and one photocopy page, Are they exactly the same? You will check it, they are not same there exist certain error, but the errors should be within some tolerable range. So, that range has to be measured, next one is coming that even the system is correct, but because you do not have the proper finger print. So, you are not able to give the data system will not except the data. Because even though if you are giving the data, but image is coming blank, nothing is there or if I have to tell you that you have to stand in front of a camera by keeping your eye open for twenty seconds. Then only I will be able to collect your data, now twenty second you cannot keep your eye open in between the blink will be there right.

So, system will not be able to capture your image. So, these type of issues will come here then which biometric system you are going to use for this application. Given an

application I want to understand that this is my problem, now I want to use a biometric tell which biometric system? So, you have to obtain certain parameters through which you will be telling that this biometrics system is good, for you are this application. Now, as I told you this is pattern recognition problem a single and once it is a pattern recognition problem you will find that lot of error would be there, false rejection rate, false acceptance rate.

Even though you try to minimize it say for example, for face recognition I am happy if my system is given the accuracy of eighty eight percent. Now, under control environment that is the word we use even though the tells no our system is ninety 9.99 percent accurate which is actually they have some other way to measure the accuracy. Because, they have to sell the product, but for all cases it is not the question of selling the product. How much you have done research and development activity? So, 80 80 percent accuracy is sufficient for80 80 89.

Now, from 80 80 to 91 improving may be a challenge for face recognition, but for eight nine suppose I have a system of 99.2 percent accuracy. And I want to make another system which will give you 99.25; that means, the improvement by 0.5 percent it sets a very challenging one in pattern recognition. So, 80 80 to 90 possibly you can achieve, but 99 and 98 say I have 98 percent accuracy and I want a system of 99 it is a very difficult problem.

So, this accuracy I can make improve if I take the help of multimodal biometrics and combine that. Because there is no need why shall I use only signature, I have in this in your application form, you have given your signature, you have given your photographs. I could have taken the data of photo graphs and signature and combine the results to draw the conclusion, whether you are a genuine person or not.

So, most of us in general application we find that we collect the data more than one biometrics straight and you could have used both of that or more than those one parameters to decide. And to take the decision on identifications, so, once you have to combines these you need to know all that you are going to combine this. So, certain efficient strategies you have to define. So, this would be discussed.

Now, these three parameters are very different parameters, I have a large data base biometrics database. Now given an image I have to see whether is there or not. So,

searching a way is a critical issue. So, what we do through classification? What we do base on your parameters, based on your behavior or other issues you can classify. So, for example, you know in a crime area the principle of locality holds good, what does it mean? That a thief will perform his operations only in few villages, thief will not go to another village which is far away to steal something. Because there exists another group of thieves, they will not allow this group to go there, the gang is there. So, that the principle locality holds well.

Now, suppose that I have the data base of all the criminals or all thieves. So, what I will do? I can classify these thieves into different classes this, is in Kanpur zone this is in luck now zone, this way or based on the behavior of the thief. See thieves also puts they keeps some information at the crime area based on that you can suspect that these type of operations being done by these type of thieves, that police also know these thieves. So, I can classify the criminals based on certain operations this is known as classifications. Once, you have to classify again within the you have a is a suppose that I am thinking about the data base size of 100 and 25 crore people, how many classes may be 5 class 6 class? you can make based on this.

So, and if I assume that they are equally likely then each of them are having the 25 crore people big number. Now, I have the feature factor against each face data or finger print data. Can I cluster based on this data? Based on the feature factors can I cluster them? So, one common clustering technique I know is k clustering k means cluster similarly, there exist other clustering techniques. So, those clustering techniques we will discuss here, but problem is little like it is not in the case of agricultural field, where clustering is very easy, because your data is type is different.

The case of feature vectors say let us consider this examples finger print size is very small one inch by inch there are three hundred points lying there now suppose I want two cluster that based on the three hundred points that with your three hundred points you will find they are very closely associated clustering will be very difficult. So, this is not that easy problem. So, we are working, we are not gone or we have not got good results. Yes, then is coming indexing, once you cluster them, then you have to properly index them. So, that extracting the set of small set of people for matching will be useful very easy, otherwise it will take time.

So, these three we will be discussing for that angle. Now is come the most important part some of you are still looking into that, there be one midterm and now the town paper. This is the new world for the new m tech students, the two components one is the implementation oriented problem and the other one is research problem. What does it mean implementation oriented problem? That a group of two students with a mentor there will be a mentor with you. One PHD student will be with you to help you out, to give you the proper guidance and there will be several biometric, we are working one sheet will be given, but in the one sheet not more than three groups, otherwise conflict of interest will come.

We do not want and the various algorithm on the selected biometrics will be given that would be given to you. And group has to understand which one is the best you have to tell. Why it is best? And then you have to implement on sample data base, the data base will also give you, otherwise you will also can create the graph if it is a new biometric.

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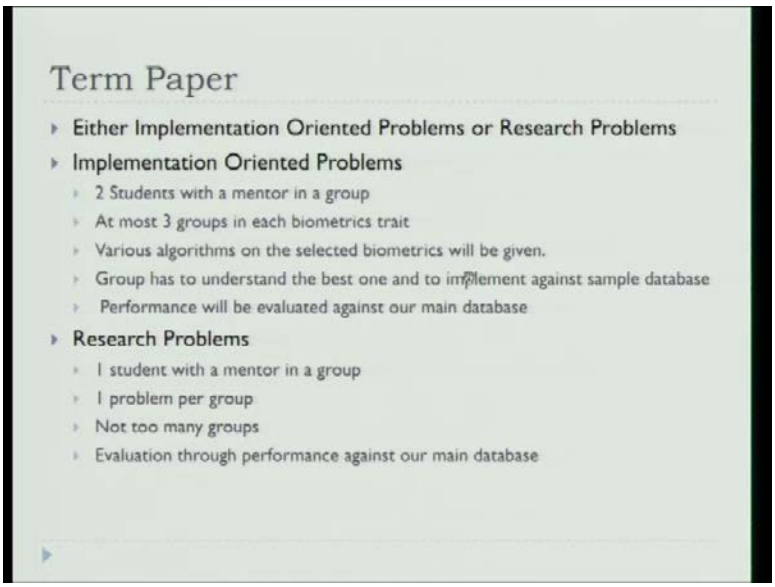

And you have to finally, evaluate your the system against the main data base. Whatever the database we have the sample database system, because you know database cannot be sharable. So, will give you a small certain 15, 20 for your purpose what you will do you have a large database, say thousand people and there will be testing to understand how better is your system, this is one type of problem.

Another one is research problem. So, here mentor will be always with you .One student is attached with you, but one student because you know here measuring how much work you have done? And how much your friend has done? Will be different and also you may like to work now? And your friend may not like to work now? So, there will be a time delay and it is not sharable. So, that is why one student per group and only one problem simple problem or may be a sub problem or a problem two will be given to you. And not too many groups you do not want, because this is a very mentor will be loaded you do not want that too much, too many groups only one or two or three groups.

And ultimate evaluation would be based on performance of your system. So, any doubt on this slide. Yes this is we cannot go outside our domain otherwise you will come with some problem. You will tell no, we will give the problem only thing is that you have to tell you can sit with you can think I do not want too much mathematics in that. But I do not mind to do some new way of solving or image processing or image analysis part. So, that part mentor will take care. So, do not worry about that part

Now, these term papers will be given to you, problem will be given to you soon after midterm one. So, remember the time distance is not too much midterm one between midterm and end term is very short term. So, do not expect that or do not think this way that I will solve this is I have one and half months time is there. I will be solving it which is not that type of simple problem also. You have to work and you have to know your mentor more closely who is the? So, the mentor gives me the good feedback, mentor gives me bad feedback, then he is bad. I cannot help you; any doubt on term paper any more questions on term paper.

Choice means what you want that? But you have to tell whether you want to come this or this side? They are not dependent on. See you know whether you are strong in implementation or strong in analytical ability that part only I want to know. You decide that I am good in writing c program, say for example, here I am looking for a team at least one team I have my own c routine or d routine l routine whatever it is. I want to go in the GPU based environment. So, can you convert my old routines into GPU routines or multi trade all those things, you have to add this is a simple implementation orientation. Because time has come and my database size is increasing.

So, I have to show this it is near real time, now to show the real near time I have to take the help of other environments, this is the first problem, another problem is that I have several routines which our mat lab can I convert it into the c routines zero? Not a difficult problem only thing, only that in the mat lab also if you want to know then the whole routine is available only thing is that the optima ion part you have to do. So, these are simple implementation issues this one I will give a 3 4 5 papers and you read and find try to find out a new idea. So, here I need analytical part this one more strong in programming, but the bottom one is only few not too many

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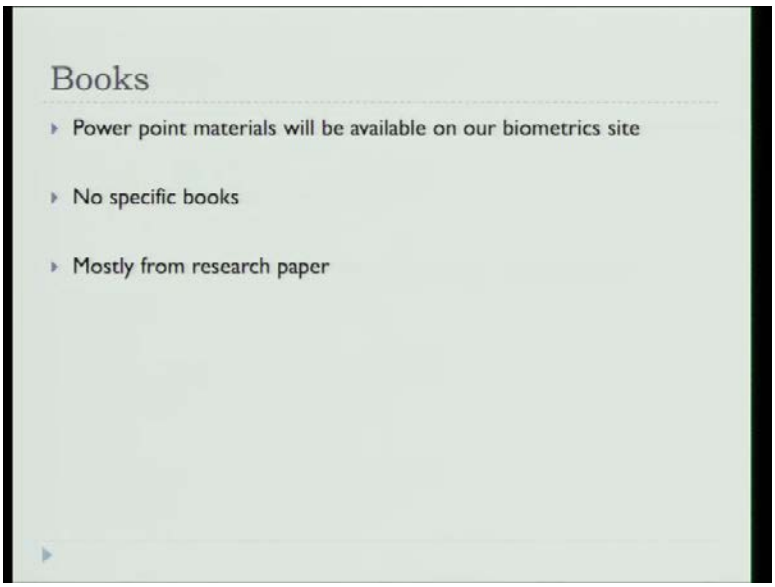

Now, that is questions are coming what are the books? And other things as I told you that I will take the help of image processing pattern recognitions and the statistics all the books are available in the library any book is for me, but we will not use any particular book. Whatever material I will cover we will have biometrics website, in that website the lecture materials will be available power point material. This power point material will be available in our website.

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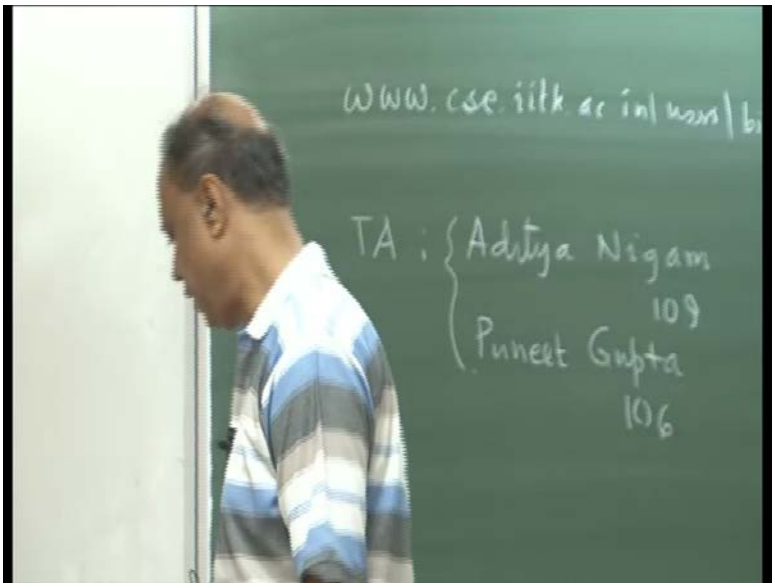

Web site name is www.c s e.i i t k dot a c in slash users, slash biometrics under that you will get it or there will be web also Kamlesh, you Adityanigam my t a are Adityanigam and Puneetgupta, your room number is 109 if his is 106 this is 109.

So, power point materials would be available we will not prescribe any books, you can take the help of any book I do not have any problem, but if we consider any research paper; obviously, we will give you the link. So, that you can make use of that and I think that is all the end of today's lecture material.