Image Signal Processing
Professor A. N. Rajagopalan
Department of Electrical Engineering
Indian Institute of Technology Madras
Lecture 57
Change detection

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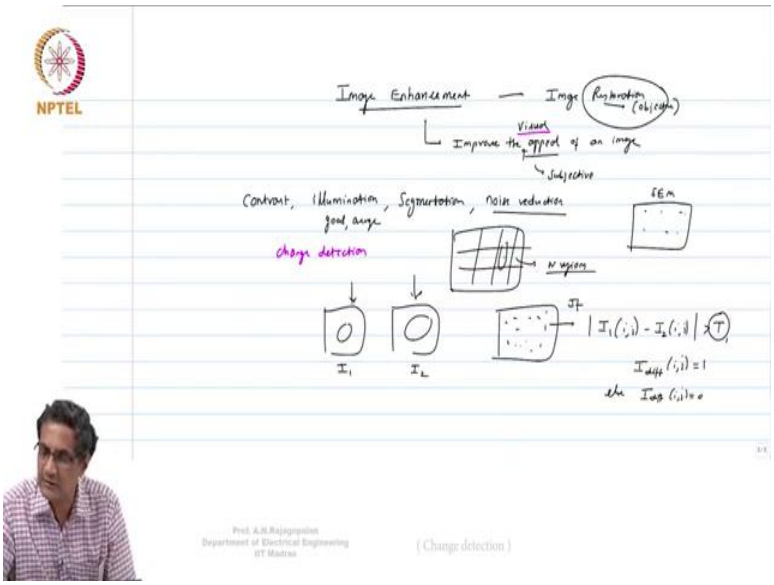

This new topic is called image enhancement. Image enhancement and as it, as the name says, as the name clearly says it means an enhancement, know in your own that in your own sort of interpretation you would mean improve, improve the appeal of an image. When you say improve or enhance an image, what do you mean is improve the appeal of an image.

And because of this word appeal what happens is, this has a connotation which is kind of subjective. Because what you might find this very appealing need not sound very appealing to the other person or need not be very appealing for someone else. So, in that sense enhancement is not really, it is not something that that kind of borders and on kind of being subjective.

And hence, I mean, so as opposed to something else that we will see later, what is called image restoration which is entirely objective. So a task like this entirely objective, whereas enhancement is more subjective by its very nature. To give you an example of what I mean by this, let us get a look at something like a contrast of an image.

Now, if you see an image and somebody might say that and have a look at an image, somebody might say that, all right, it does not have a great deal of contrast. Somebody might say that no, I am not really happy with the contrast, somebody might say well, this contrast is actually enough, somebody might say, no this is already very high and therefore I do not need to do anything.

So, the point is these things vary across individuals, this is one example. Then another thing is for example, illumination. Illumination again, when you kind of, when you look at the illumination of an image somebody might say that it is actually good, somebody might say it is average illumination, what we mean by average elimination is that all parts are not equally illuminated, some people do not seem to be very affected by that they would say well this illumination is fine.

Somebody might say that no this is not really that good because some portions are not really, not really well-lit or some portions are a little over lit again. So, when somebody tries to do an illumination compensation, the end of it whether you end up increasing the appeal of the image or not remains subjective. Segmentation is one more example.

Segmentation where you say that you have an image and then you would like to segment it into various regions. You could have some, say n number of these regions. Now, should this be, should this image be segmented into n regions or should it be segmented into m regions, where n is not equal to m. Some people might say that, 2 of these things probably look very similar to me and therefore, they ought to be merged.

Somebody might say that no, they should be actually treated independently. Again, this is kind of a subjective matter, and therefore, segmentation also, unless, of course, somebody comes and says that, they will just do, just treat that there are n regions. But then that end itself and somebody says there are n that itself could be, it could be hard to buy.

This is that somebody might say why is it n, why is it not n minus 1? Why is it not n plus 1? Why is it not n plus 2? Can I break it up further? And so on. So, therefore, segmentation also, it can be kind of classified as somewhat kind of bordering on being subjective. Then there is another thing which is called reduction of noise, what is called noise reduction. Here again, in fact, I mean, I have seen that I have seen in my interaction with these companies.

For example, when there are some companies that actually deal with what is called the SEM image, what is called scanning electron microscopy image. Now if you look at the SEM image, depending upon how you do the capturing, you can have images that are extremely noisy, you can have images that are really not so noisy. And apparently there are some people that work with these images day in and day out, and they like it if there is some noise in it.

If you show them SEM image it is completely clean. They do not to think that it is natural. They have this feeling that what you are showing them is kind of unnatural. There is not a way SEM image, and those not a natural image at all. And therefore when you do something like a reduction of noise, you have to be careful.

So somebody gives you a noisy SEM image. Imagine if you think that you are going to completely smooth it out and show them a picture, which is nicely filtered and does not have any noise, they will not actually like it, they will say no, this is very unnatural. This is not the way SEM image ought to look like there should be some noise otherwise it appears very unnatural.

So, again, so what appeals to one person may not appeal to another person. What level of noise is acceptable to one person may not be the same for the other person and therefore, such kinds of noise reduction which come under the image enhancement sort of an umbrella. There is also something noise reduction that you can do in a very objective way that we will see later.

But, as far as long as you kind of think about noise reduction to increase visual appeal and so on. So, in fact, when I say improve the appeal, I really mean here a visual appeal. Now, the point is right. So when you talk about increase, improving a visual appeal it is not really obvious as to what should be done, but what level of noise reduction should 1 do?

That would actually, that would make, let us say all of us happy, it is very hard. So, that is why, that is why in fact, image enhancement by itself as a as a kind of a technique, it comes into comes under comes under what I would say no subjective. No, it has a subjective flavor. But, right, that by that by itself, it does not mean that it is not mathematically grounded.

It is all firmly grounded only. Except that there are somethings that you might have to find tune, there are some hyper parameters at which you might have to choose appropriate, you might have

to choose appropriately and so on. And at the end it remains open that whenever you enhance something, whether all of us will agree that what we have enhanced.

Whether we have really enhanced the visual appeal, or whether all of us agree that it has been enhanced to the same extent or not, this is unclear. Some of you may like it, some of you may say well, maybe it needs a little more improvement, some of you might say I would say that maybe and maybe out of like the actual, original image itself or not the one for which you have attempted to increase the visual appeal. So, it can be, so it can have various flavors.

Now, there is 1 more thing that I wanted to add to this, which is called change detection. And what this means is that if I actually give you, if I have 2 images and suppose I subtract them. And we are supposed to find out what is the change, this could be the same scene taken after some time. This was taken at time T1, this was taken at time T2, and we want to, we just subtract the image, take the absolute value after we subtract. Now, you will find some intensities here.

You might actually find intensities all over the place. Now, what should be treated as a true change versus what we think is kind of an artificial change again. Where do we put some kind of a threshold, where we say that if that is absolute value of I1, suppose I call this I1 and suppose I call this is I2. If I1 of i comma j minus I2 of i comma j assuming that all these images are actually perfectly aligned and so on.

So, greater than some kind of kind of a threshold, suppose I say that it is greater than T, then I say that I compute at this image for which I will say that at i comma j rate it has a value 1, else I would say no i comma j is equal to 0. Now fixing this T right is not easy, because again, something that that one person would agree is really a change, may not be agreed upon by someone else.

So you say that it is a change, whereas the other guy might say that is probably say that T is chosen too high, or they may say, it is and second of all, a little too low, and so on. And this T is called really a threshold. It has a name, it is called actually a threshold. And how to choose a threshold is again, tough. Now, in this context, I am going to show you a video. But all this rate it does not undermine the fact that image enhancement is a very important topic.

And none of this undermines that which is also a reason why we actually teach image enhancement, and there is so many topics that come under it which are all important. But the point is right even with all these uncertainties, that kind of surround is, in the sense that this kind of subjectivity that surrounds this image enhancement, you can still do a lot, you can do a lot by simply doing simple things. Now this I am going to show with 1 example, I want to illustrate this idea with 1 example.

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Professor: So, what I wanted to do, so this vehicle, I wanted you to tell me what is this big guy that is coming out?

Student: Truck.

Student: Some water tanker.

Professor: In Chennai that is what you will see. Anyway, so the point is this. So, there is so much information sitting out there just by doing a subtraction. We seem to be able to tell what is that vehicle. Now, we went 1 further, 1 step further and then we actually did a classification based upon the activity matrix. If you see this right, can you see the bus going?

And then behind every vehicle there will be a flash of color. That color indicates what it is. So green is a bus. Blue guy is, red is blue. And then you will see how nicely our folks drive around. What, how nicely we follow all the traffic rules, and there is a red guy, and then auto is yellow, red. So you can even classify.

You can find out how many vehicles passed through that road that time using something as simple as building an activity matrix as you as you keep doing this image subtraction. So I just wanted to point out that this image enhancement is actually a powerful thing, it may not be, so fine, so I will kind of close this.

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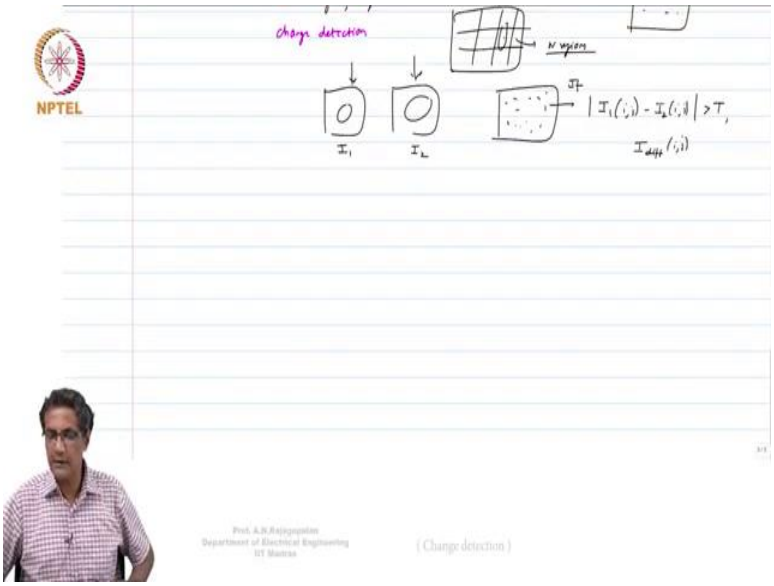

And therefore as you saw, even by doing simple frame subtraction, if you could actually find out what those vehicles are, you could classify vehicles, you are able to tell if it is an auto, if it is a bus, and if it is a 2 wheeler and so on, just by simply doing a frame subtraction. And of course, this is a very old idea that we did about 8, 10 years ago with one of my students and we could simply do it by simply taking a camera which is looking down, down the flyover and then it was simply capturing the traffic sequence as it moved under the camera.

And then you would just do a differencing of the frames and from the difference image you will build what is called an activity matrix. And then once you actually build the activity matrix, then from that the activity matrix you can actually classify shapes and it allows you to tell how many vehicles passed under the flyover at what time and so on. It gives you a count to the number of vehicles and all that.

So, you can see that something as simple as that can do actually wonders. Now, the point is, if you go further on. Now, what are the things which we did, which we sort of implicitly assumed was that we could find a threshold t.