Digital Image Processing
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Module 11 Lecture Number 51
Color Model

Hello, welcome to the video lecture series on Digital Image Processing.

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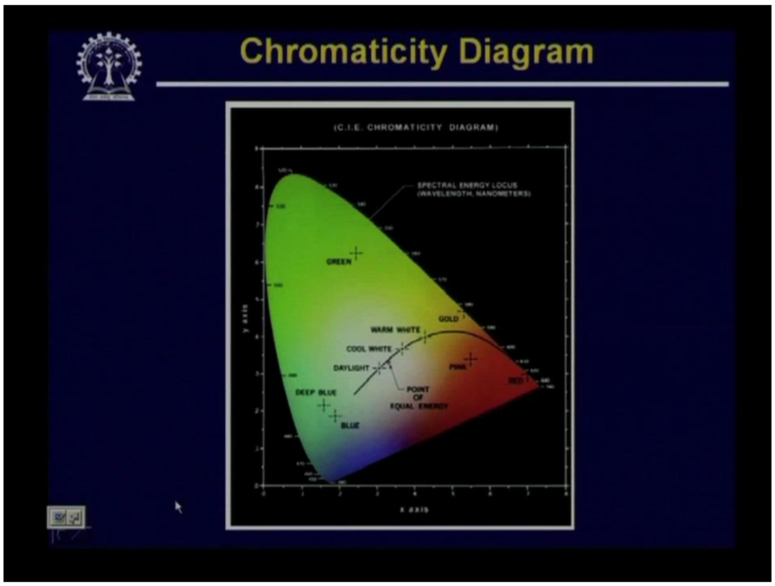

So, let us see what is this chromaticity diagram, so here we have shown this chromaticity diagram. And you find that it's a colour diagram in a 2 dimensional space. We have the horizontal axis which is the lower case , which is the axis representing the lower case x and we have the vertical axis which is the axis representing lower case y. That means the chromatic coefficient for red is along the horizontal axis and the chromaticity coefficient for green is along the vertical axis.

And if we want to specify any particular colour, say for example I take this particular point and I want to find out that how this particular colour can be, say here how this particular colour can be specified. So as we have said that we have to we can specify by its chromatic coefficient. Now two of the components of the chromatic coefficient that is x and y that is red component and green component we get, we can get from the horizontal axis and the very axis. And the third component that is z obviously in this case will be given by z is equal to 1-(x+y).

So x and y I obtained from this chromaticity diagram and I can get the chromatic coefficient component z simply by using the relation that x+y+z = 1. And if you study this chromaticity diagram you find that all the spectral colours. They are represented along the boundary of this chromaticity diagram ok. So along the boundary we have all the spectral colours. In this chromaticity diagram there is point which is marked as say this point which is marked as point of equal energy. That means all the red, green and blue components they are make in equal proportions, and this is the one which is the CIE standard of white ok. And as we said the notion of saturation, you find that all the point on the boundary because they are the spectrum colours so all the colours along the boundaries they are fully saturated.

And as we move inside the chromaticity diagram away from the boundary, that we as move away from the boundary the colour becomes less and less saturated. So, one use of this chromaticity diagram is that we can specify a colour using this chromaticity diagram, we can find out what are the chromatic coefficient x, y and z by using this chromaticity diagram. And not only that this chromaticity diagram is also useful for colour mixing.

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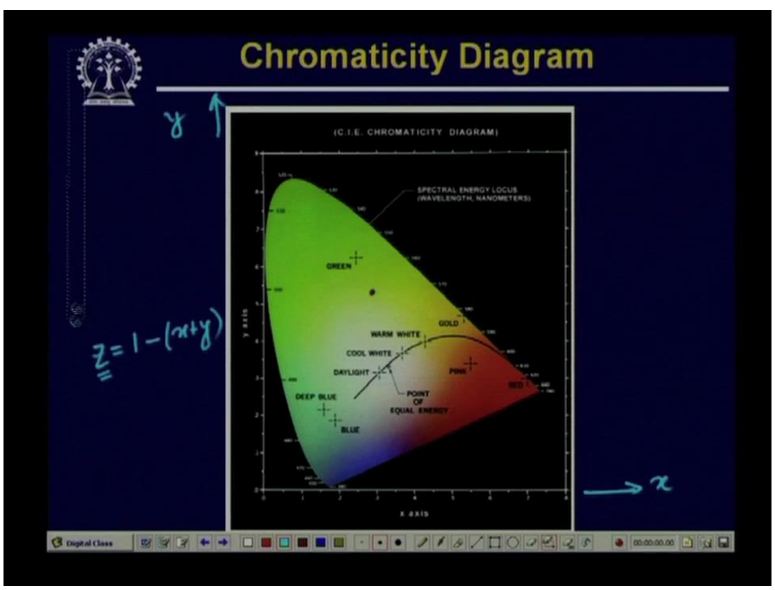

Let us see how. Say for example within this I take two colour points. Say I take one colour point somehow here and I take; I take one point somewhere here and I consider another point somewhere here. And if I join these two points by a straight line, say like this in that case this straight line indicates that what are the different colours that I can generate by mixing the colour present at this location and the colour present at this locations. So all possible mixture of these two colours can create all the colours which are lying on this straight line segments connecting this two colour points.

And same is true for three points. Say instead of just taking this two, these two points, if I take a third point somewhere here, then you form a triangle connecting this three colour points. Then if I take the colour present at this location the colour present at this location and the colour which is specified at this location, and by mixing all this different all these three colours in different proportions I can generate all the colours lying within this rectangular region. So this chromaticity diagram is also very helpful for colour mixing operation.

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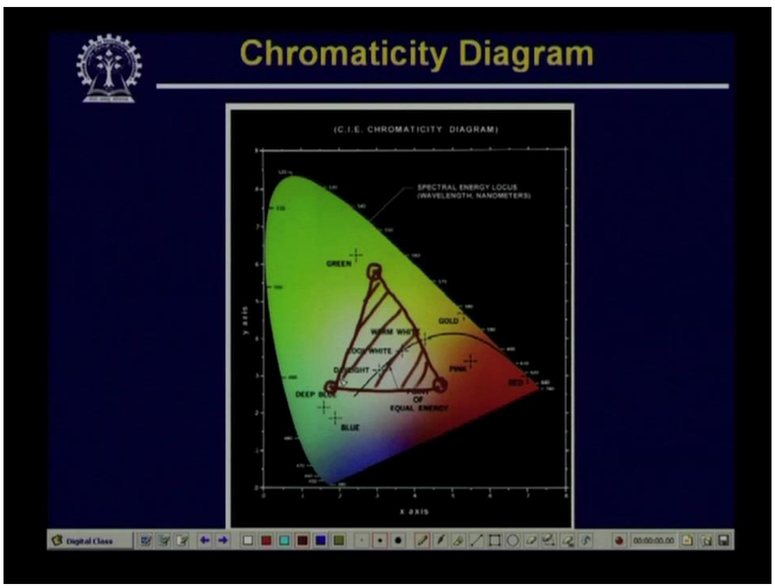

For example, we can get some other information from this chromaticity diagram like this, so as we have said that we have this point of equal energy which is the CIE standard of white. Now, if I take any colour point on the boundary of this chromaticity diagram which is said that this is nothing but a colour which is fully saturated. And we mentioned that is as we move away from this boundary the colours that we get there are getting less and less saturated.

And saturation at the point of equal energy which is the CIE standard of white just we have said here the saturation is zero. The point is not saturated at all. Now if I draw a straight line from any of these boundaries joining this point of equal energy, like this ok. So this indicates that what are the different shades of colour of this particular saturated colour that we can obtained by mixing white light to this saturated colour.

So as we have said that as you mix white light the saturation goes on decreasing that is we can generate different shades of any particular colour. So this particular straight line which connects the point of equal energy which is nothing but the CIE standard of white, and a colour on the boundary which is a fully saturated colour then what I can get is. All the shades of this particular colour is actually lying on this particular straight line which joins the boundary point to the point of equal energy.

So you find that using this chromaticity diagram we can generate different colours we can find out that in which what proportions the red, green and blue they must be mixed. So that we can generate any particular colour, and this we can do for two colours mixing of two colours, use it mixing for three colours and so on.

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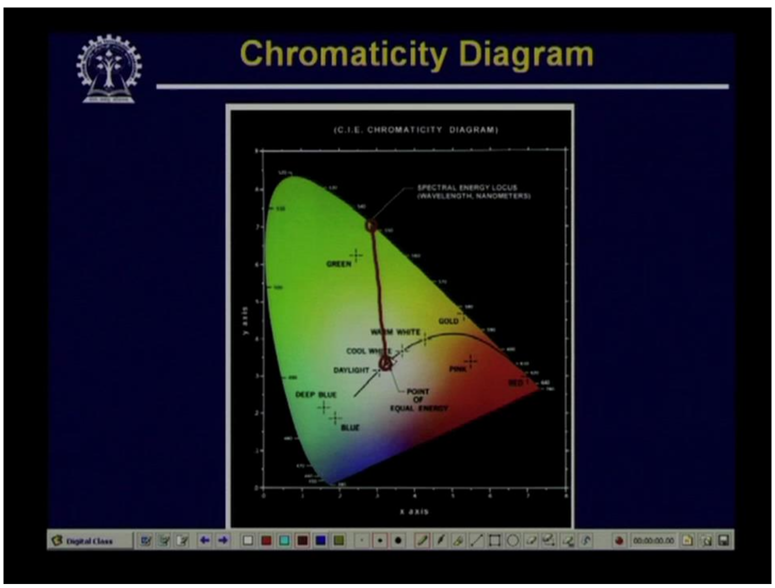

Now just to mention that as we have said that we have taken red, green and blue. As primary colours you find that in this chromaticity diagram. Your green is if I take green to be somewhere here. Say if I considered this point to be the green point. Say this point is the red point and the blue is the somewhere here and if I join this three points by straight lines what I get is a rectangle so by using this red, green and blue, I can generate as we have just discussed all the colour which are present within this triangular region. So as this triangular region does not encompass the inter part of this chromaticity diagram because this chromaticity diagram is not real triangular diagram.

So just we have said that using three fixed wavelengths as red, green and blue we cannot generate all the colours in the feasible region and that is also quit obvious from this chromaticity diagram, because if we considered only three fixed wavelength to represent red, green and blue points using those three wavelengths. We can just form a triangular region and none of the triangular region, single triangular region can fully encompass the chromaticity diagram.

So as a result of that by using fixed wavelength for red, green and blue as primary colours cannot generate all the colours as given in this chromaticity diagram. But still using the chromaticity diagram we can have many information many useful information say as we have said that we can go for colour mixing. We can find out different shades of colours. We can specify a colour and so on.

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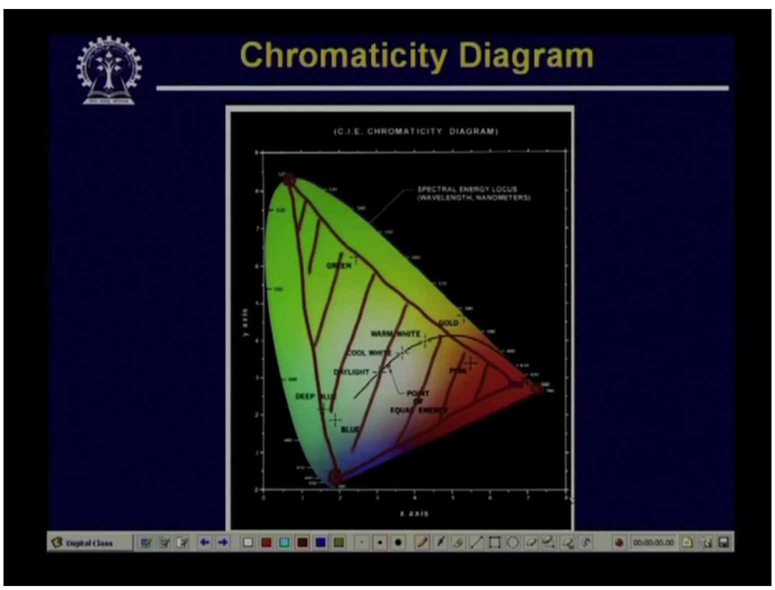

Now, coming to this next topic that is colour model, now we need a colour model to specify a particular colour. A colour model helps us to specify a particular colour in a standard way. Now what is the colour model? Colour model is actually a space or we can represent it as a coordinate system within which any specified colour will be represented by a single point. Now as we have said that we have two ways of describing a colour. One is a by using the RGB model by using the Red, green and blue components or cyan, yellow and magenta components which are from the hardware point of view.

And similarly form the perception point of view, we have to consider the Hue, saturation and brightness. So considering these two aspects we can generate two different colour models two types of colour models. One colour model is oriented toward hardware that is the colour display device or colour scanner device or colour printer. And the other colour model is to cater for to cater for take care of the human perception aspect. And will see that this is not; this will not only take care of human perception aspect it is also useful for application purpose.

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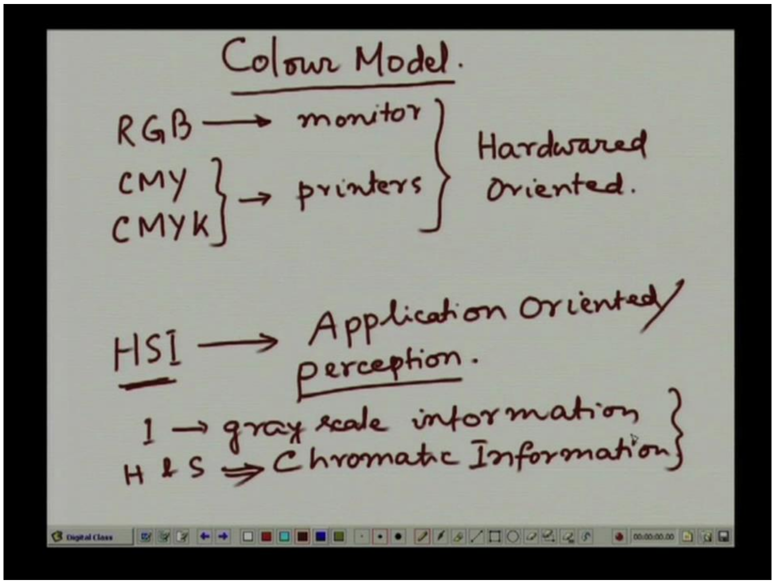

So accordingly we can have a number of different colour models, one of the colour models will call as RGB model or red, green and blue model. And the other colour model is cyan, magenta and yellow and there is an extension of this that is CMYL that is cyan, magenta, yellow and black. This RGB colour model this is useful for image display like monitor, CMY or CMYK colour model these are useful for image printers. And you find that both these colour models are hardware oriented because both of them try to specify a colour using the components as primary colour components either red, green and blue or cyan, magenta and yellow. As we have said that red, green and blue they are the primary colour of light whereas cyan, magenta and yellow they are the primary colours of pigments.

And the other colour models that will also called considered is HSI colour model that is hue, saturation and intensity or brightness. And this HSI colour model it is application oriented, also it is perception oriented. That is how we perceive a particular colour and. We have also discussed that this HIS colour model this actually decouples the colour form the gray scale information. So we have that this I part this actually gives you the gray scale information whereas hue and saturation taken together gives the chromatic information.

So the, because of this as in HSI model we are decoupling the intensity information from the chromatic information so the advantage that we get is many of the application or the algorithm. Which are actually developed for gray scale images they can also be applied in case of colour images because here we are decoupling the colour from the intensity. So all the intensity oriented all the algorithm which are actually devolved for gray scale images can also be applied on the intensity component or I component of this colour image.

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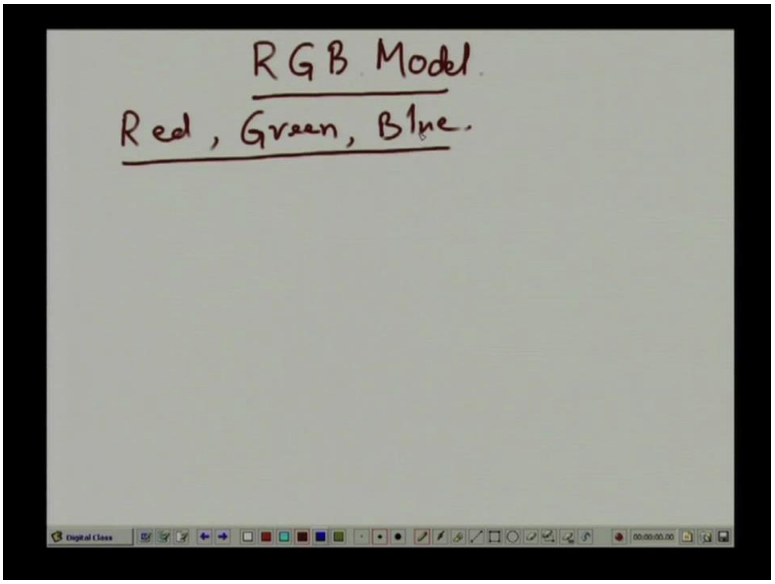

Now first let us discuses about the RGB model so will talk about RGB colour model first. As we have said that in case of RGB a colour image is represented by three primary components, and the primary components are red, green and blue. So these are the three components colour components which mixed which mixed when mixed in proper form in appropriate proportions this generates all possible colours.

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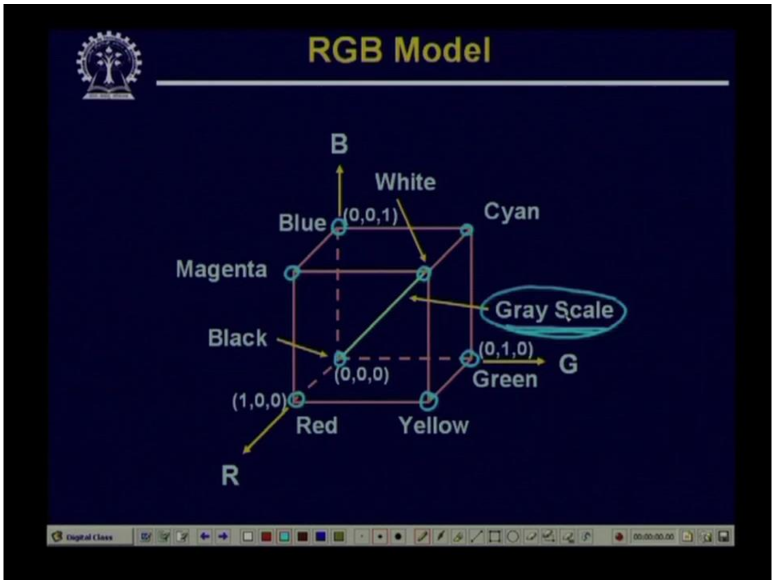

So RGB colour model is a based on Cartesian coordinate system. And we will see in this diagram that this shows, diagrammatically an RGB colour model that will normally use. So you find that this RGB colour model is based on the Cartesian coordinate system where the red, green and blue, RG and B these components are placed along the the coordinate axis.

And the red component is placed at location 1,0,0 as shown in this diagram. So this is the location which contains the red, this is the location 0,1,0 which contains, which is the green point and 0,0,1 this is the blue point. So we have this red point, green point and blue point. They are along three corners of a cube in this RGB in this Cartesian coordinate system. Similarly cyan, magenta and yellow they are at other three corners in this cube.

Now, here let me mention that this model which is represented, it is in the normalized form that is all the three colour components that red, green and blue they are varying within the range 0 to 1. So all these colour components are represented in a normalized form. Similarly the cyan, magenta and yellow they are also represented in normalized form. Now the origin of this colour model that is that location 0,0,0 this represents black and the farthest part x that is 1,1,1 that represents white.

And you find that if I join a straight line. Connecting the origin to this white point so these straight line actually represents a gray scale and we also call it an intensity axis. So as you move from the origin which is black to the farthest part in this cube which is white, what we will generate is different intensity values, ok. So as a result of this we also call it the intensity axis or gray scale axis. So we stop our discussion today we just in we have just introduced the RGB colour model and we will continue with our discussion in our next class. Thank you.