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Digital Image Processing of Remote Sensing Data

Lecture – 05
Electromagnetic Spectrum, Solar Reflection and Thermal Emission

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Hello every on and welcome to this digital image processing of remote sensing and data codes. And today we are going to discuss the lecture which is one electromagnetic spectrum solar reflection and thermo machine. And though is a purely part of remote sensing not directly a digital image processing but in digital image processing we handle all types of remote sensing data which might be coming from different part of EM spectrum and therefore the basic understanding about these section or bends of a EM spectrum are very much important for our understanding. You know that electromagnetic radiation the first requirement for remote sensing is to have energy source.

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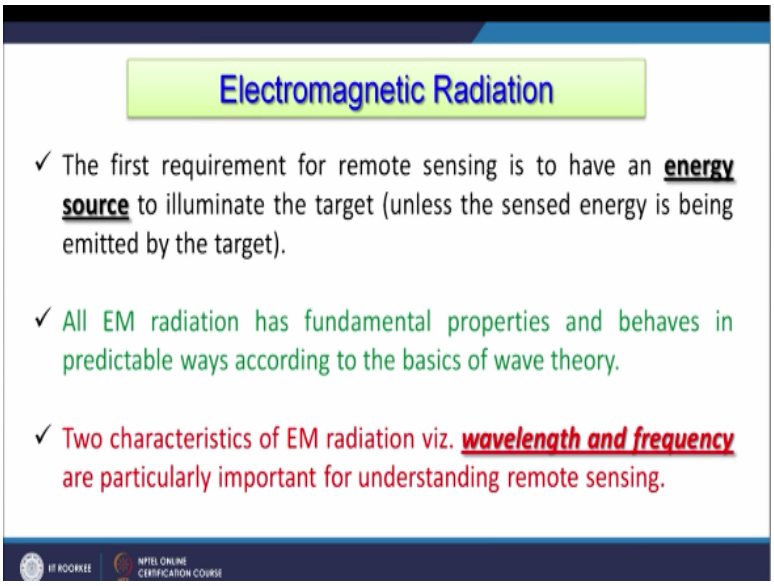

And a energy source can come data and the sun or might be emitting coming from natural objects. So it has to be eliminated and the target has to be illuminated in order to capture and the image of this. And know that all EM radiation has fundamental properties and behaves in predictable ways according to the basis of wave theory which we will see in the little brief what is wave theory so two characteristics of EM radiation.

The first one is wave length and another one is frequency and particularly important for understanding remote sensing. Generally when we speak about different bends of a located in the EM spectrum instead of using frequency term logic we generally use wave length term logic but both are related to which we will see. And this typical wave length electromagnetic radiation and wave length between two these flop are there.

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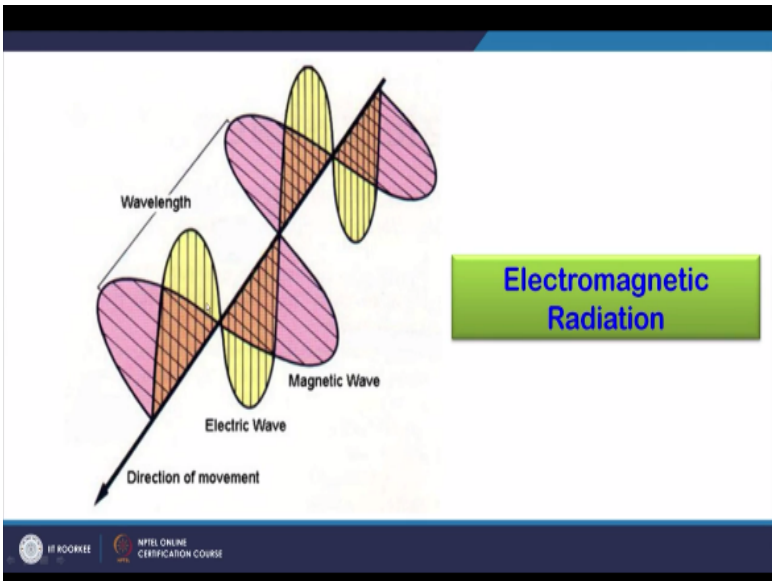

And there is this is because electromagnetic so electric field is a flowing like this perpendicular do this electromagnetic field. And likewise the direction of the moment and this how the electromagnetic radiation travels. And this is important to understand when we go for real image processing. Because the all these steps which we are going to take will depend many on these fundamentals. Another demonstration of both electromagnetic fields are there.

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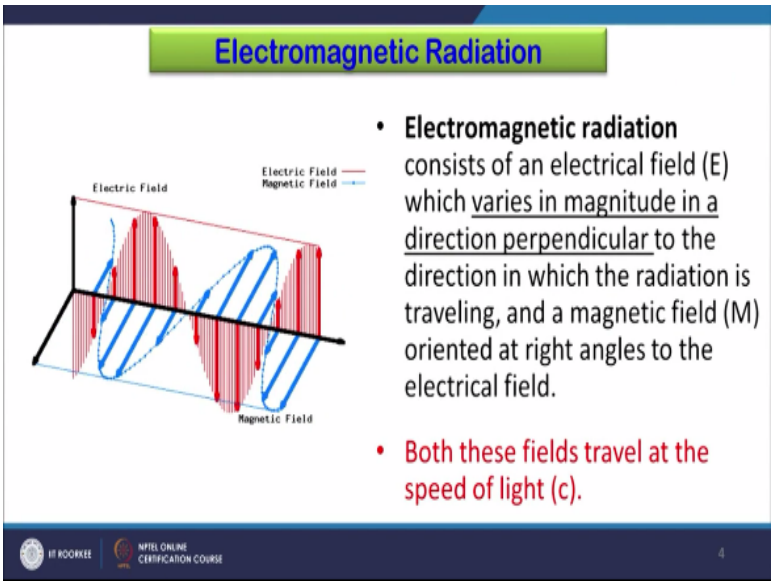

The magnetic field is shown here with the blue color electric field is shown and the red color in the simulation one can clearly understand that how both of these fields travel together but perpendicular to each other. So electromagnetic radiation of an electric field that is E which varies in magnitude in a direction perpendicular to the direction in which the radiation is travelling and a magnetic field oriented at the right angles to the electrical field.

So this one has to remember and both these travel at the speed of light. So there are having the same speed and they travel equal to the speed of light. Now this λ which is the wave length that characteristics of tow magnetic radiations as a few seconds before or the for better understanding of remote sensing it as well as in digital image processing and the wavelength frequency.

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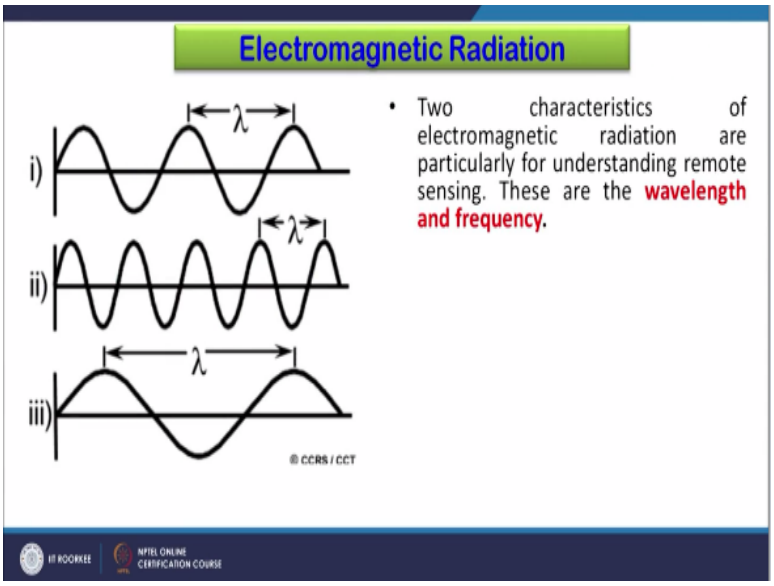

You can see that between these two high points thresholds of a wave length this one is the wavelength. And here is the wavelength and here is the wave length all three wave forms are showing three different wavelengths. And the frequency will have a just opposite to this one. The wavelength is the length of one wave cycle, which can be measured as the distance between successive wave crests or these thresholds. And then the wavelength is usually represented by the Greek letter lambda λ.

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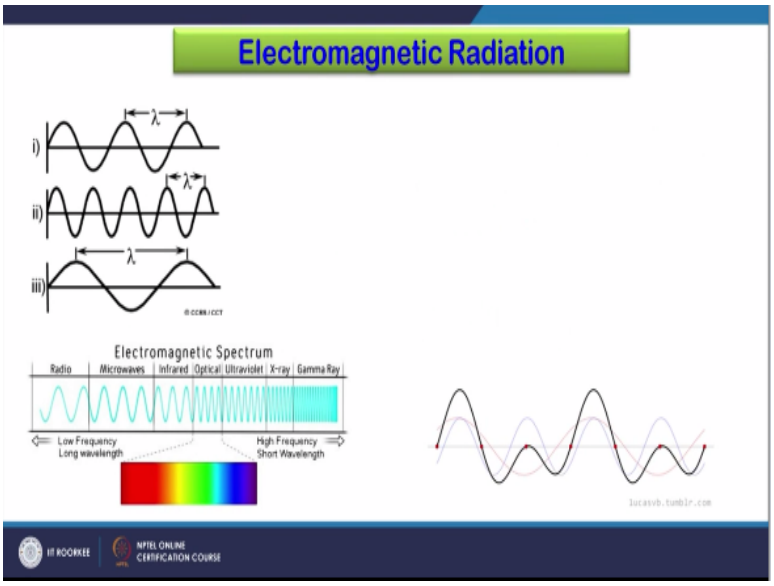

And it similarly the wavelength is measured in meters or some factor of meters such as micrometers and so on so for this. And frequency refers to the number of cycle of wave passing a fixed point per unit of time. This is what in this simulation it is shown that how its travelling and how frequently its passing from a point which are marked here by the red. So we can either defined with the frequency or we can use wavelength as well. Here the visible part is shown how the radio waves of the wavelength is much larger compare to the Gama rays and X-rays so this is how the low frequency long wavelength inwards relation high frequency shot wavelength and this also illustrated in this figure.

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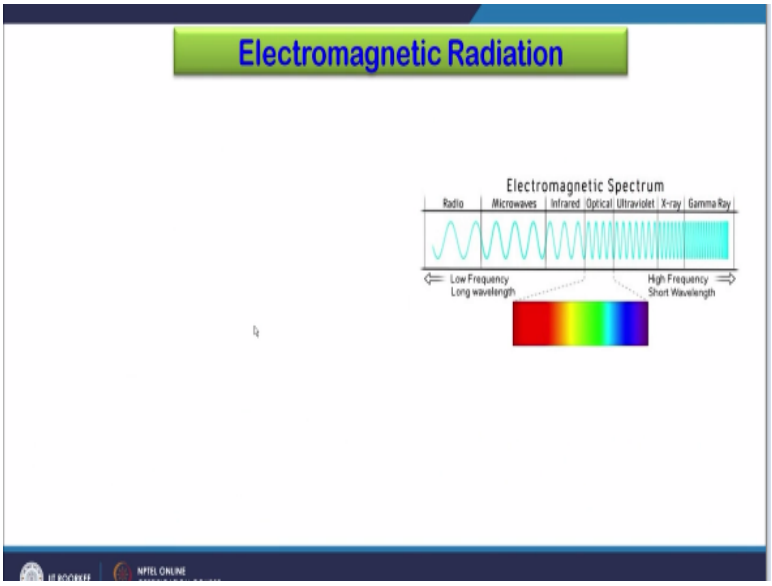

So the frequency is normally measured in hertz, equivalent to one cycle per second, and various of hertz. Wavelength and frequency are related by the following formula. And that is $c = \lambda v$ and this λ is the wavelength v is the frequency cycles per seconds and the c is the speed of the light which is 3×10^8 and the shorter wavelength the higher the frequency the longer wavelength, the lower frequency.

This one has to remember while doing the digital image processing. Understanding the characteristic of electromagnetic radiation in terms of their wavelength and frequency is crucial to understanding the information to be extracted from remote sensing data of during the digital image processing. And this is the very simple form of the electromagnetic spectrum.

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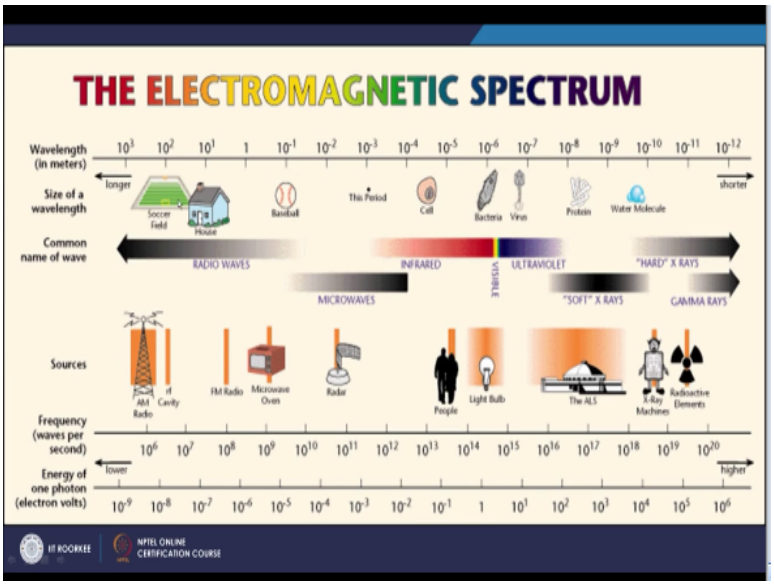

And how you know the different wave part which is section EM spectrum are shown, some example radio waves which are used for our radio transmission other purpose is announcements and other things microwaves is another one field which is very common then infrared this will part is occupy a very small portion of entire EM spectrum then you are having ultraviolet light and X – rays and other thing.

Some EM spectrum you would so or they are shown in reverse version. That means they ill started from shorter wavelength go to higher but here lower frequencies are shown. First higher frequencies are shown later. Like a EM radio and then comes a FM radio then microwave oven then radar then people which we can see the things light waves and then X – ray and so on so for.

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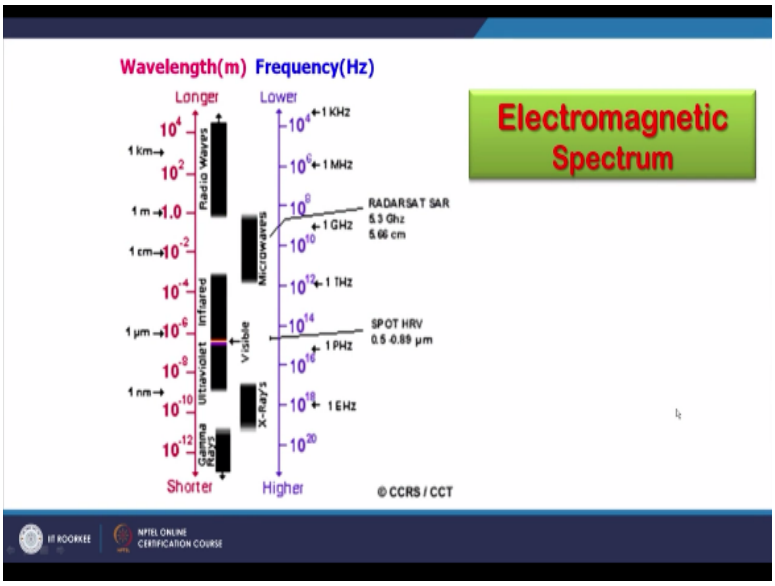

Now you will see in the tile different parts of the EM spectrum so let us start with here there are different sections are there and name of some satellites are also given for which the data we process like SPOT HRV is their dots red SR is there. So the radar sides occupy the part of the EM spectrum of that microwave section and were spot Millie focus is in this visible part.

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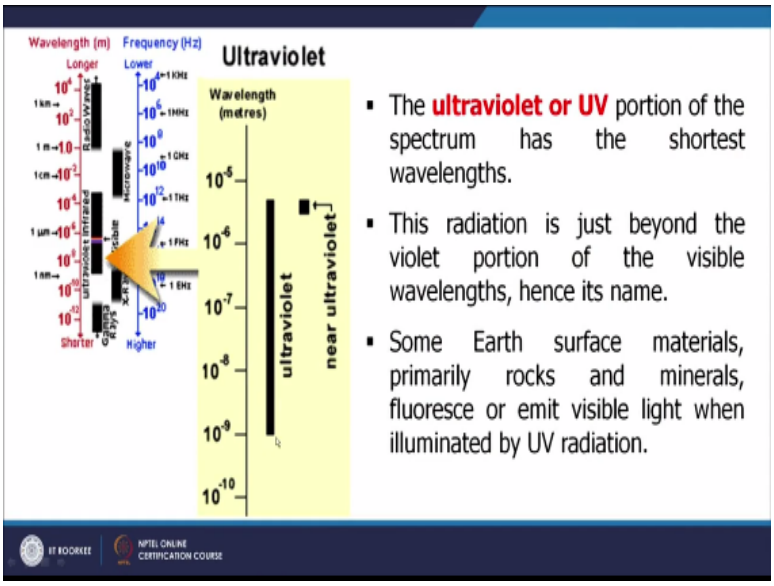

So this is how ultraviolet section of EM spectrum we don't have any set light and the reason is obvious because there is no must to do. So all the energy which is going in ultraviolet part of EM spectrum to the satellite is observed by the atmosphere and therefore we cannot have a sensor for that purpose. So ultraviolet portion of its spectrum is the shorter wavelength and that's why there are lots of disturbance because of the atmosphere. This radiation is just beyond the violet portion of the visible wavelengths, hence it name.

And sorter wavelength difficult to pass to the atmosphere and their parts where is like microwave which is the longer wavelength. It can pass through the atmosphere even it can pass through the clouds and in some cases even it can pass through to some meters in dry soil as well because of longer wavelengths. There are advantage is longer wavelength as well as some times a shorter wavelength depends on what kind of materials we are looking in our satellite images.

And for what purpose accordingly these spectrums are corresponding satellites sensors which we located or flying explaining the different parts of the EM spectrum are used. Some are surfaces material, primarily rocks and minerals, fluoresce or emit visible light when illuminated by ultraviolet rays radian and best example like there is mineral which is called fluoride so if you put under the ultraviolet light and it will grow and the this is one of the characteristics one can exploded two identify such minerals similarly in visible part where most of the satieties have been had the sensors which are covering them maximum part of visible spectrum and examples starts from land set even out Indian satellites as well.

So of them are covering red arc part and some of them are covering also thermal infrared part but many of the satellites are rather most of the satellites are having visible spectrum when I say most of the satellites as mention earlier also in pervious lectures then motley now we are talking about near polier orbiting sun and satellites note other satellites which we have disused just for our better understanding. Because the visible light as our eyes are also sensitive can detect in the part of visible spectrum it is important to recognize our small visible position is related to the rest said very tiny part of a very large EMS spectrum.

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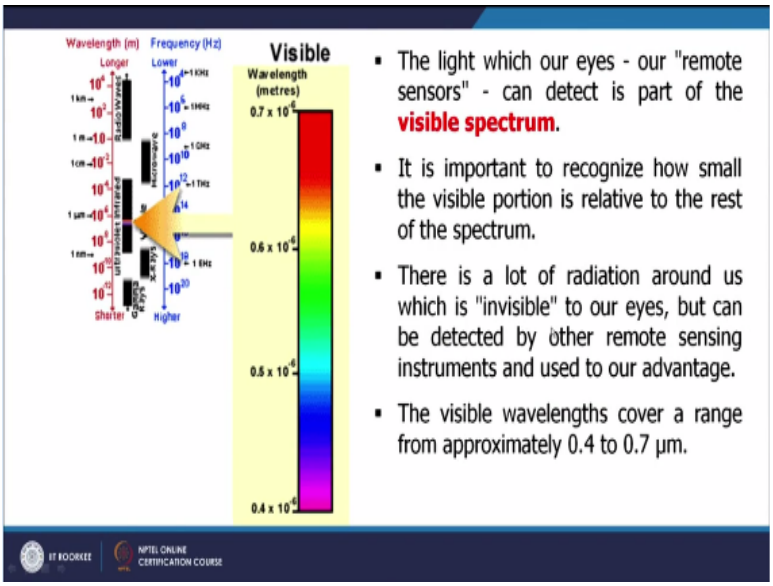

And there is a lot of radiation around us which is invisible to our eyes but can be detected by other sensors and the best example is infrared and thermal infrared.

The visible wave lengths cover a range of 0.7 to 0.7 and many satellites bands, channels our located within this part 0.4 to 0.7 micro meter as you know that the 7 colors are bib Gore is here and then it is starts from just end of the ultra violet portion the visible and then it goes and till it reaches to the near infrared so this entire spectrum those very time but very, very useful because large atmospheric windows are available in this part of a spectrum the longest visible wave length is red.

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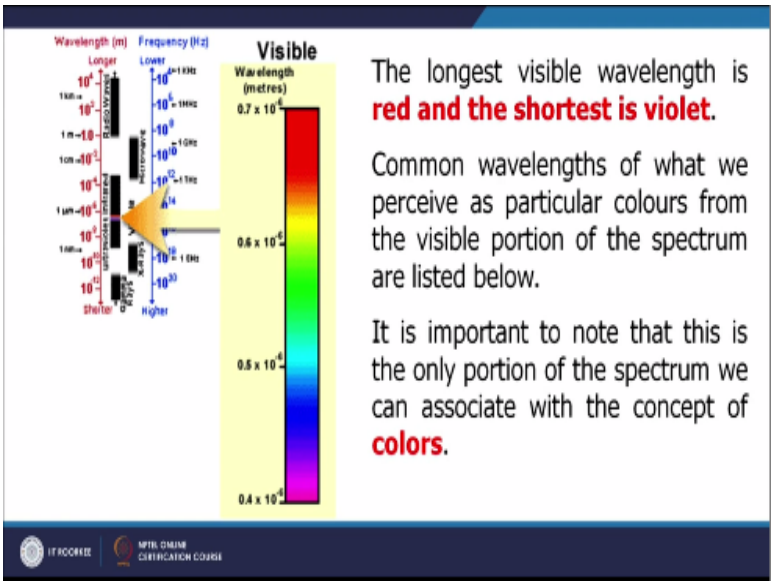

And the shortest is violet and you know that because of very short wave length it cannot pass through and the atmosphere the common wave length of what we perceive as particular colors on visible portions of a spectrum are that first is the colors which we is a colors which we say colors and we have been discussing colors we will be further discussing more focus discussion we will have in next presentation of the colors, so you know the violet spectrum is between 0.4.

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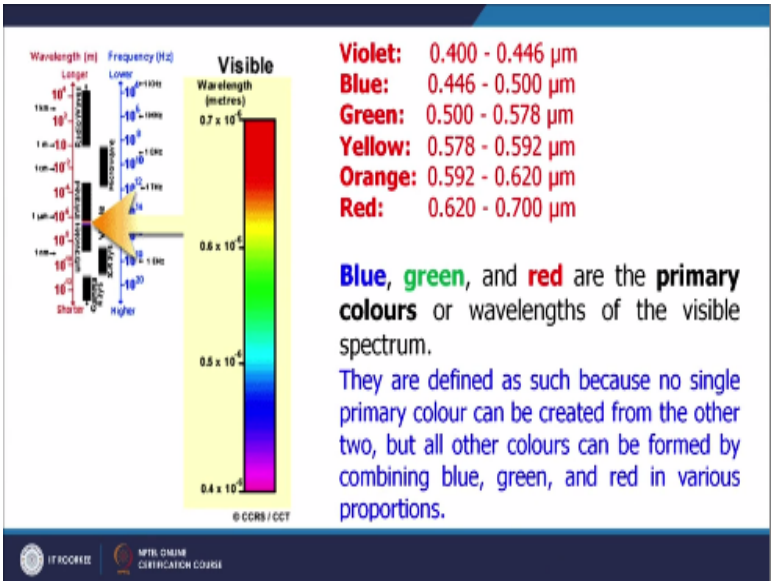

2.44 really would find the coverage in the remote sensing satellites but between blue part is starts from blue point 0.4 and 4462.5micro meter which is a very common as in case of lane said MS as an TM, VTM, OLI, IRS, 1B, 1C and so on. And green part is starts from 0.5 2.78 and then yellow 0.78 0.578 2.59 to orange there are some atmospheric windows are not available but different parts are shown here corresponding to different colors then red is 0.6 2.7.

And this part of m spectrum which is shown here and then blue green red as we know are primary colors or wavelength of the visible spectrum, and they are defined as such because no single primary color can be created from other two, so that is why in the different channels we can blue, green and red channel but all other colors can be formed combining blue, green and red.

So that is why they are also called an primary color a although we see some light as a uniform or homogenous color but actually we know it is a having a see composed over veracious wavelengths of radiation in primary.

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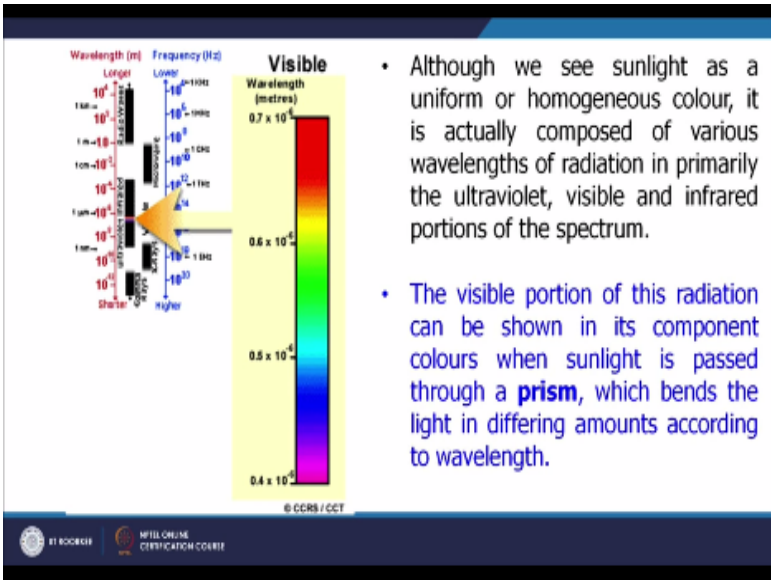

Primarily ultra violet visible an infra red part of spectrum and the visible portion of this radiation can be shown on its component colors when sun light is pass through a prism and it creates a rainbow or a bib gore and series of bib gore colors which bands the light in differing amounts.

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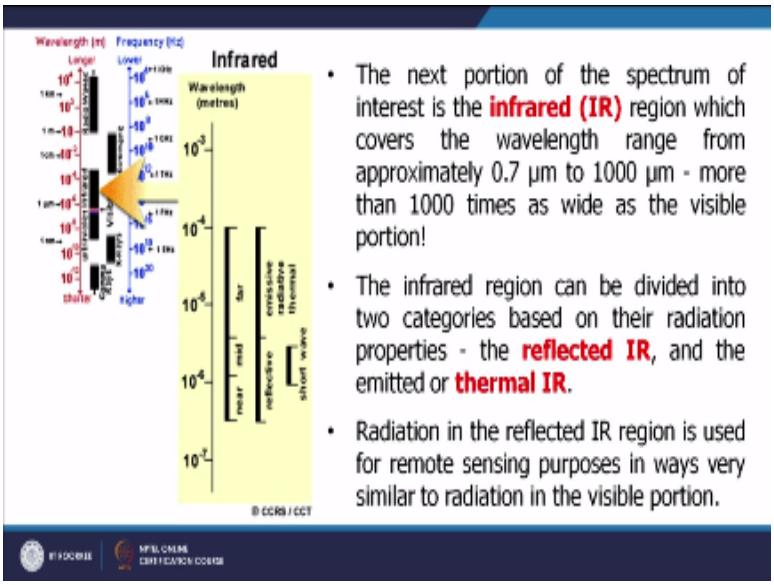

According to wavelength next portion of the spectrum is infrared again very, very important in remote sensing and in digital image processing to get information for better interpretation and this is discovers between 0.7 and 0.7 micro meter to 1.0 micro meter so they are can be different sub section of infrared like near infra red,, mid infrared or far infrared but the total one is 0.721 micrometry are there but the far infrared is having more emissive refractive radiation which is thermal portion of this.

Another one is the reflective one which we will see near and mid so near and mid infrared covers mainly the reflective radiation and whereas thermal infrared is the part of far infrared section. The reflective one are recorded in day time whereas the thermal one can also be recorded in night time although a day time is possible but because of differential heating and especially in

heliatrance it becomes not that much useful as in night time because you do not have the solar differentially heating because of undulating topography and therefore night thermal images are much more useful than day time.

But day time reflective images in me infrared part like near infrared or mid infrared are very, very useful especially for detection of vegetation, different species of vegetation the conditions growth of vegetation and so on so forth, so this portion of EM spectrum is very, very useful. The infrared region can be divided as mentioned the reflected one thermal one and the radiation in the reflected region is used for remote sensing purposes in the ways very similar to radiation in the visible portion.

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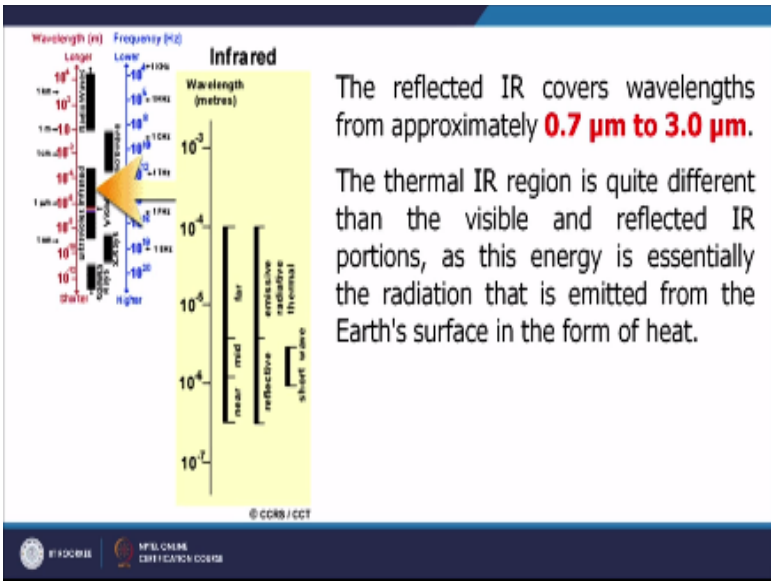

And the reflected infrared covers 0.7 to 3 micrometer and the thermal infrared region is quite different then of course the visible and reflected infrared portion as this energy is essentially the radiation that is emitted from the earth surface in the form of heat. And as mentioned earlier that any objects on the surface of the earth which is above epsilon 0 a natural condition will emit energy or heat and that can be detected by sensor which are having currently.

The sensors in thermal part of EM spectrum are having sensitivity of even 0.5° C differences can be distinguished using satellite images or there temperature can be estimated even from 840km but these objects has to be large enough because the emission which is coming the energy which

is coming is so tiny. In order to register that information we require for a large area. So this is one constrain, and thermal infrared covers

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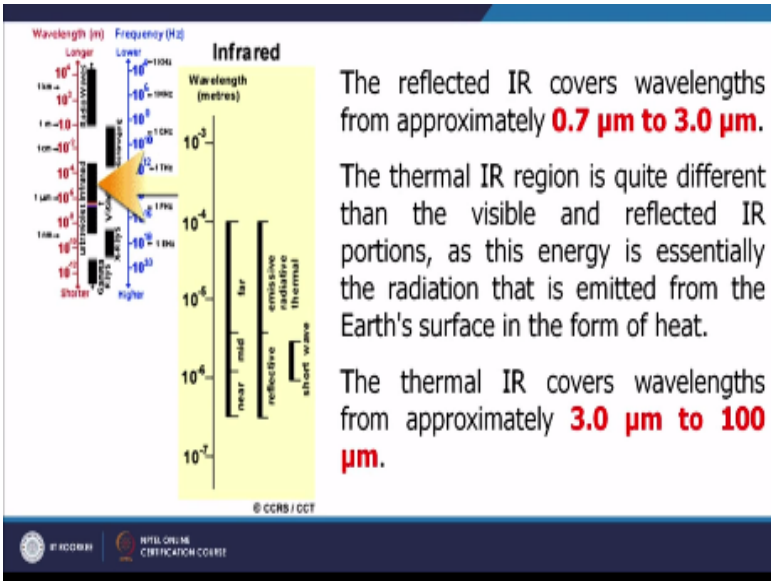

3 micrometer to 100 micrometer, so it is a quite a wide band as I have been mentioning also then the energy which is emitting in this part of em spectrum is not that large and therefore in order to call or register the reason in the temperature in band and censors have been used or still are been planned. The pore of spectrum of more recent is a microwave region.

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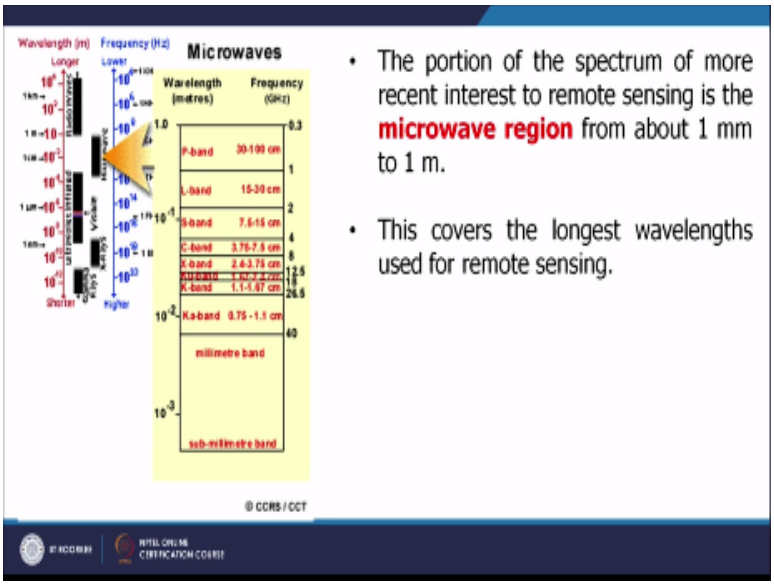

And microwave region is between here and micro wave region is 1mm to 1m as like in case of infra red portion we divided and reflective and emitted in infrared and similarly based on the wavelength we can also create section in microwave and this is because it is covering a large part of em spectrum related to visible spectrum. As we can see that p band is there l band is there s band c band x band ku band k band. So there are various bands for various portions of em spectrum within the micro wave region of the over a spectrum different names have been given the most cover and settledies and radar satellities and micro waves sattelites which are exploding they are more focusing over the c bend are x bend s bend .

And these are the most common one and there are really other part of the micro wave region and can be exploided by the satellite remote sensing there might be some other application and other main applicstion are here like this lets us in the serial again in ythe c bend explotation by the satellite .

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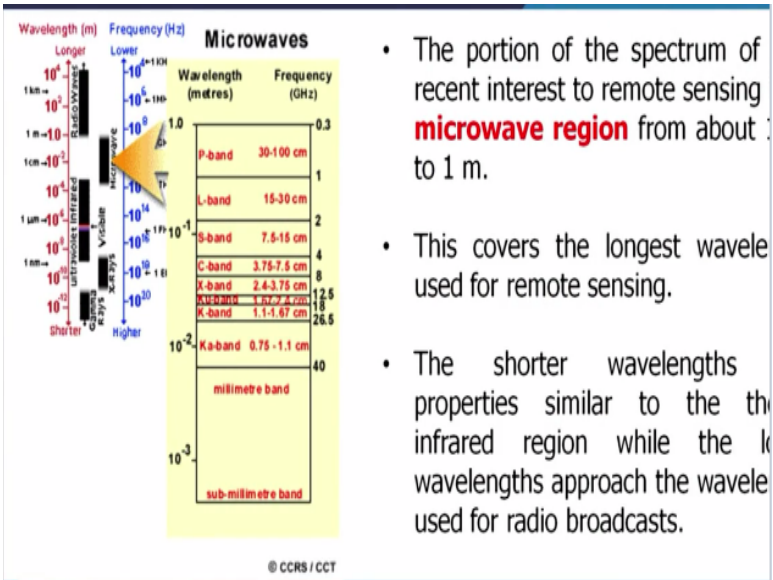

There are many properties similar in the thermal infra red region then in a microwave part here in the begging and then you go as higher and higher and longer towards the longer then properties changes say having some similar to the thermal infra red region while the longer wave length which is the wave length of radio broad cast.

So there are also it is being used so this the understanding of a spacey those portion of the am spectrum which are being exploited by the different sensor on board of different satellites this is spacey satellite or near is very much important and for our digital image processing as well and this brings to end of this presentation thank you very much.

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