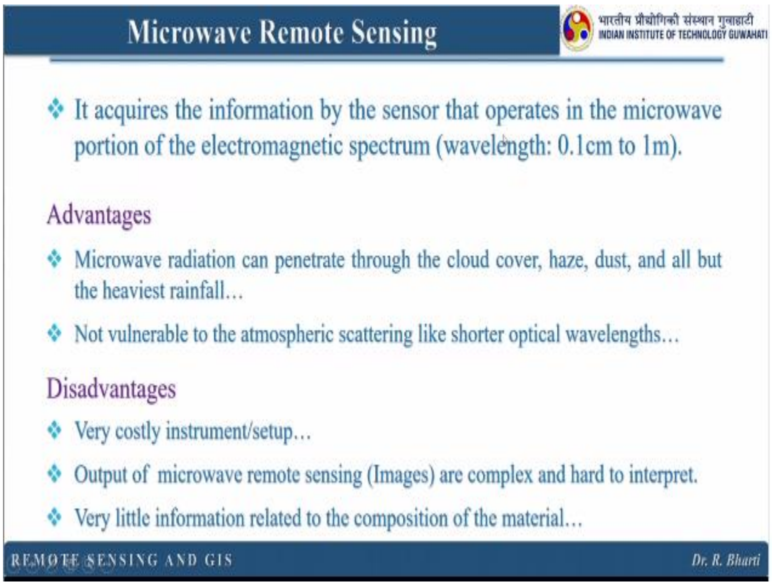
Now let us see microwave remote sensing.

(Refer Slide Time: 54:38)

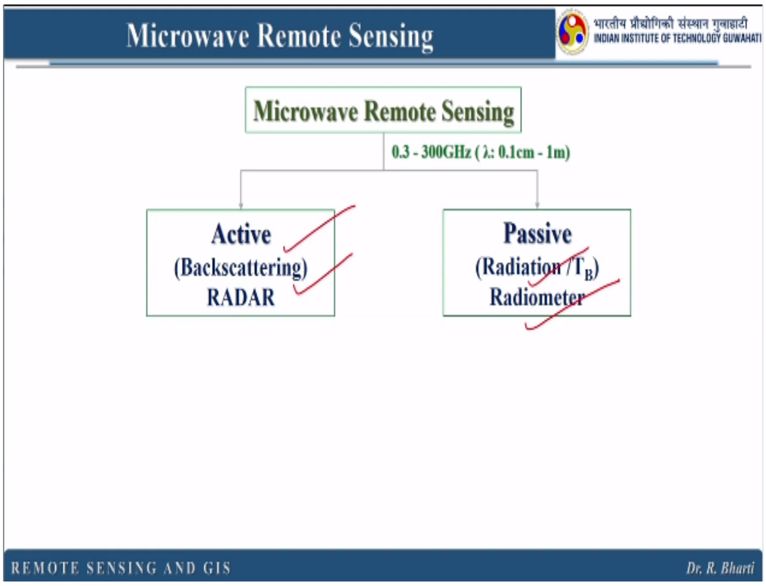


So let us understand what exactly we are doing in microwave remote sensing. So it acquires the information by the sensor that operates in the microwave portion of the electromagnetic spectrum where wavelength is 0.1 centimetre to 1 metre, right, and the advantage of microwave remote sensing is it can penetrate through the cloud cover, haze, dust and all but the heaviest rainfall, right.

And not vulnerable to the atmospheric scattering like shorter optical wavelengths. So here it is very important that you can do all weather condition mapping or the image generation and this is free from the atmospheric scattering because we have already seen in longer wavelength region scattering is minimum or negligible, right, but the disadvantages are like it is very costly and the output of microwave remote sensing are complex and hard to interpret.

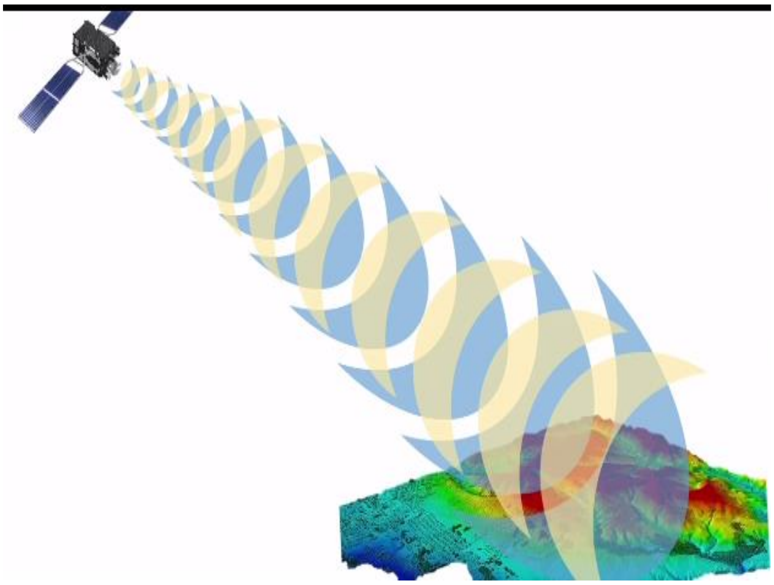
So it is not easy as your optical data, so in optical data you have only DN number, but here it will be in complex form A + IV. So let us see one by one and the next point is very little information related to composition of the material, because here this will give you more structural information, right, because this is based on the backscattered energy and in the longer wavelength region and the wavelength region is 0.1 centimetre to 1 meter.

(Refer Slide Time: 56:26)



Here also we have 2 types of sensing. First one is active sensing and another one is passive sensing. So in active we call it backscattering RADAR, in passive it is radiation or radiometre can be used.

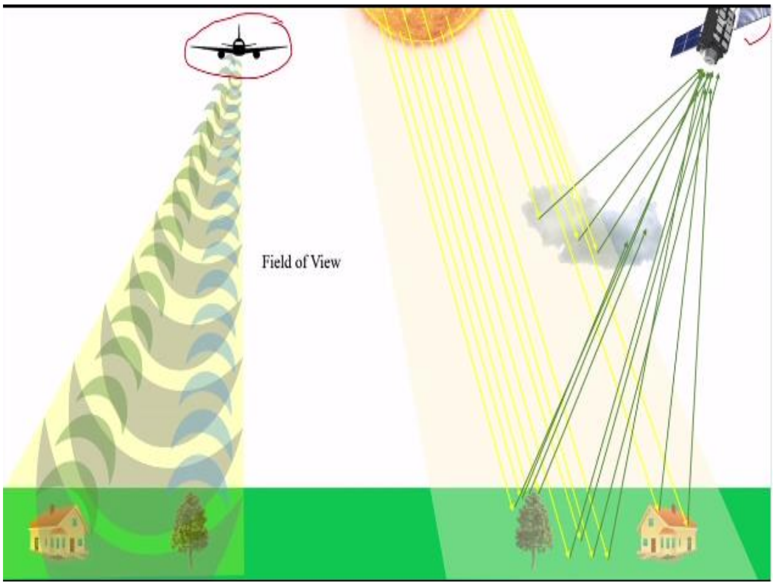
(Refer Slide Time: 56:47)



So this is one example, where I will demonstrate how we are using this active remote sensing and how we are illuminating the surface and how the pulses have been sent and received, right. So let us see here this is my microwave sensor which is illuminating this particular surface and the same time once it reaches to ground and it interact with the object then immediately it will back scatter.

So depending upon the object location the object will back scatter the energy before the another objects, right.

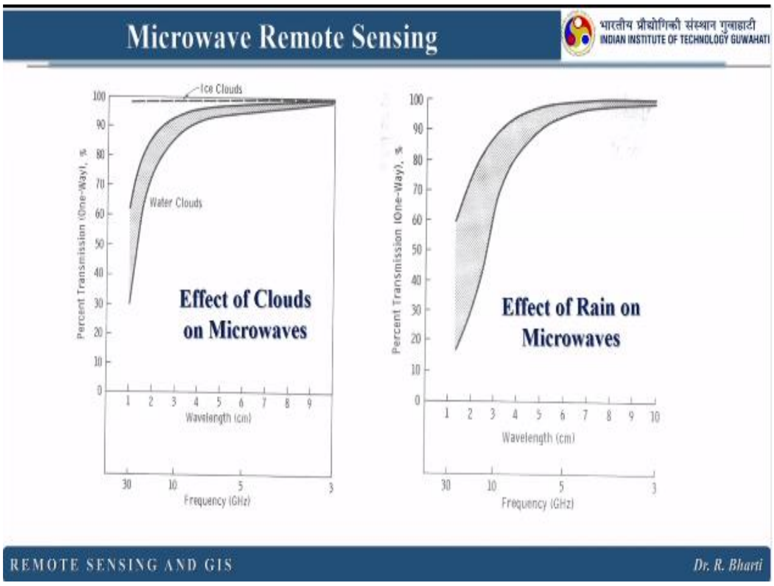
(Refer Slide Time: 57:32)



Now here this is another example where your active and passive sensing will be very clear. Now this is my field of view. Let us assume this particular flight is carrying the microwave radiometer and which is actually active, right, so in active what will happen, we will illuminate the surface, here the object which is near to this and which receives this pulses immediately they will backscattered in the first.

So you can see the house is doing this later whereas this tree has received in the beginning. Now in case of passive one, so in passive Sun is our source and here this is our satellite, right. And Sun is illuminating our surface and the backscattered energy will be received by our sensor, right.

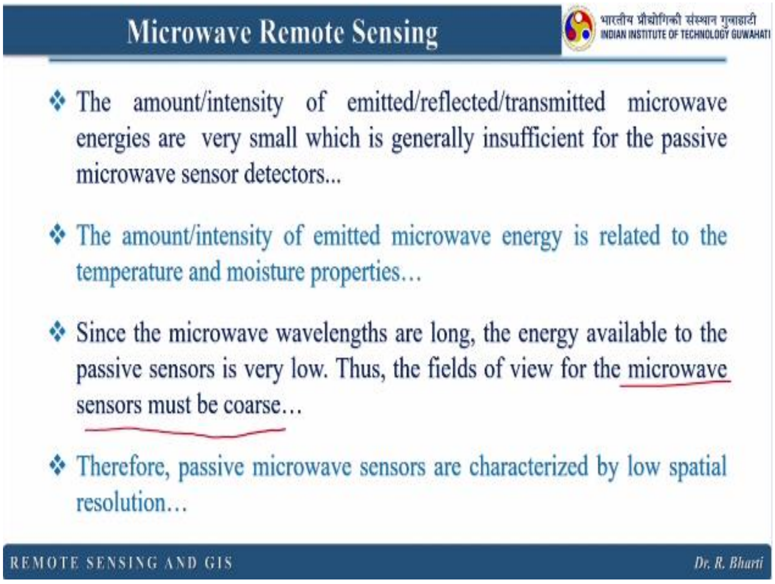
(Refer Slide Time: 58:36)



So let us see why this microwave energy is used in many application. So first of all is effect of clouds on microwave is very minimum. So here you can see this curve, this is the percent transmission and this is the frequency or you can see this wavelength, right. So as we are increasing the wavelength what is happening here, the transmission is maximum, here you can see.

The same time the effect of rain on microwave as we are increasing the wavelength the effect of rain is very less, right. This is again percent transmission.

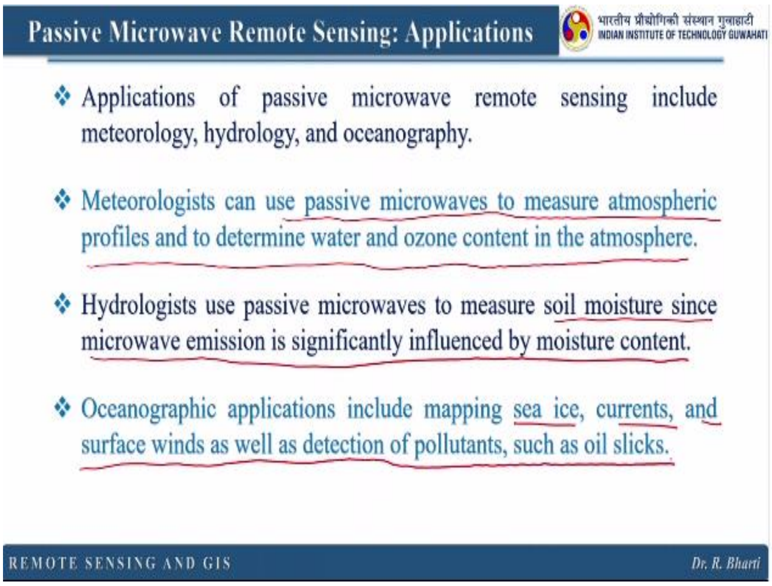
(Refer Slide Time: 59:18)



The amount or intensity of emitted, reflected or transmitted microwave energies are very small which is generally insufficient for microwave passive sensor detector. So the amount or intensity of emitted microwave energy is related to the temperature and moisture property of the target. Since the microwave wavelengths are long the energy available to passive sensor is very low.

Thus the field of view for the microwave sensor must be coarse that is the reason we are having coarse resolution in even thermal remote sensing. Now in microwave remote sensing again when we are doing this passage microwave remote sensing, again the pixel size will be larger, right. So that indicates low spatial resolution. Therefore, passive microwave sensors are characterized by low spatial resolution.

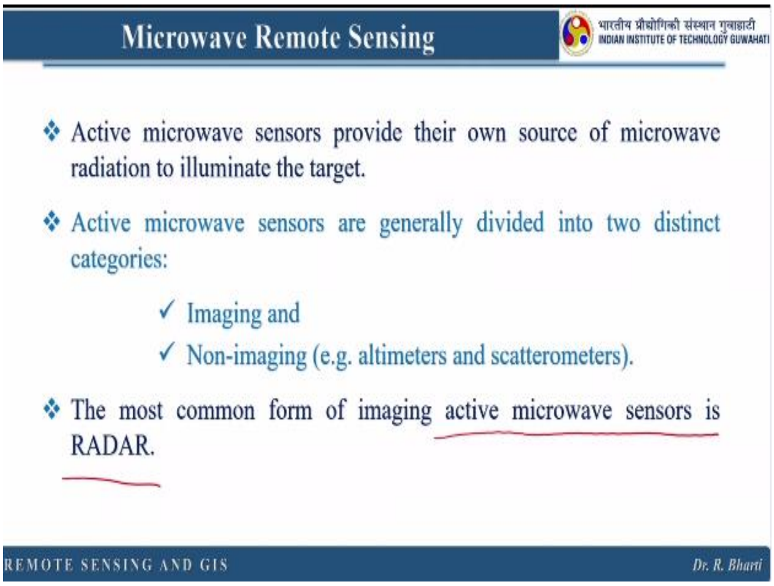
(Refer Slide Time: 01:00:23)



Application of passive microwave remote sensing includes meteorology, hydrology and oceanography, where you do not need that high spatial resolution, the meteorologist can use passive microwave to measure atmospheric profile and to determine water and ozone content in the atmosphere. Hydrologist may use this passive microwave to measure soil moisture since microwave emission is significantly influenced by moisture content.

Oceanographic application include mapping, sea ice, currents and surface wind as well as detection of pollutants such as oil slicks in the ocean, right.

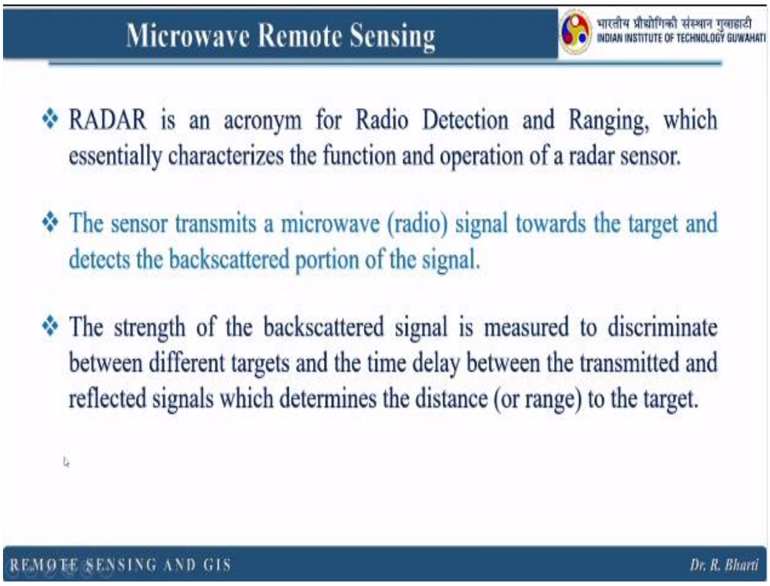
(Refer Slide Time: 01:01:13)



In case of active microwave they have their own source of energy and they illuminate the target with microwave radiation and active microwave sensors are generally divided into 2 distinct categories. First one is imaging and another one is non-imaging. We have also seen this in optical remote sensing. So here we can generate either image or we can generate values in those wavelengths, right.

And these wavelengths will be essentially 0.1 centimetre to 1 metre and this will be the range and depending upon your instrument, the values will be generated, right. The most common form of imaging active microwave sensor is RADAR. So I hope all of you have heard this word RADAR, right.

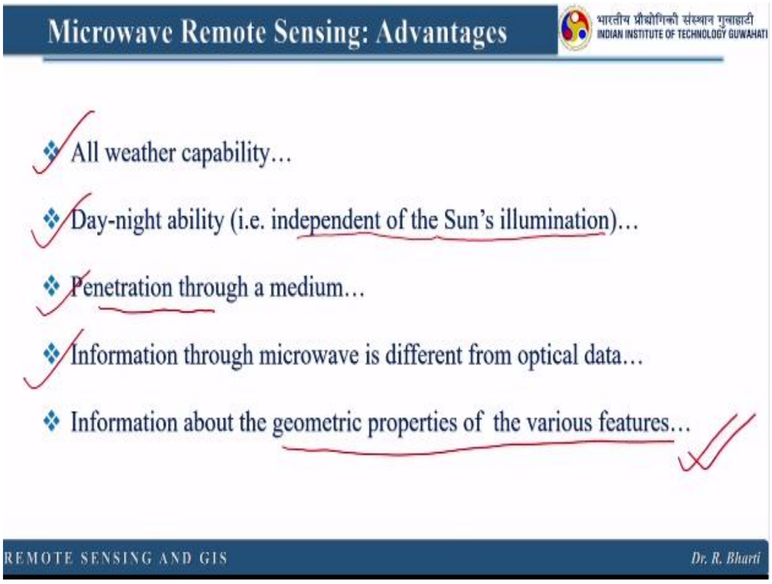
(Refer Slide Time: 01:02:09)



So what exactly RADAR means, RADAR is an acronym for radio detection and ranging which essentially characterize the function and operation of a RADAR sensor. The sensor transmits a microwave signal towards the target and detects the backscattered portion of the signal, the strength of the backscattered signal is measured to discriminate between different targets and the time delay between the transmitted and reflected signals which determines the distance to the target.

So that will define whether this material is situated here, here, here, here, here, depending upon their time, right. So depending upon their location they may receive the energy or the illumination in the first or maybe second and third and the depending upon the time delay between the transmitted and reflected signals which determines the distance to the target. So that is the advantage when we are using this microwave remote sensing.

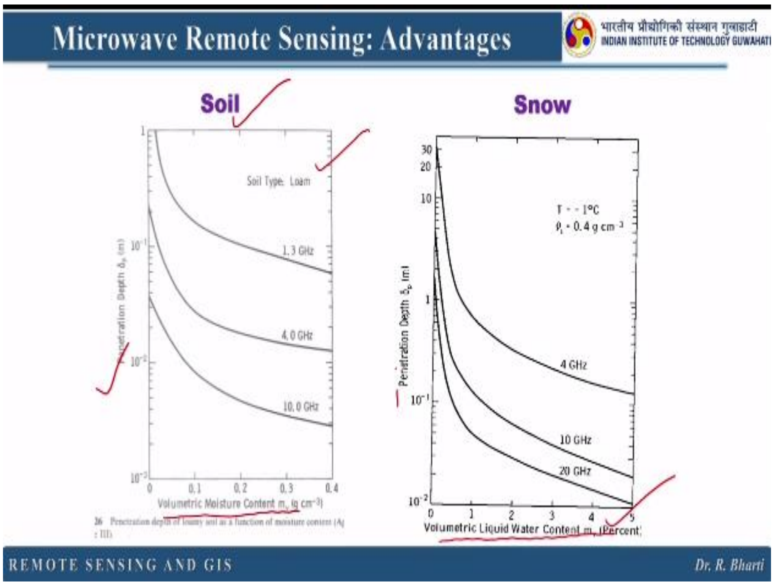
(Refer Slide Time: 01:03:25)



So it has few advantages which are very distinct and you cannot avoid this when you are having such problems. So let us see what are those advantages. So first one is all weather capability, second one is day and night ability. So independent of the Sun's illumination when you are engaged in active microwave remote sensing image generation, right. Penetration through a medium.

So it can penetrate your target, now we will see some example and then information through microwave is different from optical data, how it is different? because this is backscattered and the wavelength is longer. So your penetration will be there, right and then that indicates you will have more structural information rather than having the compositional information. Information about the geometric properties of various feature that is the positive or advantage of this microwave remote sensing.

(Refer Slide Time: 01:04:41)



Here you can see the penetration depth for soil, this is the volumetric moisture content, so when you are having more moisture content your penetration will be less or more that you can see from here. In case of snow also as you are increasing the volumetric liquid water content then percentage depth will change, right.

(Refer Slide Time: 01:05:07)

Microwave Remote Sensing

Band Designations	*Wavelength (λ) (cm)*	*Frequency (υ) (GHz)*
K	1.18 - 1.67	26.5 to 18.0
K_a	0.75 - 1.18	40.0 to 26.5
K_u	1.67 - 2.4	18.0 to 12.5
X	2.4 - 3.8	12.5 - 8.0
C	3.8 - 7.5	8.0 - 4.0
S	7.5 - 15.0	4.0 - 2.0
L	15.0 - 30.0	2.0 - 1.0
P	30.0 - 100	1.0 - 0.3

'S' band are typically used for microwave oven power sources. They operate in the range of 2-4 GHz. The corresponding wavelengths are 15 cm to 7.5 cm.

REMOTE SENSING AND GIS — Dr. R. Bharti

And like in optical remote sensing we had visible band, then everywhere we divided this wavelengths in bandwidth as per the sensor configuration, but here in microwave remote sensing we have assigned some designated number or alphabet for designated wavelength range or the frequency. So for K band, this is the wavelength, this is the frequency. So this you can just go through, right.

And the most common example of this microwave is you can see microwave in your kitchen, right. So S bands are typically used for microwave oven powered sources, right. They operate in the range of 2-4 gigahertz, the corresponding wavelengths are 15 centimetre to 7.5 centimetre. So here now you have to understand we are using this microwave technology in our day to day life, right.

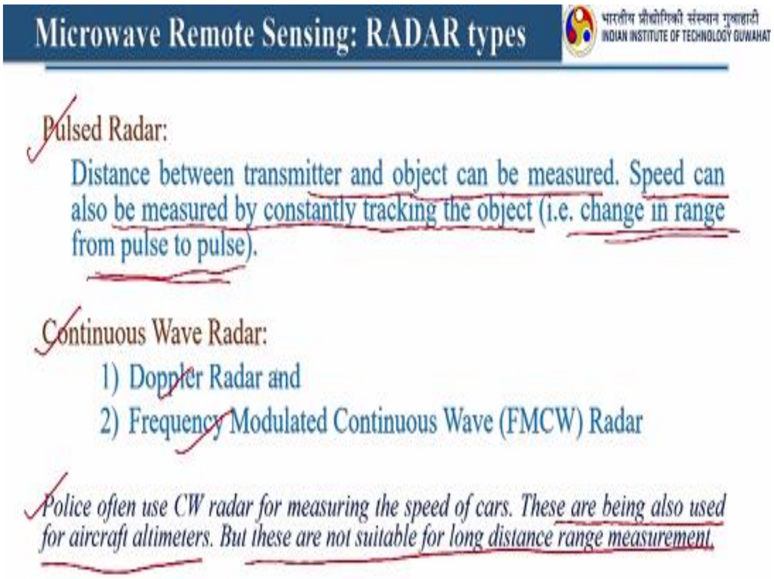
But when we are talking about the space based measurement or airborne measurement or the field measurement in order to identify or study the structural or geometric properties of the study area then application is different, approach will be different, right. So today I will end my lecture here and in the next lecture I will continue this microwave remote sensing. Thank you.

Remote Sensing and GIS
Rishikesh Bharti
Department of Civil Engineering
Indian Institute of Technology – Guwahati

Lecture - 15
Microwave Remote Sensing

In this lecture, we will see more about this Microwave Remote Sensing. In my previous lecture I already covered little bit of introduction as well as what advantages and disadvantages we have when we are using microwave remote sensing. So let us understand more about this Microwave Remote Sensing. So let us start with what are the different types of radar system we have till date.

(Refer Slide Time: 01:00)



So this is the first type where we have pulsed radar. So in pulsed radar distance between transmitter and object can be measured and the speed can also be measured by constantly tracking the object that is change in range from pulse to pulse. So when you are having track of your transmitter location and the object location so this is possible. You can track the speed of the object.

So if you have the pulsed radar installed somewhere and you are looking at maybe a moving car. You can easily track them, but here we have another type of radar which is actually more suitable for that application. So in Continuous Wave Radar we have Doppler radar and Frequency Modulated Continuous Wave Radar. So in this case it is more suitable for your measurement of speed of any vehicle and nowadays people are using it.