Remote Sensing Essentials
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Lecture-02
Historical Perspective of Development of Remote Sensing Technology

Hello everyone and welcome to the second lecture on this course that is remote sensing essentials. And we are going to discuss in this one about the historical perspective of development of remote sensing how it is started. In the previous lecture we have briefly discussed while discussing remote sensing platforms we have discussed about like using balloons. So as you know that first remote sensing started in history in 1858.

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And that is the first aerial photograph from hot air balloon, and this is how it was this is of course, the drawing not the photograph. But this is exactly the aerial photography was started. Of course, at that time, the quality of camera and images were not that good as what we see today. But nonetheless, that was a big development has taken place that too in 1858 using balloons and taking aerial photographs.

At that time these photographs were in oblique direction not particularly downward or not the direction. So that was those were the limitations if you start exploiting these photographs for some serious applications.

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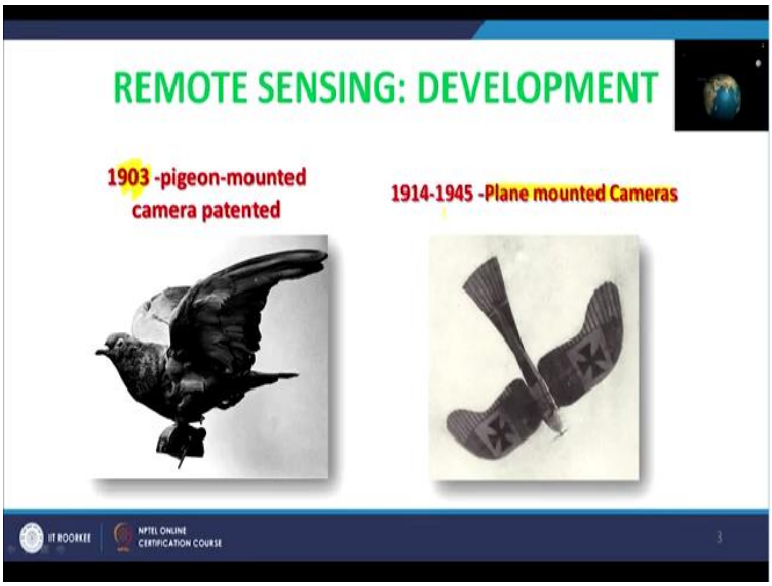

And then people thought and this was also tested imply in 1903, the pigeon mounted camera and this technology was patented. And this of course the payloads which we are on the pigeon were very, very tiny as you know that the word cannot fly the heavy load. So, these were also done and later on then small planes we are also used plane mounted cameras in 1914 and between 45. And be the development of remote sensing has taken place especially the aerial photograph has taken place during the world war II also.

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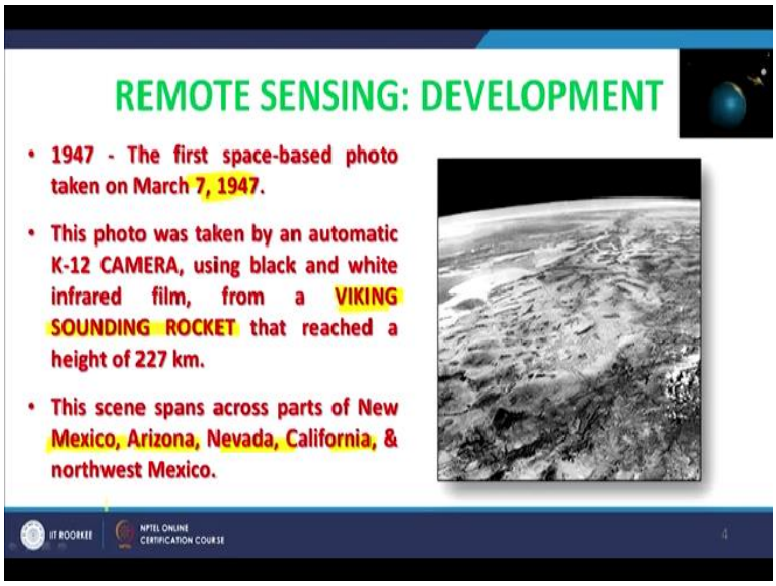

And after that of course, then in 1947 the first space base photo was taken on March 7 1947. And this was taken through automatic K-12 camera using black and white images by the viking sounding rocket. And that reached to the height of 227 kilometer and image which you see on the right hand side was taken by this rocket.

And then of course, by these smaller, small missions of steps, lot of learning has taken place since then. And this the scene which you see here covers a large part of America, Mexico, Arizona, Nevada, California and northwest Mexico too. So, because the height was this much by this rocket and of course the time it was also oblique in direction.

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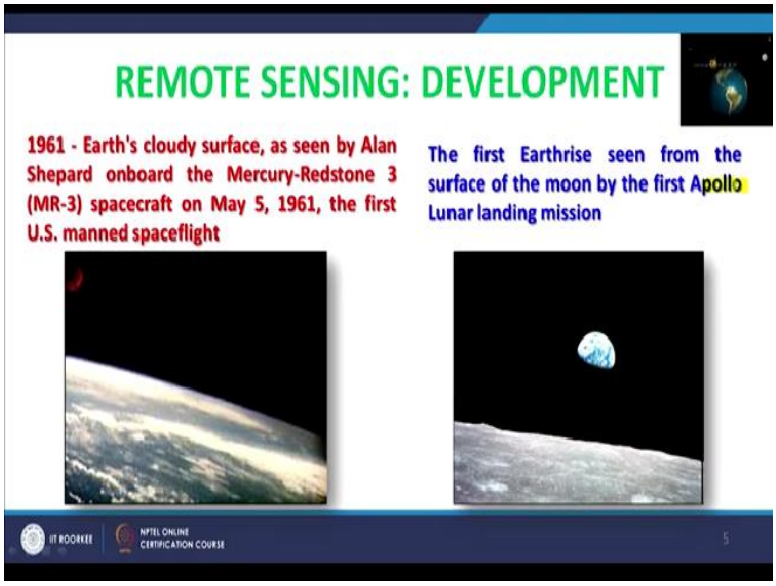

Then in 1961 the earth's cloudy surface was also captured by Alan Shepard which who was on board of Mercury-Redstone 3 or it in short it is called MR-3 spacecraft, which was May 5 1961. This is the first US manned spaceflight was there and then the first Earthrise, seen from the surface of the moon by first Apollo mission and lunar landing mission which has taken place. So, these are the developments, but in most of these photographs or images which you see are oblique in direction.

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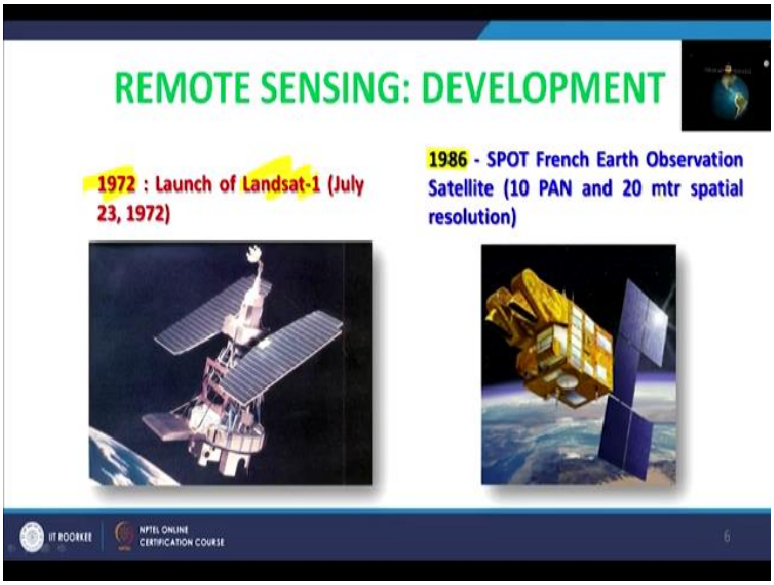

The real the current remote sensing which is very common one is the neither viewing vertically and looking downward and then once we started getting these images, the orthorectifications became also very much possible and lot of applications started developing. So, the first the real remote sensing started in 1972 with the launch of landsat-1, if you see the literature or some websites you may find a different name for this satellite landsat-1 instead of landsat-1 ERTS earth resources satellite was also mentioned in there in the literature.

But later on it was renamed and the satellite was launched on 23rd of July 1972. And since then lot of satellites by various countries of course the landsad-1 was launched by US and USGS later on shifted to NASA. And then in the new I should say, new generations of satellites started with the launch of the spot in 1986 by French earth orbiting ah satellite, which is in short we say SPOT.

Because the landsat MSS was giving space of resolution of about 80 meter, and when we had the SPOT, we started getting 10 meter panchromatic means black and white and 20 meter and spatial resolution in multi spectrum. So that was a big step forward from 80 meter and to 10 meter and 30 meter, but in between there were also landsat TM senses so which provided data in visible or infrared channels for 30 meter of course in thermal channel it was 60 meter. So, from 80 meter reach to the 30 meter, 30 meter to 10 meter and 20 meter.

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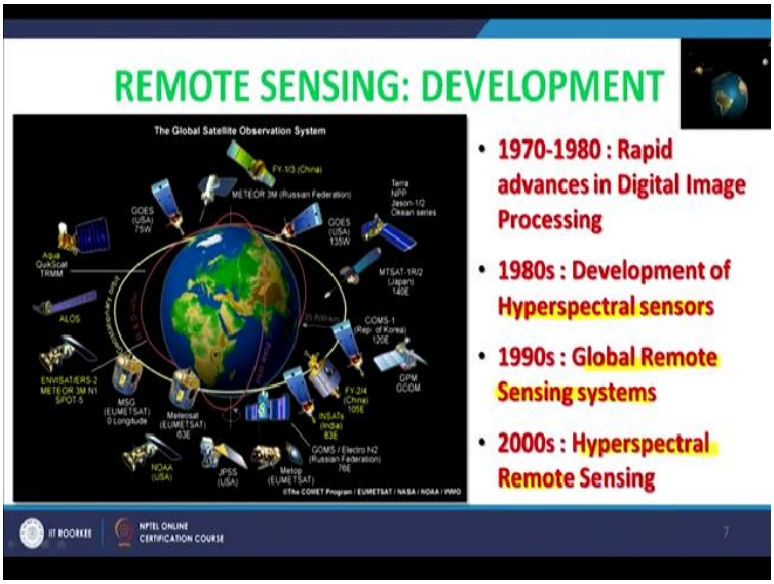

And this image here this is a photograph we have already discussed in the previous lecture, but the purpose here again to bring this one is to see that how many you know the various satellites by various countries are there and each of these satellites either a part of series like NOAA, so, now the current in the series are probably last in the series is NOAA 19. And so, I think that started in 60s and still the series is going on.

So, there are a lot of satellite here in this picture, which you see that there are series of satellites, and I am talking mainly about remote sensing satellite, but the communication satellite like insat also having series the even we went up to the insert 3d and in between lot of insat satellites were there also then Chinese also had (()) (07:28) or FY-123 satellite, and that series was also there. Then 2 4 China again is there and many, many satellites were implied.

Especially I am talking about the polar orbiting, this was also very common the Envisat satellite from European Space Agency, for microwave allows ALOS PALSAR was also very common. Then there are 2 satellites aqua and tera for modis sensors that is also very popular. So, the after this landsat-1 in 1972 this era between 70s to 80s as was the era of digital image processing era of lot of remote sensing satellites.

And of course, the development has taken place and we have gone for a spectral sensors also and its development is started basically in 1980s. But a lot of progress has been made here in case of hyperspectral remote sensing. In later discussions we will have a separate discussion on hyperspectral remote sensing, but very briefly I have introduce here that hyperspectral remote sensing that in the same part of electromagnetic spectrum we are currently we might be having 4, 5 bands.

But in hyperspectral remote sensing we might be having 200 bands there of 5 nanometers or so. So, very tiny or very thin bands, but number of bands are very large spatial resolution may not be that high, but it covers hyper order spectral resolution is very, very high, that is why they are called hyperspectral sensors. In 90s we have a lot of global remote sensing systems and which covers the entire globe. And then of course in 2000 hyperspectral remote sensing became further prudent development has taken place.

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If we see the development of remote sensing in India. Then, of course, it started on April 19 1975, after the launch of Aryabhata that was the first Indian satellite. And then of course later on Bhaskara I and II were also remote sensing satellites, which has different sensors onboard working on in different frequencies.

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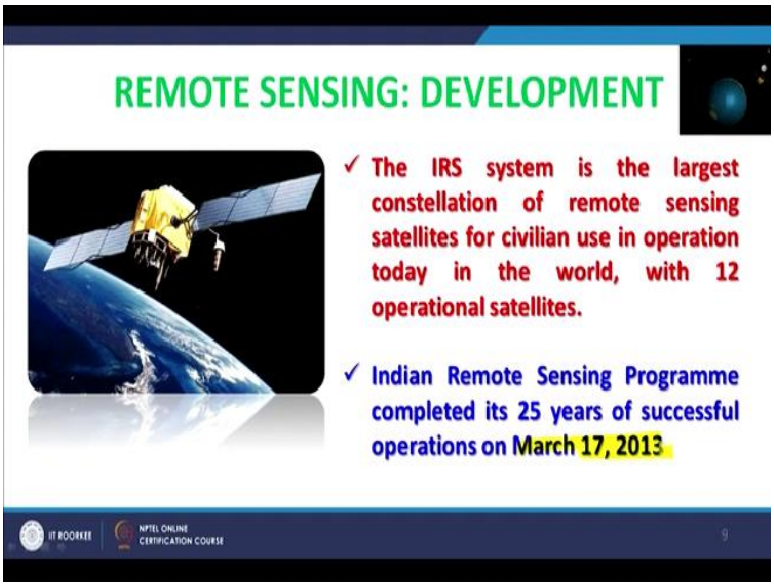

And the real remote sensing development in India has taken place with the development of IRS series of satellites. And then of course the Sosat, Cartosat and many more satellites are there. So, IRS system is the largest constellation of remote sensing satellites for civilian use in operation for India and which is a global these are global satellites. So, they are covering the entire part of the world with 12 operation satellite.

So, currently India is having many more satellites and space in Indian remote sensing program completed is 25 years of successful operations on March 17 2013.

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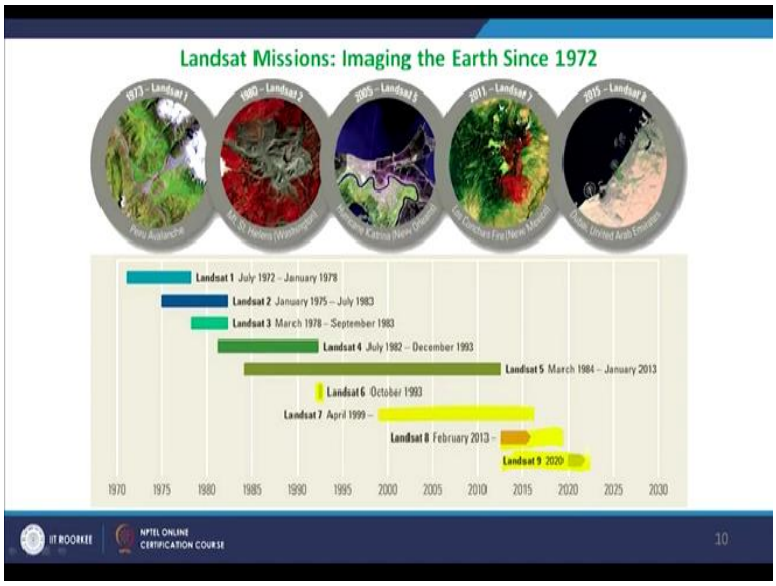

So, we are have completed more than 30 years in the space. If we look the series of landsat series, how it has evolved as the landsat-1 we have already discussed that it was launched in 1972. It worked up to 9 January 1978. In between landsat-2 was launched in 1975. Landsat-3 had a little less life was as electronics has improved landsat-5 had very long life. It was launched in 1984 and it worked up to January 2013.

And of course a large part of the earth repetitively, it has acquired the data provided lot of images, landsat-6 was almost a kind of you can say is failure and was only for a few days. Somehow there some next we have develop and it did not work. Landsat-7 of course work for very long time. Landsat-8 is still in operation and it was launched in February 2013. So we are somewhere here and still it is giving good quality images.

Very soon we are going to witness the launch of landsat-9 a new series in the series of landsat satellites. Landsat satellites have been very popular and they have covered about now about 50 years of their operations in space and had provided large number of images, big data sat have been developed. And Google Earth is having archives also of these data sets. Otherwise also there are a lot of servers which can provide and data sets part of the earth maybe 10, 20, 30 images of the same part of the earth, implying different satellite data in a very organized manner.

So that landsat is still very popular remote sensing sensor and the data is available free of cost, it can be downloaded from net and anyone can utilize. Sometimes even you do not have to register for any server.

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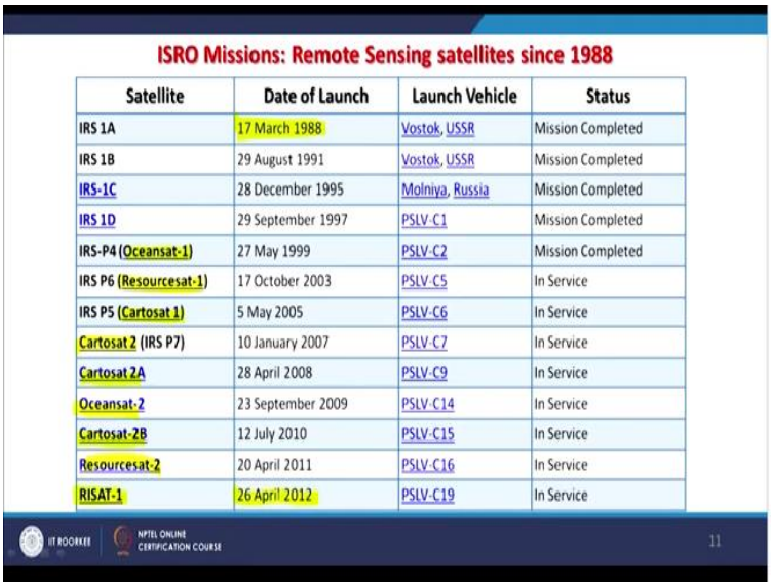

If we specifically look the Indian History of remote sensing especially after IRS 1A that is more you know traditional remote sensing way and then in 17 March 1988 that was the start for IRS mission. And then all these mission were completed first we get IRS 1A, 1B, 1C, 1D and then IRS-P4, P6, P 5 and also they renamed as Oceansat, Resourcesat and Cartosat. And then of course the new series in Cartosat came that is IRS-P7 or Cartosat-2, then 2A, then Oceansat series also came.

Cartosat another to be a Resourcesat-2 and RISAT also came in service. This is RISAT is a microwave satellite which was launched in April 2012.

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Now as you know that a remote sensing of moon has also been started by India and not only moon but also Mars. So, a very briefly I will cover the moon because only very on the 22nd July Chandrayaan-2 has also been launched, just Chandrayaan-1 was launched in 2008. That was our first lunar probes or it orbiter lunar for many times and it has acquired a lot of images.

And of course very recently as mentioned that on 22 July only this year, and this Chandrayaan moon the Chandrayaan-2 was launched and it is having orbiter, it is having Lander Vikram and it is having also Rover Pragyan. So it will take few more days for this orbiter to reach to a near moon surface. And then hopefully we would be seeing beautiful images of the moon and also lot of data about rocks and soils and water availability on moon through these Rover which is Pragyan.

So, finally this Rover would be there on the surface of the moon will move on the moon and will collect a lot of data and because it is also having a lot of sensors, which will acquire the soil data, rocks data or spectrum in different part of EM spectrum. And of course that the data which will be collected by this Rover and will also reach to the earth through the transmissions and then the SSNs on the earth. So that is going to be a very exciting time after roughly 20 or 25 days, when it reaches on the surface on the moon.

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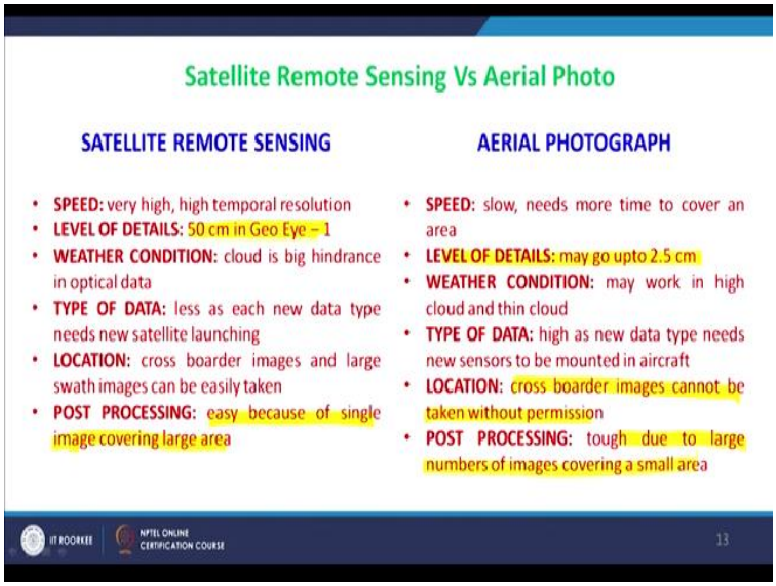

As you know that there used to be in books also you would find a lot of comparison or discussion between the satellite remote sensing versus aerial photography. Nowadays people instead of aerial photograph they would like to discuss satellite remote sensing versus your UAV or this drone remote sensing. So, less if you can put a aerial photograph instead of aerial photograph you can drones, but let us keep things currently into perspective.

And that is if we did this speed parameter then current satellite remote sensing is very high and it has a good high temporal resolution and that sometimes the satellites are revisiting after a few hours which is not possible might not be possible with aerial photograph because these missions have to be planned and then aircraft to be flown there.

So, speed is slow sometimes needs more time to cover an area, level of details nowadays we can have even 30, 40 centimeter spatial resolution one example is given here by Geo Eye-1 private satellite which can provide data up to 50 centimeter half a meter resolution. So, the resolution wise the satellites are also providing. Of course level of details with aerial photographs can be provided much more even nowadays the camera and hardware which we are having we can have up to 2.5.

Weather conditions of course cloud is a big endurance in case of satellite especially passive satellites and the most of the remote sensing which we discuss is passive remote sensing and of

course in aerial photographs n. So, there is a choice but in case of satellite once it is launched it is there and whether cloudy conditions or clean, it will acquire the images.

Then what type of data and then less as it new each new data type needs new satellite launching that means the different sensors if you want to change or have a new idea or new development then a new satellite has to carry. But in case of aerial photography the same aircraft, but different sensors can be there. Then the location that is another advantage with the satellite based remote sensing that cross border images can be taken.

A larger swath images can also be taken by the satellites, but in case of aerial photographs it is not possible easily to take the photographs of other side of the border. So, in that way cross border images cannot be taken without permission. Otherwise, there are troubles between countries. Post processing because it is more systematic and the platforms are more established in case of satellite based remote sensing.

So, that post processing or processing becomes easier, single image covers a large area in case of aerial photographs, sometimes it becomes tough because a large number images covering a small area.

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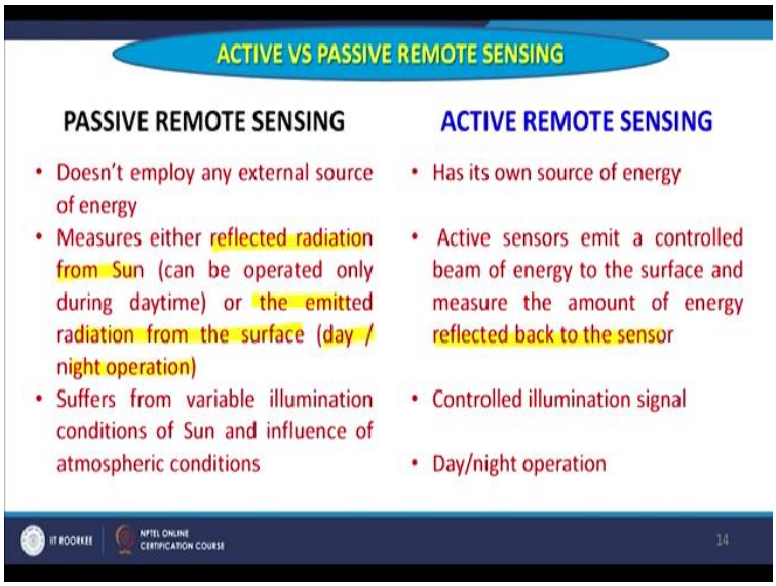

So large data handling and difficult handling is there. In case of passive remote sensing, and active remote sensing now I am discussing these 2 types of remote sensing. The most of the remote sensing which we see nowadays are all part of passive remote sensing. Active remote sensing mainly the microwave remote sensing. So, also quickly we will have comparison and that this is non invasive passive remote sensing.

So, does not employ any external source of energy. And but in case of active remote sensing, the sensor itself has to have its own source of energy, it has to send the energy or pulses towards the earth and then back scattered energy is collected by the sensor again and this is how it covers or acquired the data. But in case of passive it is either reflected energy or emitted energy because which is recorded by the sensor.

And this passive remote sensing measures either as I have just mentioned the reflected radiation from the sun or can be operated during nighttime especially the thermal infrared that is emitted energy from the surface. And so day and night operations are possible. Though day and night operations are also possible with the active remote sensing because the sensor itself is providing the source of energy.

Active sensors emit a controlled beam of energy to the surface and measure the amount of energy reflected back to the sensor. And now these passive remote sensing suffers from variable illuminations conditions of sun especially in daytime and influence of atmospheric conditions, they play a major role in case of passive remote sensing, but in case of active remote sensing we can have the controls over elimination signals.

And of course the day and night operations are possible atmosphere does not play a big role as compared to passive remote sensing.

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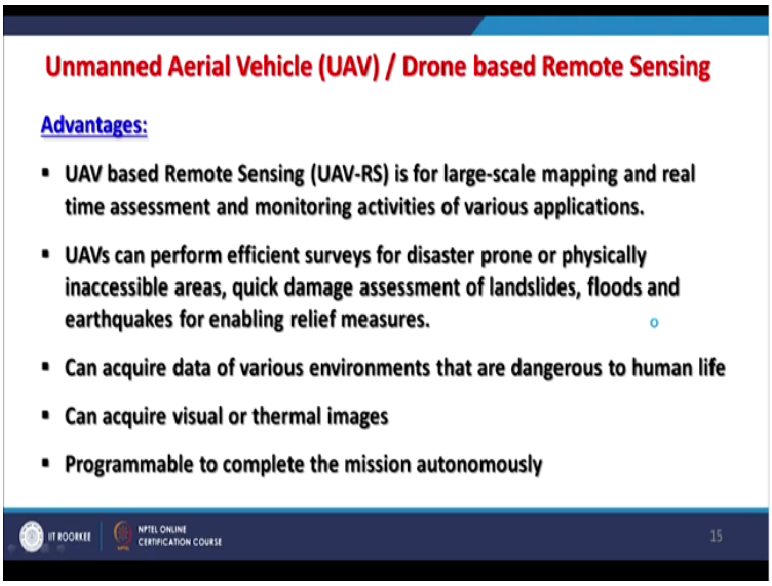

If we compare this UAV discuss about this UAV are drone based remote sensing which is nowadays it is becoming very common. We will see the advantages in other things associated with this technology that UAV based remote sensing is for large scale mapping, high resolution mapping, real time assessment and monitoring activities of various applications. So, this is how we employ for an UAVs.

And UAVs can also perform efficient surveys for disaster prone or physically inaccessible areas, a quick damage assessment of landslides, floods, earthquakes for enabling relief or rescue operations, that is another advantage with UAV and can acquire data of various environments that are dangerous to human life. So UAV in that way is very advantageous can acquire visual or thermal images.

Basically is a platform UAV is a platform, a drone is a platform. It depends on what kind of data you are looking and accordingly you put a payload or a camera or a sensor and then data is acquired accordingly. Of course, these can be program using these GNSS or Global Navigation Satellite System receivers, with them so you can plan everything and these operations can also become automatic or semi automatic.

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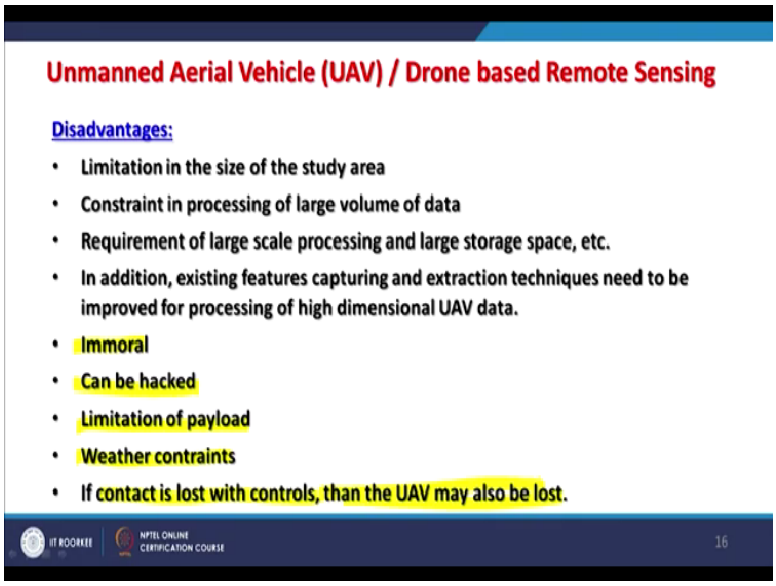

What are the disadvantages, there are some disadvantages also associated with the UAV the limitations in the size of the study area, because these do not fly very high, there are limitations or might be different constrained by the different countries. So, the coverage is relatively very small as compared to normal remote sensing, constrained in processing of large volumes of data.

Generally the data in maybe in the video form and then frame by frame, it has to be analyzed. So the processing constraints are very big in case of UAV, requirement of large scale processing and large storage space, it may be a problem with UAV. In addition to a larger story, it requires existing features capturing in extraction techniques need to be improved, whatever currently which we are having for processing of high dimensional UAV data.

And then immoral sometimes you know instead of in our own territory you go some other territories or you are flying over somebody's house. So, in that way, it has been mentioned here is immoral, it can be hacked also that may be a problem and then limitations of payload, because these cannot be used for very heavy payload. So payload has to be very light weighted. But as UAVs are improving, hopefully this problem will resolve to some extent.

Of course, whether constraints are there if it is cloudy or foggy or hazy then these problems are rainy then you will be may not function very well. And if contact is lost with controls, then UAV may be lost. So, this is a big loss. And that sometimes it is very common, especially in forested

areas or in mountain regions, where you know the controller cannot see the UAV and loses the control sometimes also loses the UAV. So, this brings to the end of this discussion about remote sensing sensors essentials and thank you very much.