Higher Surveying
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Module - 10
Lecture - 36
Conclusion Lecture: Concluding the Course

Hello everyone. Welcome back in the course of Higher Surveying. Today is our last lecture. We are concluding what we have learned in the last 35 lectures. So, whatever techniques and subjects and the logic we have learned in this course we are going to use it in order to solve the problems that we have raised in our first lecture. I hope that you remember all those problems, fine.

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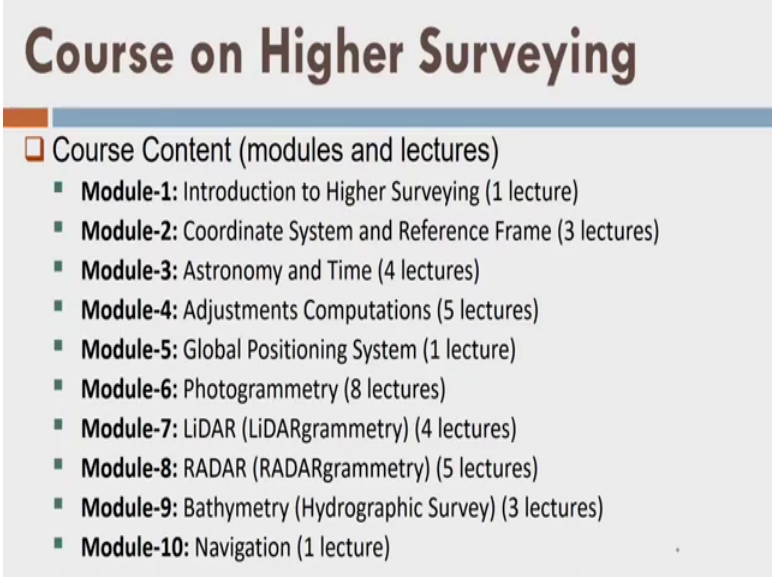

So, let us go ahead. So, these are the 10 modules we have tried to discuss in this course and, right you can read it yourself and I need not to repeat anything on that, fine.

So, they have total contributed to 35 lectures, ok. Now, let us start that what we have learned in different modules. So, in module 1, we have learned that how to develop. We developed the appropriate context of this course higher surveying, alright. And there we have taken some real life projects, for example, forest study and then we see that how the basic surveying can help us, ok.

Then we realize that yes there are many limitations of the basic surveying and as a result we need some better techniques or technology or some better facilities or so we concluded that we need something else in order to address all those real life problems. So, there once we started looking to the real life problems we realize that these problems are not resolved that easily, and as a result we call them the research projects because many of the things are unknown or many of the studies has to be conducted first in order to understand requirements of the projects.

Finally, we have concluded that in order to do these real life projects we need some kind of techniques which can acquire the 3D data. And 3D data should be highly accurate, at the same time we should have very high coverage. Moreover, we should acquire the data in the minimum time.

Then we discussed the module 2. So, in module 2, we talked about the coordinate and reference systems. So, we have first defined what is the reference system, reference frame and coordinate system, ok. Then we say that the reference frame is the realization of the reference system definition and coordinate system is the mechanism of defining a 3D coordinate or maybe 2D coordinates of a point in a given reference frame. So, then we discuss what are the type of reference frames are there and then we learn the coordinate and datum transformations. That means how to convert the coordinates from one coordinate system to another and how to change the datum or the reference frame.

Later we learned the map projections and we said that why map predictions are relevant in some of the cases especially the navigation. Then we finally, defined what is the International Terrestrial Reference Frame, ITRF and that is originated from the concept called International Terrestrial Reference System, ITRS.

So, in the module 3, we discussed about the astronomy and time, ok, how astronomy and time are connected; we have defined the astronomical reference frames, right. And then we have discussed that how to conceive concept called ICRF or International Celestial Reference Frame or using ICRF how to connect the ICRF and time to ITRF and how to find out the definition of ITRF with the help of ICRF. And how to update the ITRF continuously based on the observations of the ICRF.

Also in addition to that we have seen the applications of the astronomy and time, and that also kind of module that appears to be little off the course. However, it is very relevant if you are a student of higher surveying. Then we move to the module 4.

In the module 4, we realize that if we have lot of data that means, we have redundant data for a given problem, we should extract the useful information redundant data. In order to extract the useful information from redundant data we realize that we need to use some technique that do some kind of adjustment process that means, adjustment of the observed data and after the adjustment the adjustment process should reveal the useful information and what we call as parameters, alright.

Then we realised that the least squares solution of a problem can extract the useful information or the parameter values by adjusting the redundant data. Then we learned what are the types of least squares method that is possible with a computer to write our own codes maybe in a python or any other IDE. Well, and that was the turnaround point here for us to understand that how basic surveying is different from the higher surveying.

At the end we have also talked about the quality of the parameters or the extracted information that were derived from the redundant data. We started the higher surveying module 5, we have discussed the global positioning system rather we have discussed the additional information in just one lecture.

In module 6, we came to the photogrammetry and there we have discussed a lot about the photogrammetry in 8 lectures. So, after the introduction to the photogrammetry, we have discussed vertical photogrammetry, stereophotogrammetry and analytical photogrammetry. Then we have realized that what are the products of the photogrammetry. Let us say digital Ellucian model, digital terrain model or the ortho map. Remember ortho map is not the topographical map, the topographical map contains some information in the form of some features, but an ortho map contains the colour information or the image information as well as the planimetric coordinates of a map. So, that is why ortho map is much better than the topographic map, alright.

Then we have seen the digital photogrammetry and digital photogrammetry we learned how to calculate the derivatives or how digital photogrammetry allows us to calculate the derivatives as well as the automatic processing of the data. Then we have seen the terrestrial photogrammetry or low altitude photogrammetry and then we said that

terrestrial photogrammetry or low altitude photogrammetry, we said that since the distance between the camera and the object on the surface of earth has very less distance and as a result we said that it is a close range photogrammetry. So, then we have learned different protocols of the close range photogrammetry and we have also seen that how to develop a 3D view of a given object using the overlapping photographs, alright.

So, recently we have conducted one a study here at IIT, Guwahati and then we realized that it is possible to generate highly accurate 3D models using the terrestrial camera or miotone camera, fine.

So, here I can guarantee you that even you can create some kind of millimetre level accuracies in your work using terrestrial photogrammetry and which is quite cheaper because you read only one camera of high resolution. At the same time since you are working with the limited distance with the object automatically you will have the high resolution. And at from the high resolution achieving the higher accuracy required some kind of research here, ok.

So, if you do that research you will realize that it is quite easy to get the very high 3D accuracy of the digital elevation model and now, you can prepare the 3D models of the buildings around you or even you can prepare a good 3D map of your locality around you.

So, then we said that, then we moved on to the module 7 and that was LiDAR. Well, LiDAR we have said that is a active remote sensing method or active remote sensing technology and then we have talked about the LiDAR data acquisition, geocoding of the LiDAR data, LiDAR data errors and the data processing for LiDAR data. So as to create digital elevation model DTM, BEM and Digital Surface Model DSM, right.

With this we realized that both photogrammetry and LiDAR can give us very highly accurate 3D data in terms of centimeter level accuracy if we are using them as a air bond method. If you are using them as a terrestrial method even we can go for the millimeter level accuracy and though we have not discussed about the satellite based, but LiDAR is not available with the satellite platforms, photogrammetry is available. And it is basically useful for the planimetric mapping only most of the time not for the 3D mapping.

It is possible to do 3D mapping, but there are some limitations because the b by h ratio for the satellite photographs are slightly different and the lower compared to the what we can achieve with the flexibility of the low altitude photogrammetry or terrestrial photogrammetry or aerial photogrammetry, alright. As well as the resolution is also very high in case of these 3 photogrammetry compared to the space bound photogrammetry.

Now, we have realized that both technique that is photogrammetry and LiDAR are useful because both give the comparable results and the accuracy as well as the resolution type. But we have realized one thing that LiDAR is an active system and photogrammetry is a passive system that is why we have some other disadvantages as well as advantages.

At the end we realize that both are complementing technologies, both are not competing technologies, they do not compete with each other because of the different capabilities they are complementing technology. That means, I can compliment one technology with other that means, if I use the 3D data from LiDAR, if I use the photogrammetric information from the photography then I can equip the two things and I can generate 4D information, 3D for the 3 dimension, and the 4th for the colour information. Well, so this was the kind of integration aspect of the two technologies we have discussed.

Go for the module 8, where we discussed above the RADAR which is quite a different technology. Why because the microwave reason is sensitive to the material unlike LiDAR and that is the reason it can give multiple advantages.

That means, first is topographic mapping in certain region of microwave spectrum and in certain another reason of the same microwave range of these electromagnetic spectrum, we can use the frequencies in order to measure the type of material or since in certain reason of the microwave is very sensitive to the material. For example, vegetation for example, soil moisture. So, we can have the different studies based on the selection of the wavelength. And that is why RADAR has multiple applications and it has very wide area of applications are available.

On the other end we saw that RADAR is basically limited by the resolution and because of the low resolution it can be used for very large scale studies. For example, glaciers , where the evolution of the centimeter level is not useful because the glacier movement are itself is in the level of meters per year. So, over a year duration what happens with glaciers moves by a couple of meters let us say 18 meter, 20 meter or maybe sometimes

80 meters and that is what is happening in Himalaya. So, there we realize that for such a study RADAR is much useful compare to photogrammetry or LiDAR alright.

But at the same time photogrammetry and LiDAR can be used if high resolution studies are required. In the RADAR we have discussed about the geometric aspects, radiometric aspects, RADAR grammetry, interferometry, differential interferometry. And finally, we saw some different aspect of the RADAR which is dielectric aspect from the geological perspective and then we realize that if we use the dielectric information of the material under certain circumstances I can find out the depth of the layers or the subsurface investigation can be performed. So, that was our module 8.

And then we move to module 9 and it was all about the hydrographic survey. So, we defined what is the hydrographic survey and then we said that how to perform the hydrographic surveys using conventional and modern methods. Then we discussed about the echo sounders, and in the whole process we have defined a term called sonar. And sonar is a term that is stand for the sounding, navigation and ranging like LiDAR, like RADAR, we have sonar all, right then see that how to perform the air bond LiDAR survey in order to find out the depth of the water bed or the sea bed.

So, then we discussed our module 10 that is about navigation. And then we said that navigation includes all the output of many technologies and that is why we have discussed the navigation as a lot module of this course, fine. So, in that navigations we first defined what is navigation, we have then classified different type of navigations, then we have seen different system of navigations that are available today and they are prominent in their use.

Then we have seen the application of the navigation by a forest study where we have used a GPS in order to reach to a ground control point that they want to collect in the field, ok. Finally, today we are concluding all these 10 lectures and before conclusion or before completing this lecture let us look into the word studies again.

So, have you responded to these studies or have you responded to the requirements of these studies using these technologies. So, first was the forest study.

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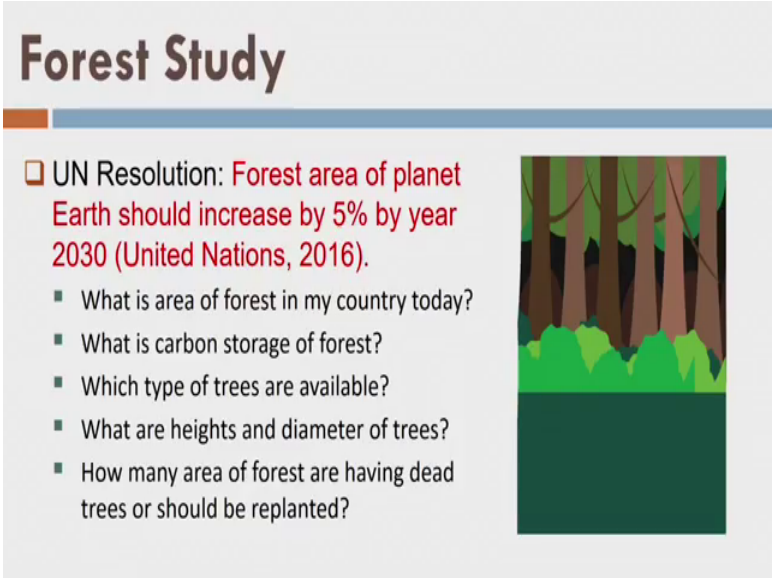

So, we are said that in case of forest study we wanted to find out what is the area of forest in my country today. So, you can use the RADAR or you can use LiDAR or photogrammetry in order to find out this information. Again if you use RADAR and the frequency is sensitive to the vegetation material you can give better answers to the large scale study related to forest. So, all these answers can be responded using either of the technology which I named here like RADAR, LiDAR or photogrammetry.

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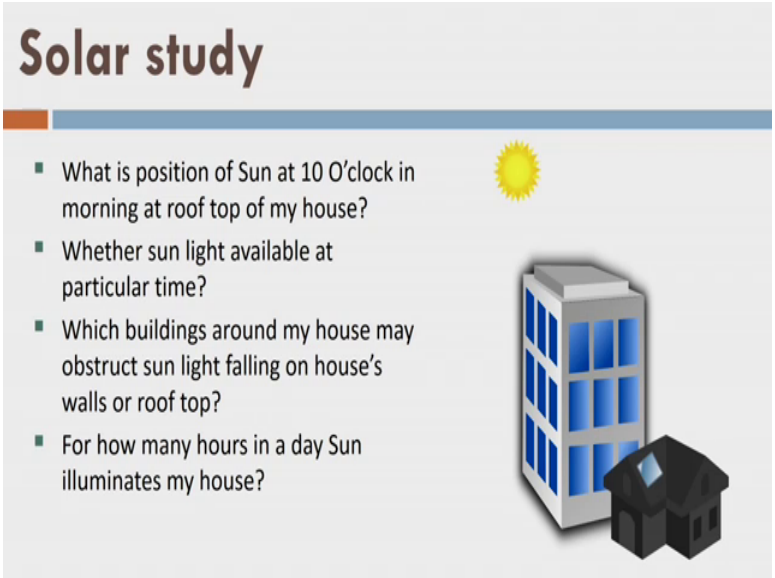

Then we have come to the solar study. So, for example, what is the position of sun at 10 O'clock in morning at rooftop of my house? So, all these things can be responded well if you have some kind of sun algorithm available to you and sun algorithms can be used which are freely available, all right.

Later on I wanted to find out that whether sunlight will be available at the certain place or not, that can be derived using sun algorithm and the available 3D data of the 3D structure. For this data we can say that both LiDAR and photogrammetry are much useful compared to any other technique, all right. Because they provide very highly accurate 3D data and in order to find out that availability of the sunlight at the rooftop or at a particular time I need to have very highly accurate 3D data. So, that I can find out the shadow of one building onto the another and that is a reason I prefer to use LiDAR or photogrmmetry.

Similarly all other questions can be responded. So, if we have some algorithm the time measurement and the 3D data of high accuracy.

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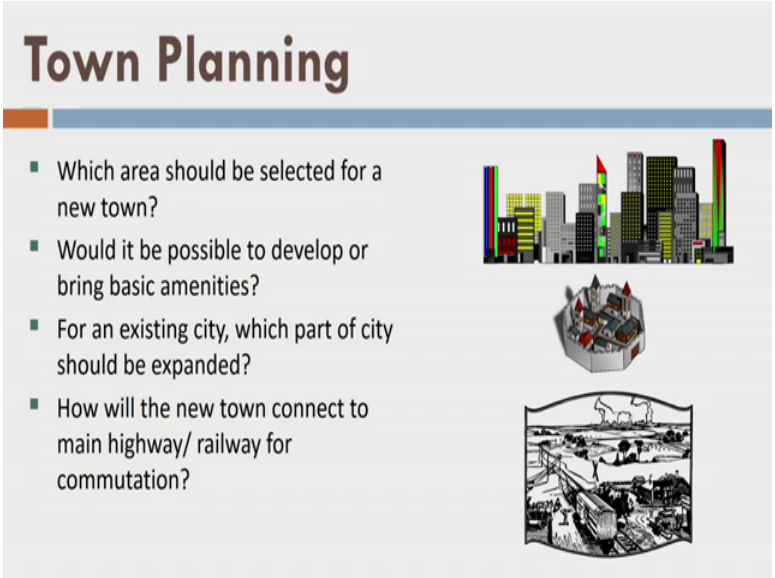

Then we discussed about the town planning. So, let us say in case of town planning which technology should be used, I can use let us say depending on the purpose if I have course resolution requirement. Then I can use even the photogrammetry or even the LiDAR, but at very low resolution or at the same time I can use a RADAR if the studies are to be done at course resolution or just to understand the terrain.

Later we can use the LiDAR or highly accurate technologies like LiDAR and photogrammetry in order to develop some kind of other aspects. For example, some building development and so on, but this town planning studies are basically to be done in the multiple series. Then we talked about military intelligence.

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Then we talked about the bullet or metro train project.

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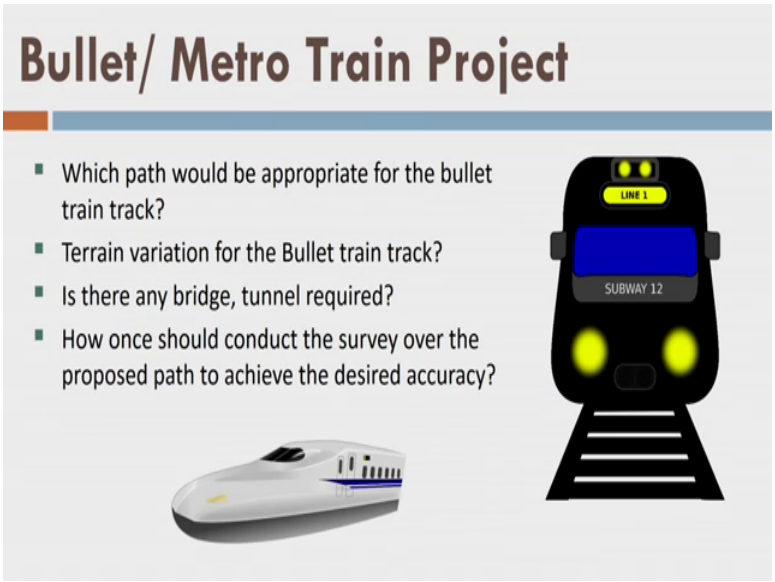

Remember in case of bullet or metro train basically the metro train can pass through tunnels or it can pass through under ways or it can pass through over ways. So, for that purpose I should use drone, a photogrammetric drone or LiDAR with the drone.

Moreover, at places I would like to confirm that the technologies like total station will also be useful to us. In case of under ways we should minimize the chances of accidents. So, in case of use of the use of UAVs there could be some chances of accidents and therefore, even such places where metro passes to under ways or over ways in a city which is highly populated like New Delhi or Mumbai.

We should use the terrestrial technologies like LiDAR that is terrestrial LiDAR or terrestrial camera or the total station, all right. So, there we can develop a good infrastructure using the 3D data. And I can respond to all the questions here.

But in case of bullet train between the two cities for example, the bulletin is coming between the Ahmadabad and Mumbai. So, there we can conduct even be air bond service for LiDAR or photogrammetry, right. So, that accuracy requirement would be quite different there in the centimetre level and these can be fulfilled with the help of LiDAR or photogrammetry especially the air bond one.

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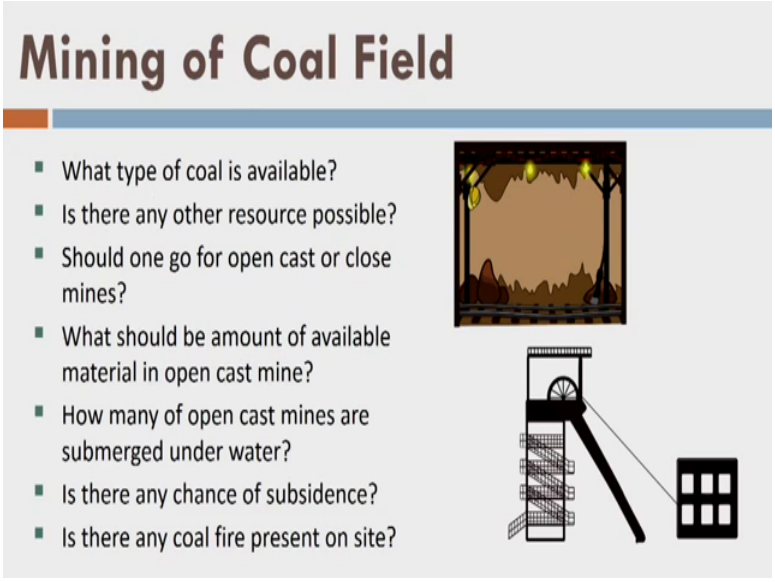

Then we discussed about the mining of coal field, ok. And here I would like to say that what should be then appropriate technology here. Areas are most of time water logged or

areas are sometimes having some kind of for coal fires. So, that is why photogrammetry will be much useful here moreover with the low altitude photogrammetry one can achieve very high resolution.

Further this can be identified with the help of LiDAR also, but still photogrammetry will be more appropriate or combination of LiDAR and photogrammetry will be the most appropriate.

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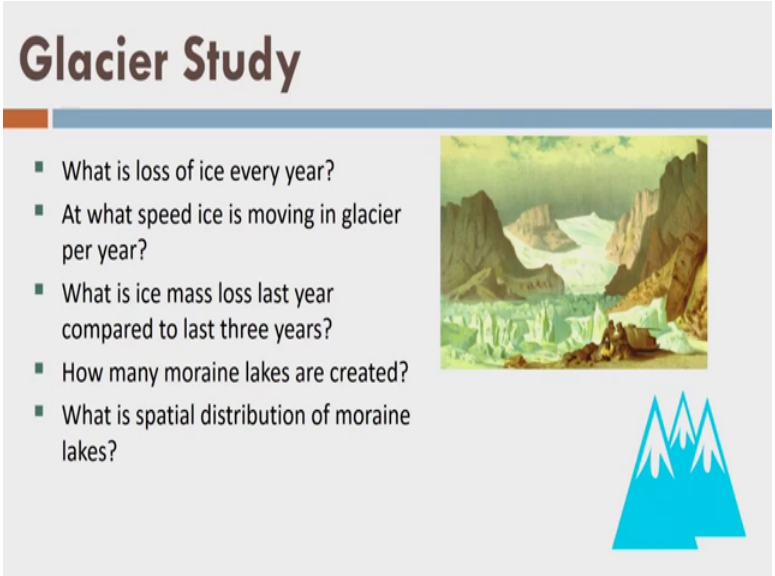

So, in case of glacier we have always said that RADAR is much better than the other technologies because RADAR is sensitive to the large scale areas or the large scale study where we believe that glaciers are melting at much higher rate.

That means, if glisters are moving at the rate of 18 meters per year or 80 meters per year no doubt RADAR is much better technology because it provides you some kind of you know resolution couple of meters. And finally, if you estimate the velocity what will happen that velocity will be of order 5 to 6 meter error and that is while acceptable if the movement of the glacier itself is 80 meters in a year, ok.

So, now, we can respond to this question. However, LiDAR as well as photogrammetric can also be used in terrestrial mode, air bond mode or low altitude mode. But in case of low altitude mode it is dangerous to use the drones over the glacier because the glaciers are not an habitable places and there lot of dangerous situations that come across while

we are performing the survey. And that is why RADAR is useful. However, we can still use the photogrammetry withdrawn with very expensive drones or with expensive terrestrial RADAR scanners.

That expensive RADAR scanners provide you a distance of almost 5 kilometre range, and that is why it is not useful from a distance where you can see the glacier so that you can map the glacier completely. Once you if you perform this study every year you can find out what is the loss of the glacier ice over a year or maybe every 6 month and you can quantify this loss of ice at very high resolution.

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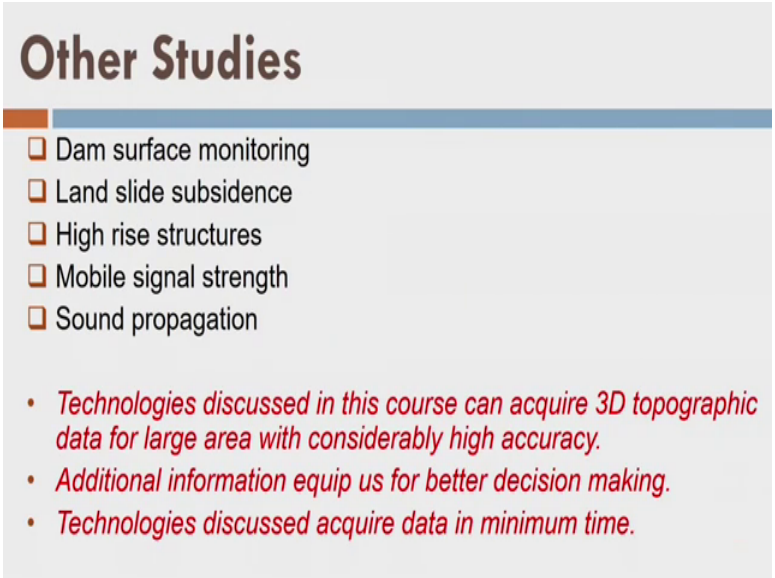

So, the next is the other studies where we can say that dam surface monitoring, land slide subsidence, high rise structures, mobile signal strength, and sound propagation. So, all these studies can be handled with very high resolution data only for example, dam surface monitoring we should use terrestrial LiDAR, we should use photogrammetry. Similarly in case of land slide subsidence even we can see use the RADAR, but landslides should be a regional landslides not the local land slide.

In case of local land slide the effect of land side is very small as well as the area of landslide is very small and hence we should use the drone photogrammetry or the low altitude photogrammetry or LiDAR because both of these technologies will provide very high resolution data. And we need the high resolution data in order to understand the

small aspect or the small integrities of the land slide which happened in very small local area.

Similarly, for high rise structures, since high rise structures have 3D development or there the planimetric area is very small and hence we need some technology, like, LiDAR or photogrammetry. Finally, mobile signal strength mapping that can be handled with the course resolution data, but still photogrammetry and LiDAR will be very useful in order to map the whole city. And then we can find out using the 3D models of the city that how mobile signal is propagating with the available 3D structure and how the strength is waiting. Finally, sound propagation is just like mobile signal strength, but it has different aspect.

So, now, with the end of this lecture I can conclude hopefully that the technologies discussed in this course can provide highly accurate 3D data for a certain research purpose or some real life project. At the same time these technologies have very high coverage and they acquire the data in the minimum time. So, these technologies are really capable of acquiring the 3D topographic data, alright.

So, with this I would like to say one more thing here, do these technologies have some limitations? Of course, they have and we should understand these limitations of the technologies by their accuracy limitations, by their resolution limitations or by their use or a certain purpose, alright.

I hope that we have discussed enough amount of material in order to improve the content of the course I would like to have a feedback from all of you. So, being the audience or the being the student of this course you will provide an important feedback, right. So, your feedback way improve the course in future or I may add some more material if required, based on the feedback given by you.

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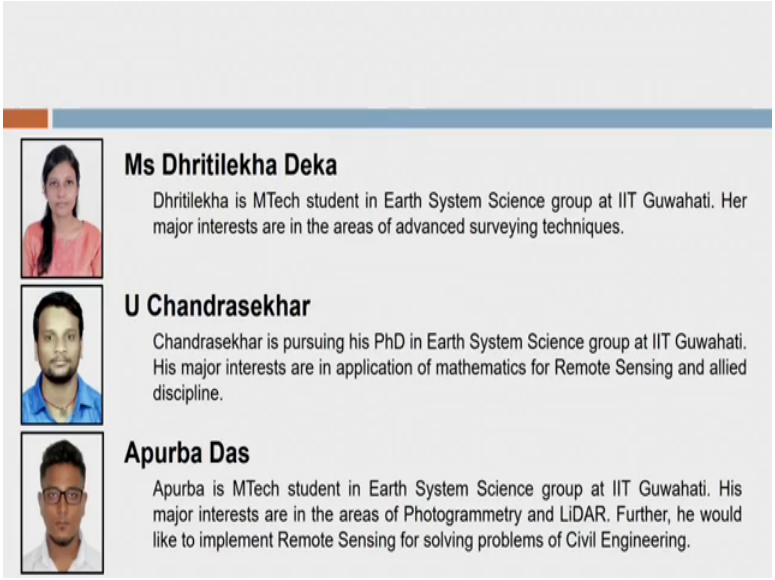

So, before ending this course I would like to thank all of my TAs especially Dhritilekha, U Chandrasekhar and Apurba Das who have help me a lot during this course and we will be also helping you if you communicate with that.

So, finally, today we conclude our course on higher surveying. I hope you enjoyed this course and the information shared in this course was very useful to you. Thank you.

Thank you very much.