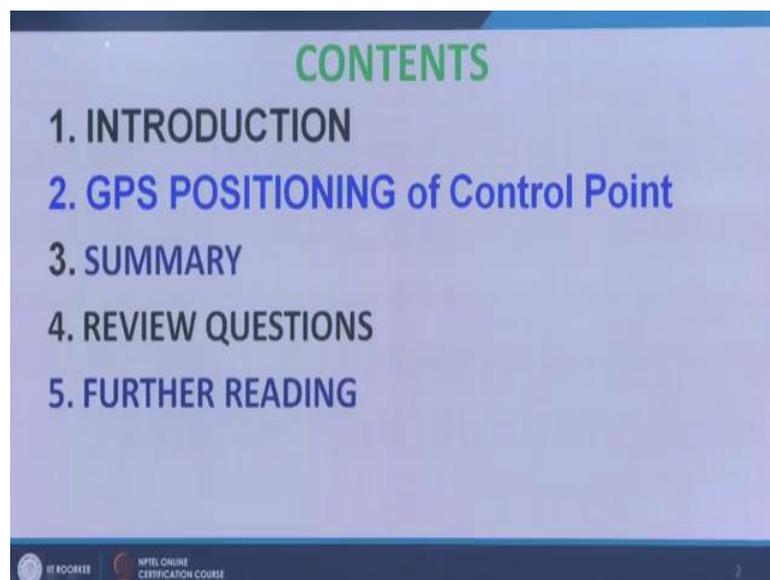


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Lecture – 07
Methods GPS Positioning of Control Point

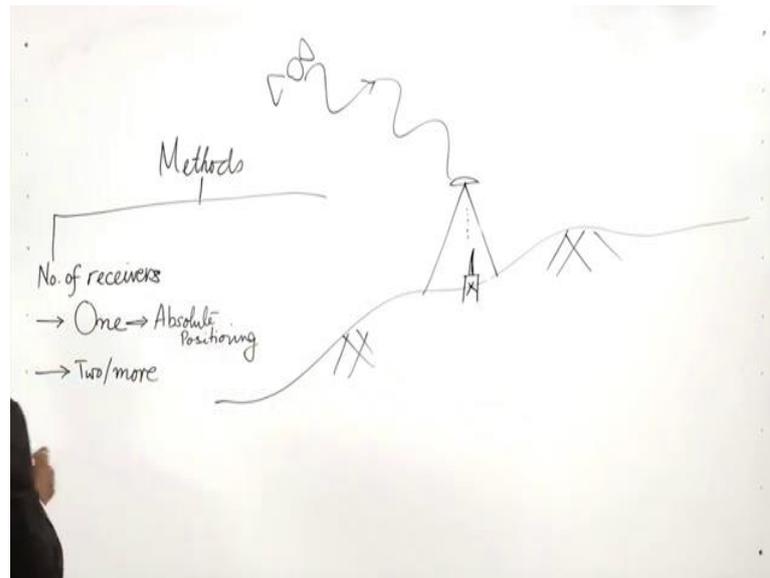
Welcome students, today I am going to deliver on lesson 7 the topic is GPS positioning methods. Actually what happens? Whenever we like to go for GPS surveying we have to set up the GPS instrument at some point. Now, how that instrument will be set up, what is the nature of setup, how long it will be set up, so all these thing comes under a terminology call GPS methods. So, today I am going to discuss on that.

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Today's class will be based on following points first I will introduce as I told you already then define GPS positioning methods for control point establishment. So, we are restricting the methods that may be useful for establishment of control point or to find out the position of control point followed by summary and review question and further reading.

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Now, as I told you that whenever we want to go for surveying suppose this is the track of land and for this point we may look for this is the control point. So, at this point we like to this is the station point, so for this point we like to find out the position. So, what we will do? We generally set up the instrument over it and we make the centering and leveling on this point and from GPS signals arrives and this receiver receives, in this way we collect the GPS data.

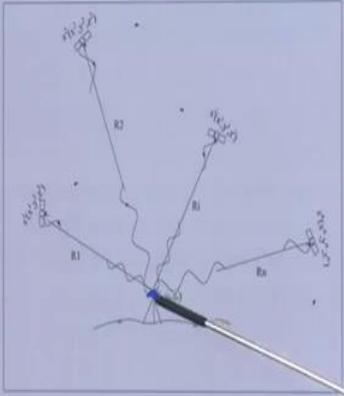
Now this is one of the way how GPS is being set up, but of course, all are as we have to set up the instrument just above the control point, but depending upon the free condition what is the accuracy of positioning how many receivers we will use for establishment of this point when we are going to process the data; so on the basis of that we have different methods. So, that is what we will discuss; however, one thing is sure that every method of positioning is very simple and straightforward and to be place the instrument just above the control point and the GPS bar we will receive the data and other information depending upon the methods.

Now, as I told you that the methods for GPS receiver will be based on different criteria. So, first criteria we will take on the basis of numbers of receiver, so basically it may be only one receiver or it may be more than one two or more. Now when there is only one receiver we use for establishment of control point that is we call absolute positioning.

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METHODS : Based on Number of Receivers

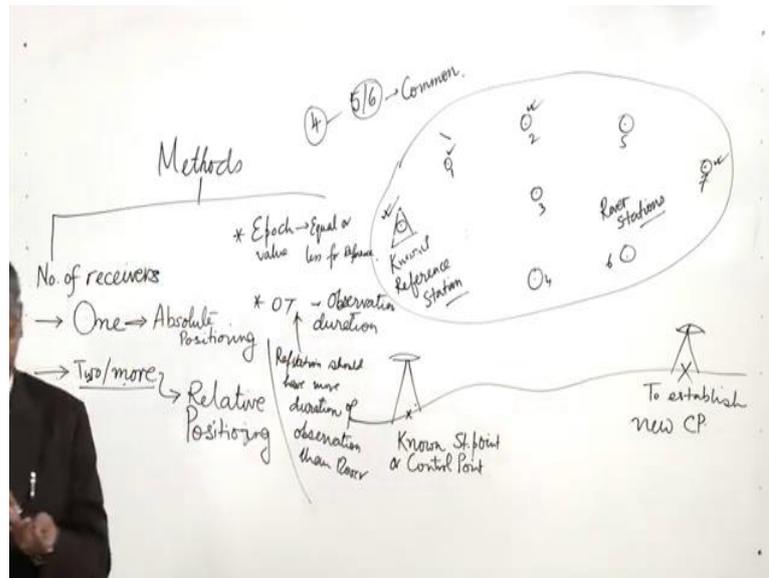
- Single Point Positioning or Relative Positioning.
- **Single Point Positioning**
Only one GPS receiver. Applied for determining the absolute position of a station (with reference to IGS stations), for precise point positioning (PPP). Useful when no other control point is known/available.



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Now, here you can see that in this slide the instrument is set up at this point and only one receiver is being used and this receiver is receiving signal from four at least four satellites, so this is an absolute method of positioning. Now this type of positioning methods are used when there is no other point whose position is known; that means, to or sometimes we use absolute positioning when we will like to process the data of some particular station with respect to IGS stations which is spread all over the world and they are collecting data continuously. So, absolute positioning basically in absolute positioning only one receiver is being used and we collect the data and generally it is not a preferred method, but whenever circumstances compared as we can go for absolute positioning method.

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Then another method depending upon the number of receiver more than one that is either two or more that is called relative positioning. Now in relative positioning as I told you there maybe two or more, so you will see that the here it is shown only two receiver.

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METHODS : Based on Number of Receivers

Relative Positioning

- two or more GPS receivers are being used simultaneously to receive signals from same set of GPS satellites.
- one of the receivers is placed on reference station whose (true or arbitrary) position is known and is termed as reference receiver.
- Other receiver/s, is/are placed at position/s whose position/s is/are to be determined. These unknown locations of receivers are known as rover stations and the receivers placed on rover stations are known as rover receivers.
- Record data having same epoch interval; otherwise, epoch interval by rover receivers should be less for reference receiver.
- To determine the positions of rover stations, carrier-phase and/or pseudo-range measurements of both the reference and rover receivers, from the same set of four or more satellites, are used.
- Relative positioning provides higher accuracy than the single point positioning.
- At any epoch, errors associated with GPS observations from the same set of satellites, to the receivers within 20 Km baseline length, is more or less same. Thus, during reduction, errors get cancelled or reduced and resulting improvement in accuracy of positioning.
- GPS surveying for establishment of control point are based on relative positioning technique.

The diagram shows a reference station and two rover stations on the ground. Dashed lines represent signals from multiple GPS satellites in the sky to each of the ground stations. The ground stations are labeled "Reference" and "Rover".

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So, one of the receiver is kept at a station or point which is known, so known station point or control point or control point, so on this one of the receiver will be maintained and other receiver will be placed at a location whose location has to be determined or if

you want to establish another establishment new control point, so here again we will set up our instrument.

Now if in an area if you want to go suppose this is an area if we take the sectional view of this, so this one is this one, this one is this one. So, we may be in need to go for establishment of many other control point and if we have this is the known control point and many other control point we want to establish. So, if we have more than one receiver then we can set the set up the instrument over more number of locations. So, now in these type of positioning actually we do determine the position of unknown stations unknown control points of a 1, 2, 3, 4, 5, 6, 7 all these control points for all these control point we will determine the position with reference to the known control points. So, this is known as reference station also in GPS terminology and the stations or control points whose position is to be determined they are also known as rover stations; that means, rover stations are the stations or points whose location we have to determine and that will be determined with reference to known control point, so it is called as reference station.

Now, in these method some restrictions or some things to be noted are that at every instant of time at least four satellites should be common with respect to this; that means, whatever satellites are visible from this station and this station; at least four satellites should be count. Like, suppose I am observing the; I am taking the observation this one and this one together. So, the satellites which are visible from this station and the satellites which are visible from this station; at least four satellites should be common this is the and preferably 5, 4 minimum and preferably 5 or 6 should be common; that means, from 4 to 5 common satellites observations should be reaching to this station as well as to this station.

Second point which is to be noted is that the epoch of observation epoch; epoch means the internal act which the receiver will take the observation that is called epoch of observation. Then the epoch of observation of reference should be lower; that means, it should take more frequently data than it should be taken by others.

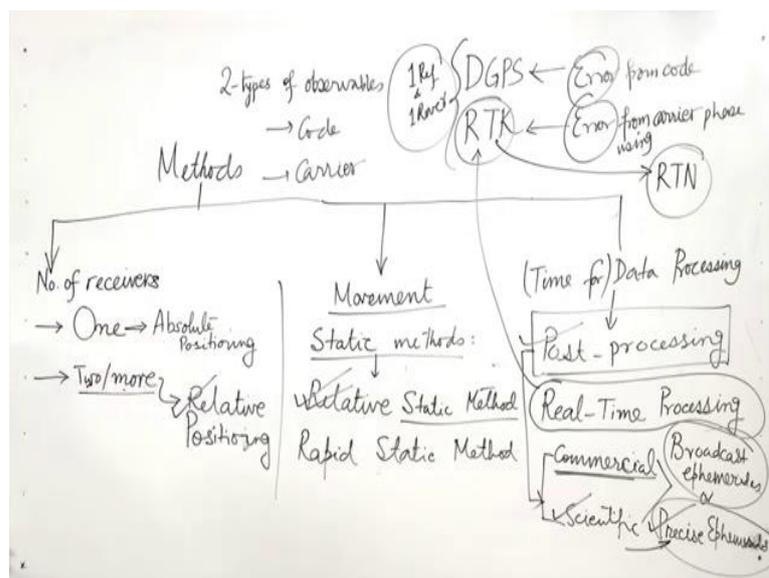
So, either the epoch should may be equal or epoch value should be equal or less for reference. So, the data observation should be more frequent or equal frequent in case of reference receiver with reference to that of rover receiver. This is very important that epoch of and next another thing which is important is the time of observation or the

observation time, observation duration or observation time. The amount of duration that will be observed for the GPS observation in case of reference should be more than that of rover station. So, reference observation, reference station should have more duration or more duration observation than rover stations or rover receiver, so this is also an important point.

Now, these generally we assume that the distance between the reference station and the rover station should be within twenty kilometer. The reason behind is that the amount of error in case of GPS observation it is the ionospheric error which is the most prominent and most dangerous and it has been experimentally found that if the distance between the reference and rover is less than twenty kilometer then they are expected to get the signals from coming from same segment of ionosphere. Thus as a result the amount of ionospheric error will be similar to reference and rover and during processing; we can remove easily the amount of ionospheric error which is the most dangerous. So, this is the reason why we generally keep the distance between reference and rover to be within twenty kilometer.

Further this relative method is the most fundamental or most widely used GPS surveying method. So, in few rest of the methods whatever we will see that always it is the relative method, it is a modified form of relative method.

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Now, methods of GPS surveying the next criteria we take first criteria is on the basis of number of receivers. The next criteria is based on movement, now as I told you our; in this class is restricted to establishment of control point methods. So, in case of establishment of control point generally or usually or it is the always our receiver should be in a static condition. So, static method of surveying now this static method may be of different types one is that called relative static relative static method and the other is rapid static method.

So, now what is relative static what is the difference; fundamentally relative static and rapid static methods are same, the only difference between these two is that relative static method is for longer duration for longer duration and in case of rapid static method or relative static method both reference and rover are in static condition, so this is the main thing about the static method. Now in case of relative static method the observation for longer duration and in rapid static method we go for less duration observation.

Now this is; so whenever we want to go very accurate control panel establishment then we should go for relative static method; that means, longer the time of observation better will be your quality of observation and subsequently we will be able to arrive at more accurate positioning and generally in relative static method also we take our epochs of less duration maybe 1 second or 2 second, in rapid static method we go for higher epoch means 5 second and also in rapid static method this is generally used for stations which are not much away maybe 1 kilometer or 2 kilometer. So, in those cases the errors that will be available in GPS observation will be more or less identical. So, long lower time duration of observation will end up with not much problem, as or less rapid static method is also useful for control points which are of lower order; that means, accuracy not that important or not that required.

So, basically they are same only duration is same and the some other parameters we do go for different adjustment, different time. Now in case of control point establishment also I have told you that it is the relative static. So, in case of; so relative positioning, relative statics these are the methods for control point establishment.

Next the categorized is that based on data processing; that means, when the GPS data will be processed. So, third criteria for classification is that time or data processing, now GPS data may be processed afterwards that is called post processing. GPS data may be

processed long after the data has been observed or captured or it may be processed as soon as it is being observed that is called real time processing. Now in case of post processing what do we do? Once the data has been absorbed, the data will be transferred to from field computer to office computer and then in the office computer we can make use of different post processing software as I already told you there maybe two types of basically post processing software one is called commercial software, another is called scientific software.

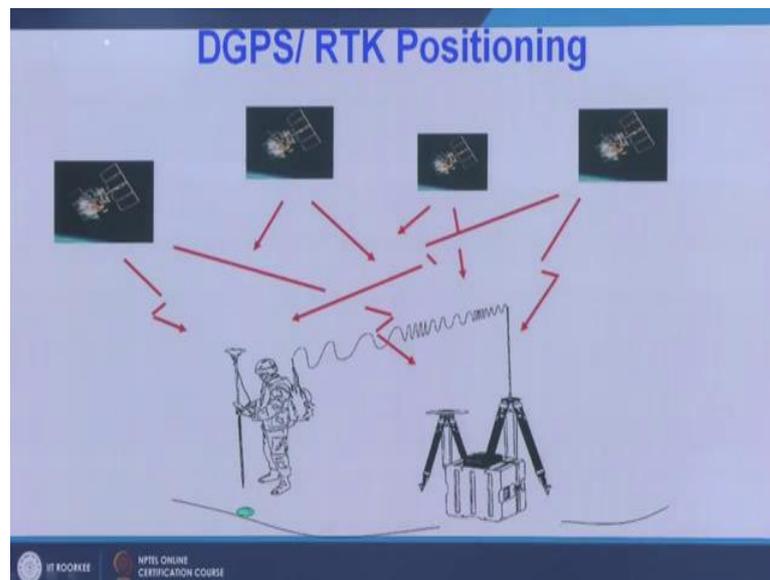
So, for post processing data will be transferred to either commercial or scientific software and then the data will be processed. Now in either case, we can go for processing of GPS data using broadcast ephemerides or precise ephemerides. Now whether we will use broadcast ephemerides or precise ephemerides again it will depend upon what is the degree of accuracy we are looking for, what is the purpose of the work we are looking for, when we are looking for; that means, if we want to post process after one hour or two hour or one day then we have to go by go for broadcast ephemerides because precise ephemerides are available after of course, after 3 hours, after 6 hours, after 9 hours, after 3 days, after 9 days then after 15 days. So, depending upon when we will like to process the data, so we can make use of the corresponding precise ephemerides.

Now, whether it is broadcast ephemerides or precise ephemerides both can be used either in commercial software or in scientific software. Now if we want to go for very accurate again scientific software has to be used. So, if we want to really go for very accurate control point establishment; we should go for post processing scientific software using precise ephemerides. So, that will be the toughest combination and the most accurate control points will be established by making use of this combination. However, we never hardly we need that type of a accurate control point establishment because the only primary control points are of this, can be used go for we can go for this combination for primary control point establishment and they are very less in number over a very big area, so we can go for many other combination depending upon the accuracy.

Now, nowadays another method of establishment of control point is coming up that is called real time through real time processing. Now there are many varieties of real time processing; now the whole idea of GPS data processing is to minimize the error and to arrive at a better solution. Now in case of real time processing actually we do in case of

real time processing, the data that has been captured by the GPS receiver get processed immediately after receiving it. Now how they do it? They do it by communicating the error message from the known station to the unknown station, so this is the main idea. So, and that communication means there should be some major communication that will be associated with the reference station which will as soon as it will receive the data it will communicate, compute the error and then that error will be sent to the mobile station.

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Now, here you can see that this is a reference station, this is the reference receiver and controller and receiver these are receiver. Along with this there is a radio communication system and this is receiver is kept at a point which is known. So, as soon as the GPS signal will be arriving at this station, from those observation it will compute its position and already its position is known, so it is it will know what is the error that it is being arrived at from the GPS signal at present it is working.

Now, near to this suppose another point whose point is to be determined, whose location is to be determined there we will set up the instrument. Now as I told you that if the distances are less than the amount of error that is associated with this observation with this station from the same sets of satellites which it will also this receiver also received will be same or identical. So, this is the basic assumption, so it will communicate the error message to this receiver and with this receiver, this is the radio link which will

receive the error message and as soon as it will receive the signals as well as it will complete it is position and it will receive the error message from this and that error message it will make use during processing and it will find out the location of this station in real time.

So, this is the most fundamental thing; that means, one few things has to be noted first that the rover the reference rover receiver mastered by radio communication and they must observe the at least the same set of four satellites, at least four satellites which are common and the distance between the reference and rover should be within as little as possible so that the amount of error that will be associated with the reference station and that of rover station for the same set of satellite will be identical. So, this is the fundamental condition or under condition actually there maybe two fundamental types that is called the DGPS and RTK.

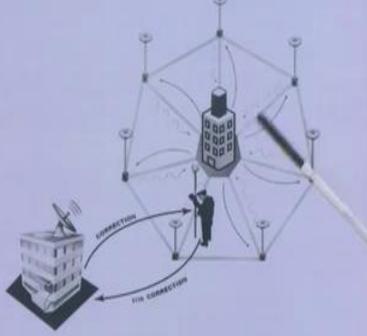
Now, if now these errors whatever error, this reference receiver will compute that error may be computed from the as I already told there are two types of the observables that is code and carrier; coded observable and carrier observable. So, if the error is computed, error from code then the method of surveying is called DGPS. Now and if the error that has been computed from carrier phase or using carrier phase, so then the method is known as real times kinematic.

Now, in both the cases generally we make use of one reference and one rover, so this is the combination we generally use for both DGPS and RTK and again this error message also may be of two types one is the error in observation, one is the error position. So, there are so many other sophistications are there, but I would like to say instead apart from DGPS and RTK; there is another variety of RTK which is coming up now a days that is called RTN; Real Time Networking.

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METHODS : Based on GPS Data Processing

- Real Time Kinematic (RTK) method
 - Connectivity same as DGPS but having specific protocol (higher bandwidths for its broadcast through radio beacon or TCP/IP data connection);
 - broadcast differential corrections based on frequency carrier phase observations;
 - provides centimeter-level accuracy within 10 kilometer radial distance from the reference station.
 - Accuracy reduces as the baseline distance between rover and reference increases.
- RTN
 - RTK method of surveying
 - Differential errors and/or measurements are based on local and/or regional network of reference stations observations.
 - Requires two-way communication links - to transmit the approximate position of the rover receiver to the processing center and to receive back corrections.
 - Correction models used to predict the differential errors associated with a baseline between a master reference station and the rover's position.



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Now, what is that in the real time networking method; instead of a single receiver there will be a network of receiver from which; which will be taking the data from the GPS and all these data will be communicated to the central processing station and the error it will compute the error message and it will sent to the individual station and then it will communicate the error message to the receivers which are around this like that. So, in that case the error message will be more accurate because the error messages are being prepared by making use of observation from a set of receivers.

So, that is what is call RTN which is coming up and in like mobile tower nowadays many countries are going on establishment of GPS control stations all over the country and specifically this is most prominent in Germany, whole of Germany is now covered by a network of GPS station. So, anywhere in Germany we can get the error message and we can only making using only one receiver we can do the GPS survey work very accurately.

So with this, I like to conclude through this class, so let me summarize that the GPS positioning method there are different types of GPS positioning methods depending upon the field condition, depending upon the number of receiver, depending upon the movement of the receiver, depending upon the processing we do have many methods. However, the charge any particular surveying methods depends on the purpose or the accuracy we will like to have.

For control point establishment, it is always the static method; that means, the receiver should be in a static condition and we do always prefer to go for relative positioning for most of the surveying specifically for control point establishment and for the highest accurate control point establishment we should go for relative positioning, static method, static relative positioning using ephemerides data post processing mode, so this is the ideal combination. With this, I like to conclude some questions are there for you to prepare.

Thank you.