Unit-4
Modern Techniques of Surveying

4.1 Basics of Digital Theodolite

- Digital theodolite: digital theodolites **consist of a telescope that is mounted on a base, as well as an electronic readout screen that is used to display horizontal and vertical angles**. Digital theodolites are convenient because the digital readouts take the place of traditional graduated circles and this creates more accurate readings.

4.2 Introduction and Principle of E.D.M. :

- Electronic distance measurement (EDM) is **a method of determining the length between two points, using phase changes, that occur as electromagnetic energy waves travels from one end of the line to the other end.**

  Modern Surveying Instruments and Their Uses Following are

  the modern surveying instruments which are used for surveying:

  - Electronic Distance Measurement (EDM) Instruments
  - Total Station
  - Global Positioning System (GPS)
  - Automatic Level 1. Electronic Distance Measurement (EDM)

  Instruments Direct measurement of distances and their directions can be obtained by using electronic instruments that rely on propagation, reflection and reception of either light waves or radio waves. They may be broadly classified into three types.

  a. Infrared wave instruments

  b. Light wave instruments

  c. Microwave instruments

  a. Infrared Wave Instruments

  These instruments measure distances by using amplitude modulated infrared waves. At the end of the line, prisms mounted on target are used to reflect the waves. These instruments are light and economical and can be mounted on theodolites for angular measurements. The range of such an instrument will be 3 km and the accuracy achieved is ± 10 mm. It is a very small, compact EDM, particularly useful in building construction and other Civil Engineering works, where distance measurements are less than 500 m.

It is an EDM that makes the meaning tape redundant. To measure the distance, one has to simply point the instrument to the reflector, touch a key and read the result.

b. Light Wave Instruments these are the instruments which measures distances based on propagation of modulated light waves. The accuracy of such an instrument varies from 0.5 to 5 mm / km distance and has a range of nearly 3 km. E.g. Geodimeter

Geodimeter-Geodimeter is an instrument which works based on the propagation of modulated light waves, was developed by E.Bergestand of the Swedish Geological Survey in collaboration with the manufacturer M/s AGA of Swedish. The instrument is more suitable for night time observations and requires a prism system at the end of the line for reflecting the waves.

c. Microwave Instruments These instruments make use of high frequency radio waves. These instruments were invented as early as 1950 in South Africa by Dr. T.L. Wadley. The range of these instruments is up to 100 km and can be used both during day and night. E.g. Tellurometer

Tellurometer-It is an EDM which uses high frequency radio waves (micro-waves) for measuring distances. It is a highly portable instrument and can be worked with 12 to 24-volt battery. For measuring distance, two Tellurometer are required, one to be stationed at each end of the line, with two highly skilled persons, to take observations. One instrument is used as a master unit and the other as a remote unit. Just by pressing a button a master can be converted into remote unit and vice-versa. A speech facility (communication facility) is provided to each operator to interact during measurement.

Total Station Total Station is a lightweight, compact and fully integrated electronic instrument combining the capability of an EDM and an angular measuring instrument such as wild theodolite.

Total Station can perform the following functions:

- Distance measurement
- Angular measurement
- Data processing
- Digital display of point details
- Storing data is an electronic field book

The important features of total station are,

1. Keyboard-control – all the functions are controlled by operating key board.
2. Digital panel – the panel displays the values of distance, angle, height and the coordinates of the observed point, where the reflector (target) is kept.
3. Remote height object – the heights of some inaccessible objects such as towers can be read directly. The microprocessor provided in the instrument applies the correction for earth's curvature and mean refraction, automatically.
4. Traversing program – the coordinates of the reflector and the angle or bearing on the reflector can be stored and can be recalled for next set up of instrument. 5. Setting out for distance direction and height -whenever a particular direction and horizontal distance is to be entered for the purpose of locating the point on the ground using a target, then the instrument displays the angle through which the theodolite has to be turned and the distance by which the reflector should move.

PRINCIPLE OF EDM:

Electronic distance measurement in general is a term used as a method for distance measurement by electronic means. In this method instruments are used to measure distance that rely on propagation, reflection and reception of electromagnetic waves like radio, visible light or infrared waves. Sun light or artificially generated electromagnetic wave consists of waves of different lengths. The spectrum of an electromagnetic wave is as shown in following figure.

• Electromagnetic waves from an instrument is transmitted to a retro-reflector, which instantly returns them to the transmitting instrument.
• However, speed of light is very high and the time interval needs to be measured extremely accurately

Instead, the principle of EDM is based on following improvised relationship

$$L = N \lambda + p$$

L = Total distance travelled by the wave
N = Integer number of wavelengths
λ = Wave length
p = Partial wavelength

• If infrared wave or laser is used, the "reflector" is typically a passive medium which bounces the signal back
• In case of microwave, the reflector captures the incoming energy and re-transits it back to the originating instrument

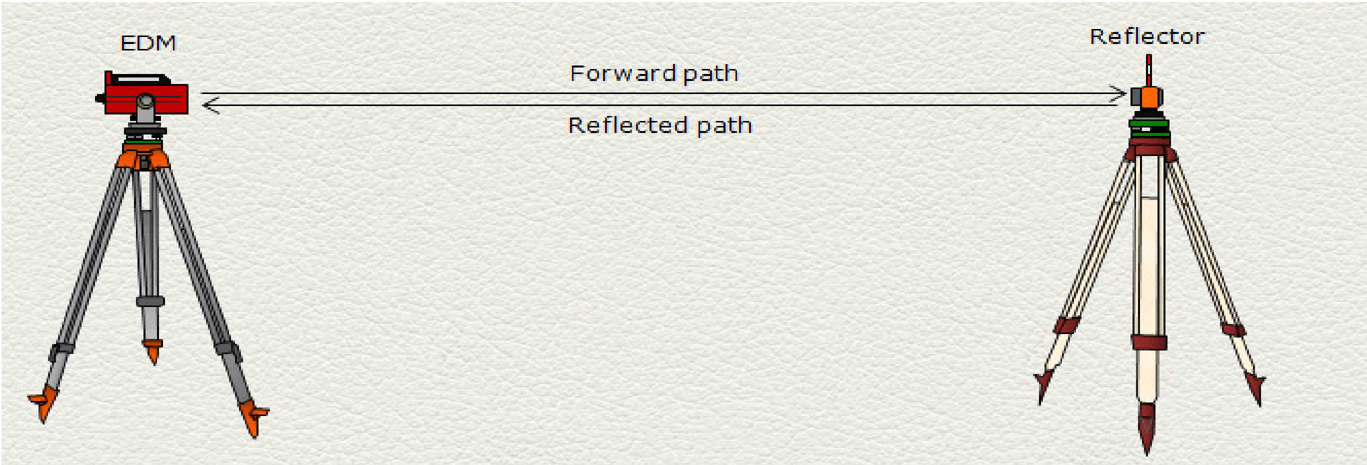


Fig 1 - Electro-optical System

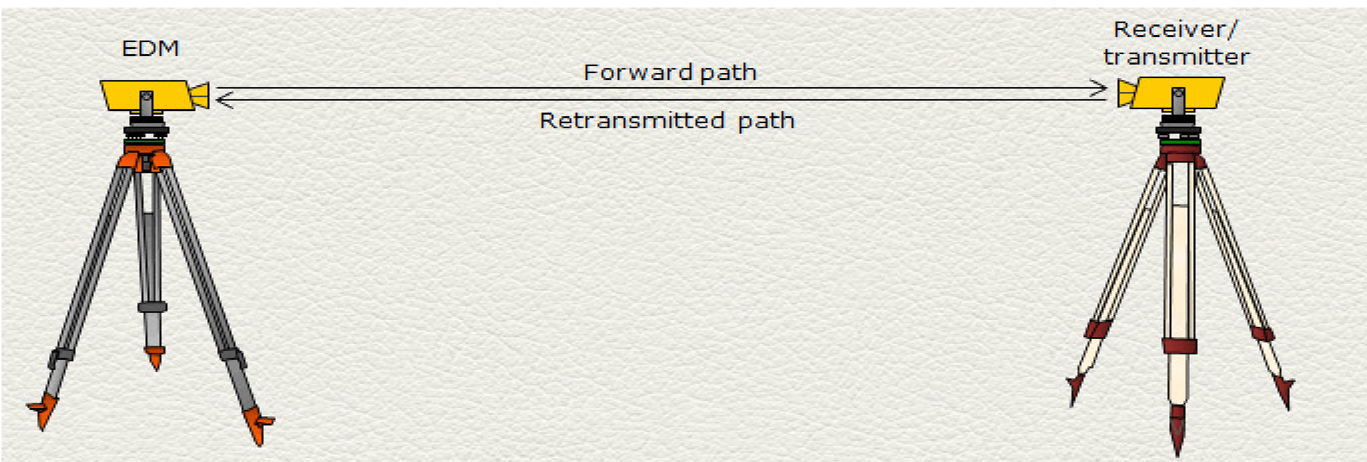


Fig 2 - Microwave System

4.3 Introduction and Basics of Total station, Fundamental Parameters of Total station Precautions to be taken while using total station

INTRODUCTION

The recent applications of electronics in surveying instruments, have enabled surveyors to collect and process field data much more easily and to a higher precision than that was possible using conventional surveying instruments. The recent development of total station has enabled all the field data to be captured and processed easily, accurately and precisely.

A total station is a combination of the objectives mandated for an electronic theodolite for measuring horizontal and vertical angles, and an electromagnetic

distance measurement (EDM) device for the measurement of slope distances and on-board software, to convert the raw observed data into three-dimensional coordinates. Thus, with a total station one may determine the actual positions (X, Y, and Z or northing, easting and elevation) of surveyed points, or the position of the instrument from known points, in absolute terms.

Most models of total station instrument measure angles by means of electro-optical scanning of extremely precise digital bar-codes etched on rotating glass cylinders or discs within the instrument. The best-quality total stations are capable of measuring angles down to 0.5 arc-second. The low-cost construction-grade total stations can generally measure angles up to 5 or 10 arc-seconds.

The EDM device that measures the slope distance can also calculate and display horizontal distance and difference in level. This is accomplished with the help of microprocessor normally working, concentric with the telescope eyepiece, and is generally housed in a casting that forms part of the telescope. Measurement of distance is accomplished with a modulated microwave or infrared carrier signal, generated by a small solid-state emitter within the instrument optical path, and bounced off of the object to be measured. The modulation pattern in the returning signal is read and interpreted by the on-board computer in the total station.

A total station has innumerable capabilities. It can measure distance between remote points and their elevations, can compute their coordinates and traverse closure and adjustment required. Furthermore, topography reductions, inversing and resection can be affected. Horizontal and vertical collimation corrections and vertical circle indexing can also be determined. Setting out works can also be carried out. It is capable of recording, searching and reviewing the recorded data. Capability to transfer data to the computer and transfer of computer files to the data recorder has made a total station the most versatile surveying instrument. Besides making the routine observations, a total station is also capable of monitoring battery status, signal attenuation, and horizontal and vertical axes status.

FEATURES OF TOTAL STATION

The various features of a Total Station Trimble M3 DR 5 are shown in fig. Typical features of a total station are as follows.

Control Panel

In order to be able to run programs and code readings, a control panel, which is essentially a special keypad with a display screen is fitted to the front of the total station on its both faces. It is the most important part of the instrument and offers a large number of facilities for making the observations, recording, storing, and then transferring the data or processing. A lot of information on the display screen, positioned under the telescope, can be seen by the surveyor at a glance while observing the target without any extra effort.

The keyboard, with its function keys is user friendly. The control panel is further discussed in Section 15.3.

Solid State Emitter

Distance measurement is made possible with a modulated microwave or infrared carrier signal, generated by a small solid-state emitter within the instrument's optical path, and bounced off of the object to be measured.

Reflector Prism for Attachable EDM

It is normally used as the target. Most total stations use a purpose-built glass Porro prism as the reflector for the EDM signal and for making measurement of distances. The details of reflector prism are described in Section 15.4.

Vertical Axis Compensator

It is similar to that provided in digital theodolites. Laser Plummet It is similar to that provided in digital theodolites.

Microprocessor

Total stations are operated using a multifunction keyboard which is connected to a microprocessor built into the instrument. The microprocessor in the total station can not only perform a variety of mathematical operations-for example, averaging multiple angle measurements, averaging multiple distance measurements, calculation of rectangular coordinates, calculation of slope corrections, distances between remote points, remote object elevations, atmospheric and instrumental corrections--but, can also store observations directly using an internal memory.

Electronic Data Recorder

Some of the total station systems also offer the external connection of data loggers, computers or batteries. A total station can interact with data loggers or other computers, either to store survey data or to retrieve previously prepared setting out data. Most total stations include data recorders.

The raw data (angles and distances) and/or the coordinates of points sighted are recorded, along with some additional information (usually codes to aid in relating the coordinates to the points surveyed). The data thus recorded can be directly downloaded later to a computer. The use of a data recorder further reduces the potential for error and eliminates the need for a person to record the data in the field. Section 15.5 may also be referred.

Memory Card

Provision of a removable memory card of the size of a credit card, which can be slotted into the side of the total station, makes it unique. Typically each card has 1 MB of memory, which can store or supply data for about 10,000 points.

Power Supply

Rechargeable nickel-cadmium batteries are used for power supply. The usage time is 2-10 h. Some total stations have an auto power-save feature which switches the instrument off or puts it into some standby mode after it has not been used for a specified time.

4.5 Setup of total station centering, Levelling, Orientation

SETTING-UP AND ORIENTING A TOTAL STATION

To start a survey work with the help of a total station, it is primarily necessary to set up the total station at the control station of which the easting and northing are already known. The process of setting up total station consists of centering it over the station, levelling and orientation. Since the two processes,

The centering and the levelling,

The step-by-step procedure for setting up a total station is as follows.

Centering

The tripod is placed over the station. The total station is mounted on the tripod with the help of centring screw, while holding the instrument with the other hand (Fig. 15.5). To achieve exact centring following procedure may be adopted.

1. The three legs of the tripod are spread. It is ensured that tripod is at suitable height so that the surveyor can work conveniently when the total station is tightened over its top.It is also ensured that the tripod head is directly over the ground reference point, also called surveying point.

2. One of the tripod leg, say leg A, is placed firmly on the ground and the other two legs are moved radially in or out so as to bring approximately centre of the total station over the ground reference point.

3. The instrument is turned on. The laser plummet is activated automatically, and the laser plummet screen appears. With the laser beam emitted by the total station, it is ensured that the centring has been achieved. The laser plummet is located in the standing axis of the instrument (Fig. 15.5).

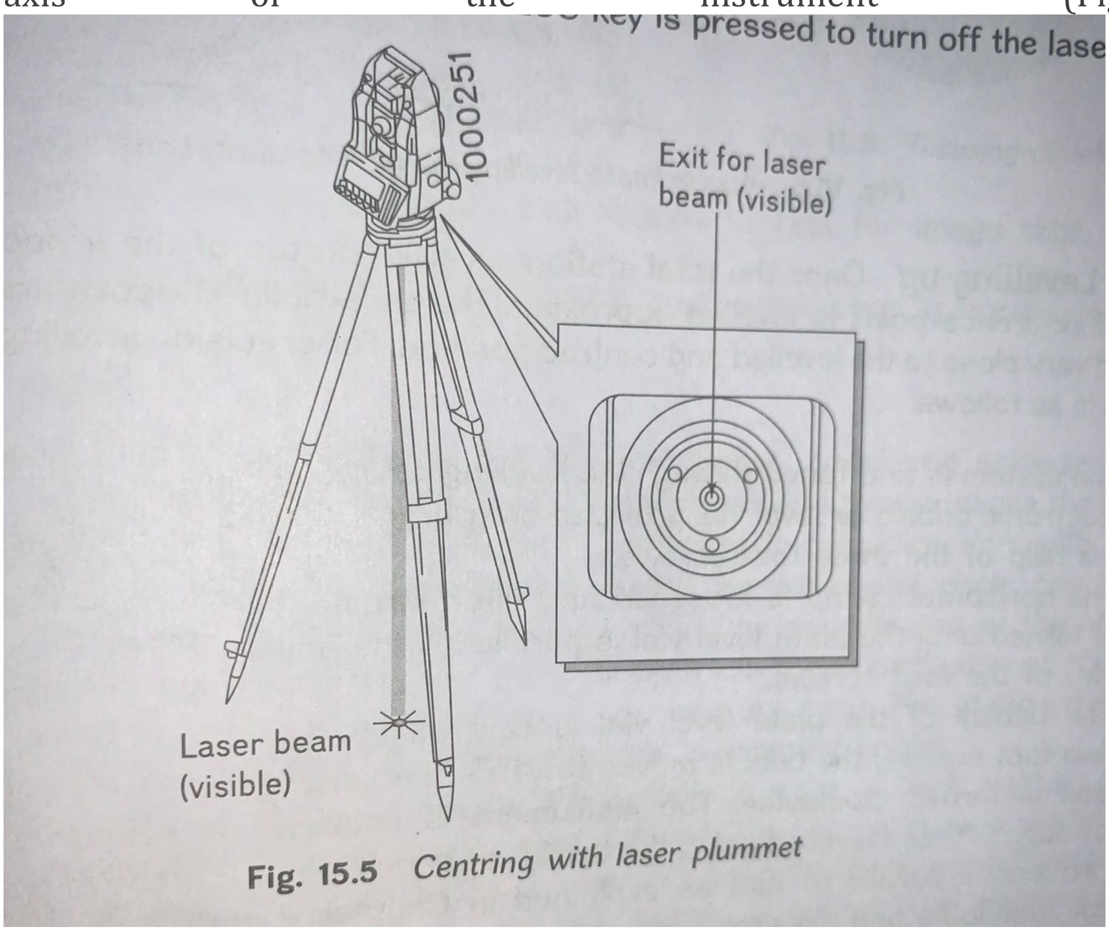


Fig. 15.5 *Centring with laser plummet*

4. Small adjustments in centring, if required, can be made by sliding the instrument over the tripod by loosening the tightening screw provided over the tripod plate. In this way centring can be achieved to desired accuracy.

5. Once the exact centring is achieved, the ESC key is pressed to turn off the laser plummet.

Levelling-Up

Total station should be levelled with sufficient accuracy to achieve the correct results. Therefore, it should be carried out very carefully. The process consists of approximate levelling and then precision levelling. The process may take about half an hour. Approximate Levelling-up The total station is set approximately over the ground reference point using the optical or laser plummet primarily as described above. The procedure used to approximately levelling-up the total station is as follows.

1. It is ensured that the tripod legs are firmly placed onto the ground.

2. The total station plate is then levelled using the tripod legs as shown in Fig. 15.6. The tripod legs are adjusted by moving the leg(s) up or down only.

3. To accomplish the task, any one of the three legs is moved circumferentially, keeping the other two legs fixed, to bring the bull's eye bubble (Fig. 15.6) central which is provided over the tribrach. However, in this process, the centring will get disturbed.

4. A number of trials may be required to achieve levelling.

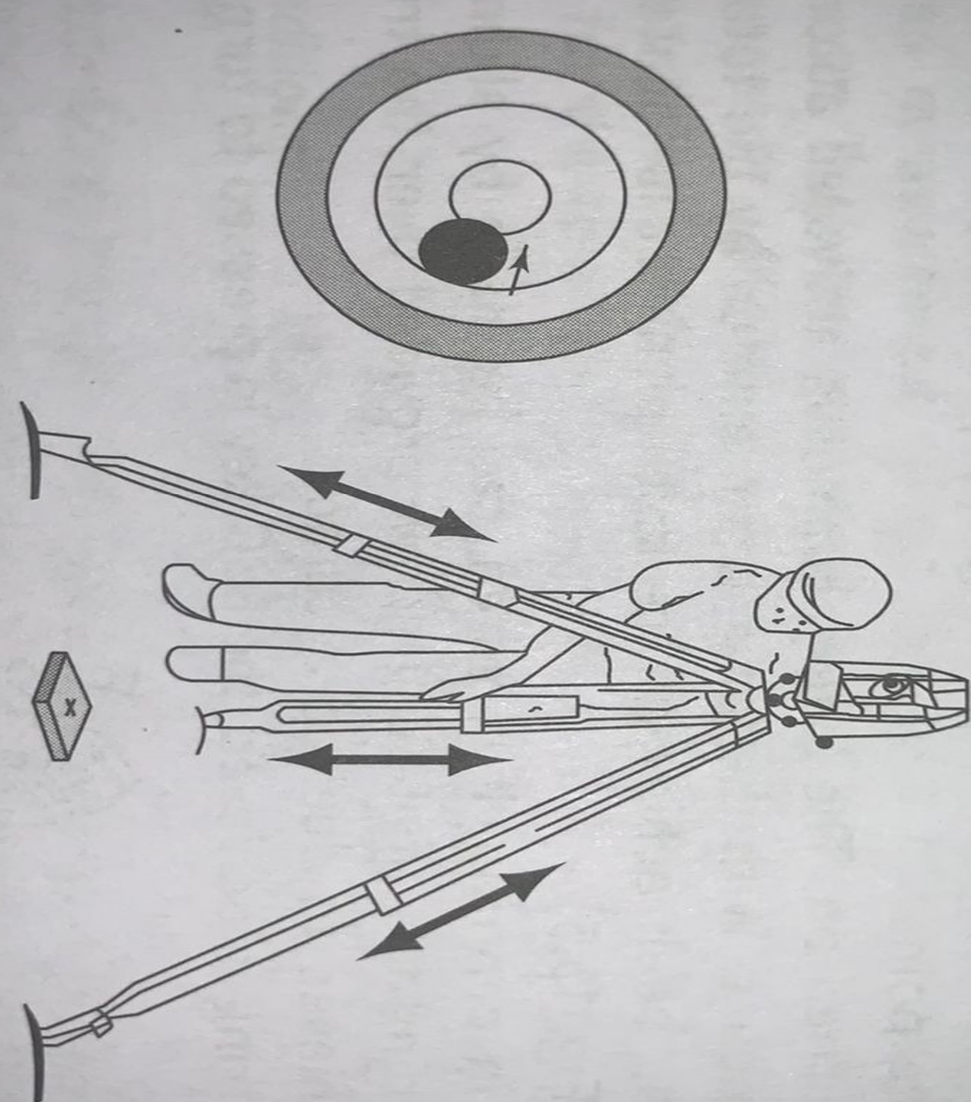


Fig. 15.6 Approximate levelling-up of a total station

- **Focusing**

Total station is focused before making the measurements. Following are the steps involved:

1. The horizontal and vertical clamp screws are released.

2. The telescope is pointed towards sky or a blank paper.

3. With the help of diopter ring (Fig. 15.8) the cross-hairs are made sharp and distinct. The eyepiece is focused.

4. The telescope is then pointed towards the target and the telescope focusing ring is adjusted till target image becomes clear and sharp, and falls on the cross-hairs.

5. The observer then moves his hands side-to-side to test for image shift, that is, the parallax.

6. If significant shift is observed, the cross-hair focus step (step 3) is repeated.

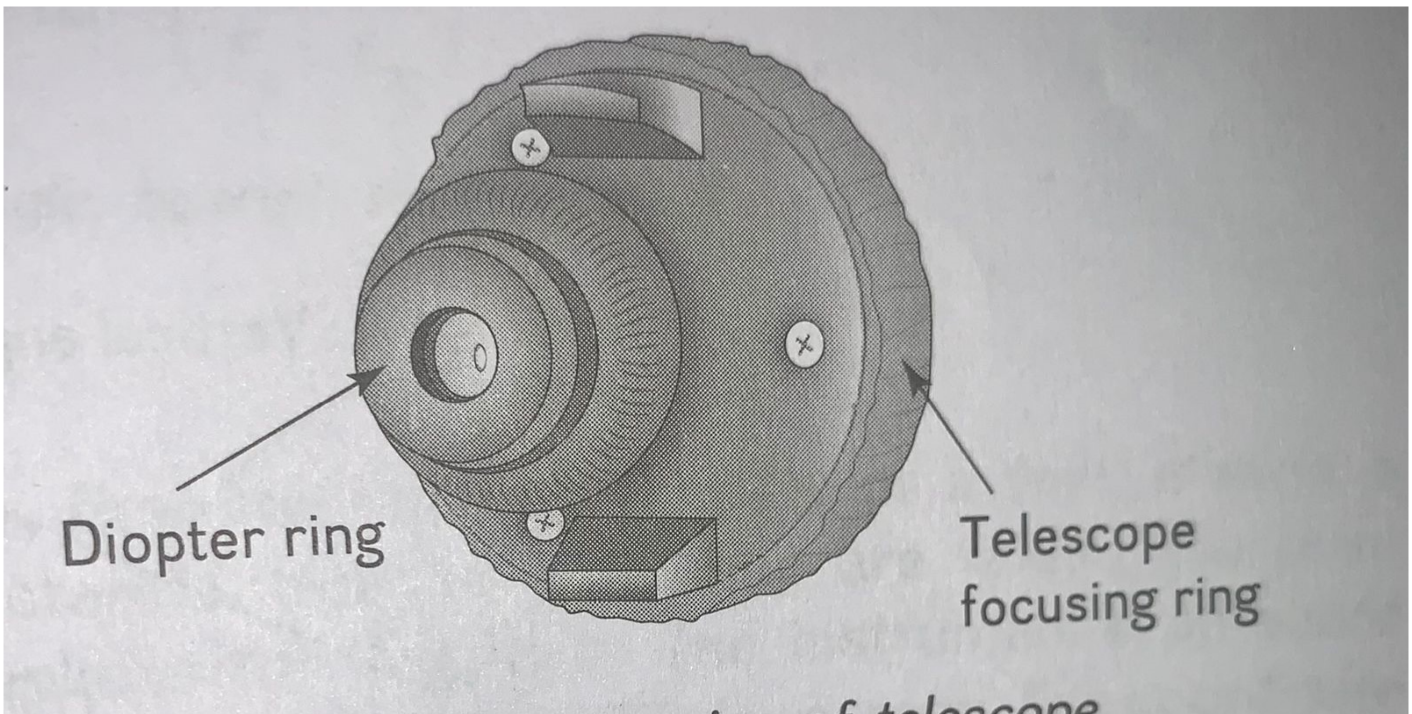


Fig. 15.8 *Focusing of telescope*

- **Orientation**

After the instrument has been switched on, the instrument model and software model are briefly displayed. The total station carries out a system test and then engages the main menu. Orientation implies fixing line of sight in a particular known direction with respect to which measurement of angles or bearings are made. The horizontal circle can be oriented and application programs can be started. For this first, the coordinates of the station point are set, and the point number of station point is entered.

The coordinates of the station is entered directly or is imported from data file of the memory card. The station data consists of point number, easting, northing, station height and instrument height. For traversing by measurement of angles, the reference point is back sighted, and the Hz direction is set to 0°00'00", or a known value is entered. The total station is ready for making the measurements of angles.

The total station can also be oriented in north direction with an attachment consisting of a magnetic needle. This facility is available in some of the makes of total station. In others where this arrangement is not available, the Hz direction is set to 0°00'00" for measurement of bearing of the first survey line and traverse measurements are made. This method of orientation is carried out with the help of on-board software.

4.6 Field procedure for total station, Initial data entry, Survey station descriptors, survey station entries, Sighted point eateries, occupied point entries, procedure.

FIELD PROCEDURES FOR A TOTAL STATION IN TOPOGRAPHIC SURVEYS

Total stations can be used in any type of preliminary survey, control survey or layout survey.

They are most suitable for topographic surveys in which the surveyor can find the X, Y, Z (easting, northing, elevation) positions of a large number of points (about 2 to 3 times of those using conventional techniques) per day.

Initial Data Entry

The initial data entry could be all or some of the following;

1. Project description
2. Data and crew
3. Temperature
4. Pressure
5. Prism constant
6. Curvature and refraction setting
7. Sea-level correction
8. Number of measurement repetitions
9. Choice of Face 1 and Face 2 positions
10. Automatic point number incrimination
11. Choice of units

Survey Station Descriptors

Each survey station or point must be described with respect to surveying activity, station Identification and other attribute data. Generally, the total stations prompt the data entry and then automatically assign appropriate labels. Point description data can be entered as alpha (for example, back sight as BS) or numeric (for example, back sight as 20) codes.

Survey Station Entries

1. Code Say 20 (BS), 30 (IS), 40 (FS)
2. Height of instrument
3. Station number (say) 110
4. Station identification code
5. Coordinates of occupied station
6. Coordinates of back sight station

Sighted Point Entries

1. Operation code
2. Height of prism
3. Station number: 120 (BS)

4. Station identification code

Procedure

Refer to Fig. 15.12.

1. The total station is mounted on tripod, centred and levelled. The initial data and occupied station data are entered.

2. Sight at desired station, say 120; press the zero set button to set the horizontal circle at zero.

3. Enter code 20 (BS).

4. The prism is mounted on a pole of known height. The reflection point of the prism gets

Aligned with the centre of the pole. Since the instrument aims at the prism, it calculates the position of the prism and not that of ground point. The ground point is located by subtracting the height of the pole. This necessitates that the pole is held upright while making observations. Measure and enter the height of the prism.

5. Press the appropriate measure buttons, for example, slope distance.

6. Press the record button after each measurement. In the automatic mode, all the three X, Y, and Z measurements are made after pressing just one button.

7. After the station measurements have been recorded, the data recorder on board will prompt for the station point number (e.g., 120), and the station identification code.

8. For next sights, repeat steps 4-7 using appropriate data.

9. When all the topographic details in the area of the occupied station (110) have been recorded, the total station is moved to the next traverse station and the process is repeated.

10. Download the data to a computer, where it is stored into a format that is compatible with the computer program that is to process the data.

11. If the topographic data are for a closed traverse, the traverse closure is calculated, and then all adjusted values of X, Y, Z are computed.

12. From the data stored in coordinate files, the data required for plotting by digital plotters is assembled, and the survey can be quickly plotted at any desired scale.

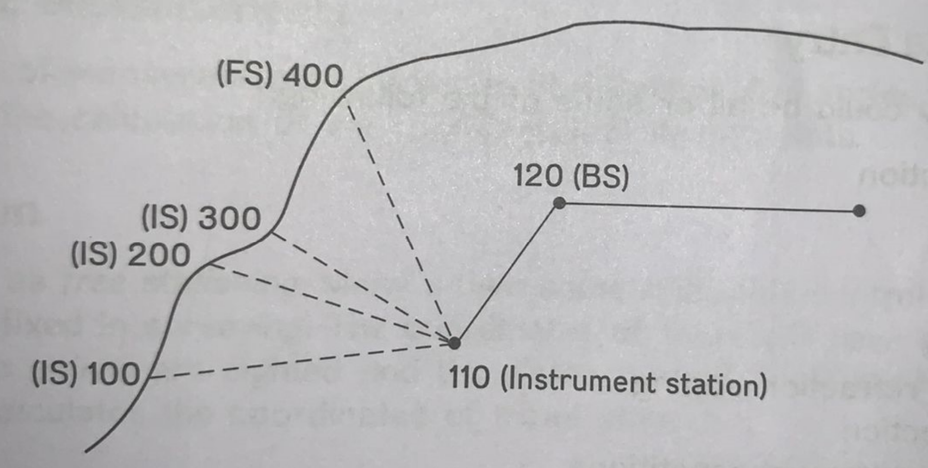
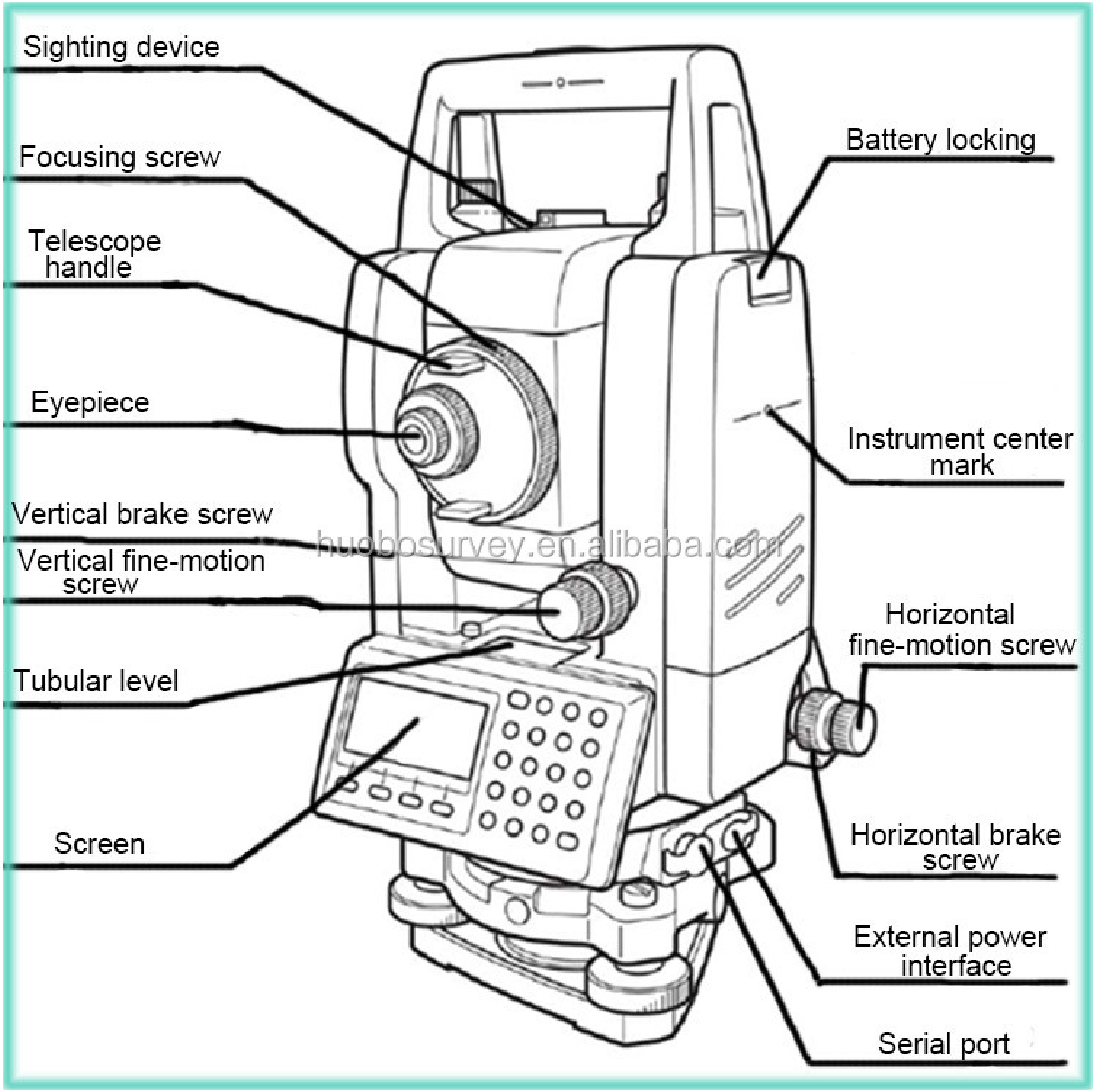


Fig. 15.12 *Surveying with total station*


Sighting device
Focusing screw
Telescope handle
Eyepiece
Vertical brake screw
Vertical fine-motion screw
Tubular level
Screen
Battery locking
Instrument center mark
Horizontal fine-motion screw
Horizontal brake screw
External power interface
Serial port
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4.7 Electronic data recording data loggers: data recorders, field computers, Memory cards, internal memory

Earlier for plotting details, surveying was done manually. Later, with the advent of computers, the practice was to key in the data recorded in the field books into the computer for plotting details. The need for a better method of getting information from the field to a computer was also accentuated with the introduction of à total station. As a result, the conventional method of recording surveys was overtaken by developments in computer mapping and survey instrumentation which made electronic data recording and transfer essential.

Electronic Data Loggers

Initially, the devices used were simple data loggers. But major advances were made when it became possible to connect small portable computers to total stations. These intelligent data loggers could be programmed to ask the surveyor for information, to record data from an instrument in a suitable format and, if necessary, to perform calculations using data transmitted to them. The following are some of the methods of recording data electronically.

1. Data recorders

Also referred to as electronic field books, they can store and process surveying observations. They use solid-state technology enabling them to store large amounts of data in a device of the size of a pocket calculator.

The angle and distance readings are transmitted from the total station to a data recorder and these are stored together with point numbers generated by the recorder and feature codes which are entered manually on site. Observations are normally stored as angles and distances, called raw data, but a data recorder can convert these to three-dimensional coordinates prior to transfer to a microcomputer. All data recorders have some resident programs to collect and process data. After completion or during the survey, data collected is transferred from a data recorder to a computer. For faster transmission, a compressed binary form is used. Typically they have a memory capacity of 2000 data blocks.

2 Field computers

These are hand-held computers adapted to survey data collection. Comparing with a data logger, they offer a more flexible approach to data collection since they can be programmed for many forms of data entry. Storage capacity may be up to 4 MB of RAM.

3. Recording modules/Memory cards:

These are also called memory cards which take the form of plug-in cards onto which data is magnetically encoded by a total station. The data logger and portable computers may be thought to be of disadvantage as these are extra pieces of instrument which may fail in some way. So, alternatives like memory cards have been developed. Data is transmitted to the memory card using a non-contact magnetic coupling system which eliminates the need to attach sockets or pins to the card. The data cards available have a memory of about 500-4000 suitably coded points.

4. Internal memories

A total station can be fitted with an internal memory capable of storing 900-10,000 points. This enables data to be collected without the need for a memory card or data recorder. The files can be retrieved, checked and edited in the field.

EXTRAA:

- **Precision Levelling-Up**

Once the total station screwed on top of the tripod and placed over the ground reference point is levelled approximately, as explained above, the total station is considered very close to the levelled and centred position. For precision levelling the step-by-step procedure is as follows.

1. The system is fine-tuned through the levelling using the electronic bubble or level vial provided on tribrach with the help of the three foot-screws.

2. The horizontal clamp is loosened and the instrument is turned until the plate level vial is parallel to the any two of the foot screws.

3. The bubble of the plate level vial is centred by the two foot screws; the bubble moves towards the screw that is turned clockwise. The instrument is rotated through 90° and levelled using the third foot screw. The process is similar to that as explained in Chapter 4 for theodolite and the steps are portrayed in Fig. 15.7.

4. Using the plummet it is ensured that the total station is still over the reference point. If not, the instrument is centred exactly by shifting the tribrach on the tripod plate by loosening the centring screw, and then the screw is tightened. The levelling of the instrument achieved so is checked electronically.

5. To achieve the objective, the 'On' button is pressed and held for a while till a beap sound is heard. Then on opening the screen MEAS', the function is selected. The foot level screws may then be used to exactly centre the electronic bubble.

6. The instrument is rotated through 90°, 180° and 270° to check that the total station is perfectly levelled.

7 In such a case the instrument is considered to be levelled perfectly regardless of the telescope direction. The tripod screw is tightened firmly.

8. In most total stations, a compensator takes care of this.

9. The process of centring and levelling are repeated until the required accuracy is achieved.

- **PLUMMET:** It is used in a total station for accurate centering over a station.

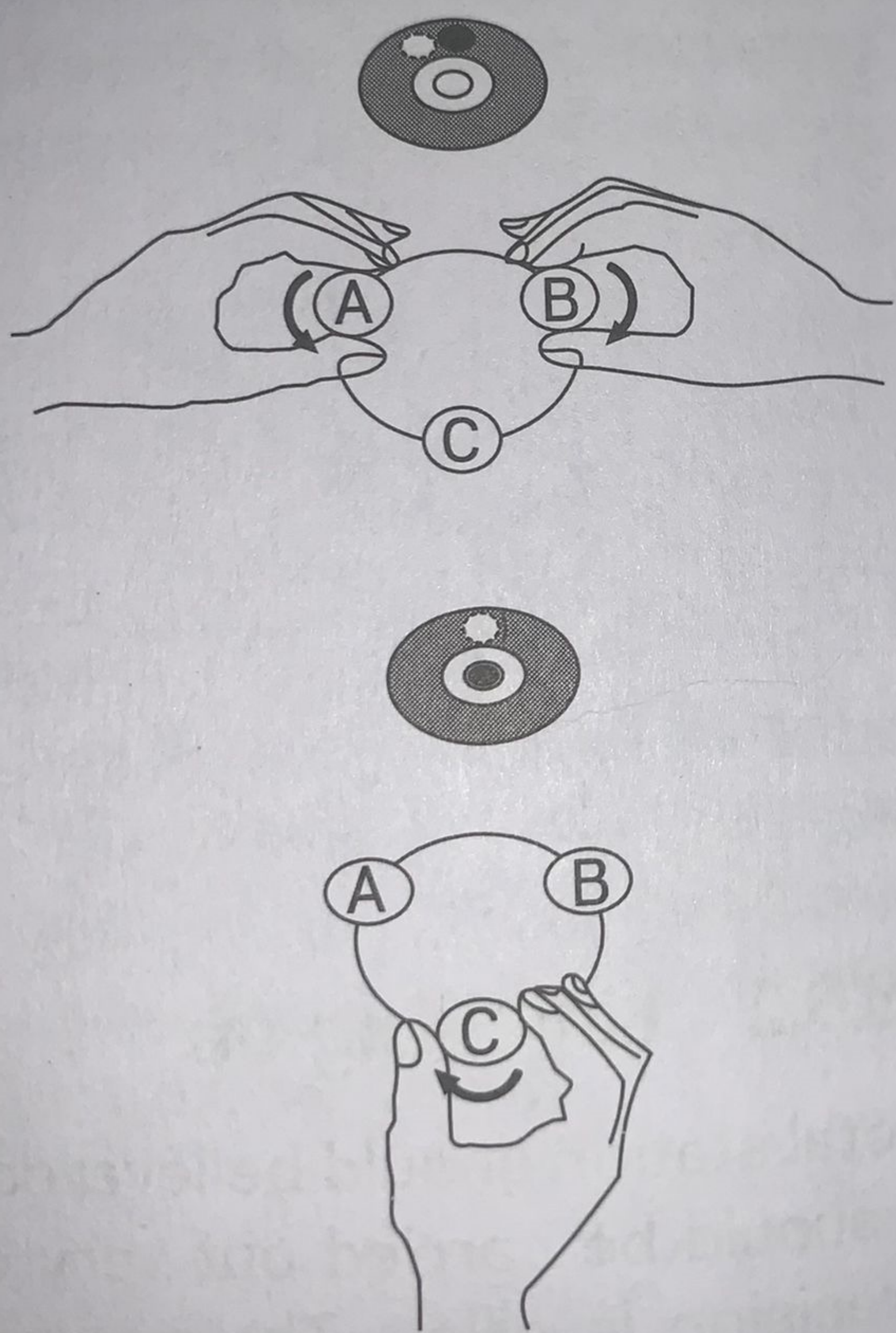


Fig. 15.7 *Precision levelling-up*

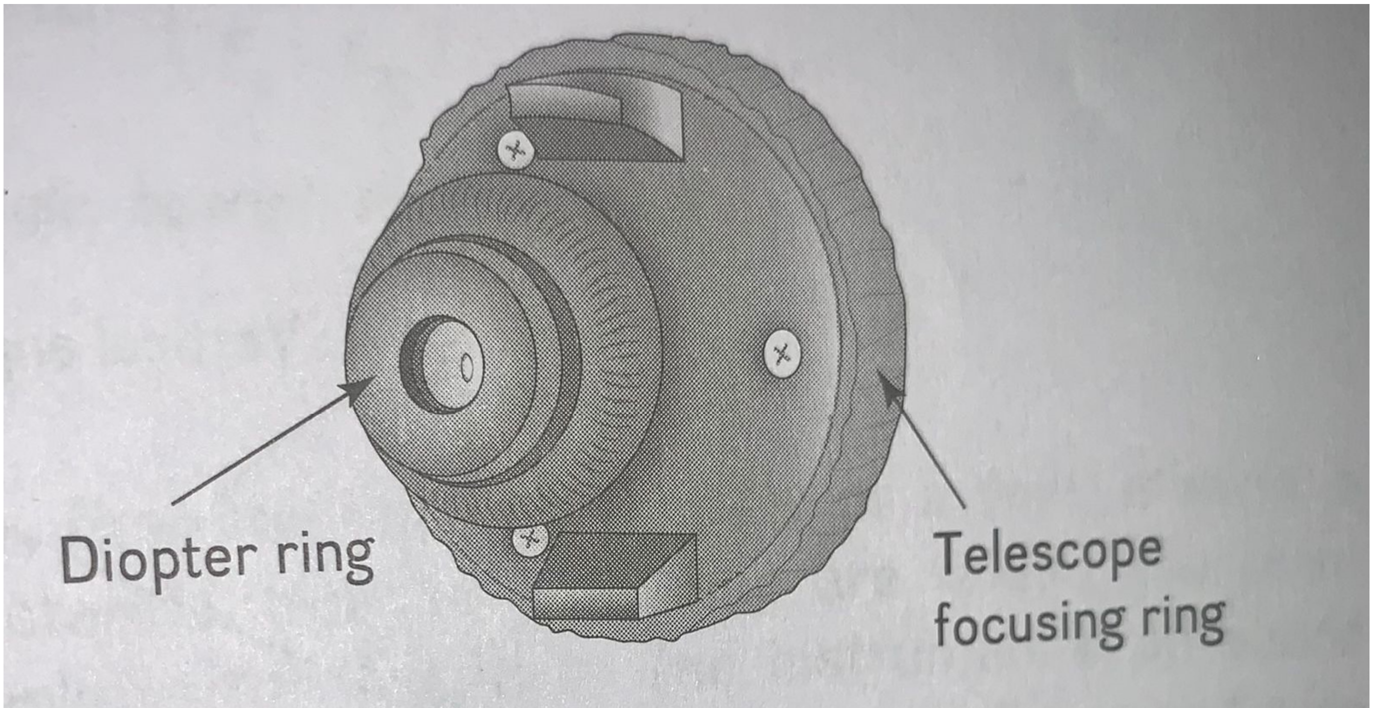


Fig. 15.8 *Focusing of telescope*

UNIT-5

GIS & GPS

(GEOGRAPHICAL INFORMATION SYSTEM & GLOBAL POSITIONING SYSTEM)

5.1 Introduction and Definition of GIS

Geographic Information System (GIS) is a data management system that provides many facilities for surveyors and planners. The difference between GIS and other data management systems is the need to have special database management wherein the locational coordinates of points need to be maintained.

GIS is a computer-based information management system which collects and stores data and help us to manipulate, analyze and display in suitable formats, such data for various planning and design purposes.

This system deals with the geographic space on the earth and its features.

The data for the GIS can come from many sources. The data may come from existing maps, surveys, aerial photography or satellites. The data is digitized using scanners to make it compatible for computer processing.

Definition of GIS

Geographic Information System is a special purpose information system designed to acquire, store, retrieve, manipulate, analyze and output in desired forms geo-referenced data for the purpose of planning and management of land, water and other natural resources, transportation, environment, urban facilities, socio-economic development projects and other administrative records.

5.2 The basic objectives of the GIS:

(a) To collect, analyze and manipulate spatial data.

(b) To produce maps and other products in standardized formats for use by different agencies.

(c) To supply information in useful formats for logical decision-making.

(e) To support research activities using spatial data.

5.2.1 GIS subsystems:

GIS has a number of subsystems for specific uses and applications. These include the following:

(a) Data acquisition

The GIS acquires data from maps and a variety of image formats. Such data can be input to the system for storing in the digital database.

(b) Data processing and analysis

The database created can be accessed by users and analysed in a variety of ways. The resultant output can be given in a format desired by the user as maps, tables or other types of information as displays.

(C) Communication

This is a very difficult stage to design and implement. The system has to have a variety of communication channels to acquire data available in different formats. Communication channels are also important for the users to have the required information output in a variety of ways through display units, printers, and plotters.

(D) Management of GIS

The system has to be planned and implemented effectively.

This requires extensive planning and interactions with users. The organization, implementation and use of GIS require specially trained managers and staff who can design, operate, look to the needs of users, and maintain the system.

5.3 Tools of representation of features or (Data Types for GIS)

There are two basic data types that are used in GIS:

Raster data

This is a series of cells or dots or pixels. Raster data is obtained when you scan a paper image, blueprint, or photograph. The raster data is a series of cells to which values are assigned. This column-row format is used to represent geographic data and other images.

Quality of raster data depends upon the cell. Small size cells increase the reliability because there are more values to represent the image details. Raster models are simple to create and use.

Vector data

This consists of points, lines and polylines and arcs. This is similar to traditional approach of representing objects in a map. They form a group of mathematical equations that generate points, lines or arcs. Points are represented by coordinates.

Advantages and disadvantages of the data models

The following are the advantages and disadvantages of the data models:

raster data Raster data has the advantage that it is a simple data structure comparable with various forms of images created, has efficient overlaying procedures, can represent continuous data efficiently, and spatial variability can be easily accounted for.

The disadvantage of raster data is the large memory requirement, difficulty in deriving topological relationships, and difficulty in editing and transformation of data.

Vector data This requires less memory space, easy to edit, discrete objects can be easily represented, more accurate for mapping and transformations and topological relationships.

The disadvantage of vector data are that it is more complex, cannot represent continuum easily, overlay operations are difficult, less amenable to represent many forms of images, and less efficient in describing spatial variations.

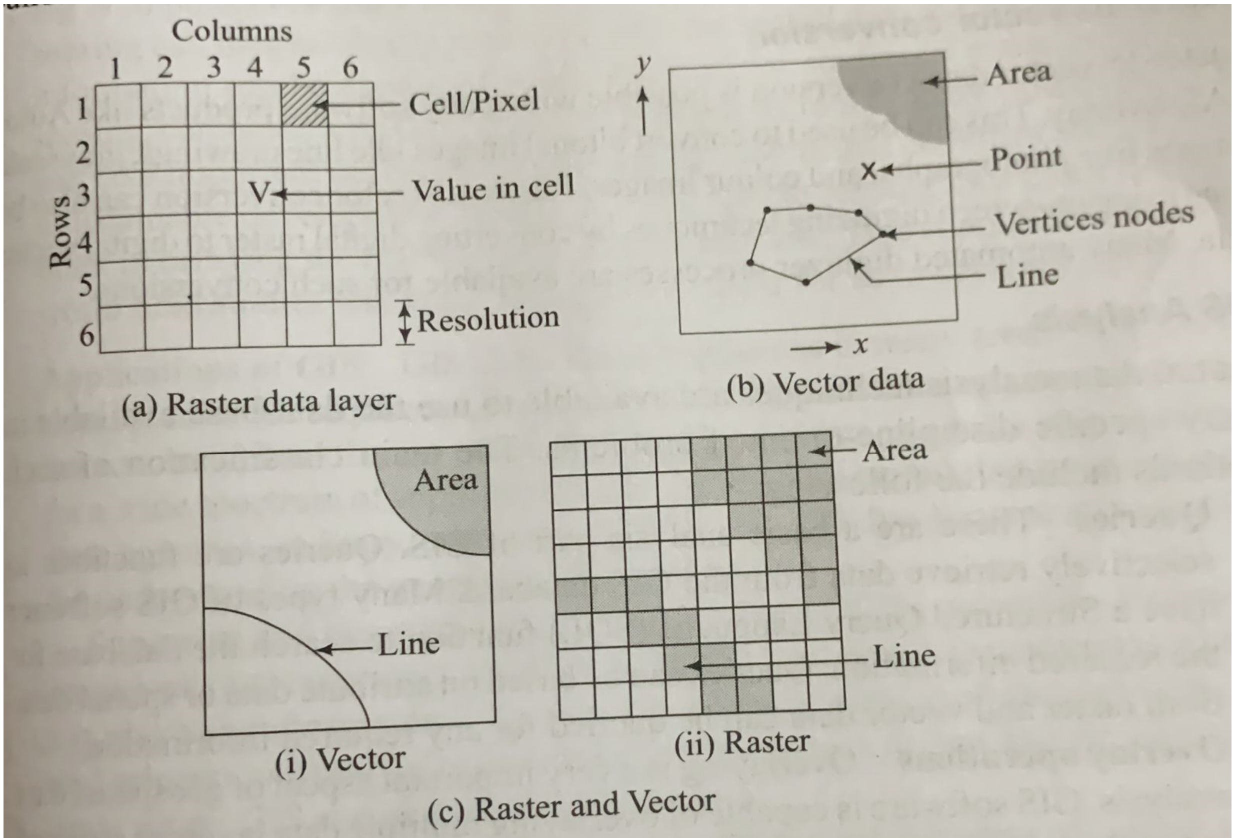


Fig. 24.7 Data models

5.3 Other tools for representation of features of point:

a. Point data-Point features are also used to represent abstract points. For instance, point locations could represent city locations or place names. In GIS, **point data can be used to show the geographic location of cities.**

b. Line data-Line (or arc) data is **used to represent linear features**. Common examples would be rivers, trails, and streets. Line features only have one dimension and therefore can only be used to measure length. Line features have a starting and ending point.

Lines are used to represent the shape and location of geographic objects, such as street centerlines and streams, too narrow to depict as areas. Lines are also used to represent features that have length but no area, such as contour lines and boundaries.

c. **Arial data-**

5.4.2 Application of GIS:

- Natural resources management-
  Forest inventory and modelling, forest cover analysis
  Wildlife management
  Land and water body management
  Locational study and mapping of flora and fauna
  Monitoring environmental hazards
- Mineral resources management
  Exploration of oil, coal and other mineral resources
  Impact of exploration on the environment
- Transportation planning-
  Routing of transportation network
  Highway design, route analysis, and analysis of accident prone areas
  Landslides and flood analysis for transport design
- Environmental planning and management-
  Air and water quality monitoring and management
  Coastal land analysis and coastal area management
  Site locations for waste disposal
  Flood zone mapping and flood mitigation measures
  Ecosystem monitoring
  Environmental hazard status studies
- Socio-economical development-
  Population studies and migration patterns
  Forecasting and analysis of socio-economic changes
- Local area management-
  Urban planning, zoning, and area management & Tax records management
  Engineering analysis for local area development
  Crime mapping
- Public utilities management (power, water supply, gas, and waste disposal lines)
  Public asset inventory and management
  Design of recreation facilities and other public services
  Designing health care facilities
- Disaster management-
  Disaster response and recovery planning
  Damage assessment and mitigation monitoring

Planning of temporary shelters and relocation program.

- Business applications-
  Market studies for location of plant, retailing outlets, and service networks
  Development of tourism potential areas
  Route analysis for postal services and other delivery systems

5.4 GIS Software packages:

Some common types of software for GIS applications:

ESRI like Arc-GIS, ArcView, ArcSDE, ArcIMS, and ArcINFO and Microsoft software packages like Geographics, Imaging solutions, Geowater and Geowaste water and GEOPAK are also useful for many GIS applications.

5.4.2 Remote Sensing:

Remote sensing is **the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance** (typically from satellite or aircraft). Special cameras collect remotely sensed images, which help researchers "sense" things about the Earth.

Applications of Remote Sensing:

Remote sensing has applications in a wide areas. Remote sensing data can be used for taking sound decisions for planning many human developmental activities. It is also possible to take preventive action as in the case of forest fires and natural disasters. Weather forecasting is another important application. Some of the application areas are given below-

Land use and land cover analysis-Perhaps one of the prime uses of satellite remote sensing is in the study of land use and land cover. Land cover through vegetation and specific crop areas can be studied using remote sensing data.

Mineral exploration-It will be possible to use satellite data and discover the presence of valuable minerals and ores that are vital to economic development. Non-renewable energy resources, such as fossil fuels, can be identified using remote sensing data.

Environmental studies-Global weather phenomena are a major area for study using remote sensing data. Global warming and ozone-layer depletion can be continuously monitored using remote sensing.

Archaeology- Archaeological studies can make use of remote sensing data. The underlying old settlements can be recognized from remote sensing data and appropriate action can be taken to excavate and study the various aspects of old civilizations.

Disaster management-It has been possible to predict earthquake hazards by detecting unusual movements in the earth's crust. Floods, landslides, forest fires, etc. can be detected on time and appropriate action can be taken for preventive action in disaster management.

Other applications-Remote sensing data is now being used to study troop movements etc. for defence purposes. Other applications include urban planning studies, traffic studies etc.

and GIS, ArcGIS--?

5.5 Introduction and Principle and Component of GPS

Global Positioning System consists of taking photographic images through moving or stationary satellites, to determine the precise position of any object, anywhere, anytime in the world (globe) i.e. latitude, longitude, elevation, etc. Satellites give messages, signals from space segment to the receiving equipment at the user's end.

The movement and the positioning of satellite status is controlled by an operational ground position. GPS consists of transmission, receiving, Micro-processor unit, recording and display unit for storing and displaying data.

It is mostly used to locate military positions, aircrafts or navigation routes. It can be used for mapping to know the global changes over the time period, to locate boundaries or borders and management of natural resources.

Principle of GPS/Component of GPS

The GPS consists of three major segments:
The Space Segment, the Control Segment, and the User Segment.

(JUST FOR YOU -The space and control segments are operated by the United States Military and administered by the U.S. Space Command of the U.S. Air Force.)

The space segment-

- Observation and controlling the satellite system regularly.
- To check the satellite functions and it’s accurate position in the space.
- To determine the time of GPS.
- Update periodically navigation messages for each satellite.
- The satellites use that corrected information in their data transmissions down to the end user.

- This sequence of events occurs every few hours for each of the satellites.

The control segment-

- The space segment consists of the complete constellation of orbiting NAVSTAR GPS satellites. The current satellites are manufactured by Rockwell International.

The user segment-

- Information that comes from space and sends to satellites is the most important part of GPS.
- The part that does this work is User Segment. It has the GPS receiver section.
- GPS collect and stored the all information that has come from space. For this, 4 satellites are required.

Working function of GPS:

Generally the functions of a GPS are completed with 5 steps:
Step1-Triangulation for satellites
Step2-Measuring distances from satellites
Step3-Getting perfect timing.
Step4-Knowing where a satellite is in space.
Step5-Correcting errors.

5.6 Introduction to GPS surveying techniques:

Static and Dynamic

1. **Static GPS**: It delivers the highest-accuracy positions available in a system, which occupies a point for longer periods of time than kinematic systems. Static systems include a range of survey styles from rapid static surveys to continuously operating stations, such as CORS sites. The equipment setup varies significantly, depending on how long the site will be operational, which could vary from 15 minutes to several years.

Equipment use for GNSS (, Global Navigation Satellite Systems)/GPS:

- Antennas, receivers, and controllers
- UNAVCO supported projects receive Topcon, Trimble, or Septentrio branded units.

Table 1. Advantages and disadvantages of different types of GNSS surveys

Survey Type	Advantages	Disadvantages
Real-time kinematic (RTK)	Real-time corrected positions in a known coordinate plane. Able to navigate to and compute geometries of data points in the field	Significantly increased equipment cost and logistics. Must have radio connection between base and rover. Must set up base on a known position to use advantages
Post-processing kinematic (PPK)	Reduced logistics, cost, and complications. Sufficient for most nonengineering-type surveys	Corrected data is typically not available until processed. Necessary to set up base at benchmark or fix its location later
Rapid Static	Reduced equipment expense and complication compared to PPK. Local base stations not necessary	Requires longer occupation times up to 2 hours, with fewer potential measurements. Lower accuracy than RTK or PPK
Static	Higher precision than rapid static, less equipment than RTK or PPK	Requires long occupation times to reach similar accuracy to RTK or PPK. Requires more precise mounting and metadata collection than RTK, PPK, and rapid static
Continuous	Highest possible precision and accuracy (mm)	Requires complex infrastructure, precision mounting, and very long occupation times.

2. Dynamic GPS-??

5.6.1 Uses and application of GPS

Aviation-Almost all modern aircraft are fitted with multiple GPS receivers. This provides pilots with a real-time aircraft position and map of each flight's progress. GPS also allows airline operators to pre-select the safest, fastest and most fuel-efficient routes to each destination.

Marine-When high accuracy GPS is fitted to boats and ships, it allows captains to navigate through unfamiliar harbors , shipping channels and waterways without hitting known obstacles. GPS is also used to position and map dredging operations in rivers, wharfs and sandbars, so other boats know precisely where it is deep enough for them to operate.

Farming-Farmers rely on repeat planting season after season to maximize their crop productions. By putting GPS receivers on tractors and other agricultural equipment, farmers can map their plantations and ensure that they return to exactly the same areas when sewing their seeds in future. This strategy also allows farmers to continue working in lowvisibility conditions such as fog and darkness. High accuracy GPS is also used to map soil sample locations, allowing farmers to see where the soil is most fertile across individual fields or even entire farms.

Science-Scientists use GPS technology to conduct a wide range of experiments and research, ranging from biology to physics to earth sciences.

Components of GIS

GIS is considered to have four key components-

(a) Hardware for GIS

GIS can run on many types of systems from personal computers to networked supercomputers. Now in days to design and implement GIS systems in computer is available in economic cost.

The computer systems have to be supported by peripheral systems for both input and output.

Input devices- include scanners, digitizers, and GPS receivers, Storage devices such as disks, tapes, CD ROMS & optical discs.

Output devices- such as display units, printers, and plotters.

(b) Software

Software refers to the programs that run in computers. There are basic software that manages the computer system and special software for specific applications. The GIS software is a special application software that provides the functions and tools necessary to acquire, store, retrieve, analyze and manipulate input and output data in a desired form desired by the user.

(c) Data: Data for GIS applications comes from many sources. The special nature of GIS is the integration of spatial data and attribute data.

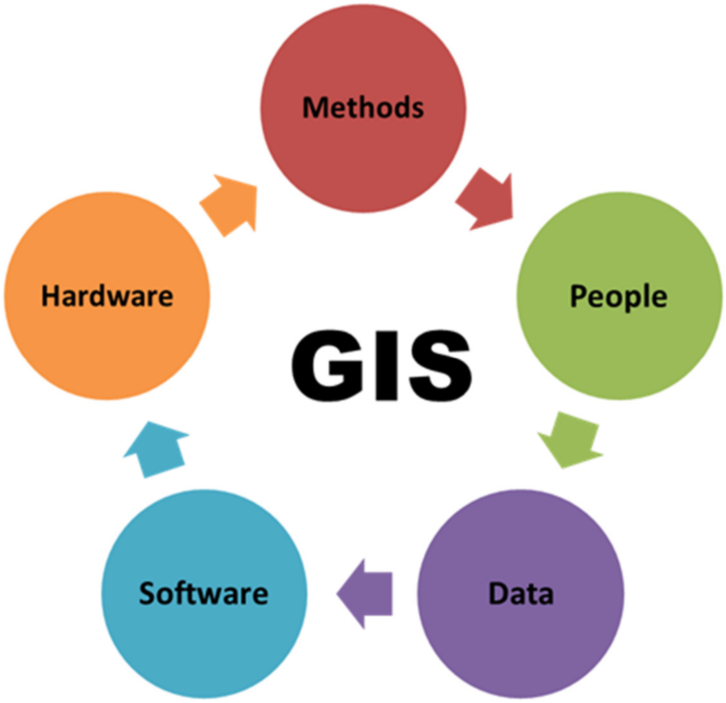
Spatial data that is obtained from digital maps, satellite images, and aerial photography.

Attribute data comes from many documents, It's related to the maps which can be in any of the document forms like tables.

(d) Users:

These are the people for whom the GIS is developed. There are different users looking for different kind of information and analysis and output in desired formats.

Customized applications can also be developed for classes of users.



Features of GIS

The essential objective is to provide information about features, objects and classes in a geo-referenced format. GIS can be considered as information provided in three basic formats:

(1) Data or geographic information is provided in a variety of forms about features, objects and classes. The common underlying feature is that the information is based on a structured database that describes the world around with geographic reference.

(2) Maps are one of the basic features of GIS. Intelligent, digital maps can be obtained that give complete description of required features or objects. This helps the users to query for a variety of information, edit or update the information.

(3) Modelling can be done with GIS to represent the abstractness of geographic reality into an analyzable form. Modelling is used for a variety of purposes for analysis and decision-making about geography-related systems.

GIS is a multi-disciplinary tool for planning and decision making. Such as geography, photogrammetry, remote sensing, computer science, information technology, environment, mathematics and statistics, civil engineering, social sciences, surveying and operations research.

Operating GIS:

The following are the steps involved in operating a GIS system:

Acquiring and relating information from different sources

A GIS can acquire and store information from many sources with integrated location data.

Data storage and management

The major points to be considered are data security, data integrity, data storage and retrieval, and data updating and maintenance.

Data manipulation and registration

Maps drawn in different scales can be adjusted for integrated use. Similarly, many projection systems are used to prepare two-dimensional maps of three-dimensional surfaces. Each projection is appropriate for some use.

Spatial data modelling

Spatial data modelling allows the user to spatial characteristics of a set of real-world phenomena and their interrelationships. This concept of spatial data modelling is implemented in GIS using spatial data structures and manipulated by various algorithms to understand the structure and behavior of the real world.

Spatial analysis

The analysis of the collected information for various uses qualitatively and quantitatively is a powerful feature of GIS. This is done by functions available in GIS such as spatial interpolation, buffering, and overlay operations.

Previous Years question:

1. Write a short note on GIS and explain the various components of GIS.

2. Write various applications area of GIS in civil engineering.

3. Write a short notes on GPS.