CE331: Principles of Geoinformatics 2024-25/I

Project Report – Monday Group 1

Introduction

In this project, we surveyed the area around the Tutorial Block to get precise measurements and create an accurate map. We started by getting a feel for the site (reconnaissance) and then used traversing and levelling to carefully map out specific points. We also used GNSS technology, which is like GPS but more accurate, and brought in software like QGIS and Excel to organize all our data. Altogether, these steps helped us create detailed maps that will be really useful for future campus planning and development.

Objective

The main goals of this project were:

- Set up a closed traverse by establishing control points with clear visibility from one point to the next.
- Utilized the Total Station for traversing to measure distances, angles, and elevations between control points.
- Perform levelling across the area using an Auto Level.
- Determine the global coordinates of control points with GNSS technology.
- Map local features, including trees, buildings, and utilities.
- Use QGIS software to create an accurate, detailed map of the surveyed area.

Equipments

Total Station, Reflector, Prism, Bipod, GNSS Receiver, Auto Level, Levelling Staff, Paint, QGIS Software, MS Excel for calculations.

Schedule of Activity

Week 1: On the first day of our camp, we started by exploring the area. We walked around to get a clear view of the whole site. Our first priority was to set up control stations for the traverse network. We made sure each control point could be seen from the next control point, so we could line up our total station accurately. After that we set up 6 control stations and for our control network. While doing this, we are interested in capturing the maximum features to be mapped.

Week 2: We used the Total Station to measure the distances between the control points we had set up (the sides of the closed traverse) and the angles between them. This helped us find the local coordinates of each control point. We then adjusted these coordinates using the Bowditch Rule to improve accuracy.

Week 3: We used Auto level for setting up the reduced level of our control station. For that, we have used Auto level and by fore site and back site reading, we got the RL of our control station. For this, we used permanent benchmark as RL value 128.031 m.

Week 4: We used a GNSS receiver (models R10/R7/R4) to capture the global coordinates for 2 out of the 6 control points. Then, we applied Similarity Transformation to calculate and adjust the global coordinates of these points for greater accuracy.

Week 5: For feature mapping, we used the Total Station (TS). First, we manually entered the control station coordinates from TBC (**Trimble Business Centre**) and the heights obtained from the Auto Level. Then, we used the station setup feature on the TS to align the network properly before we started recording the features in the area. Continued with the feature recording where we marked all important features like road, building, trees, boundary, drainage line, sewer line, garden etc.

Week 6: Exported data from Total Station into CSV format and added the data points as layer in QGIS. Provided different colours and symbols for different features according to Survey of Indian standards. Exported the map in print composer of QGIS.

Reconnaissance

It's the first step in any surveying task and involves carefully planning and making decisions about how to do the survey. We can think of it as choosing the right tools and methods needed to get the job done accurately and on time. During reconnaissance, we explore the survey area thoroughly to find the best spots for control points. When selecting control points, we want to cover as much ground as possible and make sure there's nothing blocking the view to the sky (like trees or buildings), ensure each point is distinct from the others, and keep their number to a minimum.

Methodology for Reconnaissance

1. Define Survey Objectives and Requirements

Start by understanding the purpose of the survey and the requirements of the project. Identify the area to be surveyed and outline the types of data needed, such as topography, landmarks, or infrastructure details.

2. Identify Control Point Locations

Choose preliminary locations for control points based on visibility, accessibility and stability. Ensure these points provide adequate line-of-sight for accurate measurements and mark potential locations for base stations or benchmarks.

Methodology for Levelling using Auto Level

In surveying, the Auto Level is a commonly used tool for precisely measuring height differences between points on the Earth's surface. This method is straightforward, recording measurements based on an assumed value for a temporary benchmark or the unknown Reduced Level (RL) of a benchmark.

There are two main methods for levelling: the rise and fall method and the line of collimation method. For this lab exercise, we selected the line of collimation method, which involves:

Step 1: Prepare a table in level book where we will record the observations.

BS = Back sight reading from the instrument.

FS = Fore Sight

IS = Intermediate Sight in between consecutive change points.

RL = Reduced Level Remark Column

H.I = Height of Instrument = RL + B.S

RL = Reduced Level Remark Column

US = Upper Stadia

LS = Lower Stadia

BSD = Back sight distance

FSD = Fore sight distance

Step 2: Check the instrument, staff, and tripod—these three items are essential. Calibrate the instrument if needed.

Step 3: Set up the instrument close to the benchmark and level it using the three-foot screws to adjust the bubble.

Step 4: Place the staff on the benchmark, focus the lens, and check for the "+" symbol to ensure clear visibility, adjusting the eyepiece screw if needed.

Step 5: Record the first back sight reading, establish the height of the instrument (HI), and note the upper and lower collimation, which are essential for calculating the distance between the instrument and staff.

Step 6: For the next observation, use a change point. Record the last reading on the fore sight, then set up the instrument at a new point, take a back sight reading, and establish a new HI.

New HI = RL + BS

Step 7: Continue recording data with these steps, noting key points such as control points or WLE benchmarks in the remarks section.

Step 8: Repeat these steps until returning to the original benchmark to close the loop.

Step 9: At the loop's end, calculate the level difference, known as the misclosure, and adjust this error in the readings as part of post-processing.

Table

BS	FS	IS	RL	HI	US	LS	BSD	FSD	REMARK
			128.031						BM
0.892				128.923	0.962	0.821	14.1		
	1.168		127.755	0	1.32	1.12		20	CP3
1.234			0	128.989	1.329	1.139	19		
	0.998		127.991	0	1.13	0.881		24.9	CP4
1.1			0	129.091	1.232	0.988	24.4		
	0.982		128.109	0	1.108	0.846		26.2	
1.2			0	129.309	1.336	1.062	27.4		
	1.176		128.133	0	1.301	1.017		28.4	CP5
0.982			0	129.115	1.05	0.914	13.6		
		1.094	128.043	0	1.129	1.06	6.9		IS
	1.232		127.883		1.302	1.162		14	
1.218				129.101	1.281	1.156	12.5		
	1.163		127.938	0	1.213	1.108		10.5	CP6
1.198			0	129.136	1.282	1.011	27.1		
	1.19		127.946	0	1.324	1.059		26.5	CP1
1.109			0	129.055	1.207	1.011	19.6		
	1.235		127.82	0	1.32	1.139		18.1	CP2
1.142			0	128.962	1.185	1.101	8.4		
	0.921		128.041		0.955	0.887		6.8	BM
10.075	10.065						166.1	175.4	

Calculations

Total distance = 166.1 +175.4 = 341.5m

Misclosure = 128.041 – 128.031 = 0.01m = 1cm = 10mm

C = E/K^1/2 = 17.11 mm (Accurate)

Quality of work is accurate.

Methodology for Traversing

Step 1: Prepare a table in level book where we will record the observations.

Step 2: Set up the instrument at the starting control point, level it using the tripod screws, and ensure it is stable and levelled.

Step 3: Begin by measuring and recording the bearing or angle to the next station, moving in a clockwise direction. Focus the lens for a clear view of the target, adjusting the eyepiece as needed.

Step 4: Measure the distance to the next control point using the prism, and record this measurement accurately. Note the horizontal angle accurately for precise positioning.

Step 5: Move the instrument to the next station, setting it up again. Measure back to the previous point (back bearing) and then to the next point (fore bearing), continuing clockwise around the traverse.

Step 6: Repeat this process at each station, recording all measurements (angles and distances).

Step 7: Upon completing the loop and returning to the starting point, take a final measurement to close the traverse and check for any discrepancies.

Step 8: Calculate any angular and linear misclosure. Adjust these errors throughout the traverse during post-processing to ensure accuracy.

Table:

CP	stn	STATION OBS	DECIMAL	ANGLE	CORRECTION	CORRECTED	DEGREE
	6	0° 00' 00"	0				
	2	128° 13' 02"	128.2172				
	6	0° 00' 06"	0.00166				
1	Error		0.00166	128.2172	-0.00845933107	128.2256593	128° 13' 32"
	1	0° 00' 00"	0				
	3	166° 20' 17"	166.338				
	1	0° 00' 24"	0.00666				
2	Error		0.00666	166.338	-0.0109744107	166.3489744	166° 20' 56"
	2	0° 00' 00"	0				
	4	120° 20' 16"	120.3377				
	2	359° 59' 58"	359.9994				
3	Error		0.0006	120.3377	-0.00793946868	120.3456395	120° 20' 44"
	3	0° 00' 00"	0				
	5	98° 52' 29"	98.8747				
	3	359° 59' 40"	359.9944				
4	Error		0.0056	98.8747	-0.00652341356	98.88122341	98° 52' 52"
	4	0° 00' 00"	0				
	6	80° 18' 39"	80.3108				
	4	0° 00' 18"	0.005				
5	Error		0.005	80.3108	-0.00529863111	80.31609863	80° 18' 57"
	5	0° 00' 00"	0				
	1	125° 52' 27"	125.8741				
	5	359° 59' 30"	359.9916				
6	Error		0.0083	125.8741	-0.00830474137	125.8824047	125° 52' 56"
			SUM=	719.9525		720	720
			SUM OF INTER	720			
			ANGLE MISCLC	-0.0475			
			CORRECTION I	-0.00006597657			

Calculation:

For Traversing,

We can calculate the closing error = sqrt ($L^2 + D^2$)

Closing error= sqrt (0.012*0.012 + 0.063*0.063) = 0.06413

Relative Precision= closing error/traverse perimeter =0.06413/315.996= 1/4928=2.029220779 * 10^(-4)

Angle Misclosure = -0.0475

Quality of work is third order.

Methodology for Coordinate Transformation

Here’s a step-by-step procedure based on your method using a GNSS receiver and Similarity Transformation to determine accurate global coordinates:

Step 1: Use the GNSS receiver (R10/R7/R4 models) to capture the global coordinates for two of the control points. Ensure accurate positioning and signal quality during data collection to minimize potential errors.

Step 2: Calculate or measure the local coordinates for all six control points. This could involve using traditional surveying methods (such as total stations) to achieve high precision within the local system.

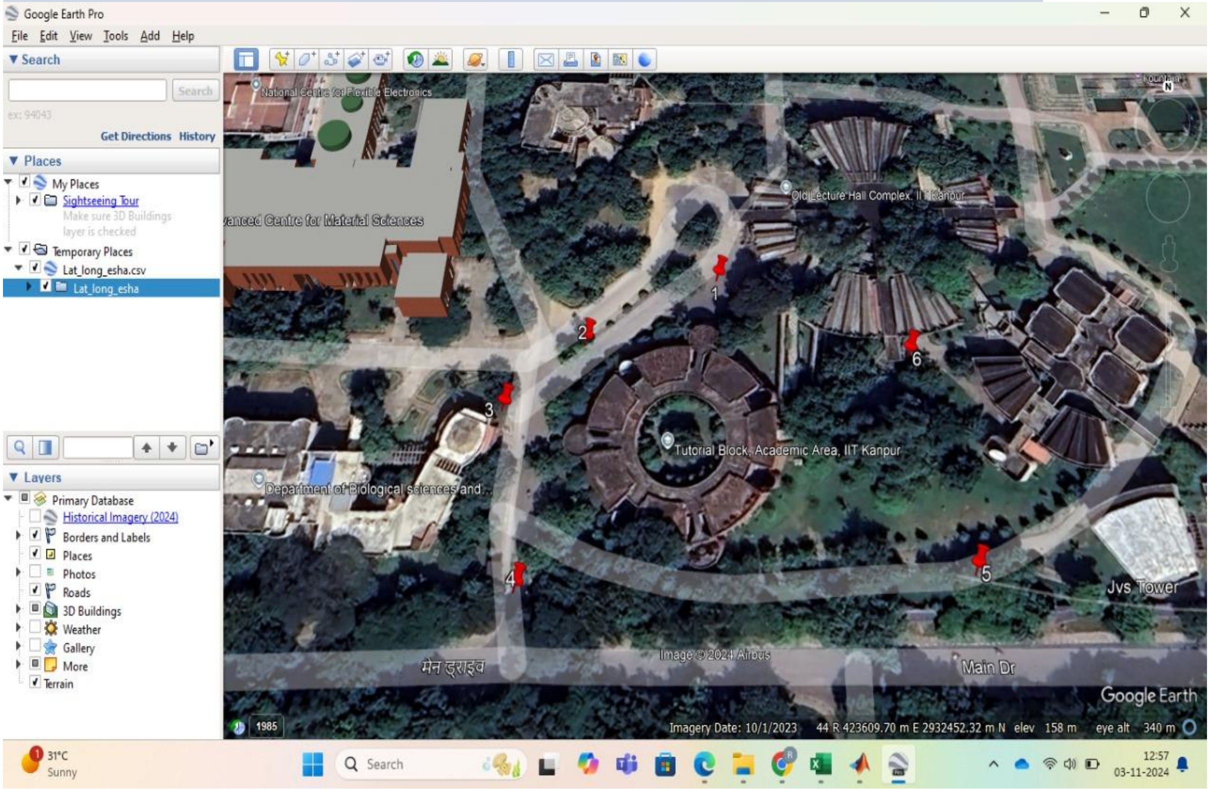
Step 3: Select at least two common points (the two points with both local and global coordinates) as "anchor" points. These will be used to establish the relationship between the local and global coordinate systems.

Step 4: Using the anchor points, apply a Similarity Transformation, which includes scaling, rotation, and translation adjustments, to align the local coordinates with the global system. This can be done programmatically or through software.

Step 5: Using the Similarity Transformation parameters, transform the local coordinates of the remaining points (without global coordinates) into the global system. This step ensures that all points are consistently aligned with the GNSS-captured points.

Line	WCB	Length	Departure	Latitude	correction	correction
AB	0°0'0"	38.781	0	38.751	0.079	-0.00147
BC	346°20'03"	25.768	-6.09	25.038	0.0053	-0.000978
CD	286°41'31"	41.392	-39.647	11.888	0.00853	-0.00157
DE	205°34'20"	105.397	-45.49	-95.07	0.0216	-0.004
EF	105°52'51"	50.831	48.89	-13.909	0.0104	-0.00193
FA	51°45'52"	53.827	42.274	33.314	0.011	-0.00204
		315.996	-0.063	0.012		

CP	Easting	Northing	Local East	Local North	Global North	Global East	CP
A	0.0079	38.751	0	0	2932539.07	423522.27	1
B	-6.0847	25.037	0.0079	38.751	2932521.58	423487.72	2
C	-39.6384	11.8864	-6.0768	63.788	2932504.85	423468.15	3
D	-45.4704	-95.074	-45.7152	75.6744	2932464.14	423475.45	4
E	48.9004	-13.9109	-91.1856	-19.3996	2932466.54	423580.74	5
F	42.285	33.3119	-42.2852	-33.3105	2932516.41	423571.06	6



Methodology for Feature Mapping

Here's a step-by-step guide for setting up a Total Station, completing station setup, and mapping features using the Direct Reflex (DR) method. This process includes the necessary steps to ensure accurate measurements and data storage.

Total Station Setup and Initial Configuration

1. Setup the Total Station on the Tripod:

- Place the Total Station securely on the tripod at your chosen station point. Level the instrument using the tripod's levelling screws to ensure stability.

2. Add the Battery:

- Insert the fully charged battery into the Total Station. Ensure the battery is properly seated to prevent power interruptions during the survey.

3. Power On and Display Check:

- Power on the Total Station. The display should show the initialization screen. Confirm that the display is functioning properly, showing no error messages.

4. Navigate to General Survey Mode:

- Select General Survey from the main menu. This mode is typically used for standard survey measurements and data collection.

5. Instrument Setup - Electronic Levelling:

- Go to Instrument settings, then select Electronic Levelling to ensure the Total Station is precisely levelled.

- Follow on-screen instructions to centre the bubble using the electronic level feature.

Station Setup in the Total Station

6. Enter the Station Point Information:

- Go to Key in or Station Setup.

- Select the RT and K Series option if applicable to your model.

- Enter the Station Point Name (unique identifier) and Centering Point for the setup location.

- Input the **Northing**, **Easting**, and **Elevation** of the station point. This data establishes the Total Station's reference location in your survey coordinate system.

7. Set Up the Backsight Point:

- Set up a bipod with a prism at a known point to use as a backsight. This backsight point is critical for orientation.

- Aim the Total Station at the prism on the bipod and take a reading to establish the station orientation.

8. Check Misclosure:

- Perform the reading to confirm that the misclosure (discrepancy in measurement) is less than 20 mm. This ensures that your station setup is accurate and that errors are within acceptable limits.

9. Store the Station Setup Information:

- Once you verify the misclosure is acceptable, save (or Store) the station setup information in the Total Station’s memory.

- Your station setup is now complete, and you are ready to begin mapping.

Mapping Visible Features Using the Direct Reflex (DR) Method

10. Switch to DR Mode:

- Enable the Direct Reflex (DR) method. This mode allows for measuring without a prism, which is useful for mapping visible features directly.

11. Select a Visible Feature:

- Aim the Total Station at a visible feature point in your survey area that you want to map.

12. Measure the Feature Point:

- Take a measurement using the Total Station. The DR method will automatically calculate the distance and angle to the feature point without requiring a prism.

13. Store the Feature Point Data:

- After taking the measurement, save the data for this feature point. The stored data should include the coordinates (Northing, Easting, Elevation) and any other relevant information.

14. Repeat for All Visible Feature Points:

- Repeat steps 10-13 for each visible feature point in your survey area.
- After each measurement, store the data to ensure a record of every feature point.

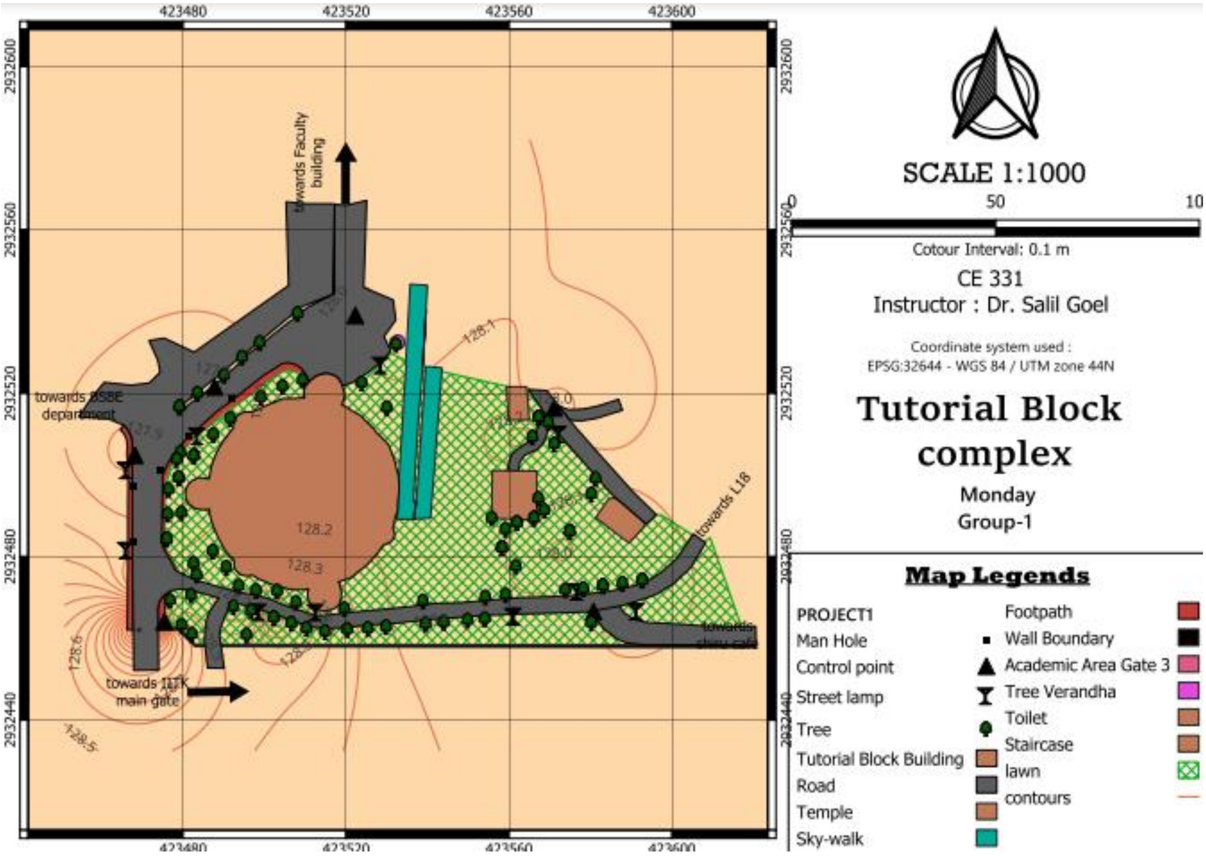
Final Checks

15. Review Stored Data:

- After mapping all feature points, review the stored data in the Total Station to ensure all measurements have been saved correctly.

16. Power Down and Secure Data:

-Once the survey is complete, power down the Total Station and back up the stored data, if necessary.



Results and Discussion

For Auto Levelling

Closing Error = -10mm

Number of Control points = 6

Quality of work is accurate.

For Traversing,

Closing Error = -0.0475

Quality of work is third order.

Conclusions

Reconnaissance is an important first step in surveying that helps surveyors understand the site and plan the survey effectively. By visiting the site and observing its features, surveyors can decide on the best places for control points, the equipment needed, and the safest, most efficient routes to take. This preparation helps identify possible challenges early, allowing for solutions before the main survey begins. Overall, reconnaissance makes the survey process smoother, more accurate, and saves time by reducing the chance of mistakes or delays. It ensures that the survey is done safely and meets the project's needs.

References

https://docs.qgis.org/3.34/en/docs/user_manual/index.html

https://www.esri.com/en-us/arcgis/products/arcgis-pro/resources