CE331 LAB REPORT

Objective

To prepare the map of Geoinformatics Lab Building using basic surveying procedures like:

1. Reconnaissance
2. Setting up control points
3. GPS observations for two control points
4. Levelling
5. Traversing
6. Feature Mapping

Introduction

1. Reconnaissance

- It refers to initial inspection of the area concernedi.e. to have a basic knowledge about that area.
- It also involves knowing about the obstacles that could possibly hinder our work.
- It also involves finding out the locations where the control points should be set up so that entire area is covered.
- It involves analyzing the terrain, key features, and the major landmarks in the area.
- Other various activities that are involved in reconnaissance are: visual inspection, preliminary measurements, identifying control points, identifying the best routes for carrying instruments and noting down about various man made and natural features present.
- Reconnaissance can be facilitated by various processes like taking photos of important features and landmarks. This could help us later in our surveying project. Creation of rough maps could also be done to have a basic knowledge about the area that is being surveyed.

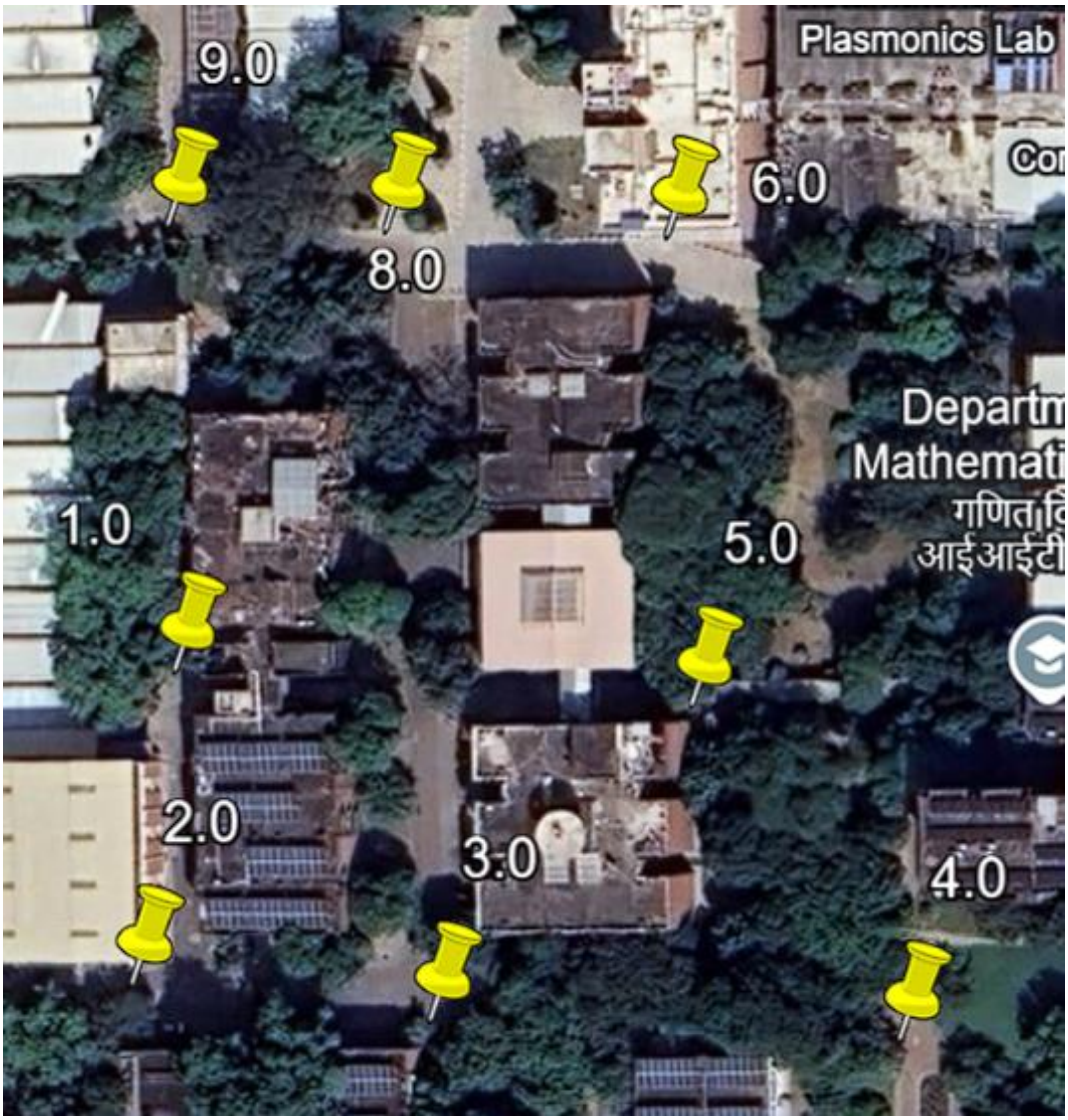
2. Control points

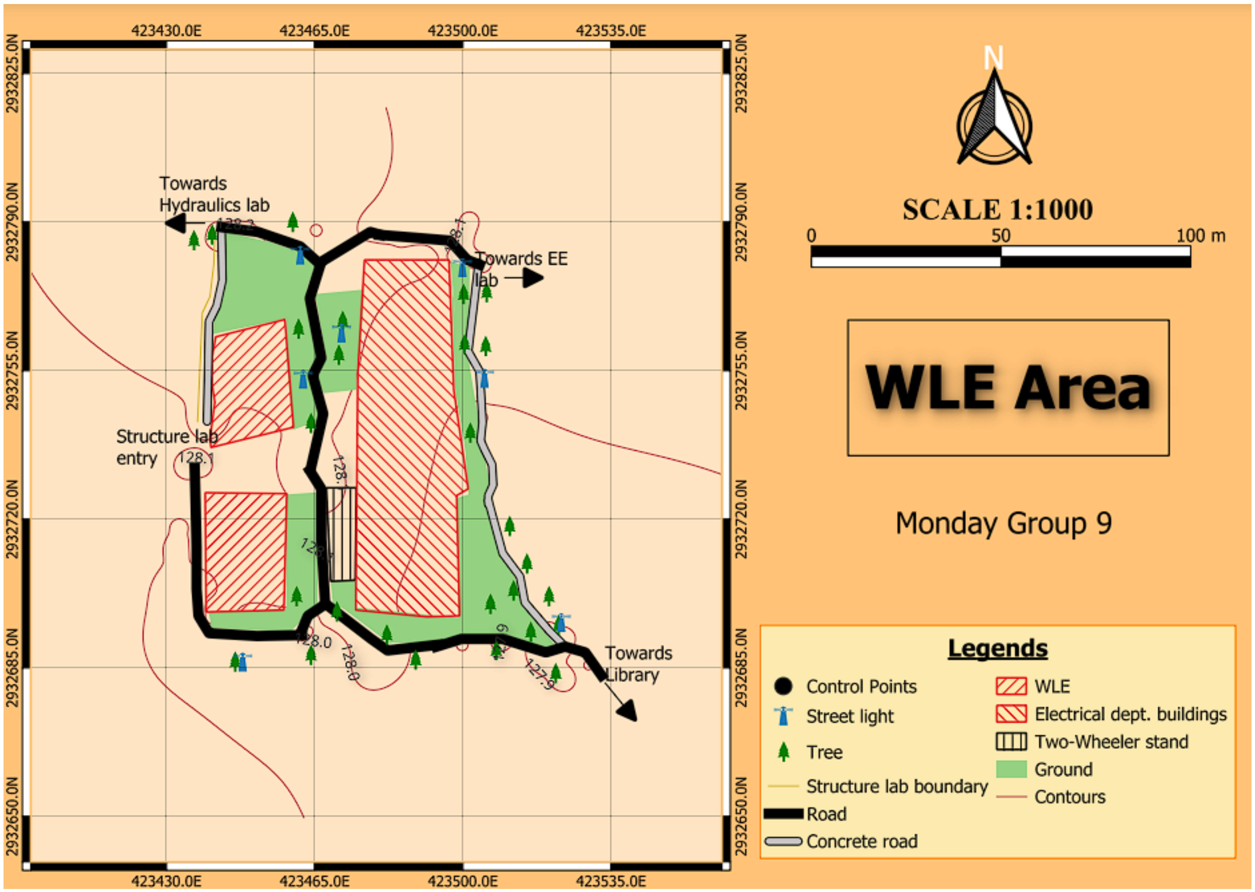
Setting up control points is the most fundamental to a map making. Various things that need to be considered while setting up control points and about their importance have been discussed below:

- Optimum number of control points needs to be selected. This is necessary as too few control points can significantly increase errors in our measurements whereas too many control points can induce redundancy in the measurements.
- Control points should be selected in such a way that each point of the concerned area is visible from at least one of the control points.

- Moreover, the control points must be visible from multiple locations to facilitate traversing and feature mapping.
- Control points must be setup at the locations which are unlikely to be disturbed or destroyed. This is necessary as we need control points till our project is completed.
- Control points should also be setup on stable grounds i.e. they should not move.

For our project, we had set up 9 control points around the GI Lab building. The location of each control points is shown in the following image:





3. Levelling

After setting up of appropriate number of control points, levelling is done. Levelling involves finding the reduced level of all the control points using an auto level and a staff. Levelling priorly requires the reduced level of a point generally known as benchmark (BM). The height (RL) of BM is already known before the levelling starts.

Key terms involved levelling operations are:

- Level line or surface is normal to gravity at all points, often ellipsoidal.
- Horizontal line or surface is normal to gravity at a particular point.
- Datum is a reference surface to measure elevations, usually mean sea level (MSL).
- Benchmark (BM) is a permanent point with a known height above the datum.
- Reduced level (RL) of a point is its height above or below a datum.

Equipment used in levelling operation are:

- Automatic Level, which is used to find the level line.
- Leveling Staff which gives the backsight, intermediate sight and foresight readings.
- Tripod for placing automatic level.

- Level Field Book to enter observations.

Methodology of the experiment are:

- Setup and level the instrument
- Take the first reading (back sight) by putting staff on the known RL (near GI lab)
- Carryout fly levelling operation and calculate RL of some fixed features (Electric Poles and Markings on Ground) using two methods given above.
- Take the last reading (foresight) and close on the same point near GI lab.
- Enter observations in the levelling field book by two methods Reporting the following in the laboratory report:
    a. Specification of Automatic Level used.
    b. Error sources, if any, in whole operation.
    c. How the closing error can be distributed/adjusted.
    d. From closing error, report the quality of your work

Observation Table: Height of collimation method

						BS		FS						
Station	**Point**	**BS**	**FS**	**HI**	**RL**	**US**	**LS**	**US**	**LS**	**d1**	**d2**	**c1**	**c2**	**c3**
BM		1.017		129.43	128.41	1.061	0.967			9.4				
	1		1.301		128.13			1.34	1.26		8	17.4	0.0010	128.1240
		1.16		129.29		1.26	1.06			20				
	2		1.295		127.99			1.392	1.198		19.4	56.8	0.0034	127.9866
		1.295		129.29		1.397	1.209			18.8				
	3		1		128			1.382	1.198		18.4	94	0.0056	127.9924
		1.273		129.27		1.248	1.128			12				

	4		1.231		128.04			1.387	1.078		30.9	136.9	0.0082	128.0318
		1.25		129.29		1.365	1.112			25.3				
	5		1.19		128.1			1.312	1.065		24.7	186.9	0.0112	128.0888
		1.324		129.42		1.461	1.187			27.4				
	6		1.231		128.19			1.389	1.04		34.9	249.2	0.0150	128.1780
		1.342		129.54		1.429	1.262			16.7				
	8		1.301		128.23			1.394	1.21		18.4	284.3	0.0171	128.2169
		1.333		129.57		1.394	1.272			12.2				
	9		1.357		128.21			1.429	1.281		14.8	311.3	0.0187	128.1913
		1.221		129.43		1.349	1.09			25.9				
	1		1.283		128.15			1.425	1.14		28.5	365.7	0.0220	128.1260
		1.301		129.45		1.34	1.26			8				
BM			1.017		128.43			1.061	0.967		9.4	383.1	0.0230	128.4090
		12.516	12.493								total=	383.1		

HI=Benchmark Elevation + BS

RL=HI−FS

Checks: Final RL – Initial RL = ΣBS – ΣFS

128.43-128.409= 12.516-12.493=0.023m =23mm

Misclosure = Final RL – Initial RL=23mm

Tachometric Distance Calculation:

D= (US – LS) * 100

Where, D: Distance levelled (meters)

US: Upper stadia reading (meters)

LS: Lower stadia reading (meters)

K = 100 is the stadia constant

Closure tolerance:

Set-up based:

Tolerance (mm) = $c\sqrt{n}$

Where c = constant= 8.133, n = no of instrument setups = 8

In this project we are calculating tolerance based on no of instruments, therefore:

Tolerance=$8.133\sqrt{8}$= 23.0035mm

Quality of work:

For a good quality of work: Misclosure error ≤ Tolerance

Our misclosure error is less than tolerance so our work quality is accurate.

4. Traversing

Traversing is the process of control establishment using total station (which measures angles and distances).

Equipment used:

- Nikon Electronic Digital theodolite NE-203
- Leveling staff
- Pegs
- Tape

We do Close Traversing, where we done traversing in a closed loop.

Basic Measurements for Traversing:

- We measure internal angles or external angles of a closed or a link traverse.
- We measure WCB of a side using compass.
- We also measure length of sides.

Bearing Systems:

1. Whole circle bearing (WCB):
   - Measurement from North in a clockwise
   - direction (0° to 360°).
   - Azimuth
2. Reduced /quadrantal bearing:
   - Measurement from North or South, in either
   - direction (0° to 90°).
   - Bearing

Face left and face right observations:

1. Face Left (FL) Observation
   - Vertical circle is on the left side of the observer.
   - Total Station's "+" sign faces right during observation.
2. Face Right (FR) Observation
   - Vertical circle is on the right side of the observer.

- Total Station's "+" sign faces left during observation.

We used the Face Left observation for traversing.

Observation Table:

Label	Angle	Error	Angle	correction	corrected
1	0	0.012	188.816	-0.455	188.361
	188.804				
	359.988				
9	0	0.018	86.841	-0.209	86.632
	86.823				
	359.982				
8	0	-0.038	180.41	-0.435	179.975
	180.448				
	0.038				
6	0	0.003	94.757	-0.228	94.529
	94.749				
	359.997				
5	0	0.002	209.165	-0.503	208.662
	209.163				
	359.998				
4	0	0.007	57.133	-0.137	56.996
	57.126				
	359.993				
3	0	0.011	176.295	-0.425	175.87
	176.284				
	359.989				
2	0	0.007	89.191	-0.215	88.976
	89.184				
	359.993				
		summation=	1082.608	misclosure=	2.608

Angle Misclosure:

$M=\Sigma\theta i - (n-2)*180$,

where n=no. of sides of closed polygon and

$\Sigma\ \theta i$ = summation of measured internal angles of the closed polygon.

M= 2.608

Bowditch's rule of angle adjustment:

Correction to angle i: Correction (Ci)= (θi/ Σθi) * M

Corrected angle = measured angle – correction

Angle	observed	correction	corrected angle	line	WCB	Length	dE	dN
912	188.816	-0.455	188.361	91	0	55.116	0	55.116
123	89.191	-0.215	88.976	12	8.361	38.957	5.665	38.543
234	176.295	-0.425	175.87	23	277.337	37.996	-37.685	4.852
345	57.133	-0.137	56.996	34	273.207	59.395	-59.302	3.323
456	209.165	-0.503	208.662	45	150.203	49.368	24.532	-42.841
568	94.757	-0.228	94.529	56	178.865	59.102	1.171	-59.09
689	180.41	-0.435	179.975	68	93.396	34.892	34.831	-2.067
891	86.841	-0.209	86.632	89	93.371	27.142	27.095	-1.596
	1082.608					361.968	-3.693	-3.76
error=	2.608							

correction in E	correction in N	corrected dE	corrected dN	final E	final N	point
				1000	2000	9
0.562	0.573	0.562	55.689	1000.562	2055.689	1
0.397	0.405	6.062	38.948	1006.624	2094.637	2
0.388	0.395	-37.297	5.247	969.327	2099.884	3
0.605	0.616	-58.697	3.939	910.63	2103.823	4
0.504	0.513	25.036	-42.328	935.666	2061.495	5
0.603	0.614	1.774	-58.476	937.44	2003.019	6
0.355	0.362	35.186	-1.705	972.626	2001.314	8
0.277	0.281	27.372	-1.315	999.998	1999.999	9
		-0.002	-0.001			

N=8

C root(n)=2.608x3600

C=3319 for quality of traverse for angles

Square of Sum(dE)=13.638

Square of sum(dN)=14.1376

Relative precision=root(13.638+14.1376)/perimeter

Relative precision=5.27/361.968=0.01455

Quality of work for traverse for distance X=68.7285

Code for Coordinate Transformation

```
# CE331 Principles of Geoinformatics - 2024
# Coordinate Transformation (Affine)

# Import library
import numpy as np

# Step 1: Define global coordinates (Y, X) for control points as matrix L
L = np.array([[2932693.226],    # Y_g1 (Northing of Point 2)
              [423432.753],     # X_g1 (Easting of Point 2)
              [2932688.617],    # Y_g2 (Northing of Point 3)
              [423470.441]])    # X_g2 (Easting of Point 3)

# Step 2: Define transformation matrix A using local coordinates of control points
A = np.array([[2094.64, 1006.62, 1, 0],          # N of Point 2
              [1006.62, -2094.64, 0, 1],         # E of Point 2
              [2099.88, 969.327, 1, 0],    # N of Point 3
              [969.327, -2099.88, 0, 1]]) # E of Point 3

# Step 3: Calculate transformation parameters (scale, rotation, translation) in X
X = np.linalg.inv(A.T @ A) @ (A.T @ L)
print("Transformation parameters in X:\n", X)

# Step 4: Define local coordinates for additional points
local_points = {
    "Point 4": np.array([[2103.82, 910.63, 1, 0],
                         [910.63, -2103.82, 0, 1]]),
    "Point 5": np.array([[2061.5, 935.666, 1, 0],
                         [935.666, -2061.5, 0, 1]]),
    "Point 6": np.array([[2003.02, 937.44, 1, 0],
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                          [937.44, -2003.02, 0, 1]]),
    "Point 8": np.array([[2001.31, 972.626, 1, 0],
                          [972.626, -2001.31, 0, 1]]),
    "Point 9": np.array([[2000, 1000, 1, 0],
                          [1000, -2000, 0, 1]]),
    "Point 1": np.array([[2055.69, 1000.56, 1, 0],
                          [1000.56, -2055.69, 0, 1]]),
    "Point 2 (Check)": np.array([[2094.64, 1006.62, 1, 0],
                                  [1006.62, -2094.64, 0, 1]]),  # Verify Point
2
    "Point 3 (Check)": np.array([[2099.88, 969.327, 1, 0],
                                   [969.327, -2099.88, 0, 1]])  # Verify Point
3
}

# Step 5: Transform and compute global coordinates for each point
results = []
for point_name, A_new in local_points.items():
    L_new = A_new @ X  # Apply transformation
    results.append(f"{point_name}: Y_g = {L_new[0, 0]:.3f}, X_g = {L_new[1, 0
]:.3f}")

# Step 6: Display computed global coordinates
print("\nGlobal Coordinates:")
print("\n".join(results))
```

```
Transformation parameters in X:
 [[-1.00805535e+00]
 [-1.80519111e-02]
 [ 2.93482291e+06]
 [ 4.24409669e+05]]

Global Coordinates:
Point 4: Y_g = 2932685.705, X_g = 423529.682
Point 5: Y_g = 2932727.914, X_g = 423503.680
Point 6: Y_g = 2932786.833, X_g = 423500.836
Point 8: Y_g = 2932787.921, X_g = 423465.336
Point 9: Y_g = 2932788.748, X_g = 423437.718
Point 1: Y_g = 2932732.599, X_g = 423438.159
Point 2 (Check): Y_g = 2932693.226, X_g = 423432.753
Point 3 (Check): Y_g = 2932688.617, X_g = 423470.441
```