CE332A (UGP-I)

Survey Camp (Chitrakoot)

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Introduction

The visit to Chitrakoot was done to conduct survey camp as the course CE 332A. The survey camp was held for 7 days (excluding the boarding and lodging days). This course was done as optional continuation of the course CE 331A, which serves basics of surveying techniques. It requires the knowledge gained in CE 331A to apply to practical field.

The area chosen for this survey camp was Arogyadham (Chitrakoot) which involves the map making of the area which start from Ras Shala to the Security Gate. The map to be made features trees, border (boundary), road, light poles, buildings, etc. It was asked to draw the contour of the specific area as well. Then we drawn the road profile from Ras Shala to Security Gate to feature the elevation of main road.

The camp entailed comprehensive tasks involving data collection, mapping and cross-section analysis, integrating the use of advanced and ~~so~~ equipment and software for precise measurements such as total station, auto level, Juno, R10 and other cartographic representation. The software used in map making is QGIS.

Objectives

The main aim of this survey camp is to create a 2D map of the designated area i.e., Arogyadham, Chitrakoot. It is also designated to include the contours of the region, which signifies the physical terrain of that area.

The objectives of this surveying project are as follows:

- To create a comprehensive 2D map (with contour) that accurately depicts the topography of the surveyed area.
- To analyze the elevation variations across the landscape to locate and identify different features and ~~or~~ gradients.
- To understand and implement the surveying techniques in the real life practical world and get hands-on experience.

- To locate and creating the traversed path across the ~~at~~ town to locate useful and important features such as hospital, school/college, police station, etc.
- To organize and acquisite the field data which is used in creating map.

Overview of Methodology

(i) Reconnaissance :- The very first step to make a map is to conduct a preliminary survey of the target area to assess the feasibility of the contour map project. Then we identified the important features of the area to develop a survey strategy for optimal data collection.

(ii) Setting up of Control Points :- First identify and locate maximum features of the area from a single point on the ground and mark it as a control point using paint. Control points are chosen based on their visibility, stability, accessibility and to cover entire area evenly with accurate data triangulation.

(iii) GNSS for Obtaining Control Point Coordinates :-

The global coordinates of control points are determined by GNSS receivers (such as R10). Set up GNSS receiver at each control point

and allow for satellite signal acquisition. dwait approximately 20 minutes at each control point to obtain precise data in the form of coordinates as: (latitude (Northing), longitude (Easting), elevation).

(iv)→ Levelling :- The auto level instrument was used for precise elevation measurements from a set benchmark (BM) at 100 meters. Carried out few polygon loops to traverse and level the whole area using control points, which will be used in total station for feature mapping.

(v)→ Feature Mapping :- Identified and mapped key features within the surveyed area such as buildings, roads, trees, water bodies, etc. using total station. This was done with reference to WGS84 (44N) coordinates to directly locate on the global map.

(vi) → Map and Contour generation :- Employed the QGIS software for map and contour generation of the area. Imported the survey data which includes control point coordinates, elevation and coordinates of mapped features into the software. Utilized contour generation algorithm to create contour lines.

Schedule of Activities

The schedule of the activities done at survey camp are as follows:

Day 0 : Reconnaissance
Day 1 : GPS Survey (using JUNO)
Day 2 : GNSS & ~~Auto~~ Levelling
Day 3 : ~~Auto~~ Levelling & ~~TS~~ Feature Mapping
Day 4 : Feature Mapping
Day 5 : Feature Mapping
Day 6 : Feature Mapping & Road Profile
Day 7 : Road Profile.

Specification and Features of Equipments Used

(1)→ Trimble Juno 3B Handheld GNSS Receiver :-

Juno 3B is used as a GPS device (Global Positioning System).

Specifications :-

- Size : 138mm X 79 mm X 31 mm , Weight : 0.31 kg
- 800 MHz Samsung processor
- 256 MB RAM , 2 GB Data storage
- Display 8.9 cm (3.5 in) , QVGA (240 X 320 pixel)
- 5MP color camera and bluetooth
- Operating Temperature (-20°C to +60°C).

Features :-

- 12 Channels (GPS) (L1 code only)
- Accuracy : 2-5 m
- USB Data Cable and Stylus with lanyard.
- Easy to carry device, lightweight and compact.
- Provides both Real time and static modes with features like Line generic, Point generic and PolyArea generic.

(2)→ Trimble R10 GNSS Receiver:- It is a high precision GNSS (Global Navigation Satellite System) receiver designed for accurate positioning in surveying.

Specifications:-

- Small, lightweight design - 1.12kg
- 20Hz update rate
- Fully integrated 3.5G UMTS cellular modem
- Bluetooth wireless technology.

* TSC3 Controller:- Equipped with Windows 10 and Trimble Access Software. (-30°C to +60°C). 5MP auto focus camera & Wifi connectivity.

Features:-

- Incorporate 440 channels
- Supports all types of codes (L1, L2, E1, E5, B1, B2).
- Surepoint auto tilt compensation technology.
- Integrated receive and transmit radio.
- Measure points sooner with HD-GNSS.
- Trimble CenterPoint RTX correction technology.
- Accuracy: Static ⇒ 3mm - 3.5mm
  RTK ⇒ 8mm - 15mm
  CenterPoint RTX ⇒ 4cm - 9cm

(3), Auto Level :- Auto levels, also known as automatic levels or dumpy levels, are optical measurements used in surveying to measure height differences. It also consists of a scale rod called target staff.

Specifications :-

- Model — Nikon AC-2S Auto Level
- Magnetic Dampened Compensator
- Shortest focus : 0.75 m
- Magnification : 24x , Stadia ratio = 1:100
- Aperture : 30 mm , Tube length : 190 mm

Features :-

- Compact and lightweight
- Water-resistant construction
- Compensator field of view : 1°30'
- Accuracy : ±2 mm

* Levelling / Target Staff :- Least count = 1 cm.
  5m maximum height

(4) Trimble S5 Series Total Station :- Total stations are advanced surveying instruments that integrate the capabilities of electronic theodolites and electronic distance measurement (EDM) instruments.

Specifications :-

- Angular accuracy : 2"
- EDM accuracy : Prism = 1 mm + 2 ppm
  DR = 2 mm + 2 ppm
- Maximum Range = 5,500 m

Features :-

- DR Plus EDM technology
- Autolock, Magdrive, Sureloint
- Tracklight, Active Tracking
- Laser sighting & resection
- Reflectorless mode

Daywise Progress

* Day 0 (Reconnaissance)

After reaching Arogyadham, a meet with all the students and professor alongwith lab staff was held, in which we were given instructions how to proceed for the survey and a time table was given to be followed the following days.

After the meet, the lab staff shown us the area to be mapped and thus termed reconnaissance. We developed a plan as how to set up the control points so that maximum features were visible. It was decided by the group on the same day to set up 12 control points.

* Day 1 (GPS Survey using JUNO 3B)

The basic objective of this activity was to utilize GPS (Juno) to navigate as per provided map directions and collect data of features along the path. The path starts from DRI Arogyadham traversing the Kamadgiri Parikrama and then arriving back at DRI Arogyadham through the other path (NH 135 BG). We were given a hard copy of the path and a KML file to navigate.

Juno 3B features three methods to create the map viz. Point_generic, Line_generic and Area_generic. Point generic is used when only points are needed to do the traverse. Line generic is used to include the path line traversed and point generics can be stored in this mode as well. Area generic gives the area of the figure formed and thus needs to be closed figure.

The functionality of the Juno 3B was taught by lab staff. The devices issued to our group were numbers 7 and 19.

Start working by switching on the device and open the Trimble software. Select the mode u you want to work with. Like use 7 for Point generic and 19 for Line and Point generic. To locate feature, pause the timer and add comments then press done to save it.

* Day 2 (Control Point Establishment, GNSS Coordination and Auto Levelling)

Control Point Establishment:- With meticulous planning, we strategically placed the 12 of control points to maximize visibility of the features of the concerned area. Each control point was selected and positioned in a way that ensured a clear line of sight to as many features as possible. And each control point was visible by at least one control point to facilitate mapping accuracy.

GNSS Coordination:- After setting up the control points, we employed the advanced GNSS R10 equipment to determine the global coordinates of the established control points. This step is very crucial as it directly helps in making the map on global scale.

In this process, we set up the GNSS receiver R10 at every control point for at least

15-20 minutes and the coordinate data is stored in the TSC3 controller. This raw data is not accurate and thus need to be adjusted to obtain accurate coordinates. It is done with the help of a reference base station and closing the GNSS loop (control points) to satisfy the model.

Levelling :-

The levelling of the control points using given 100 m benchmark (BM) was the next task. This is done to determine the reduced levels at each control point.

Between any two points (BM or control point), we set up the auto level instrument approximately midway and erecting the levelling staff at next control point and ending the loop at BM.

The work was done in 3 loops by the height of instrument method. The unit throughout the survey is 'meter'.

Loop 1:

Point	Back Sight (BS)	Intermediate Sight (IS)	Fore sight (FS)	Height of Instrument (HI)
BM	0.982			100.982
CP4		1.503		
CP3	0.845		1.479	100.348
CP2	1.679		1.662	100.365
CP1	0.745		0.767	100.343
CP2	1.418		1.649	100.112
CP3	1.492		0.604	101
CP4		1.54		
BM			1.019	
Total	7.161		7.18	

Now,

$\Sigma FS - \Sigma BS = 7.18 - 7.161 = 0.019\,m$

$BM - \text{Last } BM = 100 - 99.981 = 0.019\,m$ (Okay)

Total traversed length, $L = 5.7 + 21.6 + 10.9 + 16.2 + 50.9 + 48.9 + 52.3 + 47.7 + 8.3 + 18.2 + 15$

$= 309.4\,m$

$= 0.3094\,km$

Error, $\varepsilon = 0.019\,m$

(Upper sight − lower sight) × 100 m

Reduced Level (RL)	Backsight Distance (BD)	Foresight Distance (FD)	ΔRL	Adjusted RL (RL + ΔRL)
100	5.7			100
99.479		7.8	0.0008	99.479
99.503	10.9	21.6	0.0017	99.505
98.686	50.9	16.2	0.0033	98.689
99.598	52.3	48.9	0.00947	99.607
98.694	8.3	47.7	0.0156	98.709
99.508	18.2	13.7	0.017	99.525
99.46		17	0.019	99.479
99.981		15	0.019	100

$$(\Delta RL)_i = \frac{\sum l_i}{L} \times \varepsilon$$ (length traversed till that point)

e.g., $(\Delta RL)_{CP4} = \frac{5.7 + 7.8}{309.4} \times 0.019 \approx 0.0008\,m$

$(\Delta RL)_{CP3} = \frac{5.7 + 21.6}{309.4} \times 0.019 \approx 0.0017\,m$

$(\Delta RL)_{CP2} = \frac{5.7 + 21.6 + 10.9 + 16.2}{309.4} \times 0.019 \approx 0.0033\,m$

* Parameter, $C = \frac{\varepsilon}{\sqrt{L}} = \frac{19\,mm}{\sqrt{0.3094\,km}} = 34.158 \approx 35$ (moderately accurate)

Loop 2 :

Point	BS	FS	HI	RL	BD	FD
BM	0.035		100.035	100	11.3	
CP5	0.66	3.173	97.522	96.862	17.6	26.7
CP6	1.522	1.67	97.374	95.852	17.1	21.9
CP7	1.865	1.722	97.517	95.652	25.4	21.5
CP6	1.711	1.663	97.565	95.854	23.1	18.5
CP5	3.288	0.698	100.155	96.867	22.1	17.1
BM		0.154		100.001		22.2
Total	9.081	9.080				

$\Sigma BS - \Sigma FS = 9.081 - 9.080 = 0.001\,m$

Last BM − BM = $100.001 - 100 = 0.001\,m$ > (Okay)

Since the error is only 1 mm, it is negligible and thus no need to adjust the error in RLs.

$$C = \frac{\varepsilon}{\sqrt{L}} = \frac{1}{\sqrt{0.2495}} = 2 \text{ (Highly accurate)}$$

* Day 3 (Levelling & Feature Mapping)

We continue our work of levelling of day 2 and start the work by closing the loop 2. and Then, we proceed with loop 3 and did the traverse closing the loop to the same BM of 100m. We then carried out the necessary calculations and thus finally calculated the Reduced level (RL) of all the control points with the help of these three loops.

Note → To calculate the RL of CP11 from CP8, we used an intermediate point as a new pseudo control point (which was only used to determine RL of CP11). This is because the elevation differences between these two control points was way more than the height of levelling staff and also due to rough visibility.

Loop 3:

Point	BS	FS	HI	RL	BD	FD
BM	0.407		100.407	100	18.1	
cp 8	1.699	1.401	100.705	99.006	10.5	45.6
cp 9	1.248	1.547	100.406	99.158	20.9	9.5
cp 10	1.867	1.921	100.352	98.485	18.2	21.4
cp 9	1.569	1.192	100.729	99.160	9.3	24.1
cp 8	0.181	1.723	99.187	99.006	14.5	11.6
IP	0.115	2.757	96.545	96.430	10.6	11
cp11	0.251	2.988	93.808	93.557	21.5	16.2
cp12	2.369	2.365	93.812	91.443	19	19.2
cp11	3.378	0.255	96.935	93.557	23.8	22
cp5	3.253	0.067	100.121	96.868	26.2	29
BM		0.121		100		23.6
	16.337	16.337				

$\Sigma FS - \Sigma BS = 16.337 - 16.337 = 0.000\ m$

BM - Last BM = 100 − 100 = 0.000 m > (okay)

Error = 0.000 m

Thus, perfectly accurate measurements.

Final Calculation of RLs :-

We combined and tabulated the RLs of same control point from all the loops and take average of these RLs to calculate final reduced level (RL) of these control points which will be used as elevation in total station.

CP	RL			
	Loop 1	Loop 2	Loop 3	Final RL (elevation)
CP1	99.607			99.607
CP2	98.699			98.699
CP3	99.515			99.515
CP4	99.479			99.479
CP5		96.865	96.868	96.866
CP6		95.853		95.853
CP7		95.652		95.652
CP8			99.006	99.006
CP9			99.159	99.159
CP10			98.485	98.485
CP11			93.557	93.557
CP12			91.443	91.443

Feature Mapping

After performing GNSS coordination and levelling, we obtain the final coordinates of our all control points on global scale in terms of northing, easting and elevation, which are analysed (tabulated) on the next page.

With more than an hour to spare, we start the main work i.e., feature mapping. On the 3rd day, we set up our total station, namely T/S5/N-04 on our first control point CP1 near Rasshala. After performing levelling and entering, we feed in the data (coordinates) of all the control points in the total station. We used CP2 as backsight to set up the total station at CP1.
Then, we started the feature mapping by storing contour points of the area and end the work of Day 3.

Final Coordinates of Control Points :-

ID	Northing	Easting	Elevation
CP1	2781731.889	486352.124	99.607
CP2	2781764.221	486257.460	98.699
CP3	2781780.080	486247.607	98.515
CP4	2781813.330	486238.850	99.479
CP5	2781856.929	486221.919	96.866
CP6	2781834.929	486188.967	95.853
CP7	2781799.393	486190.391	95.652
CP8	2781869.909	486273.349	99.006
CP9	2781886.062	486284.723	99.159
CP10	2781928.144	486282.676	98.485
CP11	2781905.555	486236.429	93.557
CP12	2781931.590	486206.324	91.443

* Day 4-6 (Feature Mapping)

For feature mapping, we use different codes for different features which are stated below:

Feature	Code
~~Plants~~	~~P~~
Trees	T
Bush	BS
Road	R
Boundary	BR
Buildings	BU
Light Pole	LP
Sewer	SW
Contour	C
Shrubs	S
Petrol Pump	PETROL
Temple	TEMPLE
Kund(water body)	KUND

During the subsequent three days (Day 4 to 6) of the survey camp, our primary focus revolved around detailed feature mapping using the Total Station at all 12 established control points. For some inaccessible points from the control points, we used the resection technique to locate the remaining features of the area. This resection method involved utilizing two known control points to create an intermediate control point using triangulation.

On Day 4, we start the work by setting up the total station at CP1 and storing all the features visible from CP1. Then we performed resection between CP1 & CP2 to set up an intermediate point IP1. Proceeding with the work, we set up total station at CP2 & CP3 and performed the feature mapping.

On Day 5, we set up total station at CP4 using backsight at CP3 and did the feature mapping (petrol pump, contour, buildings, road, etc.). Then we moved to CP6 and CP7 to map the residential (park) area and conclude the work by taking observations at CP8 near Aahar Vihar.

On Day 6, we start the work by setting up total station at CP9 and mapped the area in front of Aahar Vihar. Then we moved to CP12 to map the area of Matra Sadan. After lunch, we mapped the remaining area of Aahar Vihar using CP10. Thus, we conclude our work of feature mapping by setting up the total station at CP11. We also used an intermediate point IP2 using resection of CP11 and CP12 and CP6.

* Day 7 (Road Cross-section Profile)

During the final day of the survey camp, our task was to record the cross-section data of the road profile which start from the speed breakers in front of instrument distribution office to the security gate near Panchvati traversing a total length of 314 metres.

The objective was to store the coordinates of the marked points along the road (5 points at each 20 m, thus incorporating $\frac{[314 \to 320]}{20} + 1 = 17 \Rightarrow 17 \times 5 = 85$ points).

We start our work at CP5 to store points upto 60 meter and then CP11 to store points upto 160 meters. Then we performed resection (IP3) to establish point between CP11 and CP12 along road using CP11 & CP12. Using backsight, we establish total station on extreme sight point at 200 metres and did the mapping upto 260 metres. We set up another point IP4 to store points upto the final points at 314 m and call off our work concluding the survey camp.

Map Making Using QGIS Software

After concluding our survey camp, we import the collected data from total station to pen drive in .csv format. We opened the file in MS Excel and segregate the data codewise i.e., featurewise, to create different .csv files to add layers in the QGIS software.
The coordinates were derived on global scale thus we chose WGS 84 (44N) as coordinate system.
To show the map, we chose 1:1000 as the map scale.
To draw contours, we choose 0.150 m as contour interval i.e., 15 cm.
The Road profile is plotted in MS Excel.

Conclusion

- The CE332A Survey Camp, an intensive seven-day expedition in Chitrakoot, provided an immersive experience in practical surveying methodologies
- Our group's meticulous approach and collaborative effort were evident from the strategic establishment of 12 control points, leveraging GNSS technology to determine coordinates and levelling exercises to feature mapping and map making.
- This hands-on experience not only honed our technical competencies but also underscored the significance of adaptability and problem-solving skills in real-world surveying.
- Overall, the camp was an invaluable journey, equipping us with practical insights and skills crucial for future endeavors in surveying and mapping endeavors.
- We are thankful to the lab staff and mentors for supporting us throughout the survey camp.

Precautions and Bottlenecks

- **Equipment Calibration:-** Regular calibration and maintenance of surveying equipment are crucial to ensure accuracy.

- **Weather Conditions:-** Precautions must be taken to account for weather conditions that might hinder visibility.

- **Obstructions & line of sight:-** Challenges in visibility due to obstacles like trees, buildings, or terrain features. The use of resection techniques and careful planning is essential to address such bottlenecks.

- **Human Error and Training:-** Adequate training of personnel operating the equipment is crucial to minimize human errors.

Suggestions for Future Work and Recommendations

- Provide continuous training and workshops to keep up with the latest advancements in surveying technology and methodologies.
- Encourage collaborative research initiatives with other academic institutions or industry partners to expand knowledge and explore innovative methodologies in surveying.
- Mounty areas can be chosen to prepare map of the vulnerable areas with a slight fun.