Garscube Project Submission

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Project Deliverables

Surveyor should sign to confirm project deliverables (individual files submitted to Moodle) in Table 1.

Table 1

Deliverable	Document Filename	Surveyor (Student Number)
Report (this document) (pdf)	GEOG5020_LS1_Garscube_Report_Template_Zhaocheng Tan2964649T	Zhaocheng Tan （2964649T）
Map (pdf)	24MOND MAP_Garscube Sport Centre_Zhaocheng Tan2964649T	Zhaocheng Tan （2964649T）

Report - Topographic Survey of Garscube

28/10/2024 –04/11/2024

Zhaocheng Tan - *2964649T*

Executive Summary

- **Project Summary:**

On October 28, 2024, I and other members of Group D used technologies such as GNSS, total station, level gauge, and RTK to conduct topographic surveys of Garscube and its surrounding areas. After the field survey was completed, I preprocessed the data and independently completed the production of a Garscube Sports Complex Project Map.

- **Key Results:**

1. The coordinates and elevations of the control points were measured by GNSS and level gauge, and the final elevation data was calculated through the adjustment calculation of the level gauge data.
2. The angle and distance data of the control points and buildings were obtained through the total station so that the specific coordinates of the buildings could be calculated later in the n4ce software.
3. The range coordinates of parking lots, roads, small bushes, and street lights were measured by RTK.
4. A measurement control network was established, the measurement report output by n4ce software was used, and topographic maps and project reports were produced.

- **Problem:**

On the day of the measurement, the weather was cloudy and rainy, and the air humidity was high. The optical lenses of total stations, level gauges, etc. were prone to fogging and getting damp, affecting the observation line of sight and accuracy. The work intensity on that day was relatively high. In addition, due to the muddy and slippery roads on rainy days, surveyors were prone to slipping and falling when walking and transporting instruments and equipment in the wild, and the work efficiency of the team on that day was relatively low.

Survey Brief and Specifications

- **List of objectives:** establish a control network, measure coordinates and elevations of control points, obtain topographic detail data, produce topographic maps and reports.

- **Location overview:** Garscube Sports Centre is located to the north of the University, postcode G20 0SP.

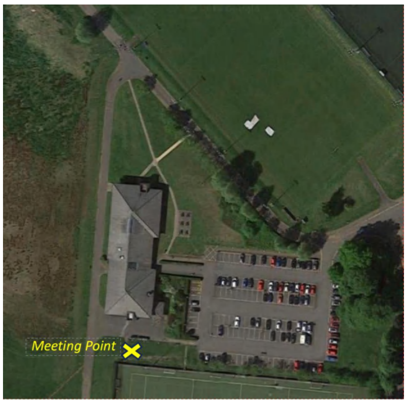

Figure 1Garscube Google Maps Satellite view

- ***Specification :***

Plan Accuracy Band: G--1 sigma +/- 100mm; 2 sigma +/- 200mm

Height Accuracy Band: F--1 sigma +/- 50mm; 2 sigma +/- 100mm

GNSS: Measurements of C, D, E (plus A or B if necessary) are taken using a Global Navigation Satellite System (GNSS) mounted on a bipod/tripod. An average of 10 readings will be taken (or a suitable equivalent, e.g. 6 minutes of observation as directed by the crew).

Leveling: Calculating the height difference between their control points observed in a loop. Observations should start and finish at the same point.A digital Level will be used. A misclosure should be calculated andifgreater than 3mm, the loop or leg should be remeasured until a satisfactory result is obtained (if time allows).Regardless of results a Bowditch adjustment should be performed to your initial reduced levels.

Total Station: Using points C, D and E, capture the detail of the outline of the building (as a minimum) using your Total Station. A prism on a detail pole can be held at a selected RO to set the orientation. We should capture some of the detail from at least 1 of the 3 control points, and the error in the point position of a feature point relative to a neighbouring control point should not exceed ±0.05m, and the error in the elevation of an elevation notation point relative to a neighbouring control point should not exceed ±0.07m.

RTK: Features to be measured include roads, paths, kerbs, fences, street light poles, etc. The appropriate code should be selected for each feature and recorded before recording the point locations with the controller.

Resources

Materials and information: Materials such as project manuals, assessment forms, basic safety instructions documents, emergency contact and medical forms, and information such as links to Google maps are provided.

Equipment: GNSS receivers, Total stations (Leica FlexLine TS06), Single Base Station RTK (Leica SmartNet), Tripod, Prism and prism pole, Leveling rod, nail stakes and digital levels were used.

Personnel:

Name/Job	Levelling	RTK GNSS	GNSS Control	TS Detailing
Allison Theresa Leyer	Booker	Booker	Booker	Booker
Chenning SUN	Instrument Person	Observer	Instrument Person	Observer
Yidan Tang	Observer	Observer	Instrument Person	Instrument Person
Yue Yang	Staff peroson	Booker	Marker	Prism Person
Yunru Pan	Observer	Observer	Instrument Person	Prism Person
Zhaocheng Tan	Staff peroson	Observer	Instrument Person	Marker

*2 RTK equipments using simultaneously

Figure 2 Members of Group D and work arrangements

Planning & Reconnaissance

- **Task summary**: A survey was carried out to locate and mark the control points and Detail Points.

- **Problems**: The location of the control points was poorly chosen and there should have been a better solution. At the time the control points could have been chosen with visibility in mind, without considering other future circumstances that could affect the achievability, for example, when measuring point D at point C the view was often blocked by weeds growing in the middle of the moorland, which shook into the view in windy conditions, which in turn affected the measurement. Our group had to send someone to clear the weeds away, which was not difficult but this could have been avoided when selecting the control points.

Fieldwork

- **escription of operation:**

GNSS receiver: install and adjust the height of the tripod on the three control points C, D and E, place the total station on the tripod and connect it, move the tripod for alignment, adjust the foot screw for levelling, and finally check the alignment and levelling situation. Set parameters, establish control net measurement control points, wait for six minutes measurement, collect coordinates and elevation data of C, D, E three control points.

Total station: install and adjust the height of the tripod on the three control points C, D and E, place the total station on the tripod and connect it, move the tripod for centring, adjust the foot screw for levelling, and finally check the centring and levelling situation. After all the above are in order, we first carry out control measurement, then carry out feature fragmentation measurement on the building, then process the data, and finally draw the topographic map.

RTK: Setting up the reference station and mobile station, measuring the detail points, such as car parks, roads, grass, street lights, according to the survey area on the map, and finally exporting the data for post-checking and processing and plotting.

Level: Choose a stable, flat place with good visibility, our team tried to choose the middle of two points to facilitate subsequent calculations and avoid systematic errors. After choosing a suitable point for setting up, open the tripod and adjust the height, install the level on the tripod, move the tripod to roughly centre the level, adjust the foot screw to centre the level bubble and complete the levelling, and then check the alignment and levelling status. After there is no problem above, we will start to measure, first of all, we will focus the telescope on the rear view level, through the eyepiece to make the cross filament clear, and then use the objective lens to focus the spiral to make the image of the level clear, read the reading of the rear view level, and record it down. Then we rotate the telescope by 180°, aim at the front sight level and take the reading of the front sight level.

- **Equipment and personnel performance**:

The equipment operated normally, but some problems were encountered during operation, such as instrument setup and calibration, and our team had to spend too much time on pre-setup and levelling. The personnel performance was good, all the group members were very friendly, there were 4 Chinese students in the group and 1 from other countries, we also used English to communicate in the group discussion, which was convenient for all to understand, but I have to say we still need to communicate more fully, and also need to further improve the operation skills and teamwork ability.

- **Weather effects**:

As mentioned before, the weather was cloudy and rainy, which had a certain impact on the measurements, it will affect the use of the instrument and the accuracy of the observations, and also make it inconvenient for people to move around.

Processing & Office Work

- ***Data download and preliminary checks:*** *Total station and GNSS data were downloaded and preliminary checks such as data completeness and accuracy were carried out.*
- ***Reference summaries, photographs, sketches:*** *Materials such as the project manual, assessment forms, basic safety instructions documents, emergency contact and medical forms were referred to, as well as photographs of control points taken and sketches of terrain details drawn.*
- **Data processing:**

1.Data Import:

(1) Import control data into 'Stations' folder, set the data interpretation order, check the data integrity and accuracy, and view the control points through the graphical view.

(2) Import total station detail observation data, select the correct format and check the attributes.

(3) Import RTK.csv file, set the data layout, check and process the imported data.

2.Data processing:

Calculate detail point coordinates, set tolerances and perform calculations, generate reports and view results, perform graphical checks.

3. Model Creation and Adjustment:

Create a new model, set name and scale, import data, view model and add control points, adjust coded point display settings, control data processing using code.

6. Plot Creation and Editing:

Create new drawing, set relevant parameters, open drawing space, create view and import model, adjust view position and size, add legend, control point list, map title and metadata, etc., save drawing and close.

7. Generate PDF output:

Open the drawing, check the paper settings, make sure the print range contains all the drawing contents, set the printing parameters, generate a pdf file and check its layout, display, range and resolution.

Results & Analysis of Results

GNSS results:

NAME	EASTING	NORTING	HEIGHT
C	255264.946	670116.480	33.667m
D	255302.962	670229.037	33.208m
E	255334.730	670167.364	33.210m

RTK results:

NAME	EASTING	NORTING	HEIGHT
C	255264.907	670116.51	33.693m
D	255302.858	670219.94	33.537m
E	255334.746	670116.51	33.693m

We also used RTK to measure the terrain around the stadium as well as the features, but there is only one piece of data that can't be compared with the others, neither can we do an error analysis between different equipment and measurement methods, so I only listed the coordinates of the C, D and E control points and the high level.

Total Station results:

NAME	EASTING	NORTING	HEIGHT
C	255264.902	670116.49	33.691m
D	255302.849	670229.052	33.529m
E	255334.753	670167.400	36.219m

We also measured the four corners of the stadium building using a total station, but there was only one piece of data that could not be compared with the others, neither could we do an error analysis *between different equipments and measurement methods, so I only listed the coordinates of the C, D and E control points and the high level derived from the n4ce calculations.*

Leveling results:

NAME	HEIGHT
C	33.667m
D	33.100m
E	36.244m

Series Levelling with Rise and Fall Booking Method

Assumes arbitrary TBM of A at 100m. Note observation sequence in BS and FS columns.

Survey Activity / Task: Levelling					Weather Conditions: Overcast			
Location: Garscube	Date: 28-10-24		Time: 09:42		Observer: Y.T, Y.P			
Booker: A.T.L	Staff person: C.S, Z.T, Y.Y		Instrument: SPRINGTER/LEICA		Serial Number: 24MOND			
Backsight (BS)	Foresight (FS)	Rise	Fall	Reduced Level (RL)	Point ID	Adjustment	Adjusted RL	Comment & Distance
0.598				100	C	N/A	100	Start Datum. Paces:
3.517	1.051		0.453	99.547	D	-0.114	99.661	Paces:119
0.885	0.174	3.343		102.890	E	-0.199	102.691	Paces:88
	3.423		2.538	100.352	C	-0.352	100	Paces:159
∑BS =5.000	∑FS =4.648	∑Rise =3.343	∑Fall =2.991	Misclosure =0.352				
∑BS - ∑FS = 0.352		∑Rise - ∑Fall =0.352						Total paces: 366

The data in column Adjustment and Adjusted RL is fixed due to in[illegible]opriate formula used in calculation.

1. Data comparison

1.1 Coordinate comparison

- Coordinate data of control point C:

The comparison shows that the GNSS and total station coordinates are almost identical, while the RTK data is slightly off. This deviation is not completely negligible in precision measurement, but it is still within a certain permissible range.

- Coordinate data of control point D:

Here it can be observed that the north coordinate of RTK (670219.49) is deviating a lot, which indicates that there is a big error in the RTK method in the measurement of control point D.

- Coordinate data of control point E:

The north coordinates of control point E also show a large RTK deviation, especially the RTK north coordinate (670116.51) is significantly different from the GNSS and total station results.

1.2 Elevation comparison

- Elevation data of control point C:

The results of GNSS and Level are consistent, while RTK and Total Station are slightly higher, but the difference is in millimetre level.

- Elevation data of Control Point D:

The difference in elevation here is large, especially the RTK and total station results are tens of centimetres higher than the level and GNSS, showing a large deviation.

- Elevation data of control point E:

There is a significant difference between the results of GNSS and Level, the elevation value of Total Station is nearly 3 metres higher than that of GNSS, which may be caused by measurement error or data recording error.

2. Error analysis

According to the above comparison, it can be seen that different measurement methods produce different degrees of error, and the main reasons may be as follows:

1. Error of RTK data: RTK method is a real-time dynamic differential technique, which is greatly affected by the environment. For example, factors such as multipath effect, signal masking, and the distance between the base station and the mobile station will affect the accuracy of RTK. The obvious deviation of the north coordinates of control points D and E may be caused by poor signal reception.

2. Elevation error of total station: The elevation data of the total station has obvious abnormality at control point E, which may be caused by improper calibration of the instrument or operation error. In addition, the total station needs to carry out sight distance elevation calculation when measuring *elevation, if the ground is uneven or the instrument is not placed correctly, it may lead to elevation deviation.*

3. Difference in accuracy between GNSS and level: Both GNSS and level measure the elevation of point C and the results are consistent, which indicates that GNSS static measurement has high stability in elevation, but GNSS is slightly lower than level at points D and E. This may be due to the multipath effect of satellite signals or small errors caused by atmospheric delay.

3. Improvement initiatives

In order to reduce these errors and improve the measurement accuracy, the following measures can be taken:

1. Optimise the RTK measurement environment: Try to choose an open and unobstructed area for RTK measurement to reduce the influence of multipath effect. If necessary, the location of the base station can be adjusted to ensure that the distance between the base station and the mobile station is within a reasonable range.

2. Increase measurement redundancy: Where conditions permit, obtain redundant data by taking multiple measurements or using multiple methods (e.g., joint use of GNSS and RTK), and correct errors through data comparison and analysis to ensure the reliability of the results.

3. Calibration and standardised operation of total station: Calibrate the total station regularly, especially the elevation measurement part. When operating on site, make sure the instrument is placed horizontally and avoid tilting. At the same time, you can use repeated measurements and comparison of horizontal elevation differences to reduce the error.

4. Combine with levelling instrument to measure elevation: for the measurement tasks that require high elevation accuracy, you can use levelling instrument to remeasure the elevation after GNSS or total station measurement to ensure the accuracy of elevation data.

Conclusion

1. On the day of measurement, the weather was cloudy and rainy with high humidity in the air, so the optical lenses of the total station and the level meter were easy to be fogged up and damp, which affected the observation line of sight and accuracy.
2. Poor choice of control point location, for example, when measuring point D, the line of sight of point C was often blocked by weeds growing in the wilderness, and when there was wind, the weeds shifted into the line of sight, affecting the measurement, although people can be sent to clean up, but should be avoided when choosing the control point.
3. Problems were encountered in the operation of the instruments, such as excessive time spent on setting up and calibrating the instruments.
4. Different measurement methods produce different degrees of errors, for example, the RTK method has a large deviation in the measurement of control points D and E, which may be due to poor signal reception; the elevation data of the total station at control point E have obvious abnormalities, which may be due to improper calibration of the instrument or operational errors; and there are discrepancies in the elevation measurement of the GNSS and the levelling instrument at some points.

References

1.Tiberius, C., van der Marel, H., Reudink, R. and van Leijen, F., Surveying and Mapping.

2.Awange, J. and Kiema, J., Fundamentals of Surveying and Geodesy.

3.Chekole, S.D., Surveying with GPS, Total Station, and Terrestrial Laser Scanner: A Comparative Study.

4.Kizil, U. and Tisor, L., Evaluation of RTK-GPS and Total Station for Applications in Land Surveying.

Appendix

As required.