

The Practicality of Trigonometric Heighting

Comparing Trigonometric Heighting, Geometric Levelling, and GNSS Heighting

Technical Report Presentation by
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Introduction

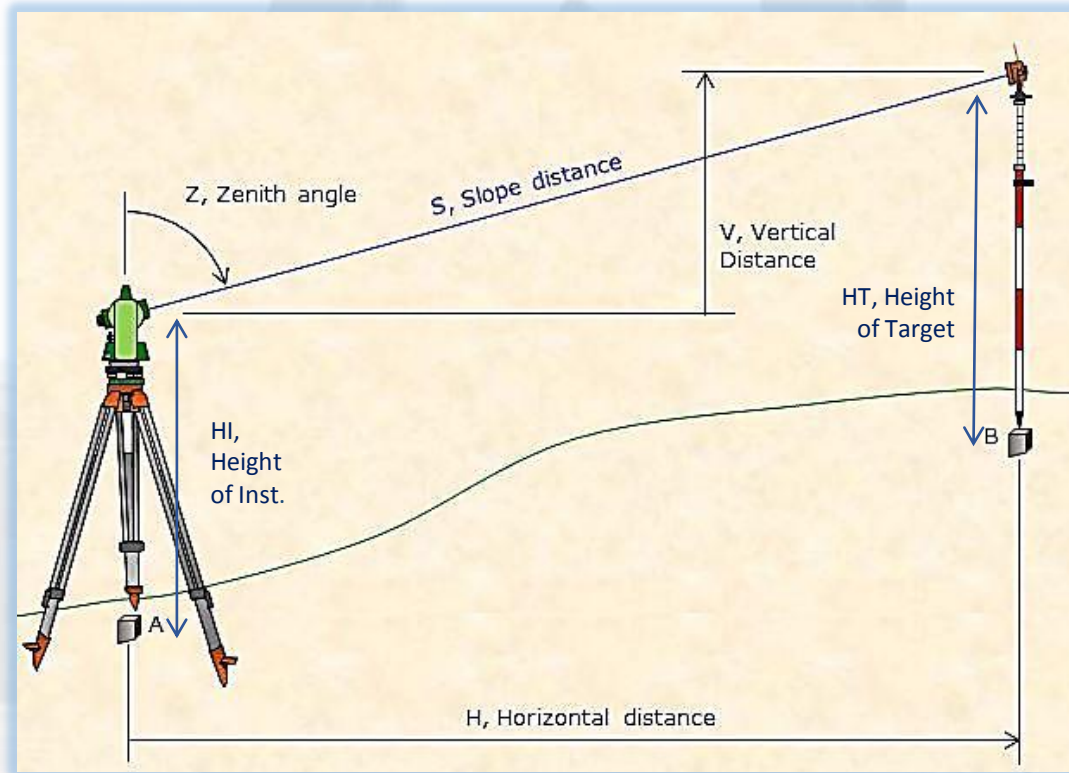
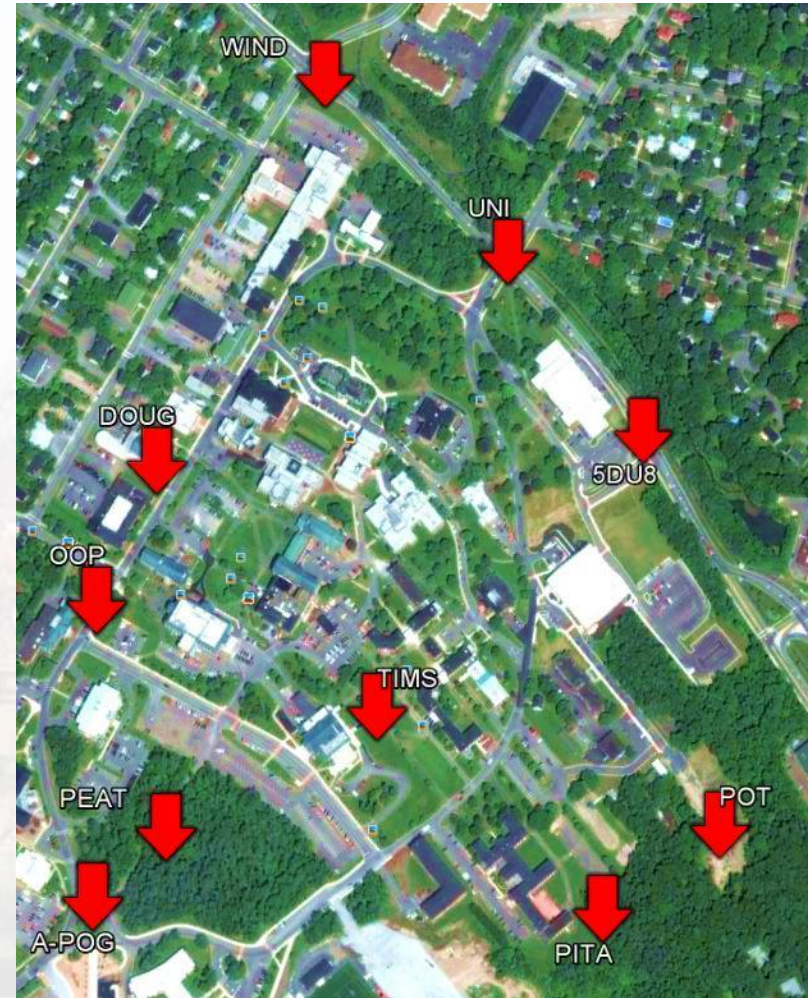


Figure 1: Diagram of Trig Heighting Observables
Image Obtained From <http://www.jerrymahun.com/>

- What is trigonometric heighting?
- Historically considered inferior in quality to levelling
- Previous efforts have proven that good results are possible
- But is trigonometric heighting practical today?

Comparison of Heighting Methods

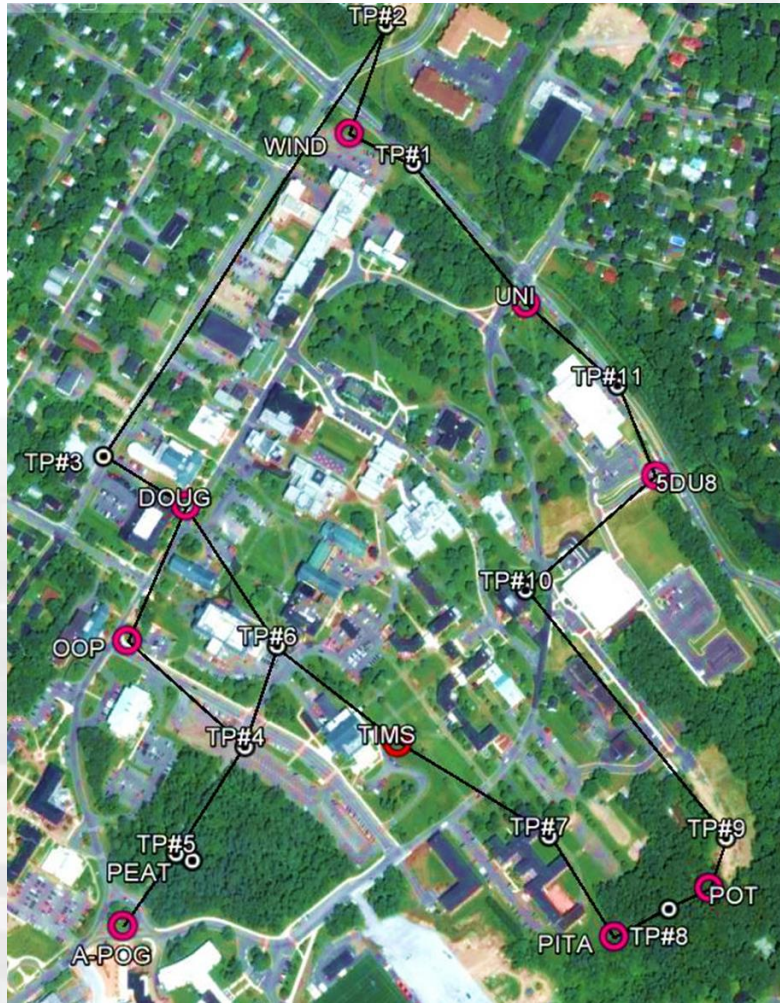
- Establish heights of UNB control network in order to compare:
 - Trigonometric Heighting
 - Geometric Levelling
 - GNSS Heighting
- Comparison of quality
- Comparison of practicality



UNB Control Network

- UNB Network designed to challenge students abilities
- 10 primary points (monuments) with many more temporary traverse points (nails/laths)
- Point locations and lines of sight are not ideal
 - Poor inter-visibility
 - Tree cover
 - Mix of ground cover
- Perfect conditions to compare the practicality and data quality

Design and Methodology



- Traverse designed to attain best possible vertical results while contributing to 2-D survey
- Refraction mitigation through field procedures
- Elimination of systematic errors in HI/HR through experimentation

Field Work

- Levelling

- A few hours of recon with 3 days and counting of field work
 - Slow progress through snow and around obstacles
 - Issues with lighting conditions on rod

- GNSS

- 3 days of field observations (4 hours on each station)
 - Affected by snow bank obstruction at some points
 - Issues with equipment shutting down

- Traversing

- 5 days of intermittent field observations including reconnaissance
 - Slow progress in areas where snow banks required shovelling
 - Weather conditions made mitigating refraction difficult

Data Processing

- Levelling

Ongoing (Incomplete) – will be easier after learning Star*Net with Traverse

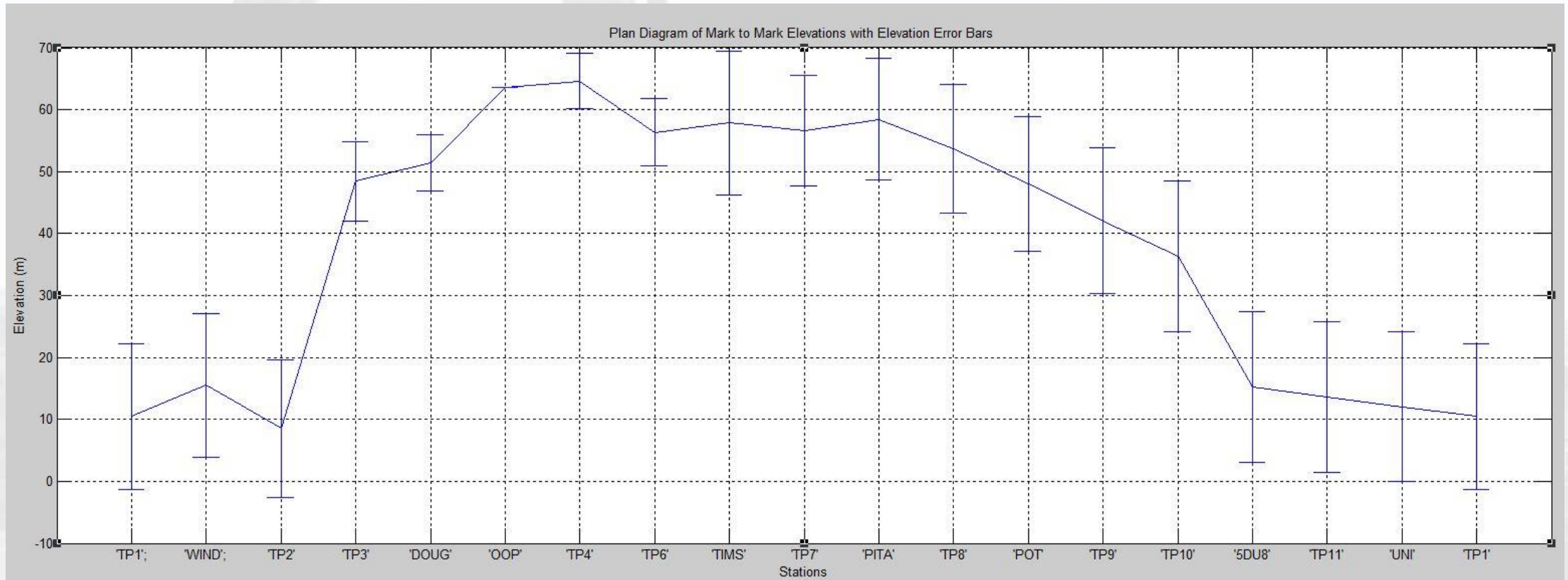
- GNSS

Several Days – conversion of files and adjusting with Trimble Total Control

- Traversing

Many days spent due to (ongoing) learning curve of Star*Net

Data Processing



Plan Diagram of Elevations with Station Errors Scaled by a factor of 1000

Comparison of Results

Station	Trig Heighting Adjusted Elevation Error (m)	Geometric Levelling Misclosure (m)	GNSS Adjusted Elevation Error (m)
DOUG	0.0043	Sub mm	0.0307
UNI	0.0115	To be determined	0.0255
5DU8	0.0116	To be determined	0.0099
POT	0.0103	To be determined	0.0695
PITA	0.0093	To be determined	0.0356
OOP	0*	Sub mm	0.0100
TIMS	0.0072	Sub mm	0.0082
WIND	0.0110	Sub mm	0.0210

* Station 'OOP' set as fixed during processing

Comparison of Results

Criteria (score of 1-3 based on a weight of 1-5)	Weight	Levelling	GNSS Heighting	Traversing
Planning Effort (Office / Recon)	2	2	3	1
Field Efforts (Person-Hours)	5	1	3	2
Cost of Survey Equipment	4	3	1	2
Precision	4	3	1	2
Adaptability (Performance in all Terrain)	3	1	2	3
Data Processing (Time and Cost)	3	3	1	2
Total Score		45	38	43

Conclusions

- Best overall results achieved with digital level
- Trigonometric heighting in certain conditions is much more practical than geometric levelling or GNSS heighting
- GNSS heighting not recommended for heighting in most applications

Lessons and Recommendations

- Trigonometric heighting has practical applications in certain conditions (Thick Forest/Steep Terrain)
- It is very applicable where best possible precision is not required (~ 1 cm)
- Weather dependent observations are not the most practical
- Robotic total station would be even more practical

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