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OPERATIONALIZING THE USE OF TOTAL STATION IN HIGH-ORDERED LEVELING

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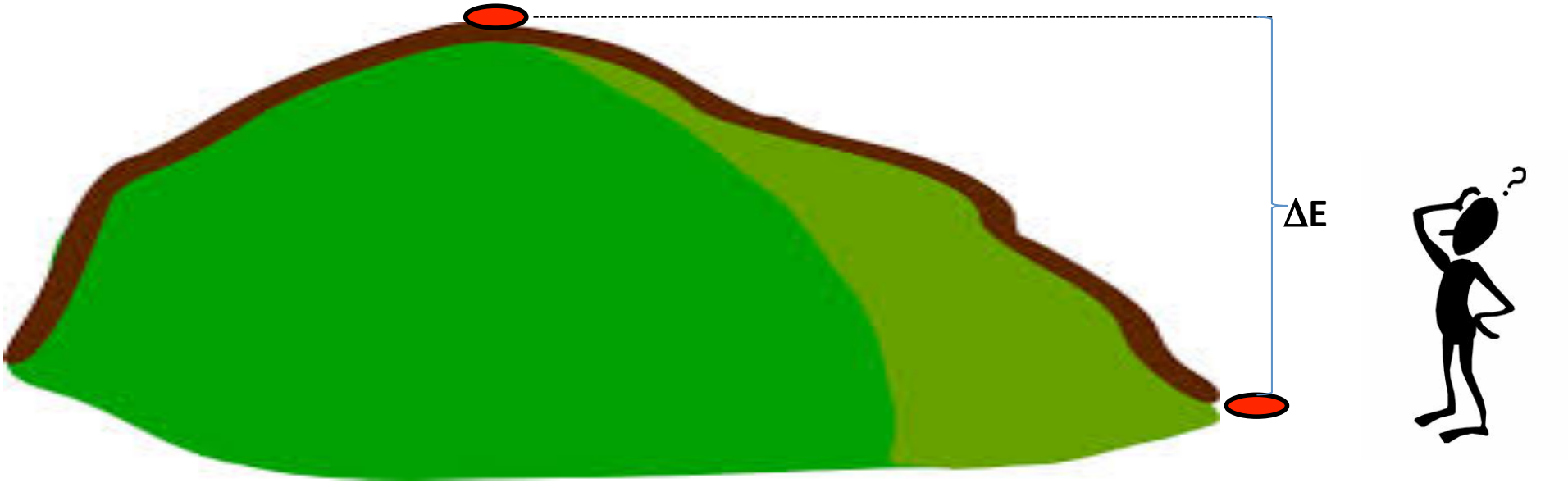
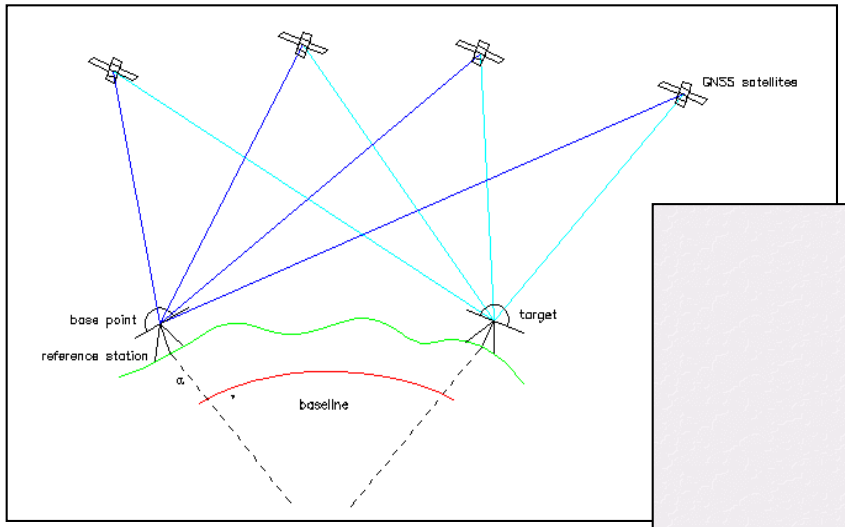
Louie P. Balicanta

INTRODUCTION

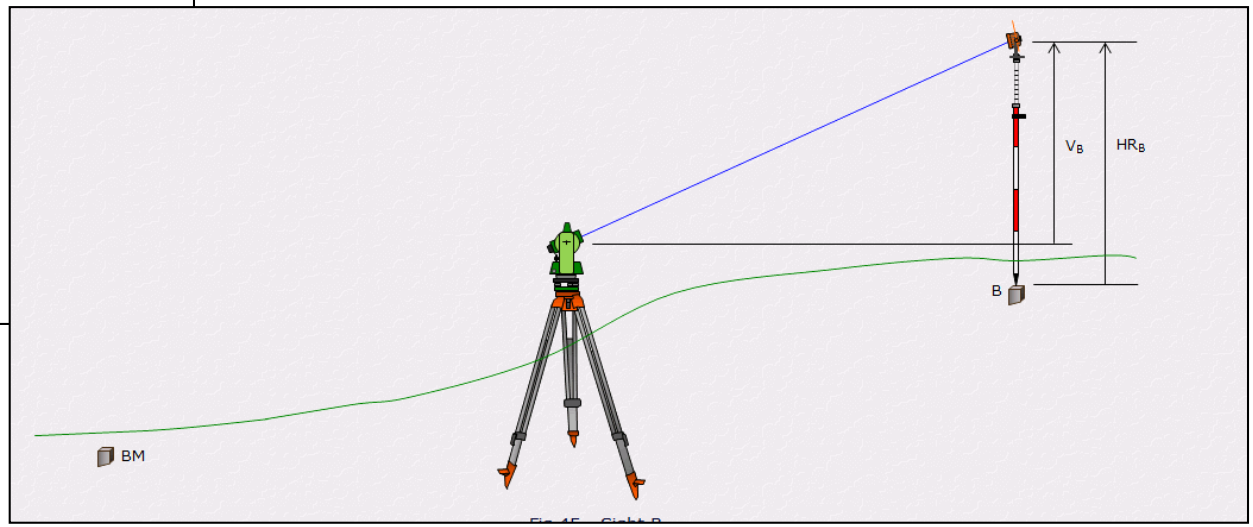
LEVELING



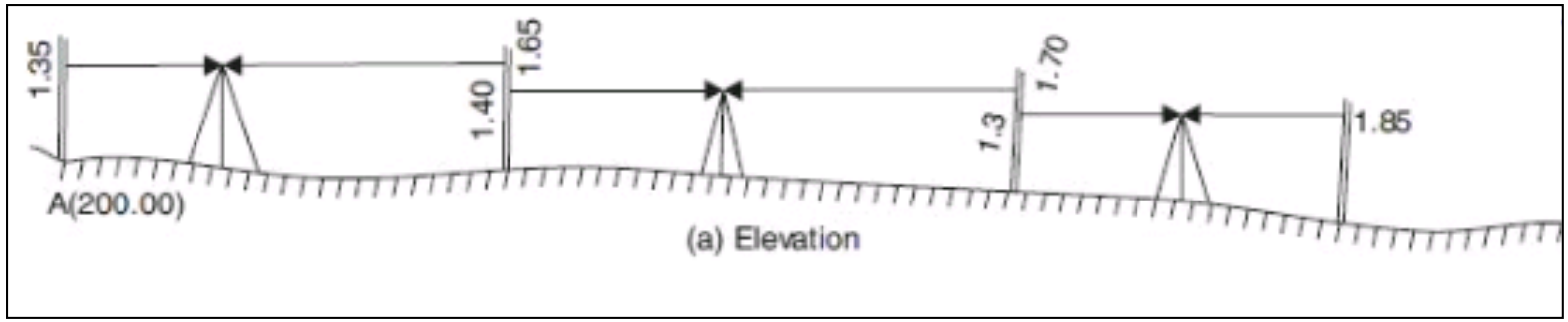
INTRODUCTION



GNSS Leveling



Indirect/ Trigonometric Leveling



Direct Leveling

RESEARCH MOTIVATION

Why TL with TS?

•Due to the advancement in total station technology

• least reading in angular and distance measurement has improved over the years

RESEARCH MOTIVATION

Phase 1 (Balicanta, Ines & Ramsa 2012)

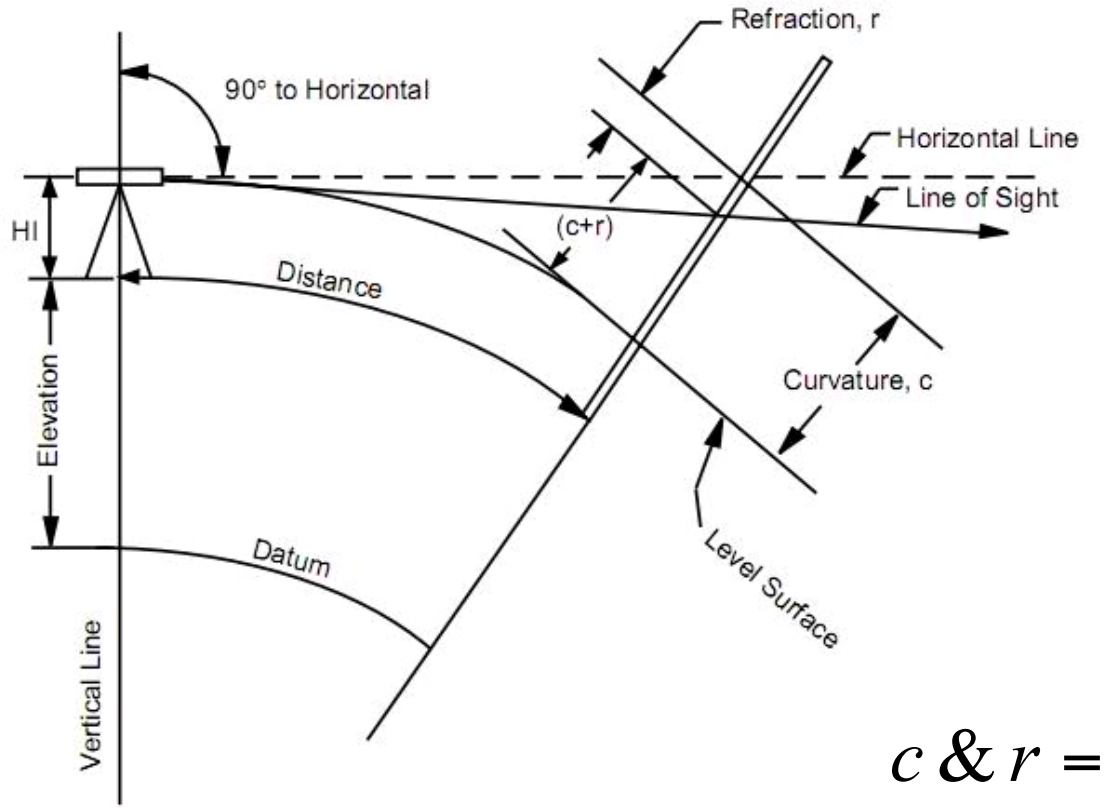
- fixed experimental set-ups between points on the ground fronting Melchor Hall, UP Diliman and points at the third floor of the same building

- high ordered leveling of at least third order accuracy can be achieved

Phase 2 – this research

- Vertical control establishment
- To operationalize the use of TS for H.O.Leveling

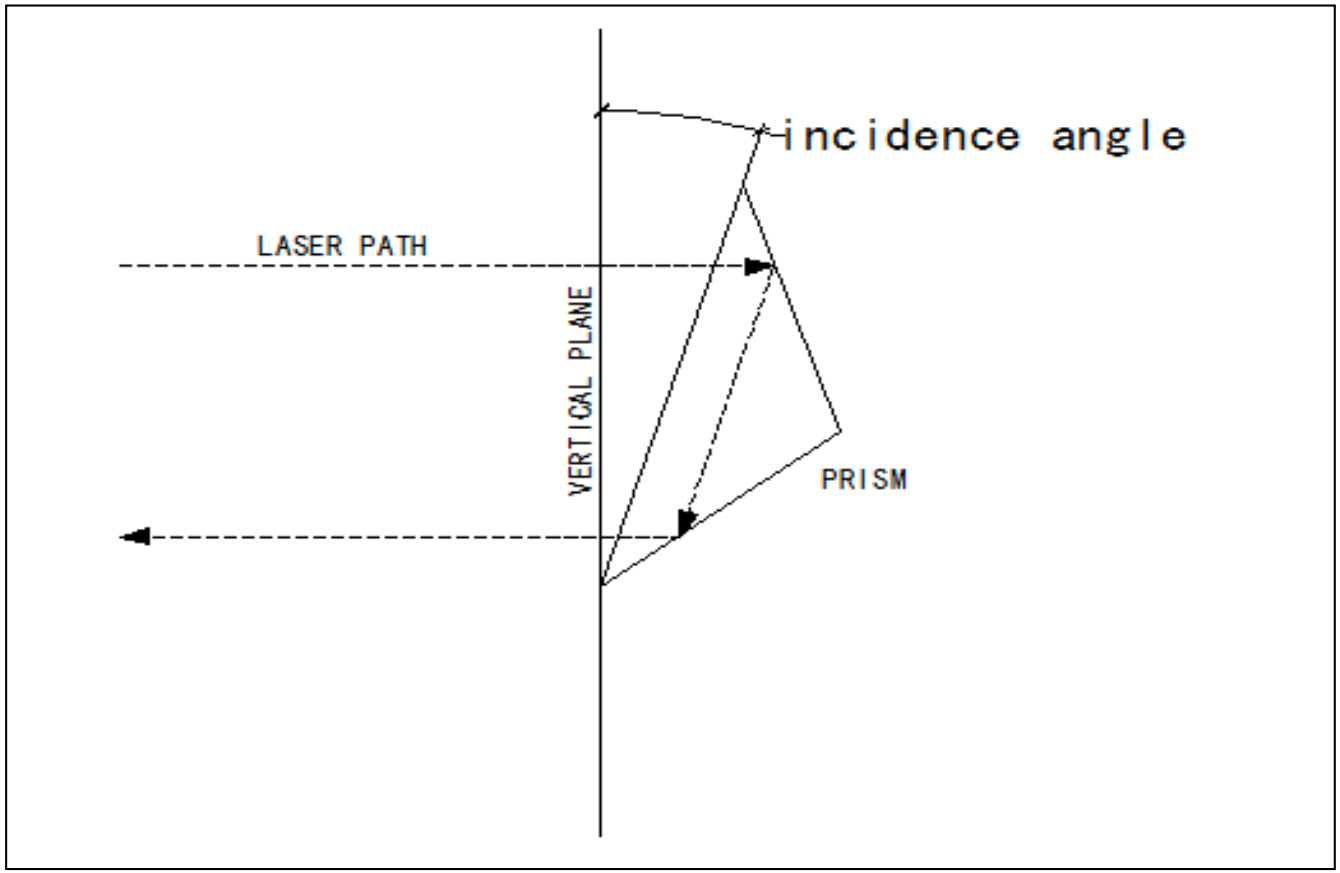
REVIEW OF RELATED LITERATURE
Error Sources: C&R effect



$$c \,\&\, r = 0.0675K^2$$

REVIEW OF RELATED LITERATURE

Error Sources: Incidence Angle



Total Station Laser Path with Incidence Angle

REVIEW OF RELATED LITERATURE

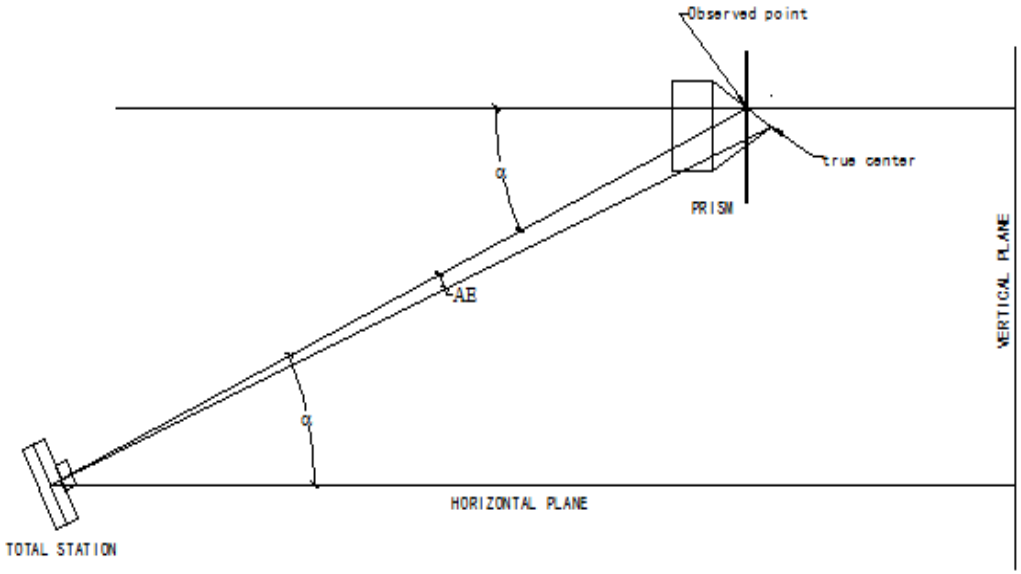
Error Sources: Index Error

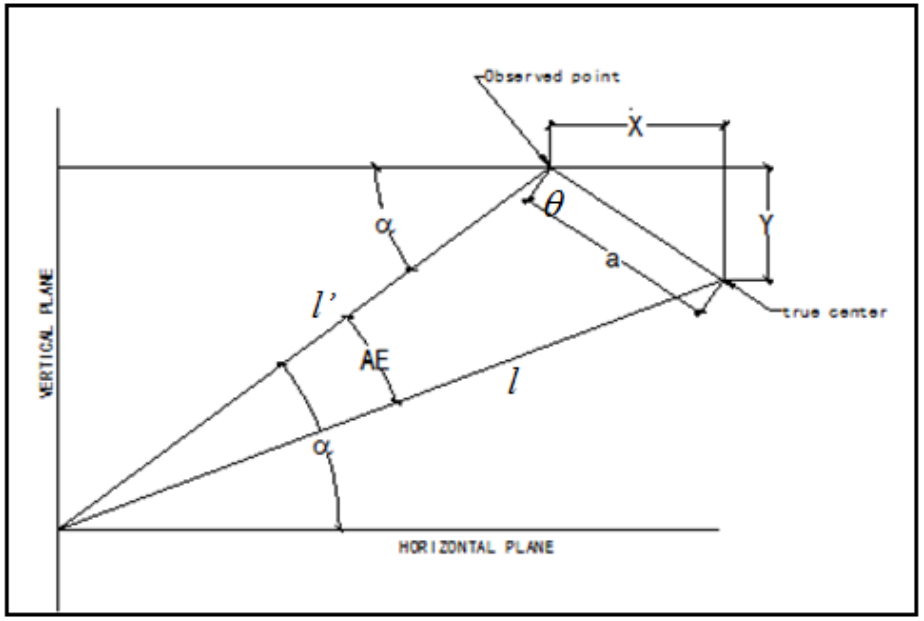
- observed if the TS is not perfectly leveled thereby affecting the vertical angle (Cruikshank, 2005)

- Double Centering Method

$$i = \frac{(VA_D + VA_R - 360^o)}{2}$$

REVIEW OF RELATED LITERATURE
Error Sources: Prism Marker Offset





$$tanAE = sin\theta/((l'/a) - cos\theta)$$

$$corrected\,VA = \alpha \pm AE$$

$$l = a\,sin\theta/sinAE$$

where:
α = observed angle
Y = offset along the vertical axis
X = offset along the horizontal axis
θ = 180-(α + atan (Y/X))
a = offset distance
l' = observed slope distance
l = true slope distance

REVIEW OF RELATED LITERATURE
Leap Frog Method

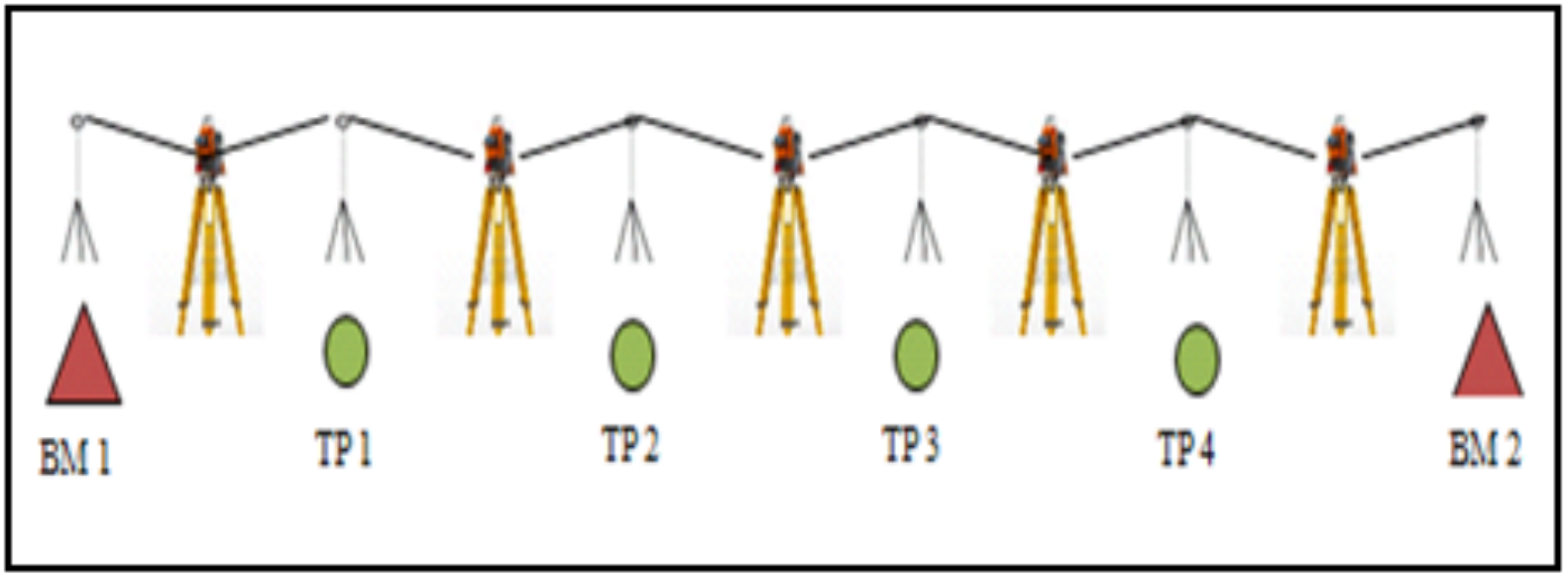


Fig. 3 Leap Frog Trigonometric Leveling Method Set-ups

METHODOLOGY

$$VD = l' \sin(cVA)$$

$$\Delta E = Hpt_{BS} \pm VD_{BS} \pm VD_{FS} - Hpt_{FS}$$

Enhanced Field Technique
-(LFTLM)
-poles fixed on tripod
-Prism held fixed upright position
-Recording of height of prism and pole
-Equal backsight and foresight distances
-Recording of SD, Vertical angle

↓

Application of Systematic Corrections
-Index Correction
-Angular Correction due to pointing error

↓

Corrected Leveling Observations
-Corrected vertical angle
-Corrected slope distance

Total Station Differential Leveling

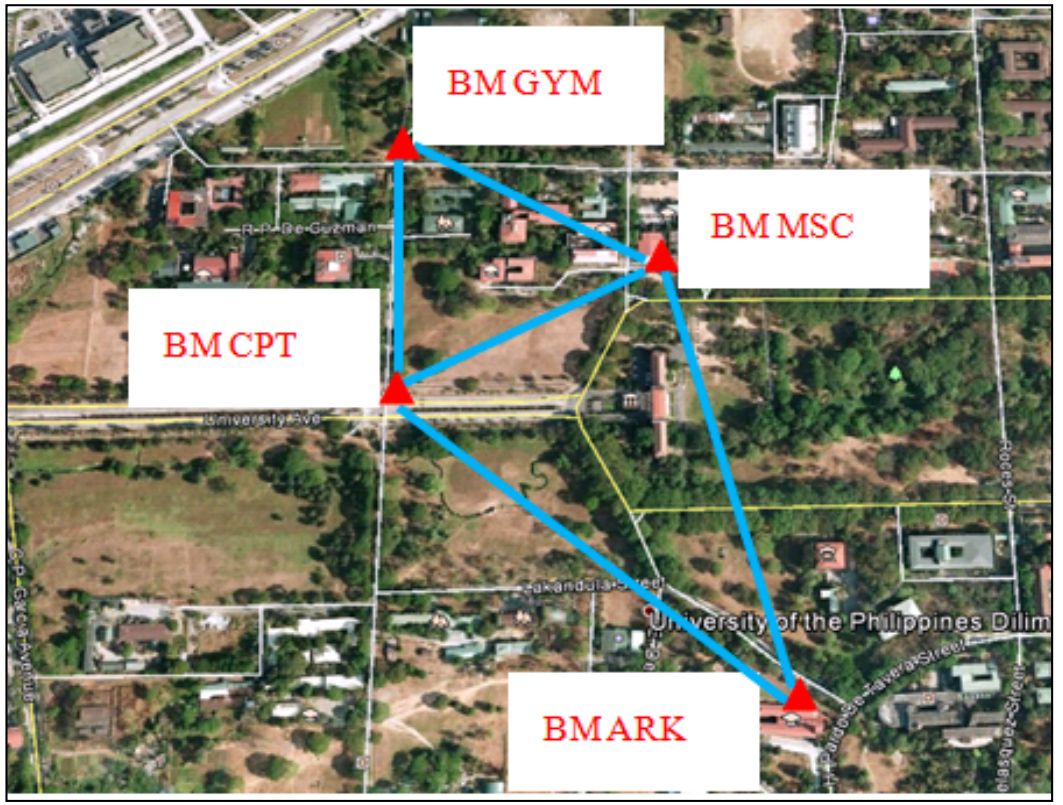
Experimental Set-up

- Nikon NPR-332
- Topcon Digital Level (for Validation)
- Index error =22”
- Diff. ΔElev

  <=12mm sqrt (K)

  <= 8.4mm sqrt(K)

  <= 4mm sqrt(K)



RESULTS

Table 1: Precision Assessment between the Two Sets of TS Leveling

Lines	NIKON NPR-332 with corrections		Distance in km	Difference (mm) Set 1 vs Set 2	Precision
	Set 1 DE (m)	Set 2 DE (m)			
MSC to GYM	-6.231	-6.230	0.471455	-1.000	First Order
GYM to CPT	-1.131	-1.131	0.287809	0.000	First Order
MSC to ARK	1.011	1.018	0.528385	-7.000	Third Order
CPT to ARK	8.381	8.381	0.55428	0.000	First Order
CPT to MSC	7.372	7.365	0.368798	7.000	Third Order

RESULTS

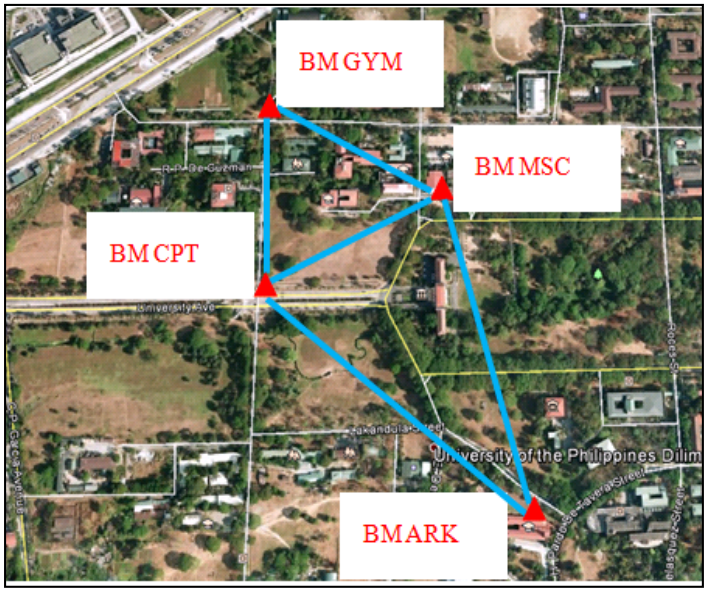
Table 2: Accuracy Assessment between Adjusted Digital Level DE and Average DE TS Leveling

Lines	Digital Level	NIKON NPR-332 with corrections		Distance in km	Difference (mm) Level DE vs Ave TS DE	Precision
	Adjusted DE (m)	Set 1 DE (m)	Set 2 DE (m)			
MSC to GYM	-6.233	-6.231	-6.230	0.471455	-2.500	First Order
GYM to CPT	-1.130	-1.131	-1.131	0.287809	1.000	First Order
MSC to ARK	1.020	1.011	1.018	0.528385	5.500	Second Order
CPT to ARK	8.383	8.381	8.381	0.55428	2.000	First Order
CPT to MSC	7.363	7.372	7.365	0.368798	-5.500	Third Order

RESULTS

Table 3: Time spent for each level line for digital level and total station differential leveling

Lines	Digital Level time per Set (min)	Total Station time per set (min)
MSC to GYM	30	30
GYM to CPT	15	10
MSC to ARK	39	45
CPT to ARK	45	53
CPT to MSC	24	30



CONCLUSION & RECOMMENDATION

- A methodology to perform TS differential leveling was provided that can be used by surveying practitioners.

- Results of the experiment showed that high ordered leveling at least third order can be achieved with the use of a 1 second and 1 mm least reading TS

- Full capability of using the unit was not fully met since most of the level lines has vertical angle reading not more than 5 degrees and maximum distance less than 150 meters

CONCLUSION & RECOMMENDATION

- Time spent for both digital level and TS leveling seems to be comparable but still inconclusive

- Recommended that additional research and experiments be done using longer level lines and using points that are highly elevated or depressed to obtain vertical angles greater than 5 degrees to further test the capability of TS for high ordered leveling works

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