

FIG

FIG WORKING WEEK 2017

Helsinki Finland

29 May - 2 June 2017

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Optimum establishment of total station

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Motivation and content

- Questions from practitioners: where is it better to set up total station: Centering on a control point? If free station, where in relation to the control and detail points?
- Best horizontal location with respect to optimality criteria
 - Least uncertainty in total station coordinates
 - Least uncertainty in detail point coordinates
- Recommendations



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What is the best location of total station?

Criterion: least uncertainty in total station coordinates



1. Small resection angle ?
2. Resection angle 90° ?
3. Resection angle 180° ?
4. Centring on control point?



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What is the best location of total station?

Criterion: least uncertainty in detail point coordinates



1. Small resection angle ?
2. Resection angle 90° ?
3. Resection angle 180° ?
4. Centring on control point?
5. Close to DP?



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And the best location is.....



- Centroid of all control points, if uncertainty of total station coordinates is to be optimised (even uncertainty in orientation is least)
- If uncertainty of detail point coordinates is to be optimized, the location of total station does not play any role
- These conclusions are valid exactly (analytical proof) only under assumption that all points surveyed from the total station have the same horizontal uncertainty expressed in the total station's coordinate system ("equal uncertainty assumption")



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What if “equal uncertainty assumption” does not hold?

- In practice, it does not, precision depends on distance
- No general, closed solution exists, the optimality problem must be found iteratively or empirically, we applied empirical approach
- Standard uncertainties in total station coordinates, orientation and in detail point coordinates were computed for discrete locations of total station
- The best location depends on chosen weights (uncertainties in measured angles, distances and uncertainties in centering and coordinates of control points)
- We used $u(d) = 2 \text{ mm} + 2 \text{ ppm}$, $u(\psi) = 1.5 \text{ mgon}$, $u(\text{CP}) = 10 \text{ mm}$



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“Equal uncertainty assumption” does not hold

The best location for symmetric distributions of control points is again centroid

For non-symmetric distributions and reasonable weights, the best location is close to the centroid

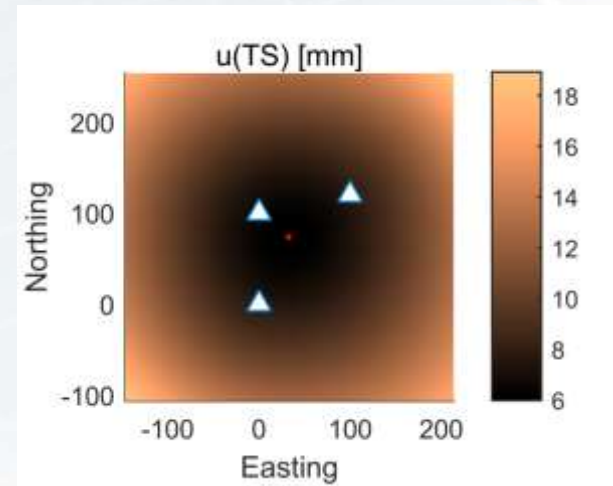
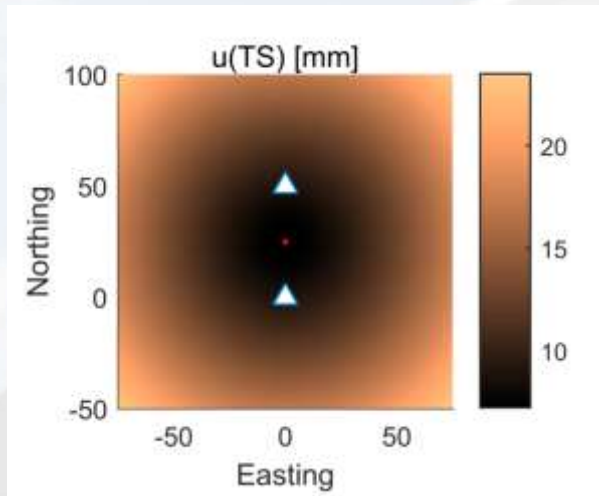




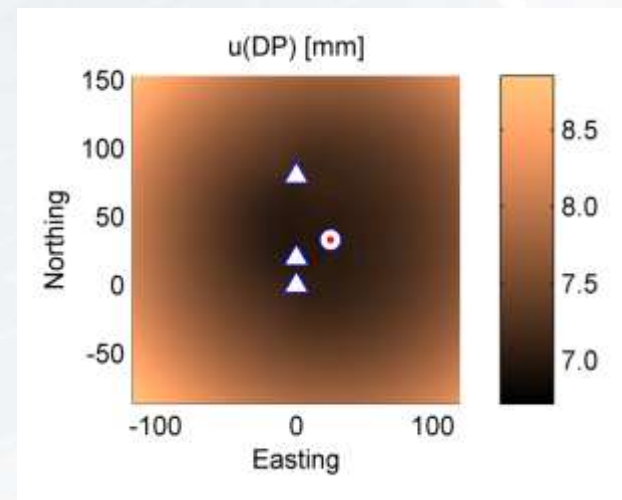
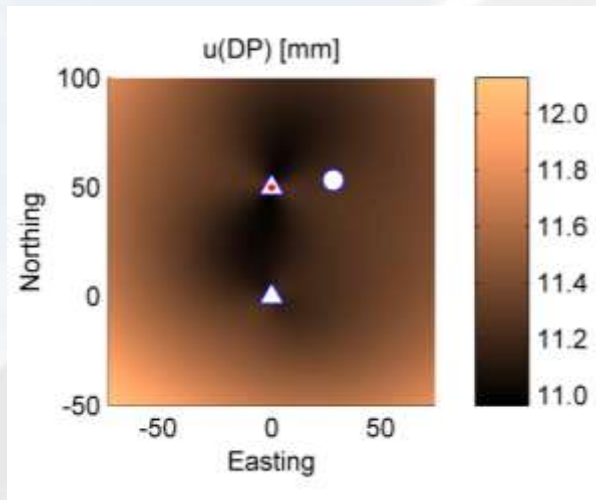
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Standard uncertainty in coordinates of detail point $u(DP)$ varies very slowly and its least value depends on the number and distribution of control points



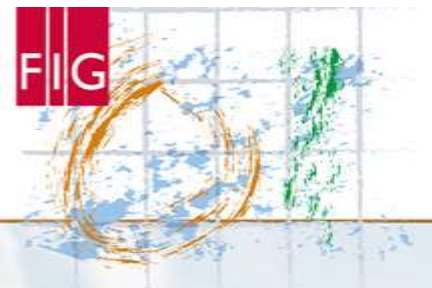


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Conclusions

- The best location of total station is in or close to the centroid of control points, if uncertainty in total station coordinates should be least
- If uncertainty in detail point coordinates should be minimised, the choose any location with the best visibility towards detail and control points
- The reliability (ability to detect and/or resist gross errors) does not depend on the chosen location; it depends on number and distribution of control points. Use at least 3 control points!
- If you have possibility to choose location of control points (e.g.combination with GNSS) distribute them around the working area



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Thank you
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