Advanced DistoX Calibration

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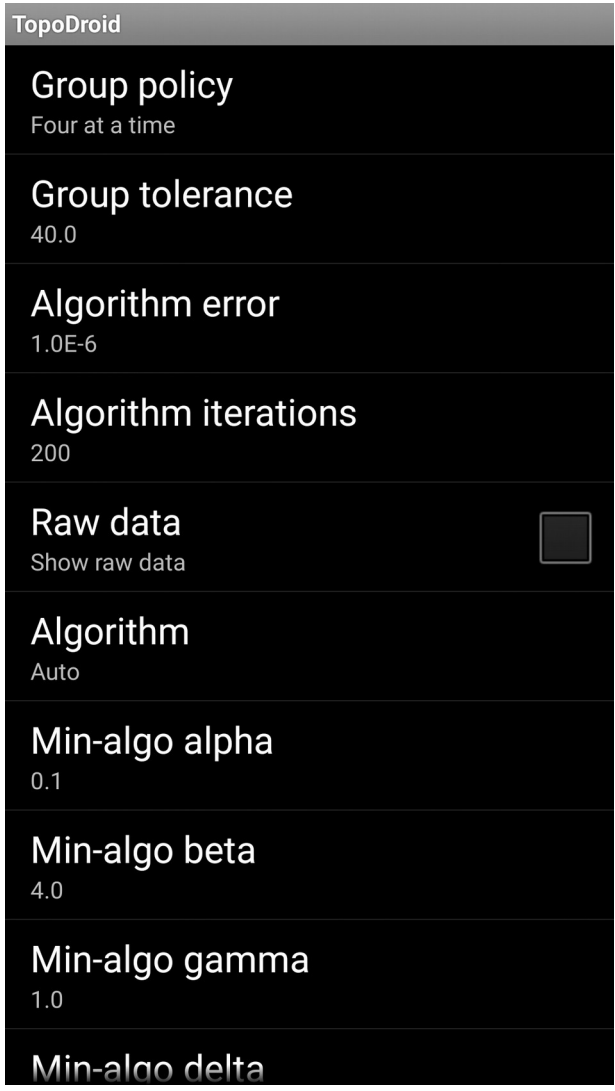
TopoDroid calibration settings

- **Grouping policy**
  - **four by four**
  - four by four for the first 16, then individually
  - by the angular distance
- Angular distance tolerance
- **Algorithm**
  - **auto**
  - linear
  - non-linear
  - [alternative error minimization]
- Algorithm exit error
- Algorithm max. number of iterations
- **Raw data display**



TopoDroid calibration functions

- delete a shot (recoverable)
- reassign group numbers starting from a shot
- shot angular distribution display
- calibration cross-validation

Calibration checks

- A-B azimuth+clino consistency at different rolls
- A-B and B-A azimuth+clino consistency
- triangle closures: A-B, B-C, C-A

B. Heeb *Memo: DistoX accuracy precautions* 2010-05-11

TopoDroid calibration validation

- cross-comparison of two independent calibrations
- in-group errors of calibration A shots using the coefficients of calibration B
- in-group errors of calibration B shots using the coefficients of calibration A
- for each shot differences between values corrected with coefficients of calibration A and those corrected with coefficients of calibration B

Calibration algorithms

- Iterative error minimization
- Linear (G' calibrated, G sensor values)
  - $G' = B_G + \mathbf{A}_G G$
  - $M' = B_M + \mathbf{A}_M M$
- non-linear
  - instead of G use the “linearized” $G^L = G - \mathbf{G}^S N$

$\mathbf{G}^S = \mathrm{diag}(G_x^2, G_y^2, G_z^2) - \mathbf{1}/2$

N non-linearity (estimated)

B. Heeb *A general calibration algorithm for 3-axis compass/clinometer devices* 2011

Heeb's calibration algorithm

- B. Heeb's algorithm error function

  $E^2 = 1/n \, \Sigma_i \, |G'_i - \underline{G}_i|^2 + |M'_i - \underline{M}_i|^2$

$\underline{G}$ true values, G' calibrated values

- Data in a group differ by the roll angle: this is estimated and data are reduced to the roll of the first in the group

  $G'' = \mathbf{R}_\phi \, G'$

- Minimize with respect to calibration parameters

rotation angles of “true” values G

dip angle: $\tan(a) = \Sigma \, |M_i \times G_i| \, / \, \Sigma \, M_i \, G_i$

- Overall roll ambiguity: impose $G_{yz} = G_{zy}$

Heeb's algo

- $s_a = \Sigma \sin\sphericalangle(G,M), \quad c_a = \Sigma \cos\sphericalangle(G,M)$
- $B° = E[G]$, $\mathbf{A}° = E[\ \text{outer}(G,G)\ ]$, same for M
- $\mathbf{G}° = (\ \mathbf{A}° - \text{outer}(B°,B°)\ )^{-1}$
- Iterate, from $B_g=0$, $\mathbf{A}_g=1$, ...
  - $G^r = B + \mathbf{A}\, G^s$
  - For each group adapt vectors to first vector
  - Get “true” group vectors
  - Estimate s_a, c_a
  - Estimate roll angles and “true” data vectors
  - Update $B = E[G]$, $\mathbf{A} = E[\ \text{outer}(G,G)\ ]$

TopoDroid Minimal Algo

- Error function

$$E^2 = \Sigma\, |G_i^2 - 1|^2 + \Sigma\, |M_i^2 - 1|^2$$

$$+ b\, \Sigma\, |G_i M_i - a|^2$$

$$+ c\, \Sigma_{group}\, E[(G_x - \langle G_x \rangle)^2] + E[(M_x - \langle M_x \rangle)^2]$$

- Iterative minimization