DistoX calibration basics

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What is a “calibration”?

- Analogy: a scale

Equilibrium indicator

Mechanical calibration

$M\,[g] = 5\,n + 500\,N + m\,x - M_0$

The position x of the calibration mass m is set
so that the scale reads M=0 when the plate is empty

Why “calibration”?

- The DistoX contains tri-axial Magnetic and accelerometric sensors
- The sensors axes are not perfectly orthogonal
- the X sensor axes are not perfectly aligned with the laser direction
  - placement of chips on the board
  - installation of the board in the device
- sensors have different bias and gain
- Magnetic effects
  - due to magnetic components (hard-iron)
  - induced by earth field (soft-iron)

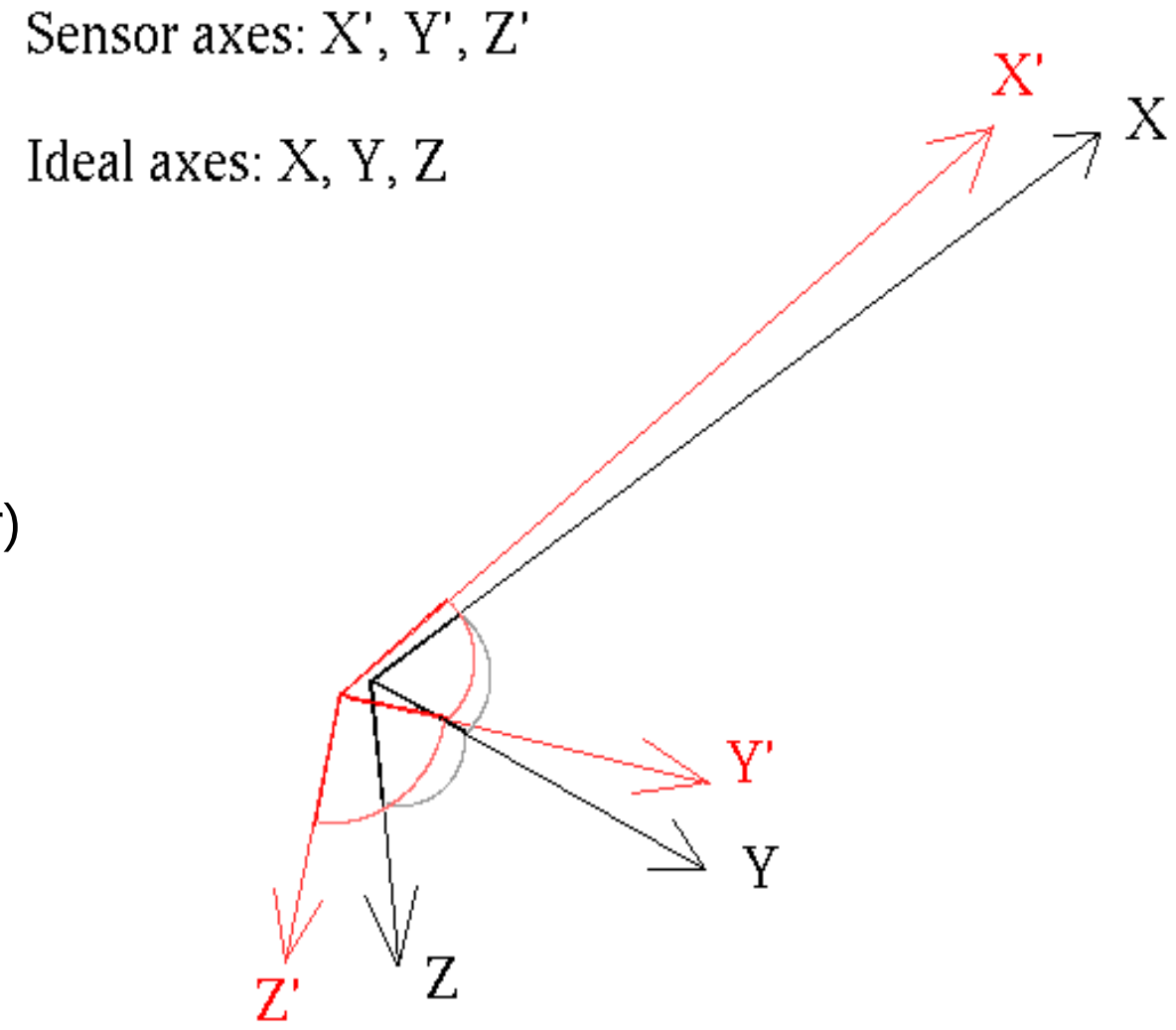
Sensors

Each sensor has its own (non-orthogonal) axes

- offsets
- gains
- rotations

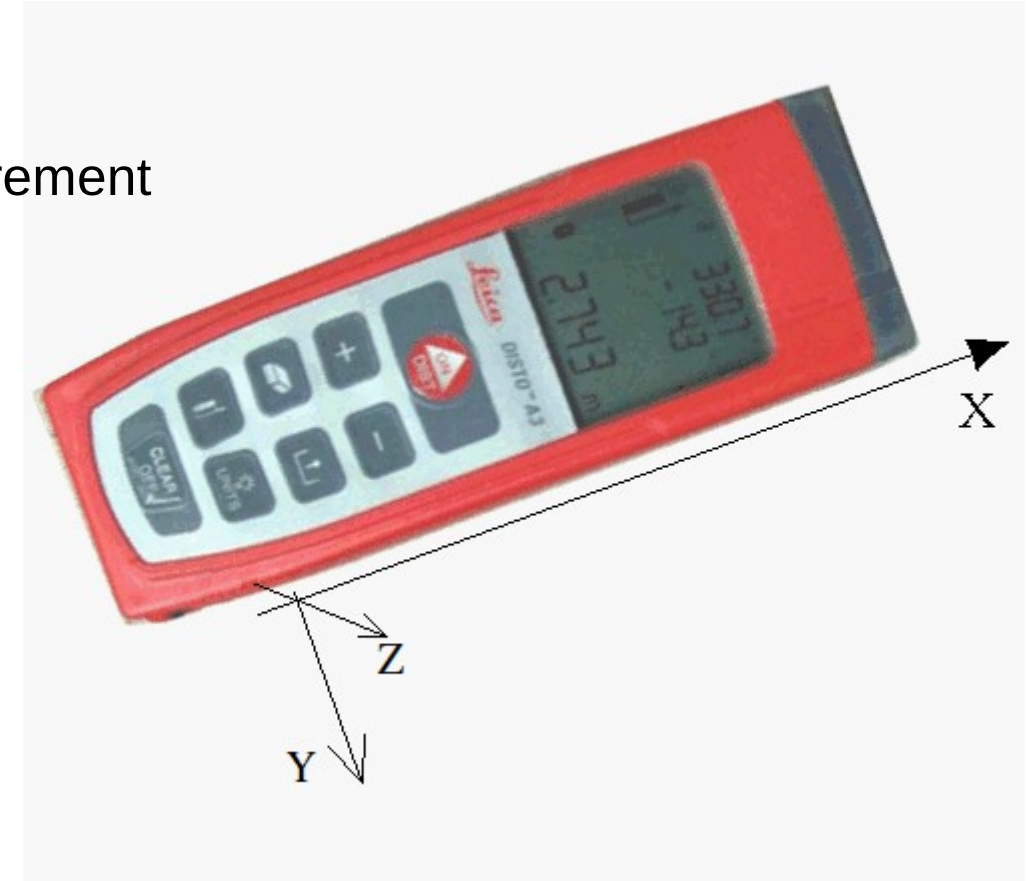
- correction (1sf order)

V = B + A * V'



Calibration transformation

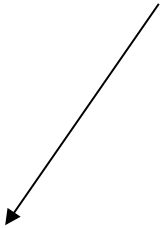
- the DistoX calibration is a geometrical transformation that “rotate” the sensors measurements into the frame of reference of the DistoX
- 24 (or 27) numbers
- uploaded and stored in the DistoX
- automatically applied to every measurement



Calibration

In principle Minimize the discrepancy between values obtained by applying the calibration transformation to sensors data, and “real” values

In practice Exploit the “redundancy” of the rotation about the X axis (roll invariance)



Find the coefficients of the sensors transformations

Store them into the DistoX

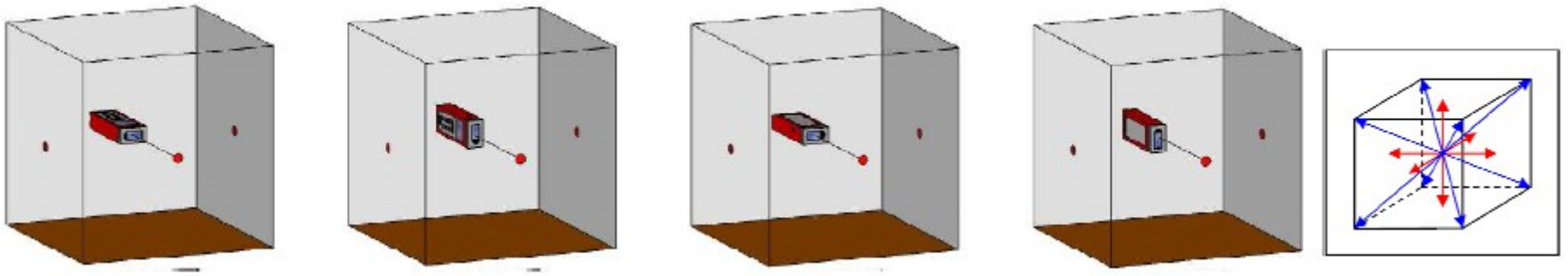
- the DistoX applies the trafnsformation to every sensors data
- from G,M (DistoX frame) computes azimuth, clino, roll
- stores azimuth, clino, roll

Calibration in practice

- Take several measurements in directions that **covers all the azimuth and inclinations**
- For each direction **four** measurements rotating the DistoX around the laser axis by 90° at a time
- At a minimum (face centers and corners of a “cube”):
  - four directions in the horizontal plane, roughly at 90° of azimuth with one another
  - four directions at +35°, and four at -35°, roughly at 90 degrees of azimuth with one another, possibly at 45° of azimuth with those in the horizontal plane
  - one direction upward +90°, and one -90°
- But you can take many more !!!

Calibration advices

- Calibration shots must be taken
  - in an environment with **constant magnetic field**: cave, wood. Not good: house, town, etc.
  - between **fixed** points: “stations”
  - enough **far apart** points (the farther the less uncertainty in the angle): 3 m
  - no need to be perfectly aligned to the “directions” of the “cube”



From L. Redovnikovic et al., INGEO 2014, 269-274