Pointcloud alignment: Combining LiDAR scans from different positions

Stefan Seifert, SCIMOND
Anton Kunecke, Stellenbosh University

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- How to combine two TLS point clouds from different positions?
  - Directly measure the scanner position (GPS, totalstation)
  - Use identifiyable points (reflectors, labels) to measure the scanner position
  - Identify structures (e.g. primitives) in both scans to match the clouds
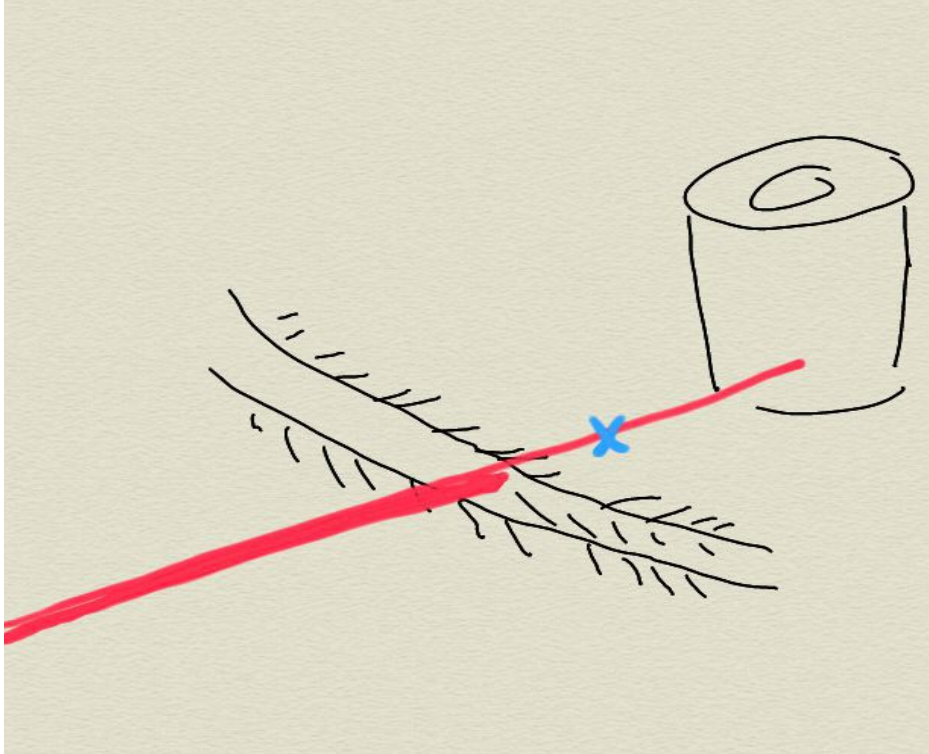
Direct Position

- GPS
  - Dirrerential GPS
  - Free Sky
  - GSM network
  - XY-accuracy ~ 1 cm (SAPOS-HEPS)
  - Z-accuracy ~ 2 cm
  - No orientation of the scanner
- Total Station
  - Measure the relative positons of the scanner
  - Need marker/prisms to calculate the scannner center
  - Second tool to carry
  - Precision 1 mm

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Targets / Reflectors

- Artificial objects
  - Easy to identify (colour, reflectance)
  - Known shape (sphere, cylinder, circle, billboard)
  - Rescan / finescan necessary for shape fitting
 - Enough reflectors visible form both postions

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Pitfalls

- Too few reflectors clearly visible from both scan positions
  - At least 4 reflectors needed to seen from both scan positions
  - Partly occluded (wrong center!)
  - Need some more to calculate stddev and find errors
  - To minimise angular errors, some distance is required

Hints

- Allways check the reflector postions from both scan positions

- Have a look at the reflector fine scans

- Place enough reflectors

Fit primitives

- Identify structures in the scans which are visible from both positions
  - Ground
  - Stems
  - Branches
- Fitting cylinders on a partly scanned stem/branch is tricky
- Use medial axes to register both scans

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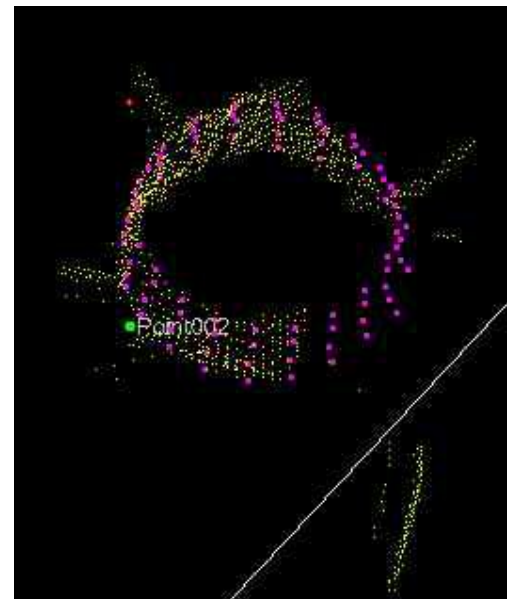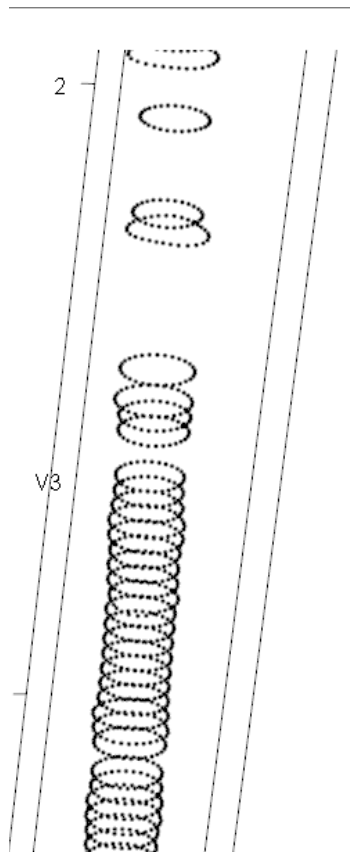
Fit planes

- Identify structures which can be used to match both scanpositions
  - Planes like bare ground, walls, sign-boards
  - Fit the plane in both scans and use ist to fix one axis
  - At least three differently orientated planes are needed
  - In architecture easy, but in forests?

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Fit cylinders to stems

- Fit cylindes to stem pointcoulds, which are seen from both scanpositions

    - From the same direction → same as planes fitting. Use „surface" points directly

    - From opposite direction → fit „good" cylinder, use cylinder axis to match point clouds

    -
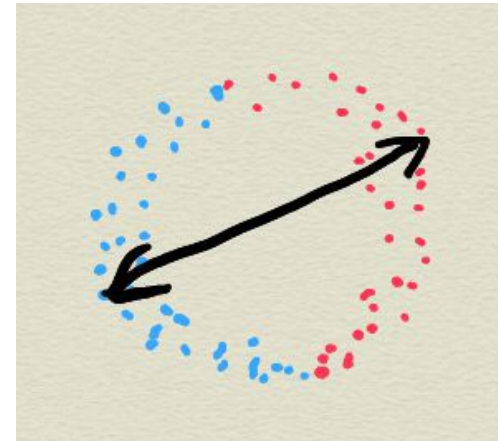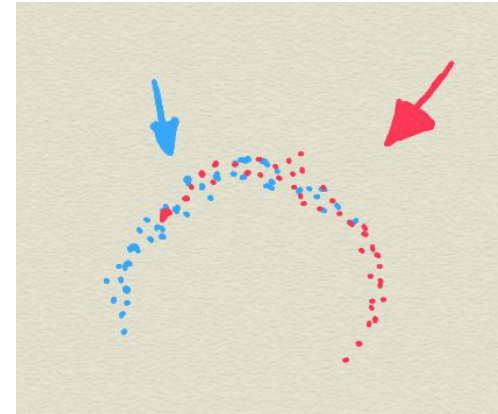
Use fixed objects

- Swinging of reflectors problematic

- Trying to fit upper tree parts

  - Tree are swinging (wind, convection)

  - Use stem parts near the ground

  - Don't use easily movable bushes or twigs

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Iterative Closest Point (ICP)

- Good if points are on the same surface

- Wrong if points are on opposite stem surfaces

- „Wrong" in tree crowns

- Sometimes OK for the ground

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