Reducing Noise and Redundancy in Registered Range Data for Planar Surface Extraction
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Introduction
- Generating 3D models from 3D data
  - triangle based for objects
  - point based for general indoor scenarios towards a high level description using planar surfaces
- Using SwissRanger SR3000 (infra-red Time-of-Flight sensor; 176x144 pixel resolution)

Problem Statement
- Aligning several scans into a global representation with the coordinate system of the first scan as global coordinate system
- Noise and reconstruction inaccuracies leads to noisy and thickened surfaces which contain redundant information
- Determining and merging redundant points
- Methods in literature:
  - voxel sampling (VS), merging points per voxel
  - Fua's patch merging (FPM), points per voxel are represented by patches defined by a normal and a center

Virtual Image Plane Projection (VIPP)
- Using projection properties of range camera inspired by reverse calibration of Blais and Levine
- Algorithm:
  - compute the major plane of the global point cloud via Principle Component Analysis (PCA)
  - position the points with the major plane parallel to the image plane (reason: evenly distribute the points into pixels)
  - extend the image plane of the first scan to an infinite virtual image plane with equal intrinsic parameters (focal length $f$, pixel size $(w, h)$, principal point $(p_x, p_y)$)
  - cluster locally per pixel by region growing
    - advantage: preserve structure characteristics

Evaluation
- On manually extracted planes
- Evaluate the standard deviation $\sigma$ of the points to the corresponding plane and color code these points according to their deviation $\sigma$
  - examine the percentage of points with $\sigma < 10$mm
- VIPP improves the smoothness of planar surfaces

Results
- scene 1
- scene 2

Clustering
- replace local clusters by their mean value

Image of a 3D model with labels:
- points of the first frame
- points of the second frame
- clusters for merging
- optical center

Evaluation of scene 1
Evaluation of scene 2