Geometrical image analysis

TDBD19

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Purpose

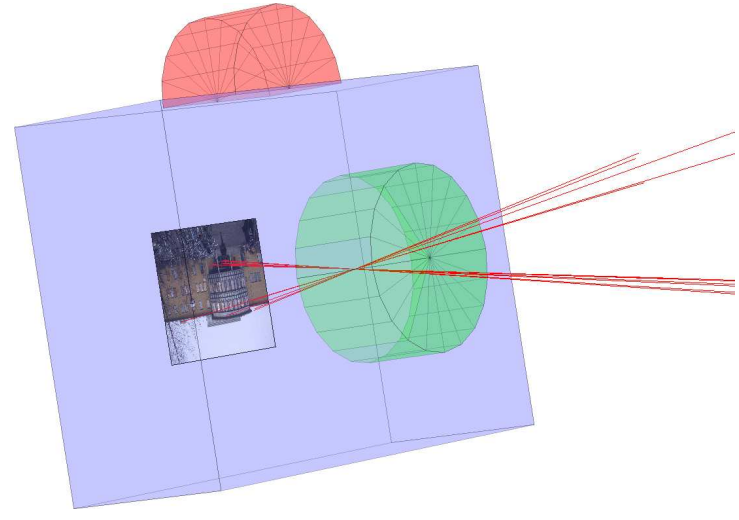
- The purpose of Geometrical Image Analysis is to obtain 3D information from 2D measurements.
- Depending on the available knownledge about the camera, the camera position, and the object we get different problems.
- All knowledge about the object, determine camera internal geometry (camera calibration).
- Knowledge about camera and camera positions, calculate position of object points (stereo cameras on mars rovers).
- Some knowledge about camera, no knowledge about object, calculate position of cameras and object points (3D reconstruction)

Example

- Assume we have two image where we have made measurements.

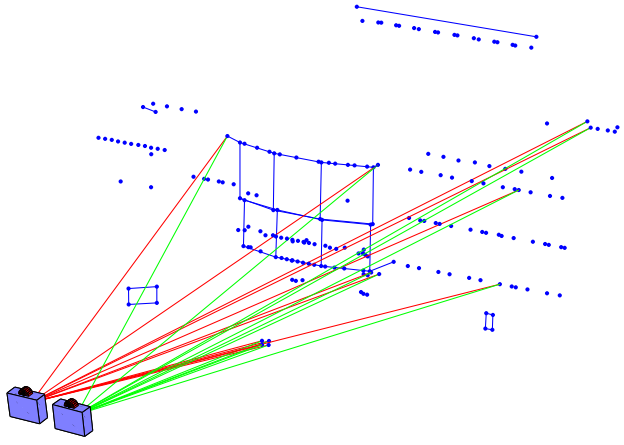
Camera model

- All rays that hit the detector are assumed to pass through a common point — the *projection center*.



Multi-camera measurements

- The measured point, the projection center, and the object points are collinear in space.
- From multiple measurements of the same object points we may calculate the position of the object points, as well as the position of the cameras.



Some questions

- How do we find the points in the image? (Manually, synthetic targets, natural targets, etc.)
- How do we find out which points correspond to each other? (Position, image content, etc.)
- How do we calculate the position of the cameras? (Approximately, optimally.)
- How do we calculate the position of the object points? (Approximately, optimally.)

Tools

- Image analysis
  - Edge detection.
  - Förstner interest operator, Harris corner detector.
  - Normalized cross-correlation.
  - Least squares template matching.
- **Projective geometry.**
  - 2D mappings.
  - 3D mappings.
  - 3D→2D mappings.
  - Camera models.
  - Multi-camera relations
    - Epipolar lines.
    - Trifocal tensor.
    - The fundamental matrix.

Tools

- Error models.
  - Gaussian.
  - Non-gaussian.
- Estimation.
  - Linear estimation.
  - Algebraic estimation.
  - Optimal (non-linear estimation).
- Problem parameterizations.
  - Linear, non-linear.
  - Constrained, unconstrained.