Geometry-Based Recognition of 3D Objects

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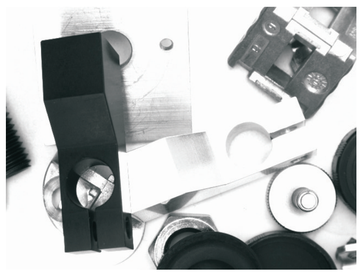
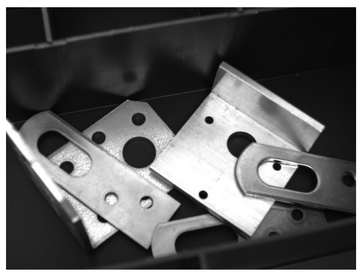
Motivation

- Pose determination of untextured objects is essential to increase the automation level of many industrial processes

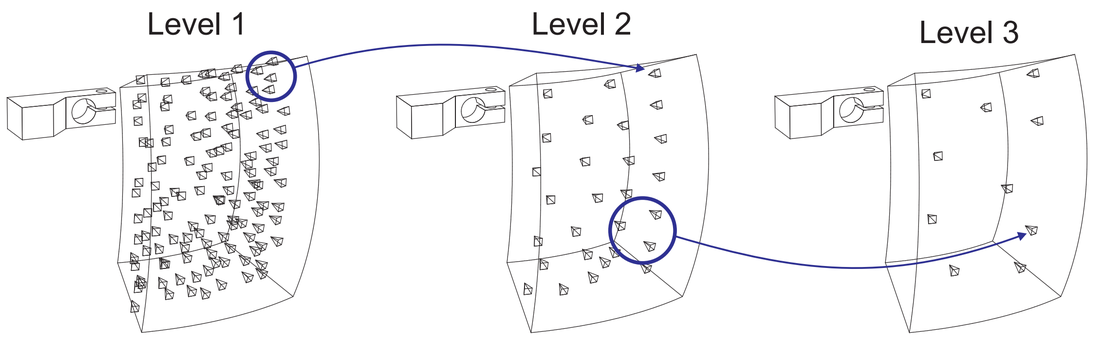


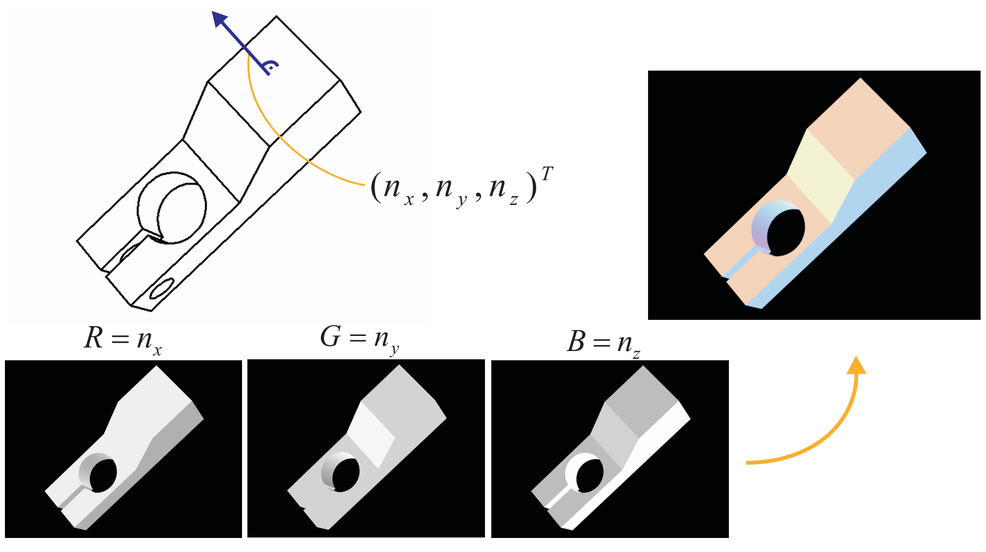
- Only one image ⇒ no stereo
- No texture ⇒ no descriptor-based approaches
- No a priori pose ⇒ no tracking approaches
- Partial occlusions, clutter, and reflections ⇒ high robustness
- Online environment ⇒ fast recognition

Model Generation

- Read the geometry information from a 3D CAD model
- Compute model views on different pyramid levels

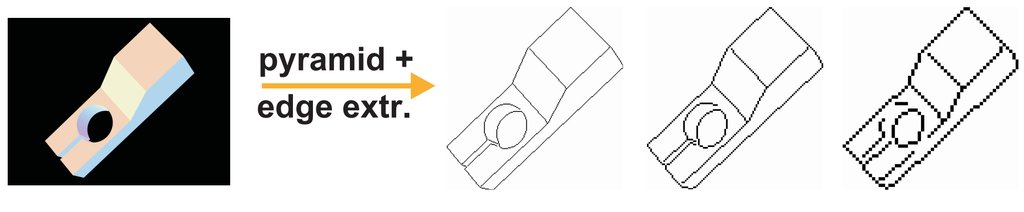


- For each view generate a 2D shape model (Steger, 2002) based on the projected edges of the 3D CAD model
- Generate a three channel model image



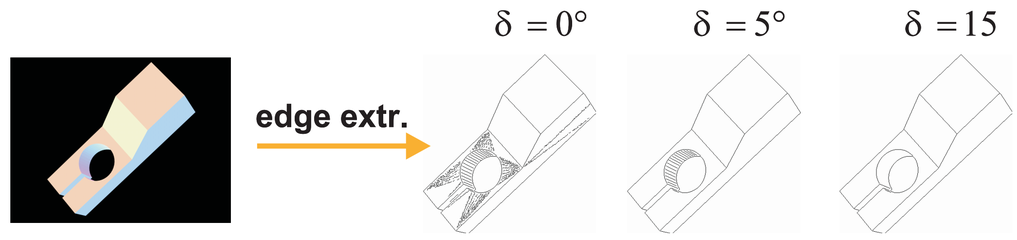
- Advantage 1

  A 2D shape model can be easily derived for a certain pyramid level (including all scale-space effects)



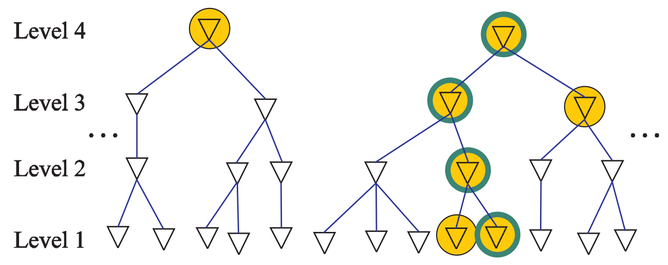
- Advantage 2

  Edges between faces with similar orientation can simply be suppressed by applying a threshold to the color edge Amplitude $A = 2\sin(\delta / 2)$

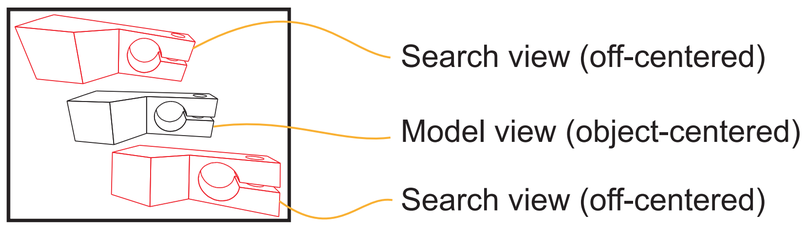


Recognition

- Refine the matches through the pyramid



- Projectively transform the 2D shape models online



- Refine the pose by minimizing the distances between the image edge points and the projected model edges

Evaluation

- Setup: f=8.5mm, Images 640x480, 2.33 GHz Intel Xeon E5345

Object	Pose Range	σ_{pos}[mm]	σ_{pos}[%]	σ_{rot}[°]	Time[s]
Clamp	$\Delta\lambda = \Delta\varphi = [-50,+50]°$ $\Delta d = [150,200]$ mm	0.39	0.20	0.48	0.3
Fuse	$\Delta\lambda = \Delta\varphi = [-50,+50]°$ $\Delta d = [250,350]$ mm	0.74	0.21	0.60	0.9

Results

References

- C. Steger: Occlusion, clutter, and illumination invariant object recognition. In *International Archives of Photogrammetry and Remote Sensing*, volume XXXIV, part 3A, 345-350, 2002

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