

Marker-less Object Perception and Articulation Discovery

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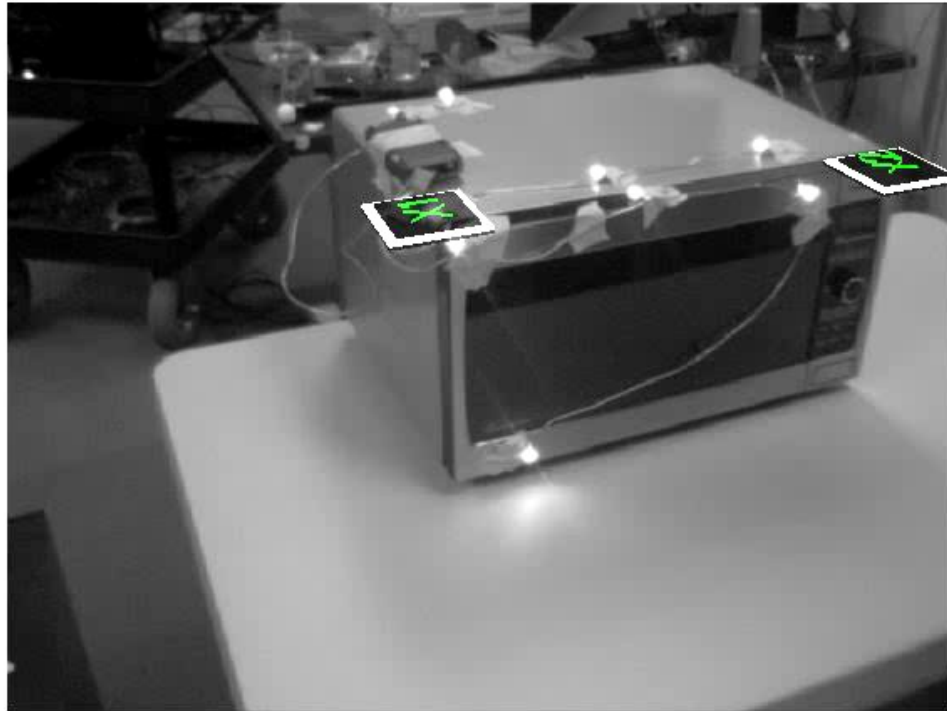
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Previous work

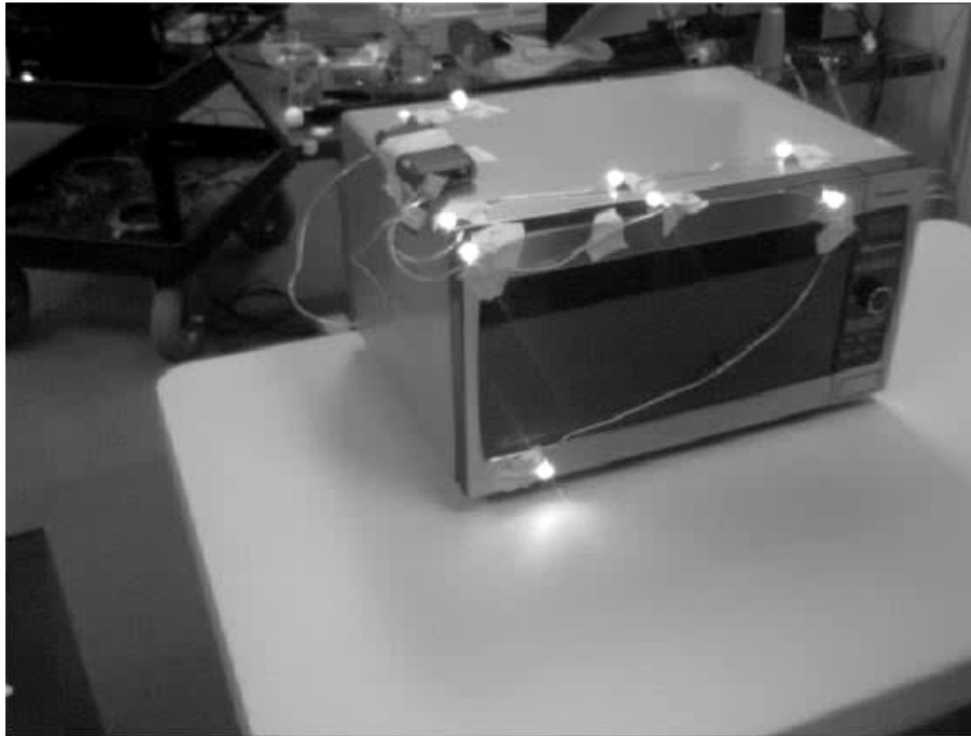
- Learn articulation models from pose observations
- Model selection
 - Rotational model
 - Prismatic model
 - Non-parametric LLE/GP model
- Structure discovery

Microwave Door: Observations



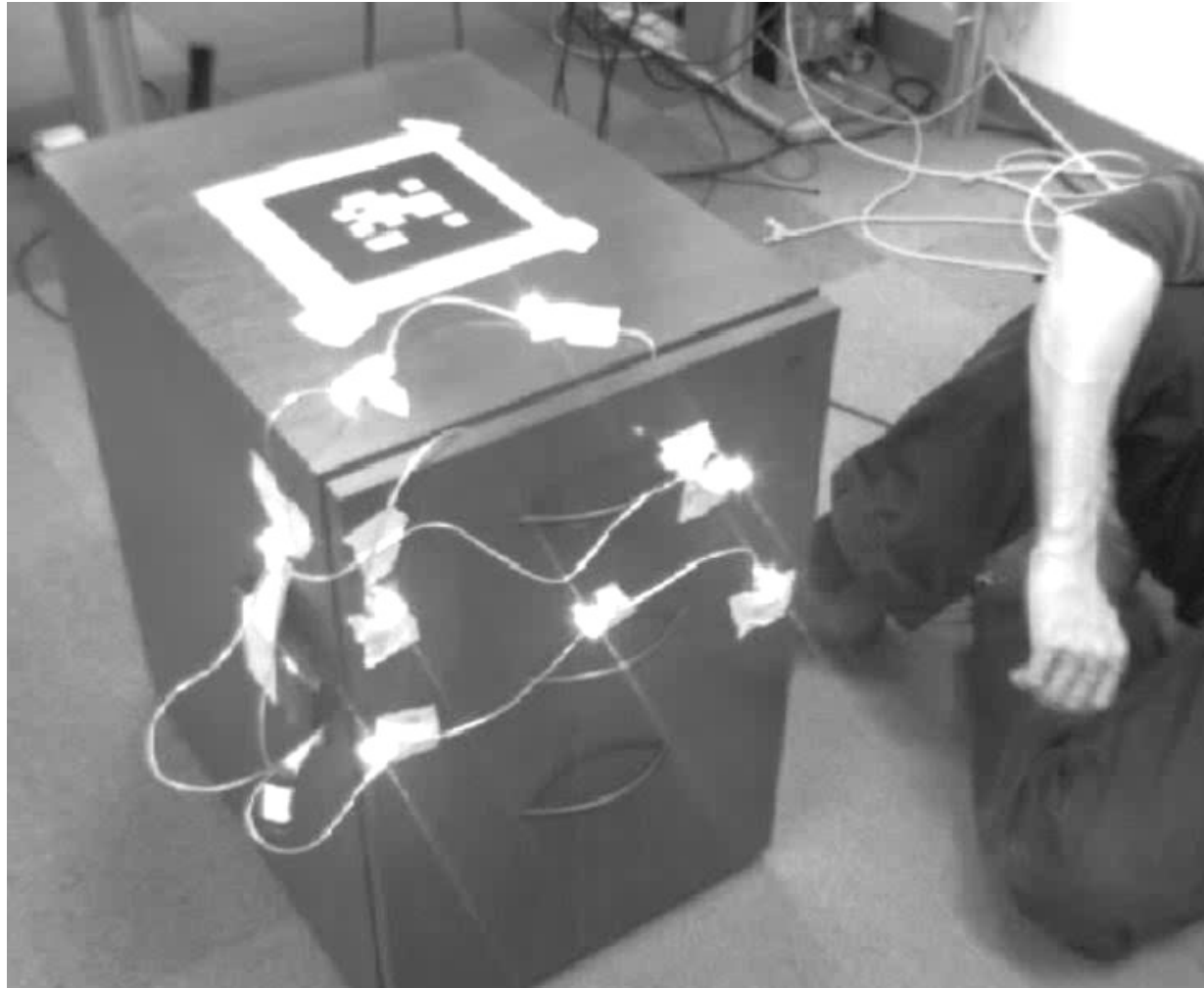
microwave pose observations
from motion capturing studio

Microwave Door: Learned Model



learned model for microwave door

Cabinet with Two Drawers



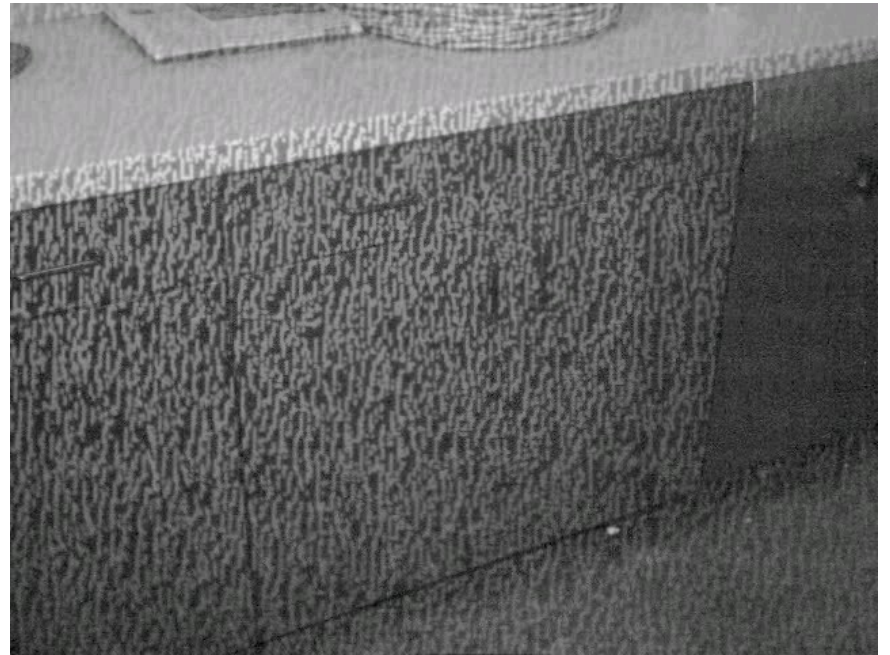
learned models and structure

Research question

- Can we get rid of artificial markers for pose registration?
- Can we learn articulation models in unprepared environments?

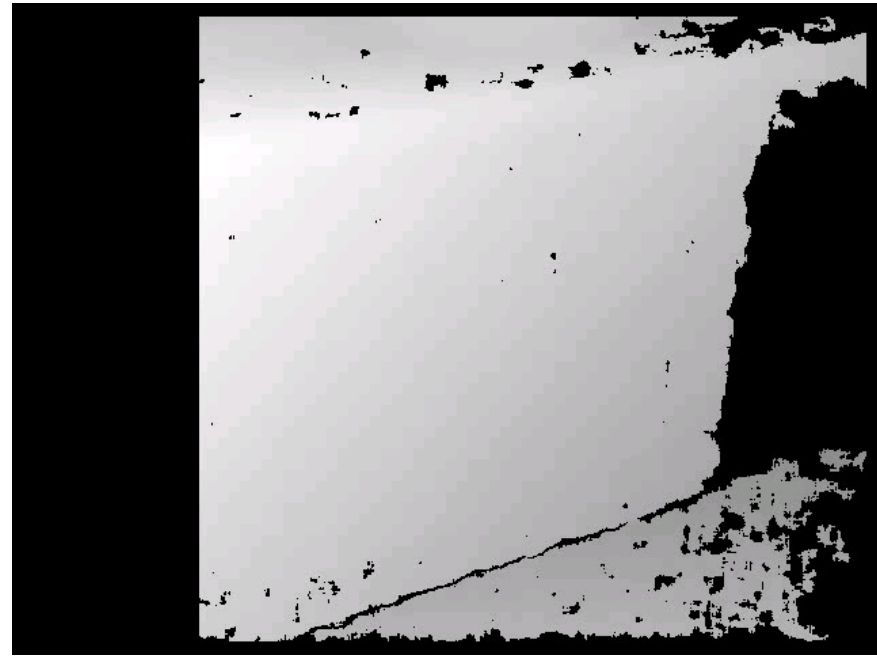
Choosing the sensor

- Use stereo vision?
 - Videre stereo camera
 - Projected light



Stereo vision + structured light

- Structured light projector adds much texture to scene
- Disparity image is dense
- Dense depth video

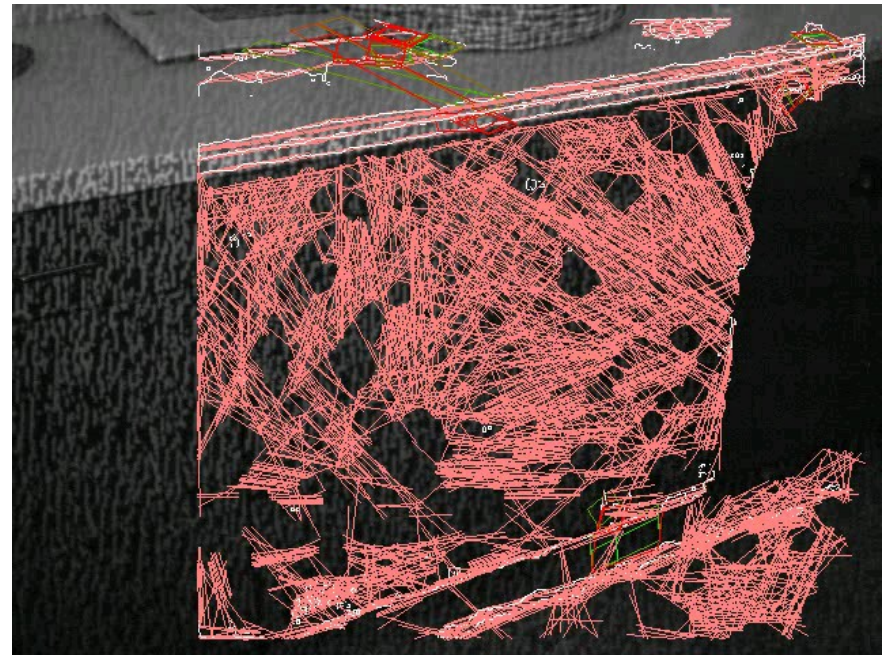


Problem formulation

- Dense stereo data
- Objects have rectangular shape
- Unknown position
- Unknown size
- Unknown orientation

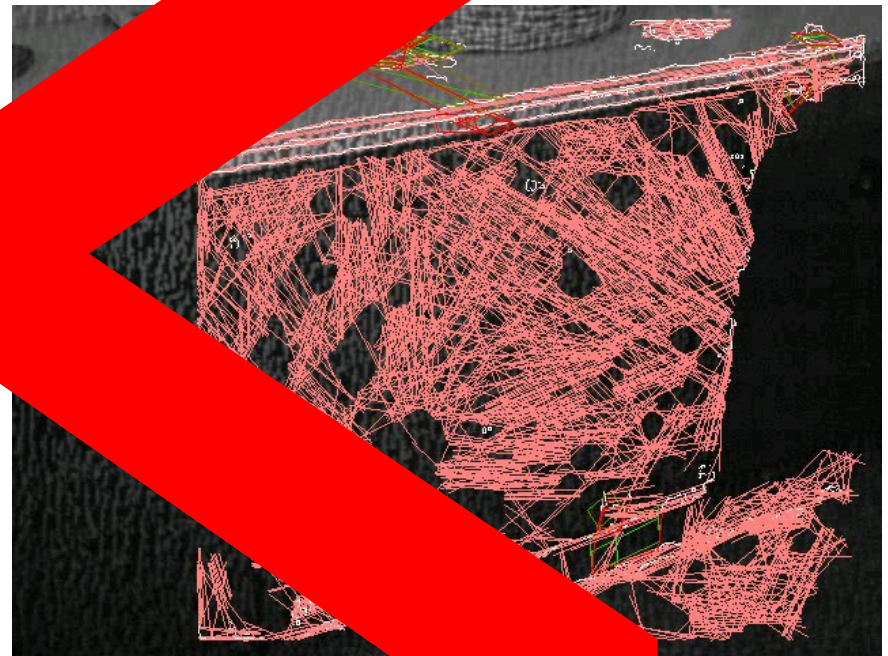
First approach

- Segment planes
- Search for edges (Canny)
- Search for lines (Hough)
- Line intersections
→ corner candidates
- Find width, height
- Optimize fit on distance transform (chamfer matching)



First approach

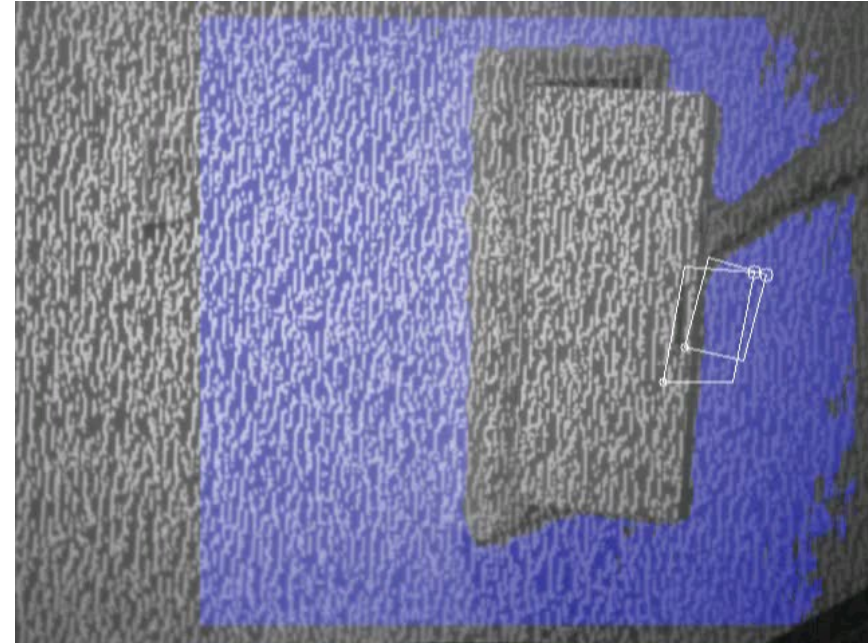
- Segment plane
- Search for edges (Hough transform)
- Search for lines (Hough transform)
- Line intersections
→ corner candidates
- Find width, height
- Optimize corner placement
transform corner
minimize error



- Depends on good edge visibility
- Poor performance on doors
- Way too complicated!

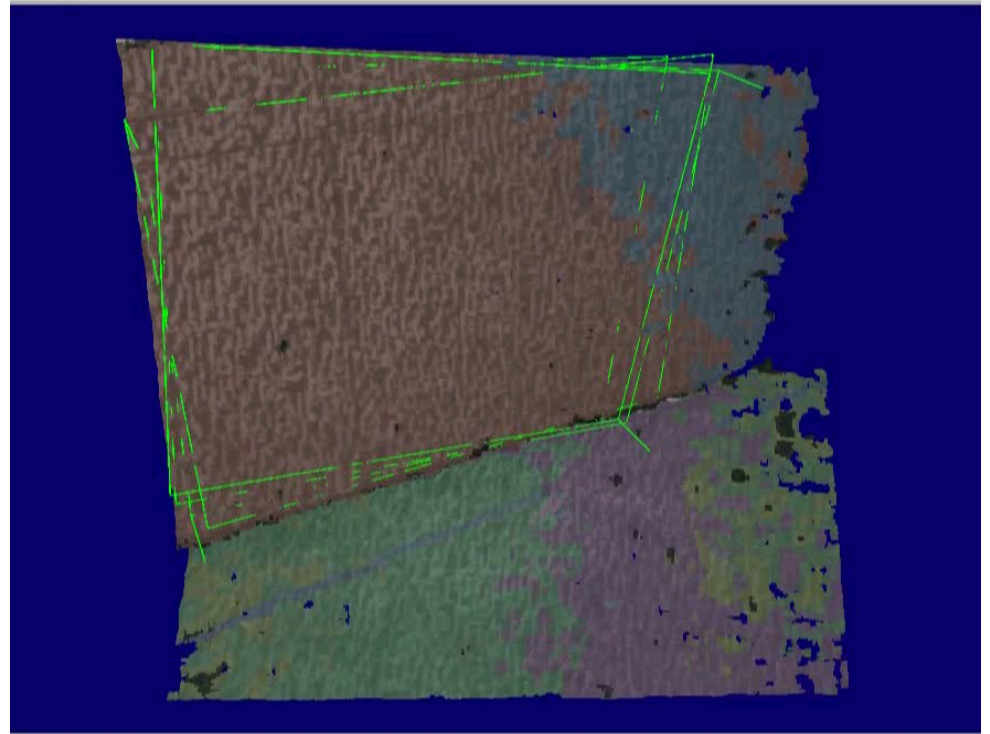
Second approach

- Segment planes
- Pick random seed pixel
- Iteratively optimize in small steps
 - width (from left)
 - width (from right)
 - height (from bottom)
 - height (from top)
 - rotation
- Objective function
 - fill ratio of rectangle
 - slight bias term that favors larger objects



More examples

- Cabinet door
- Cabinet drawer
- Fuse door
- Book
- Carton



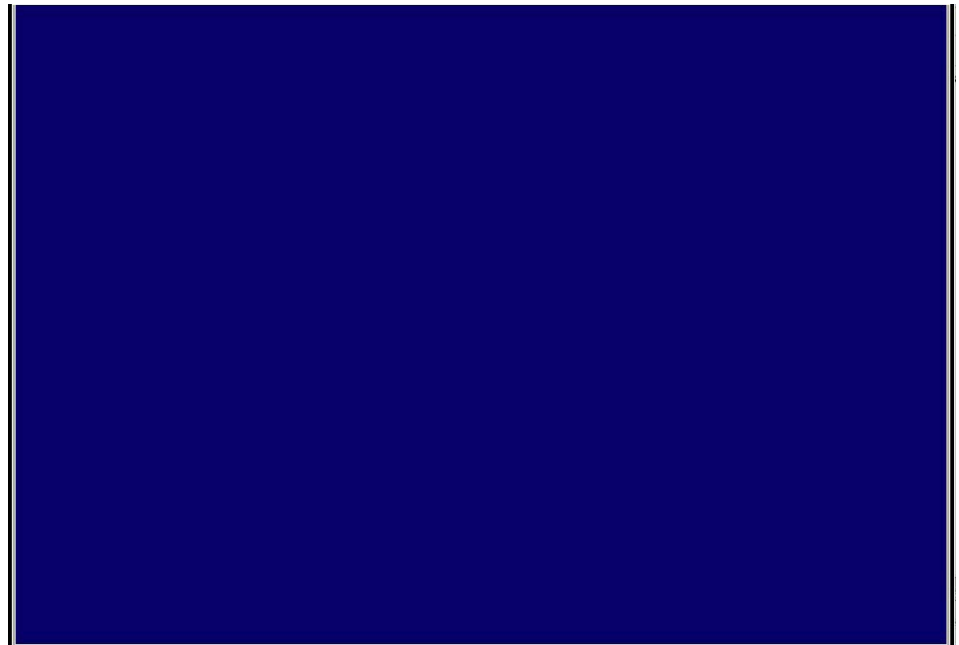
Object Tracking

- Track observations over time
- Noise
- Partial observations
- Ambiguities
 - Front/backside flips
 - Rotations of 90/180/270deg
 - Track assignment
- Data association



Discover articulated objects

- Learn articulation models for tracks
- Measure model fit
- Estimate current object configuration
- Make pose predictions for unseen configurations



Conclusions

- simple object detection
 - full pose estimates
 - articulation model learning on natural features is possible
 - (currently) limited to rectangular shaped objects

 - implemented as ROS package `planar_objects`
 - `box_detector`
 - `box_tracker`
 - `articulation_learner`
- ➡ Demo after this talk in green room

Future work

- ground truth evaluation
- improve objective function (use occ/free/unknown)
- appearance-based matching
- add rotational articulation model
- improve plane extraction using surface normals
- optimize code (currently 1-4s per frame)
- ICRA paper