

Inferring Generalized Pick-and-Place Tasks from Pointing Gestures

Nico Blodow, Zoltan-Csaba Marton, Dejan Pangercic, Thomas Rühr, Moritz Tenorth, Michael Beetz

Intelligent Autonomous Systems Group

Technische Universität München

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Motivation



www.ros.org/wiki/kinect_cleanup

Semantic Perception, Mapping and Exploration Workshop, May 2011

Pick-and-Place Tasks from Gestures

Pangercic et al.





Introduction

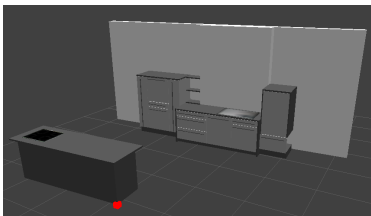
System:

- ▶ the use of human tracking to guide segmentation of objects in RGB-D images;
- ▶ virtually hiding the original object location and possibility of moving objects around freely for easing the user's task;
- ▶ semantic reasoning based on the object's type and its required position in the environment for task execution.



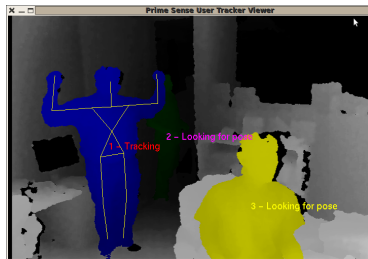


How it works



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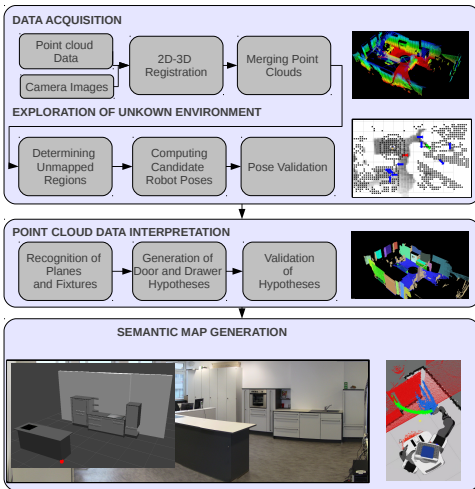


```
?- rdfs_subproperty_of(Prop, knowrob:spatiallyRelated),
   rdf_triple(Prop, knowrob:'Cup67', Loc).
Loc = 'http://ias.cs.tum.edu/kb/knowrob.owl#Drawer13'
```



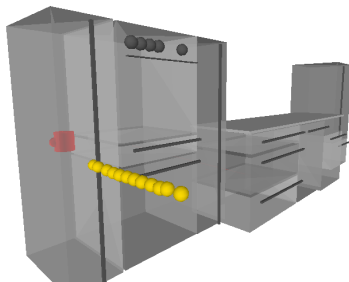
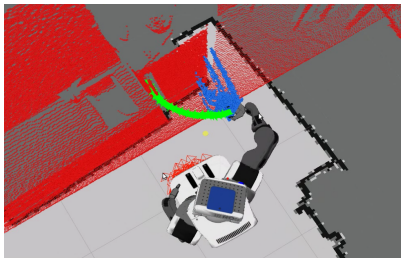
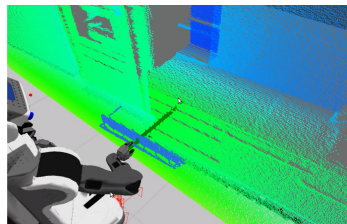


Autonomous Semantic Mapping based on 3D and RGB



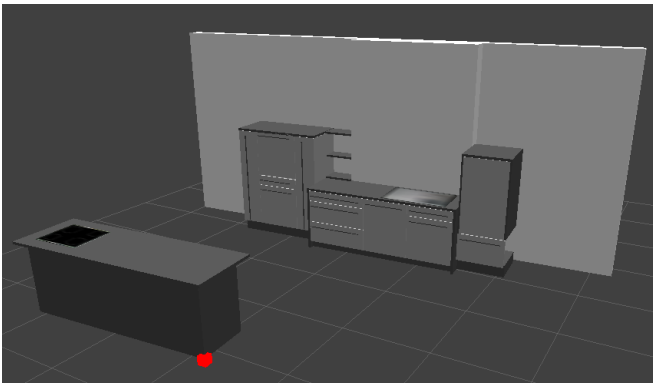


Door and Drawer Hypotheses Validation - Segmentation of Differences





Final (Manually Augmented) Map



CODE (Coming in May 2011):

http://www.ros.org/wiki/autonomous_exploration

Full Video:

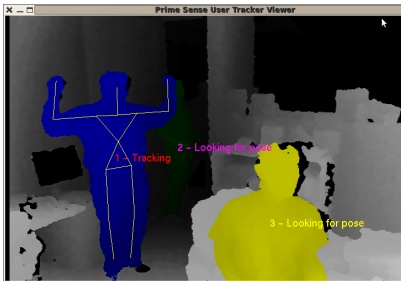
<http://www.youtube.com/watch?v=T15ycSmNOFY>





Gesture Recognition and Data Filtering

- ▶ Tracking based on OpenNI tracker using Kinect sensor
- ▶ Start, stop gestures
- ▶ Hand-neck transforms



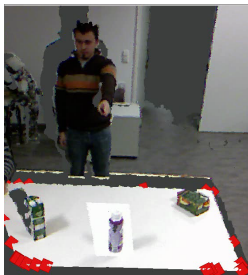
Exponential Smoothing:

$$y'_k = ay_k + (1 - a)y'_{k-1} \quad (1)$$





Specifying the Object and Target Position



Object Grabbing:

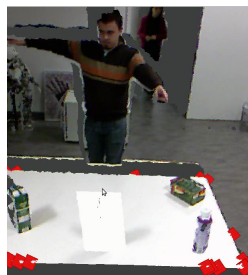
RANSAC-based plane and cluster extraction, line of pointing and cluster intersection, object to right wrist

transform



Object Moving

Points within polygonal prism projected on the plane and colored with plane color



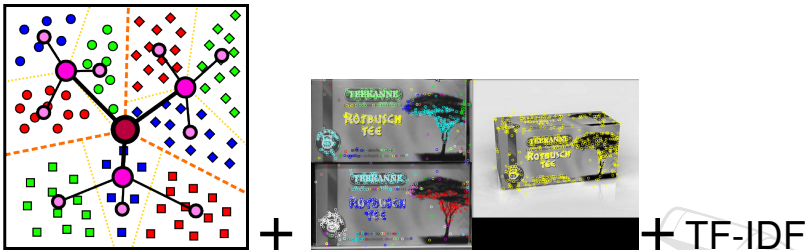
Object Releasing

Stop gesture, new sensor origin to object transform





Object Recognition using Vocabulary Tree and SIFT



Code available online:

http://www.ros.org/wiki/objects_of_daily_use_finder





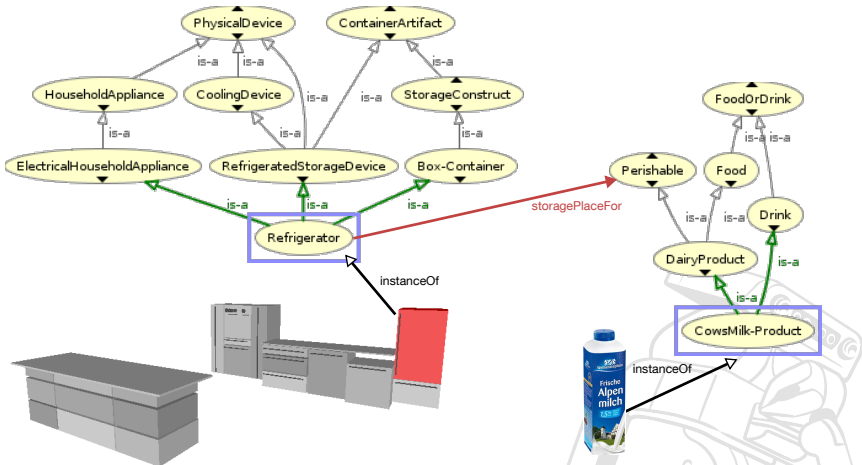
Semantic Map Representation

- ▶ KnowRob system (www.ros.org/wiki/knowrob)
- ▶ OWL + SWI Prolog
- ▶ Classes and Typed object instances
- ▶ Inspired by OpenCyc
- ▶ Concept of Computables (kind of procedural attachment to the semantic relations that describe how these relations can be computed)
- ▶ Common sense knowledge imported from OMICS (e.g. fridge is a storage for perishable foods), www.germandeli.com



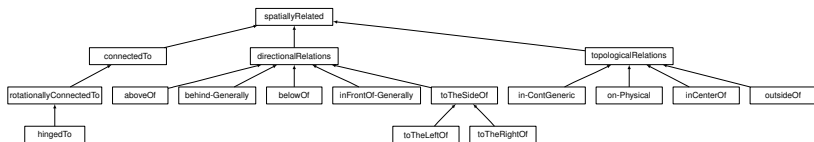


Inferring where to search for milk





Qualitative spatial relations



- ▶ topological relations
- ▶ directional relations
- ▶ connectedTo



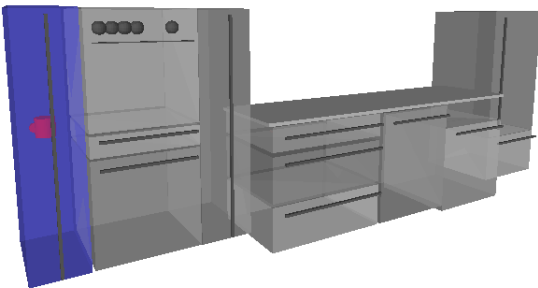


Semantics Interpretation

Where is an object of type Cup?

```
?- rdfs_subproperty_of(Prop, knowrob:spatiallyRelated),  
   rdf_triple(Prop, knowrob:'Cup67', Loc).
```

```
Loc = 'http://ias.cs.tum.edu/kb/knowrob.owl#Drawer13'
```

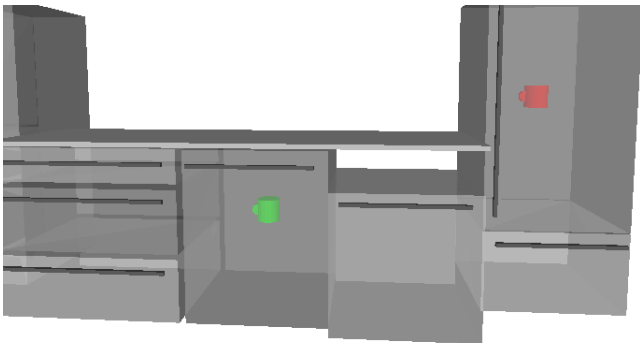




Verifying object placement

Is an object of type Cup placed correctly?

```
?- rdf_triple(knowrob:'in-ContGeneric', knowrob:'Cup67', Loc),  
storagePlaceFor(Loc, knowrob:'Cup67').
```

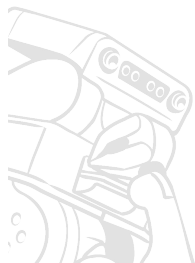
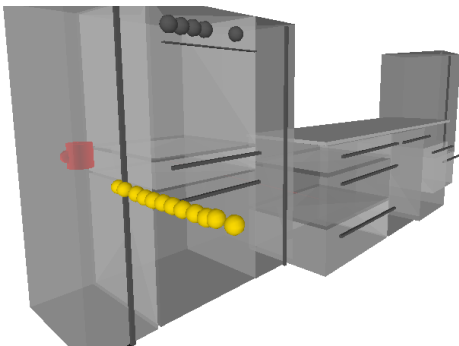




Additionally required actions

Do we need to open a container?

```
?- rdf_triple(knowrob:'in-ContGeneric', knowrob:'Cup67', B),  
   rdf_has(B, knowrob:openingTrajectory, Traj),  
   findall(P, rdf_has(Traj, knowrob:pointOnTrajectory, P),  
          Points).
```





Conclusions

- ▶ System that effectively combines 3D environment modelling, fully body motion analysis and knowledge representation and reasoning.
- ▶ Household assistant for the elderly/sick.
- ▶ Control of robot by pointing gestures
- ▶ Inferring missing steps from the instruction
- ▶ Future work: task planner and full room tracking





Q&A

Thanks!

Closing the loop:



Intelligent Autonomus Systems Group:

<http://ias.cs.tum.edu>

TUM ROS Packages:

<http://www.ros.org/wiki/tum-ros-pkg>

Contact:

{blodow, marton, pangercic, ruehr, tenorth,
beetz}@cs.tum.edu

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