Computational proto-object detection in 3D data

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IVS intelligent vision systems

Motivation

◆ Object Discovery: find objects without pre-knowledge.

◆ Individuate objects before their category is known (Pylyshyn 2001) [4]

◆ Approach:
  ◆ observe a 3D scene over time
  ◆ guide and bound processing by visual attention and segment attended regions
  ◆ store and update object information incrementally in a 3D map
  ◆ read more in [5]

System Architecture

A moving RGB-D camera captures a sequence of the scene.
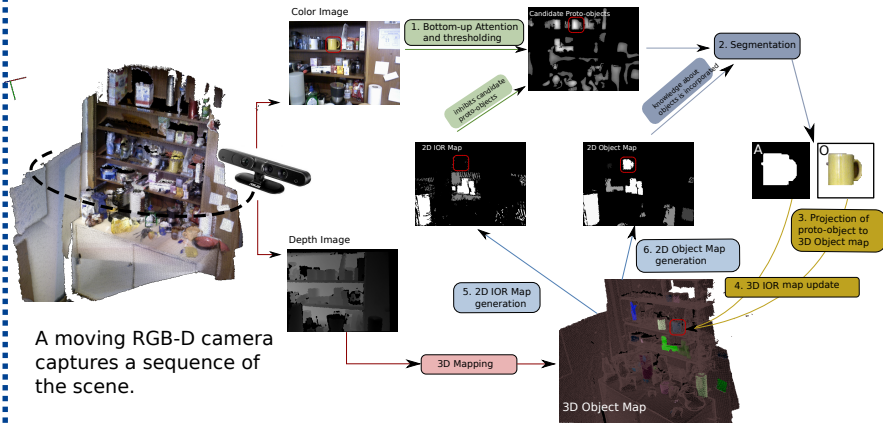
From Saliency to Object Candidates
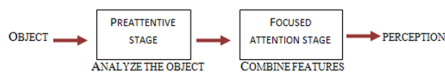
Generate proto-objects:

Pre-attentive (parallel) stage:
1. compute the saliency map [1]
2. threshold the saliency map
3. find connected components (**proto-objects**)
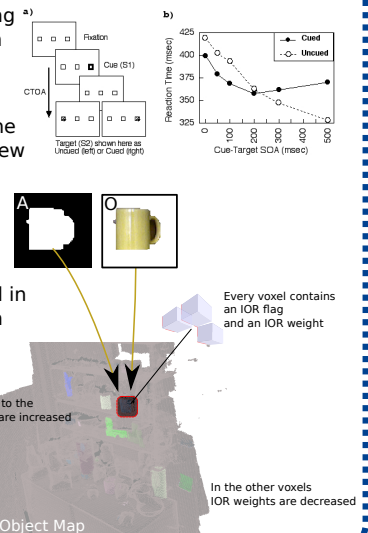4. rank them by average saliency
5. inhibit already attended regions

Attentive stage:
6. Pick one salient blob & fit a rectangle around it
7. Refine shape of blob with GrabCut segmentation
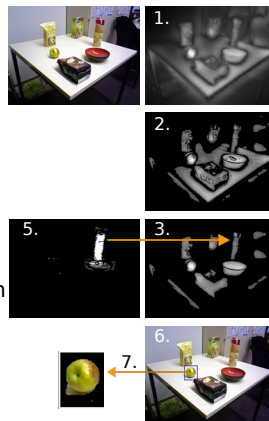
Inhibition of Return (IOR)

◆ Suppression of processing locations that have been recently the focus of attention [3]

◆ Enables exploration of the scene and focusing on new objects

◆ It is both object- and environment-based [2]

◆ IOR information is stored in spatial 3D coordinates in our system

Every voxel contains an IOR flag and an IOR weight

In the voxels that correspond to the attended region IOR weights are increased

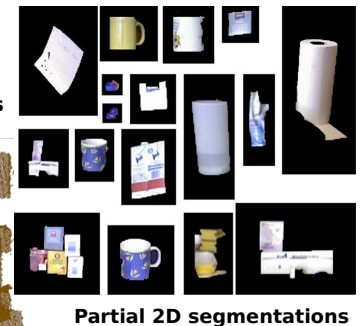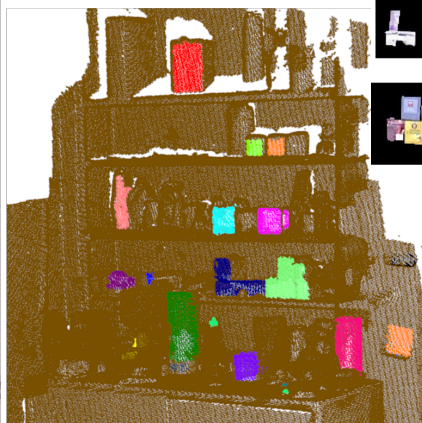In the other voxels IOR weights are decreased

3D Object Map

Evaluation

Object	Precision	Recall
Note	69	43
Y. cup	90	40
W. cup	93	40
Box	99	30
Paper	99	40
Sugar	62	61
Cup	90	36
Water	99	37
Milk	98	39

Ground truth

Final 3D Segmentation results

Partial 2D segmentations

References:
[1] Klein, D., Frintrop, S. (2012): Salient Pattern Detection using W_2 on Multivariate Normal Distributions. DAGM-OAGM
[2] Tipper, S. P., Weaver, B., Jerreat, L. M., & Burak, A. L. (1994). Object-based and environment-based inhibition of return of visual attention. J. of Experimental Psychology.
[3] Posner, M. I., & Cohen, Y. (1984). Components of visual orienting. Attention and performance X: Control of language processes, 32.
[4] Pylyshyn, Z.W. (2001): Visual indexes, preconceptual objects, and situated vision. Cognition 80(1-2)
[5] Martín García G., Frintrop, S. (2013): A computational framework for attentional 3d object detection. In: Proceedings of the Anual Meeting of the Cognitive Science Society