
Attentive Robots

Simone Frintrop

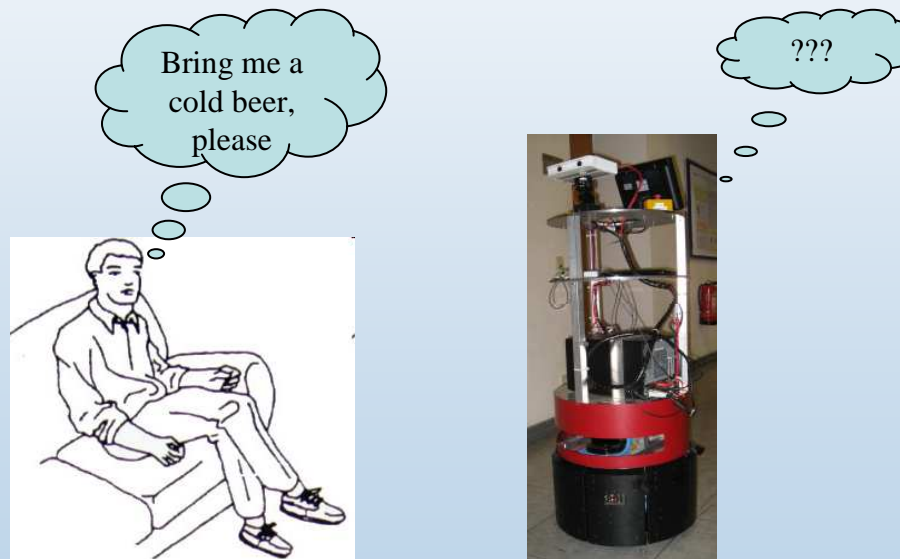
Rheinische Friedrich-Wilhelms-Universität Bonn

19.10.2012



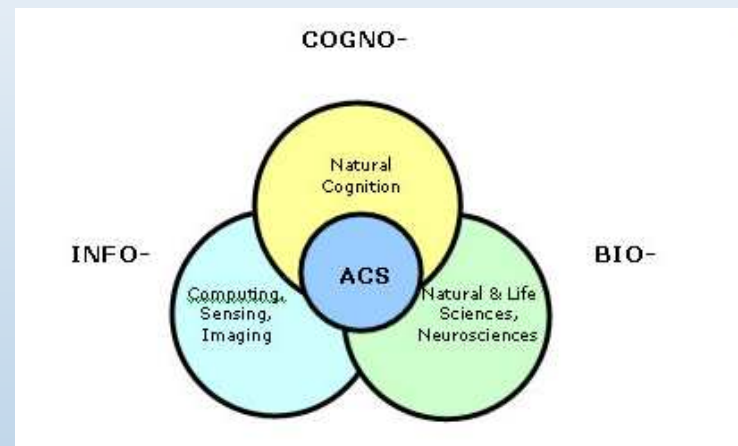
Why Cognitive Vision?

- Big steps in robotics and computer vision during last decade
- But: still many challenges for systems acting autonomously in a dynamic world



Cognitive Systems in the EU

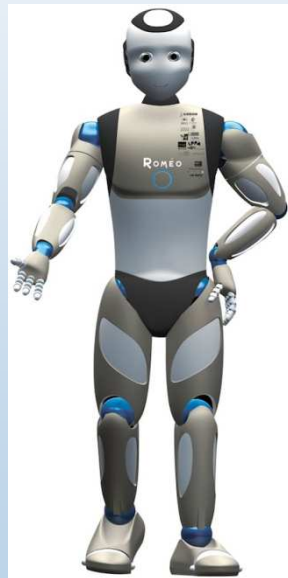
- Since 2001: Cognitive Systems intensely funded by the EC
- More than 100 projects on Cognitive Systems funded, e.g.: CogX, COSY, MACS, CogVis, NEUROBOTICS, Paco-Plus, POP, ...



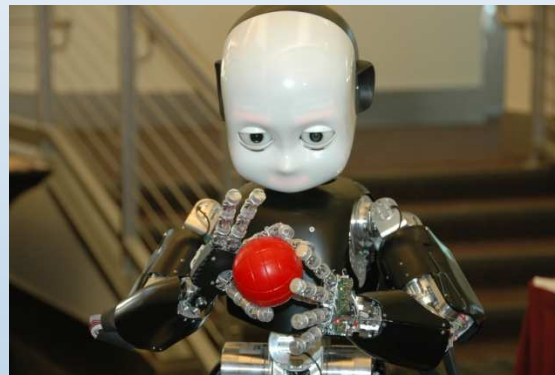
http://cordis.europa.eu/fp7/ict/cognition/home_en.html

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Romeo



iCub



Rhino

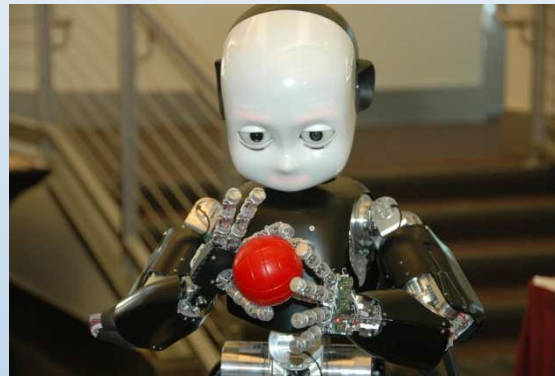
Cognitive Systems in the EU

"Robots need to be more **robust, context-aware and easy-to-use**.
Endowing them with advanced **learning, cognitive and reasoning capabilities** will help them adapt to changing situations, and to carry out tasks intelligently with people"

[Challenge 2: Cognitive Systems, Interaction, Robotics]



Romeo



iCub



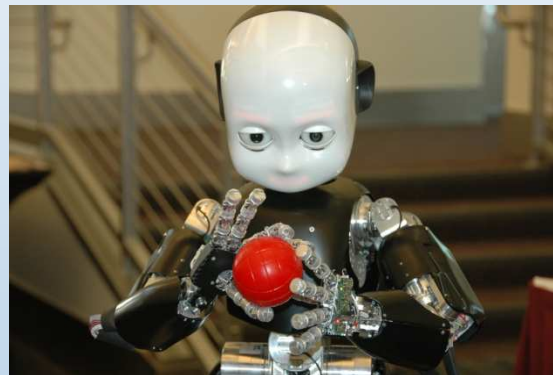
Rhino

Cognitive Abilities

Cognition is a group of mental processes that includes attention, memory, producing and understanding language, solving problems, and making decisions. (Wikipedia)



Romeo



iCub



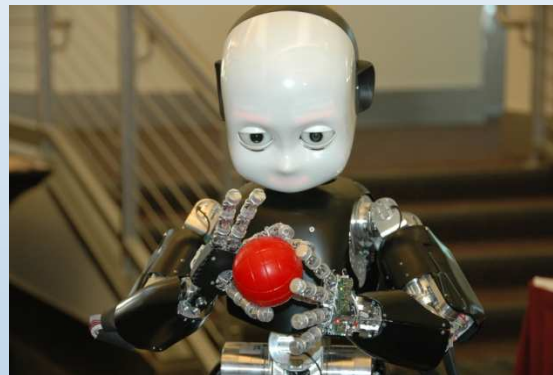
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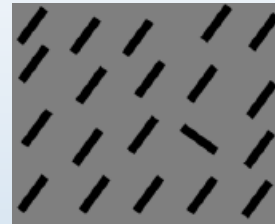
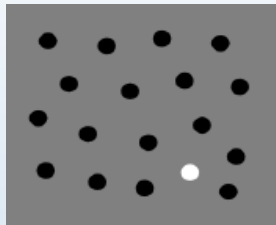


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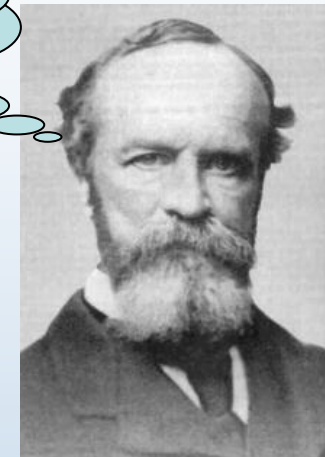


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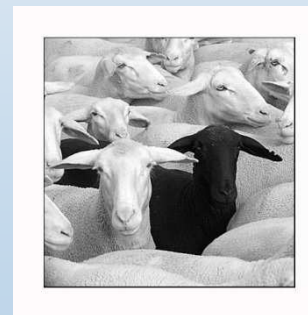
What is Attention?



Everyone knows
what attention is!

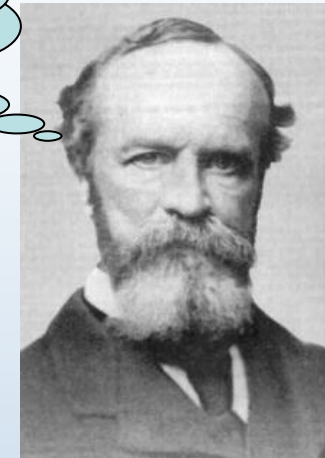


William James



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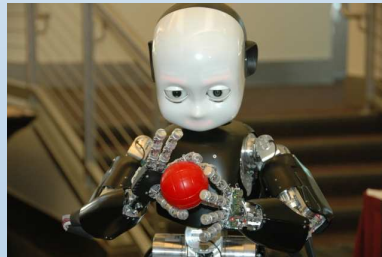
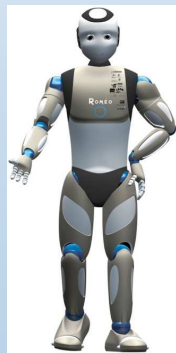
Attention is the cognitive process of selectively concentrating on one aspect of the environment
(Wikipedia)

Why Attentive Machines?

Do we need "Attentive Machines" and why?

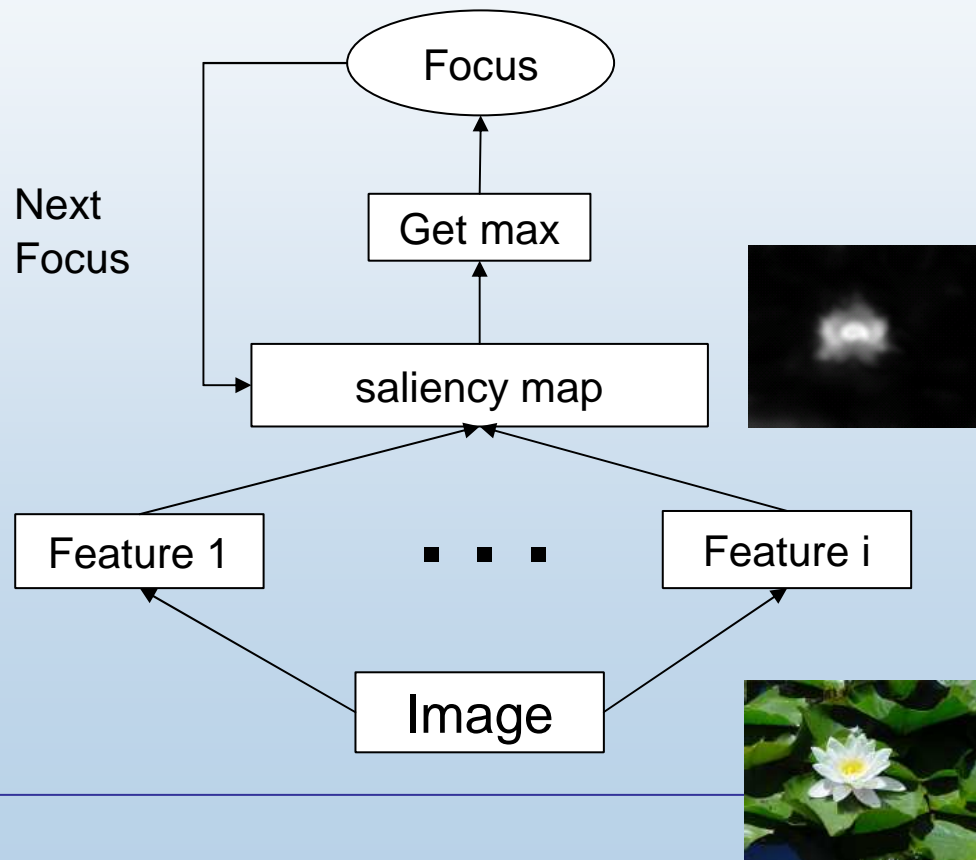
Robots have similar requirements as humans:

- They can process only a fraction of the perceptual input in reasonable time \implies **prioritize!**
- They have physical constraints (one/few cameras for zooming and pan/tilt, one/few arms,...) \implies **decide!**
- They act in the same environments as humans and interact with humans \implies **establish joint focus of attention!**



Visual Attention Systems

Standard structure of computational attention systems:

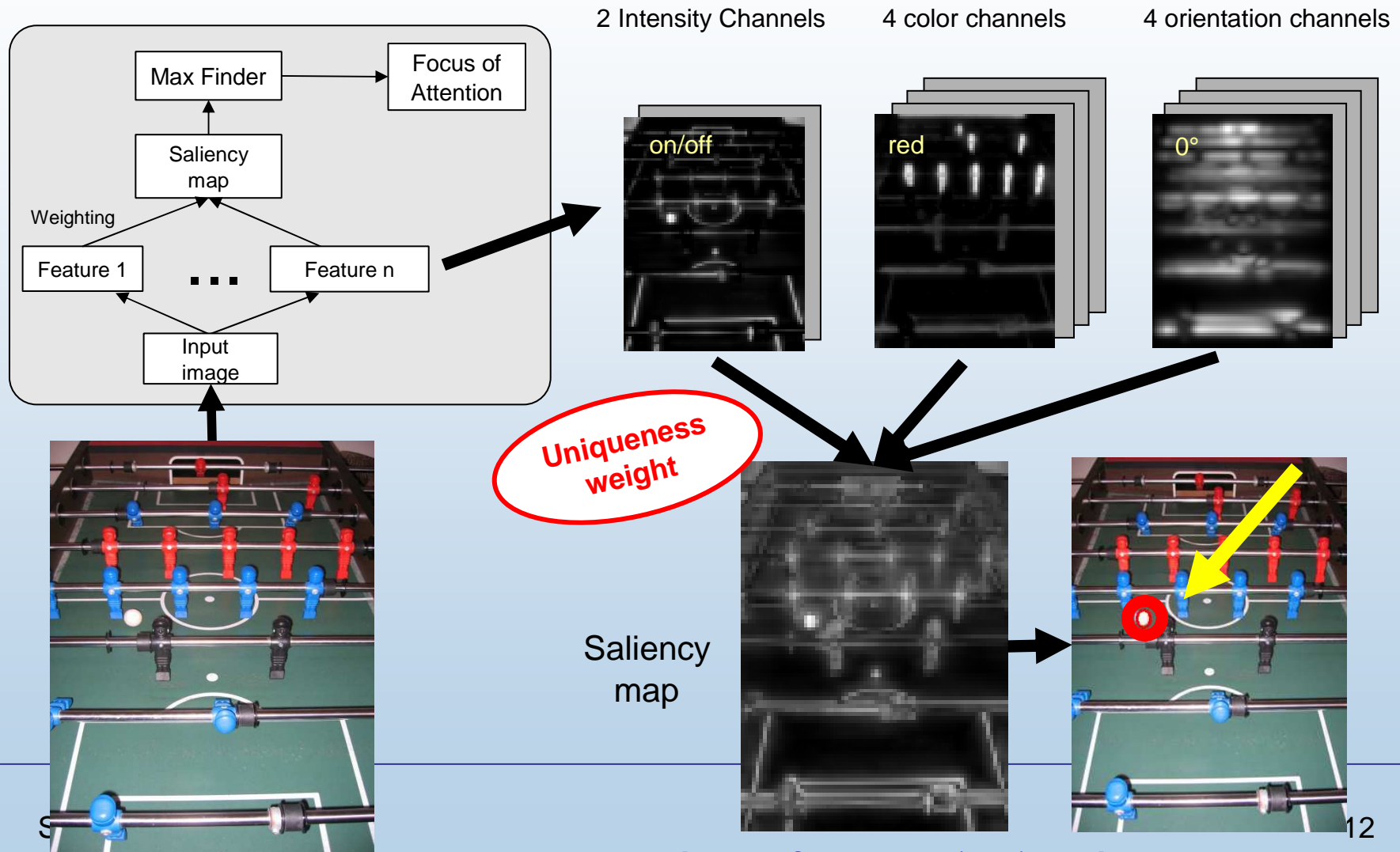


Motivated from Feature Integration Theory
[Treisman, Gelade 1980]

Examples:

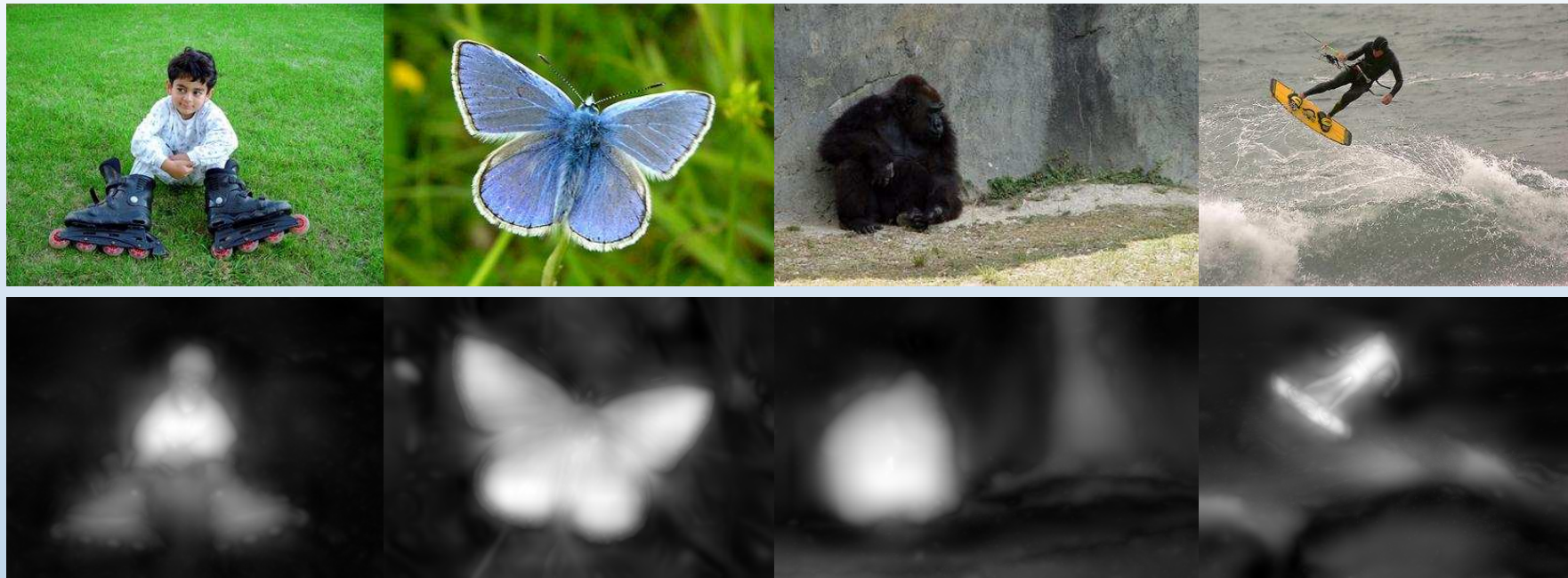
- [Koch, Ullman 1985]
- [Tsotsos 1995]
- [Itti, Koch, Niebur 1998]
- [Sun, Fisher 2003]

Attention System VOCUS



Attention System CoDi

Our newest attention system CoDi
(Work with Dominik A. Klein [[Klein/Frintrop DAGM 2012](#)])



CoDi is fast: 82ms on average per image on Intel Core i7-2600.

Applications in Computer Vision and Robotics

Main application areas:

1. Attention as salient interest point detector
2. Attention as front-end for object recognition
3. Attention to guide robot action

Salient Interest Points

Attentive Robot Localization and Mapping (SLAM)

[Frintrop,Jensfelt: IEEE Trans. on Robotics 2008]



Salient Object Detection



"Curious George" won the robot league of the Semantic Robot Vision Challenge in 2007 and 2008 [Forssén 2008]

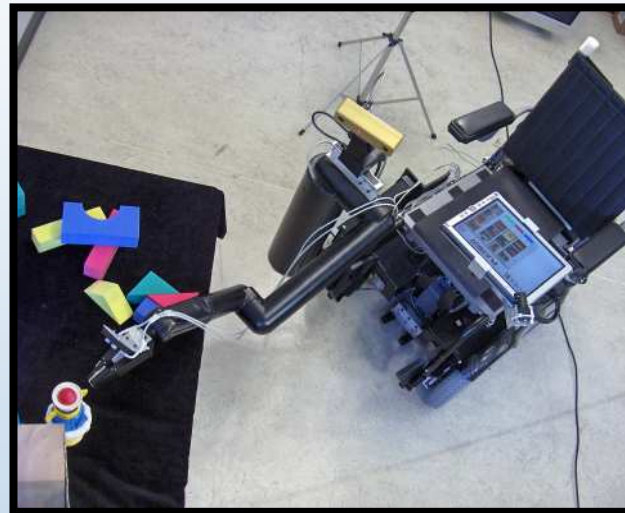
Salient Object Detection in 3D



Attention-based Detection, Segmentation
and Registration of Unknown Objects

Germán Martín García, Dominik A. Klein
Simone Frintrop

Attention to Guide Robot Action



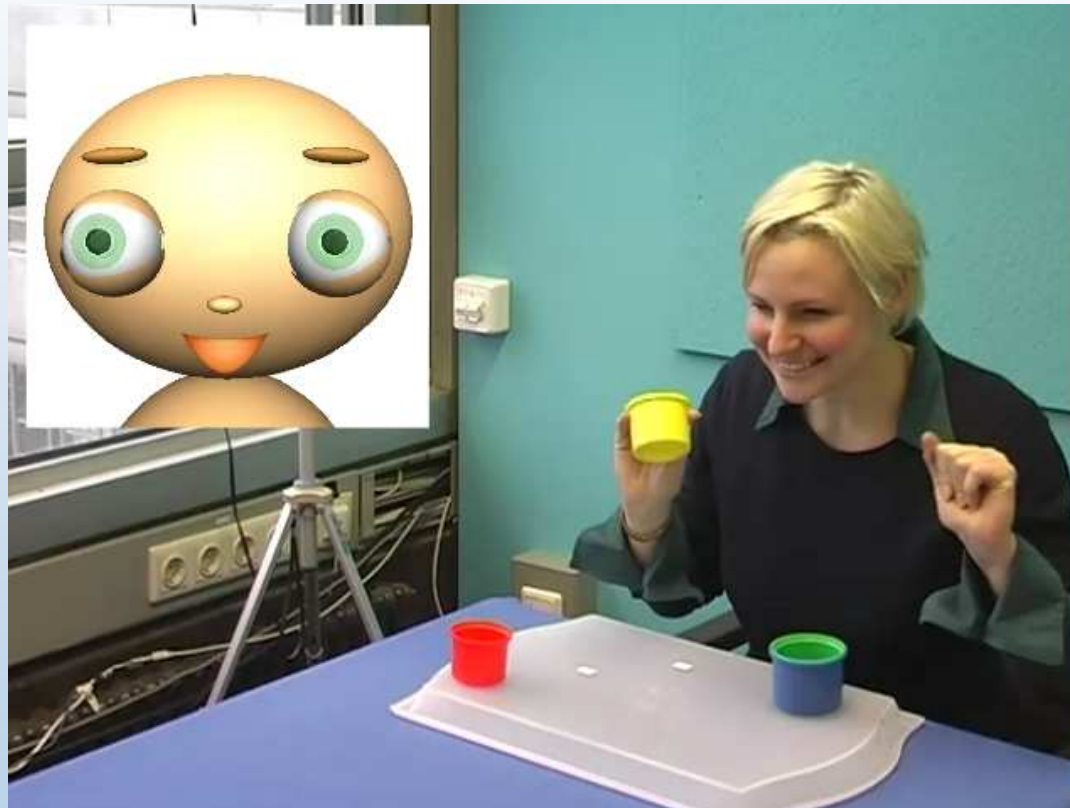
PlayBot: a robotic
wheelchair for disabled
children

[Tsotsos et al. 1998;
Rotenstein et al. 2007]

(image from <http://www.cse.yorku.ca/~playbot>)

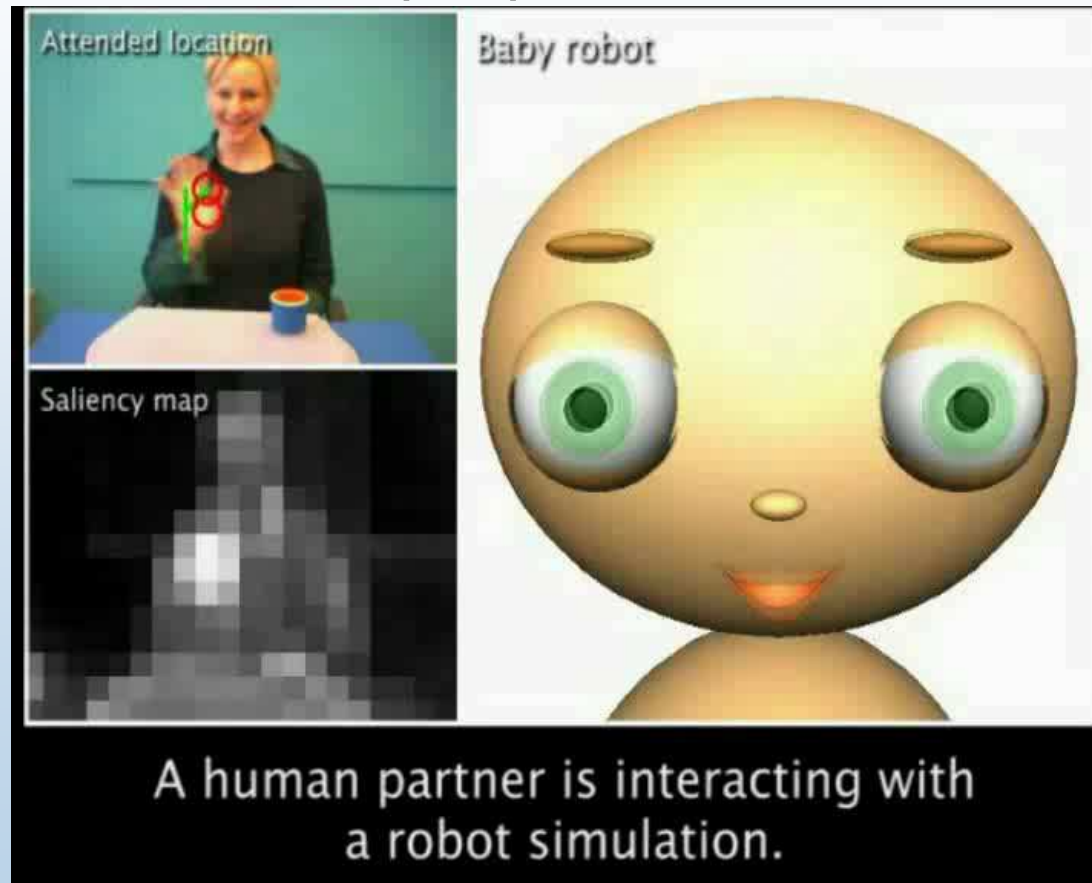
Joint Focus of Attention

Human-robot interaction: people react to robots as to people



Joint Focus of Attention

Human-robot interaction: people react to robots as to people



Conclusion

Why do we need attentive robots?

- Prioritize what to process first
- Decide what to do next
- Establish joint focus of attention

Thank you for your
attention!



More in:

["Towards Attentive Robots", Simone Frintrop,
in the PALADYN Journal of Behavioral Robotics, Springer, Vol 2, Issue 2, 2011]