A*STAR

Institute for Infocomm Research

Social Robotics

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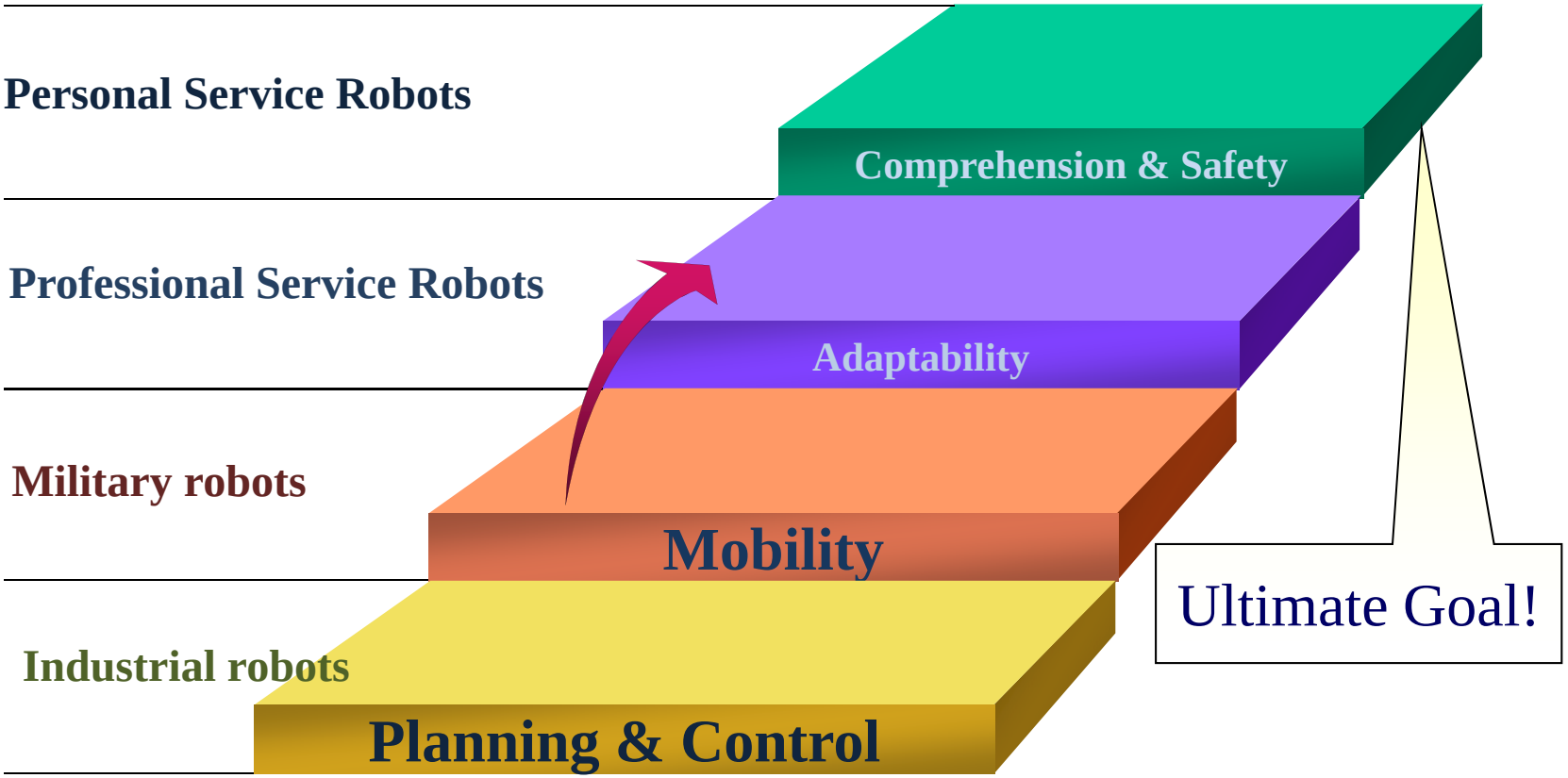
Outline

- Introduction
- Social Robotics in I2R
- Core components: mapping and navigation
- Robot development
  - Cognitive robot
  - Robot mapping and navigation
  - Vision guided robot
- Conclusion

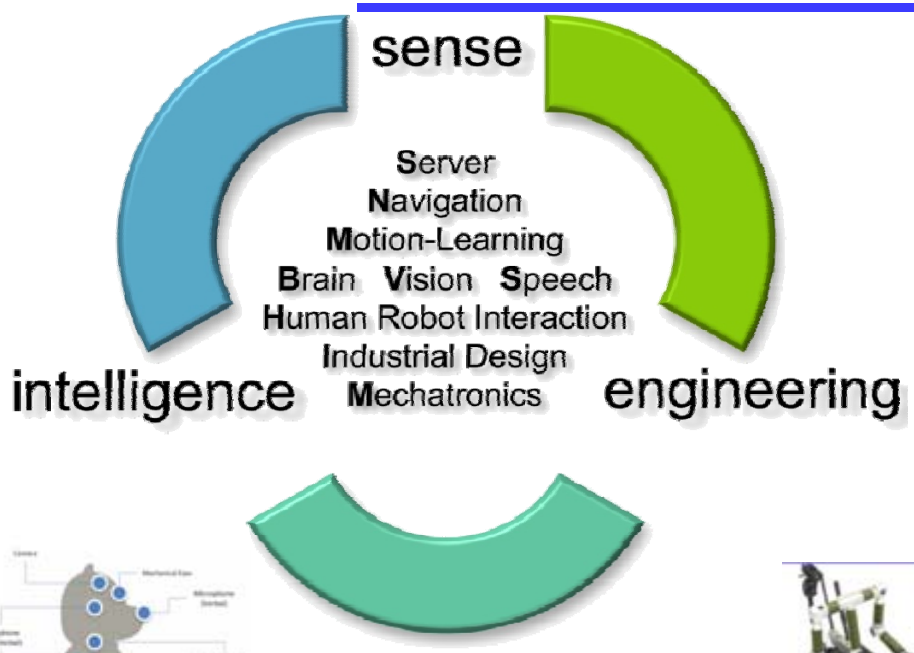
What is social robot?

- Have a physical embodiment
- Autonomous
- Interact with humans
- Understanding of social beings

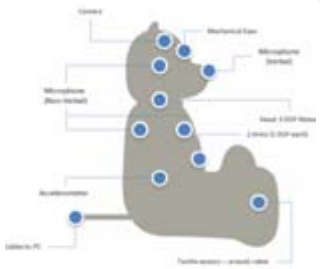
Robot Development Trends



Social and Service Robotics



- Robotic Attention
  - Sound localization
  - Robotic audition & vision
  - Human-robot dialogue
  - Robotic operating system (Brain)
  - Cognitive learning

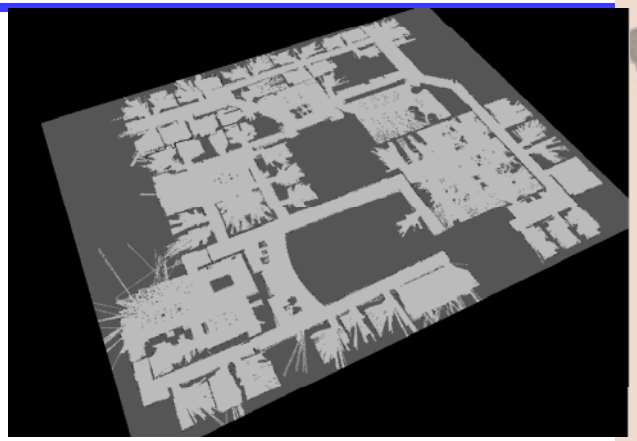


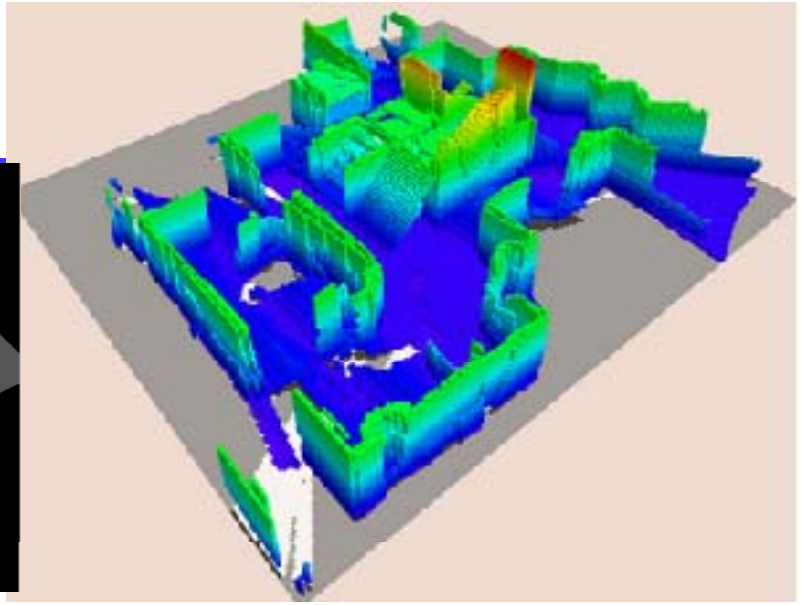
OLIVIA 2.0

Robotic Cognition

MIKA

Mapping





Occupancy-based SLAM

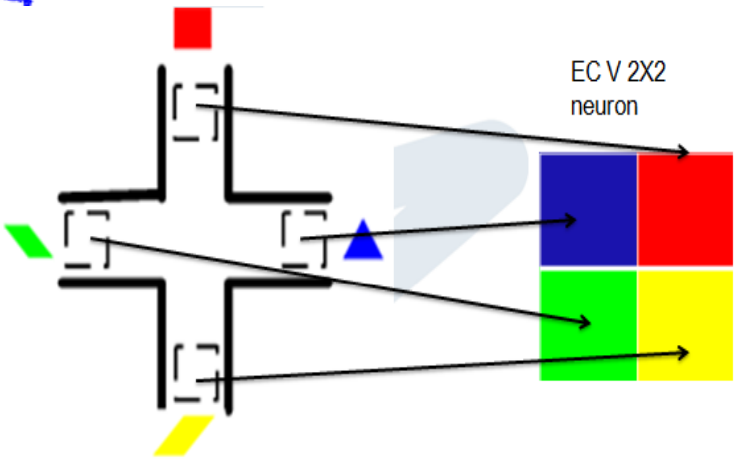
- Features: very detail information of the physical environment is required to construct the ground-truth map, accurate representation

Appearance-based SLAM

- Features: Only record partial information of the environment to construct topological map

Neuronal Activities

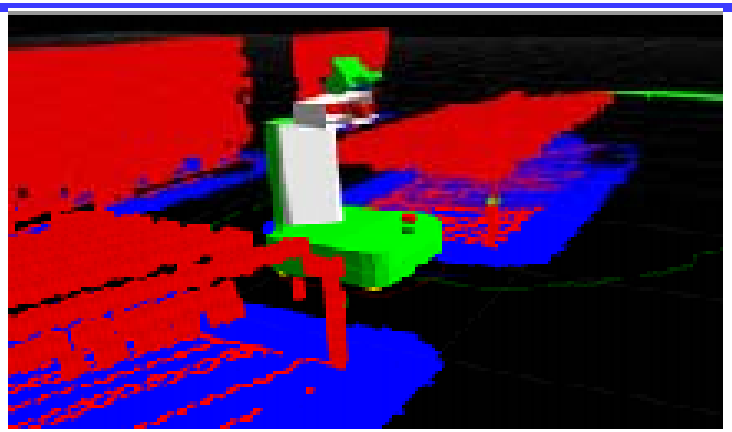
- Features: Spatial information - in neuronal activities

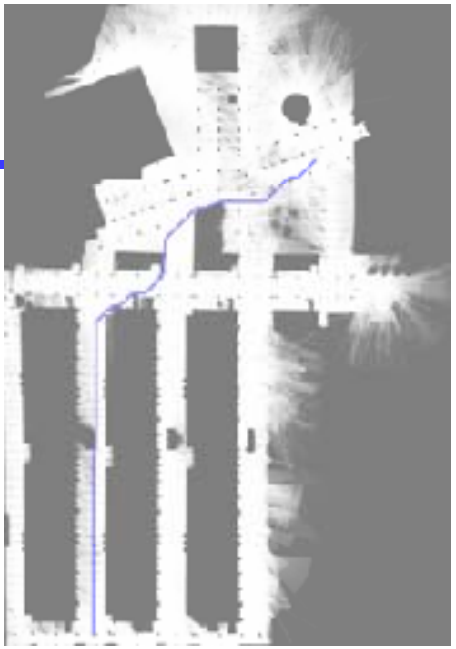


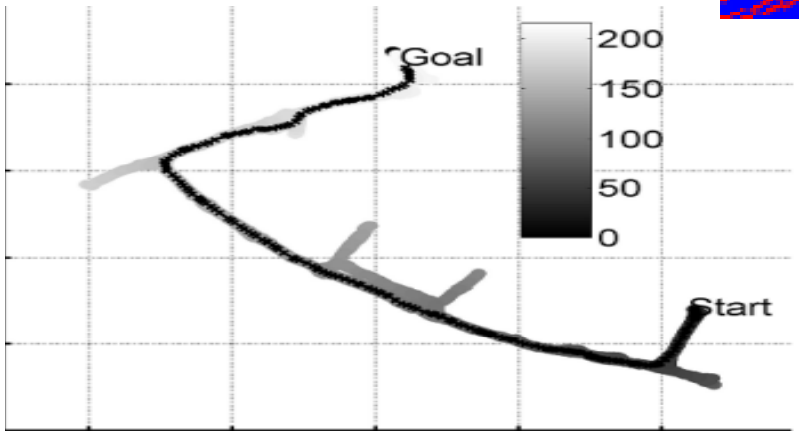
Navigation

Voxel-based 3D mapping (Eitan et al. 2010)

- **Map:** Used occupancy grid to build costmap
- **Cons:** Detailed environmental data is required, slow





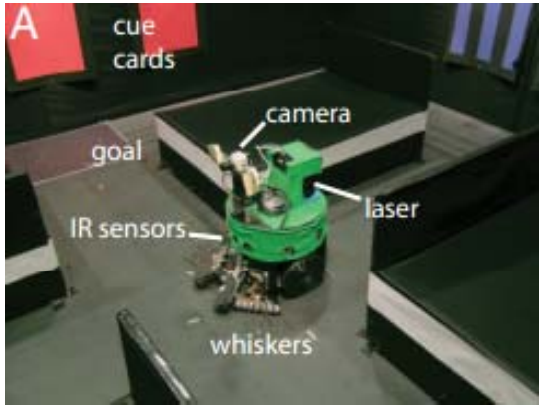


RatSLAM (Milford and Wyeth 2009)

- **Map:** Topological's cognitive map
- **Cons:** Need to follow closely the global path

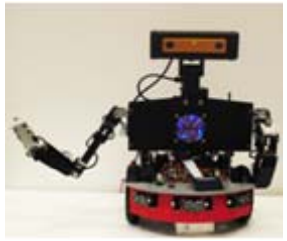
Darwin XI (Fleischer et al. 2007)

- **Map:** Location as neuronal activities
- **Global planner:** No.
- **Cons:** Small area



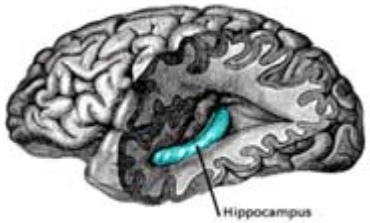
Neural Cognitive Robot (NECO)

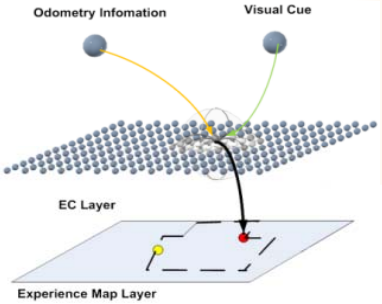
Robot Platform + **Peripheral Algorithms**



Sensors
Actuators
Manipulation
Communication

+ **Brain Based Model**





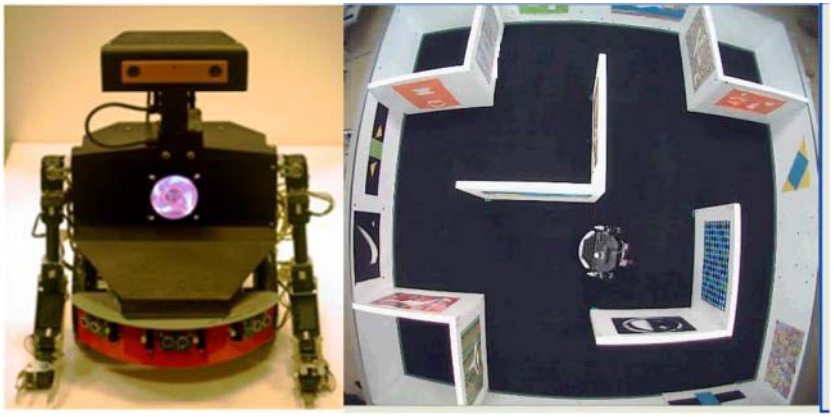
Discovery of navigational cells in brain

Applicable Computational Model based on brain structure and function

The robot is able to navigate in very complex unknown environments through active cognition.

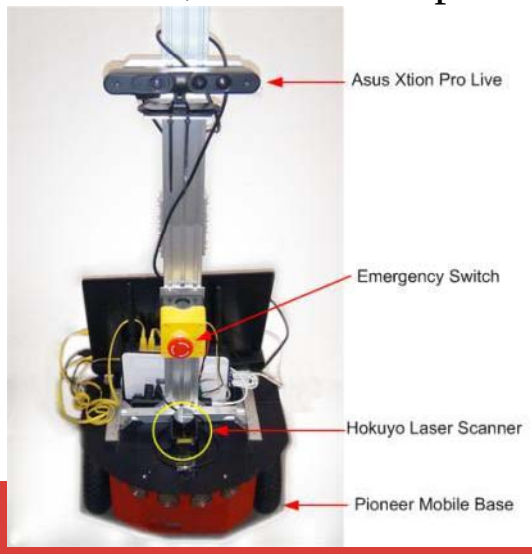
NECO Series

NECO I and the maze environment



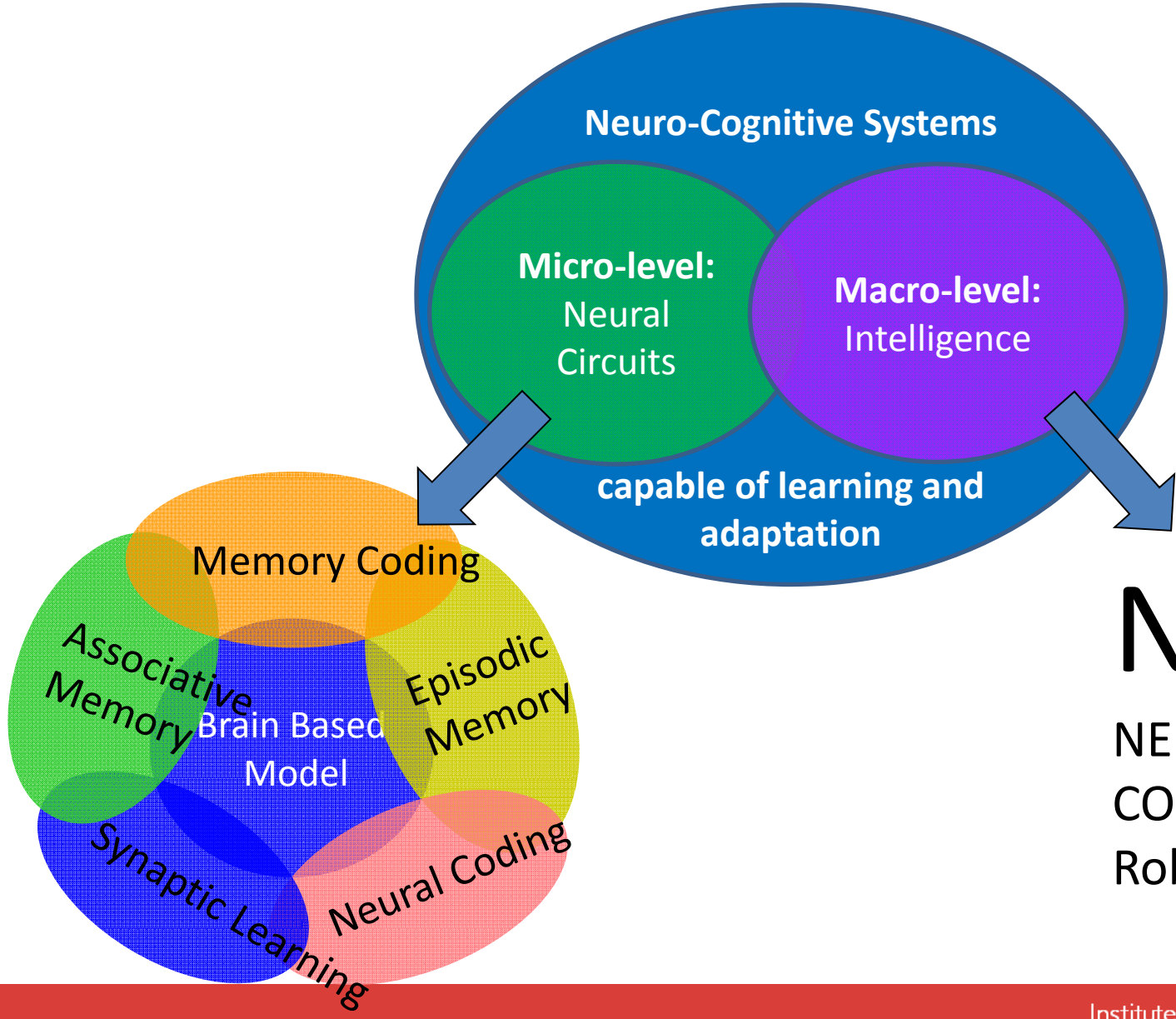
NECO II, preliminary setup

NECO II, current setup



NECO III, in development

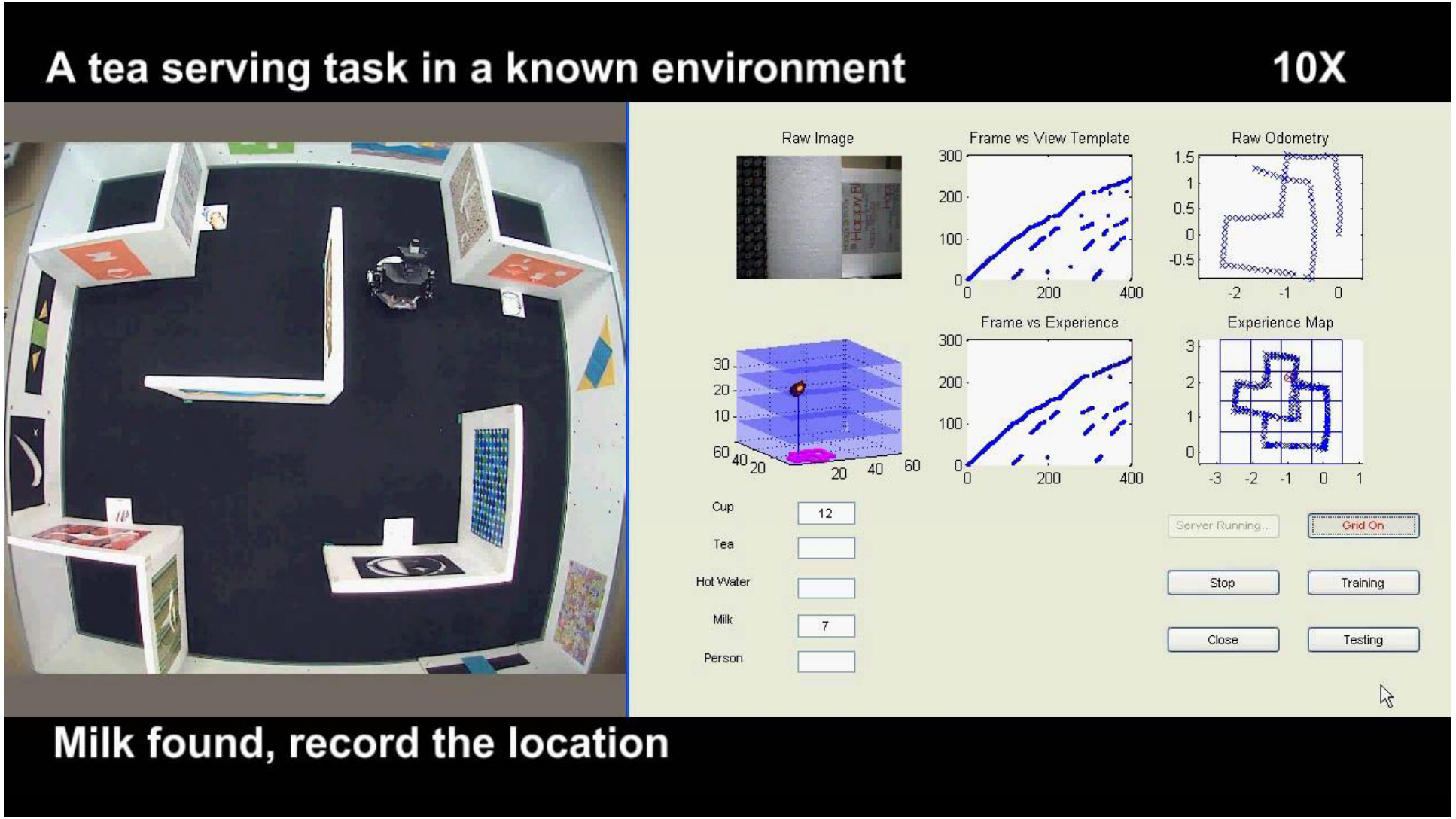
Research Map



Neco

NEural
COgnitive
Robot

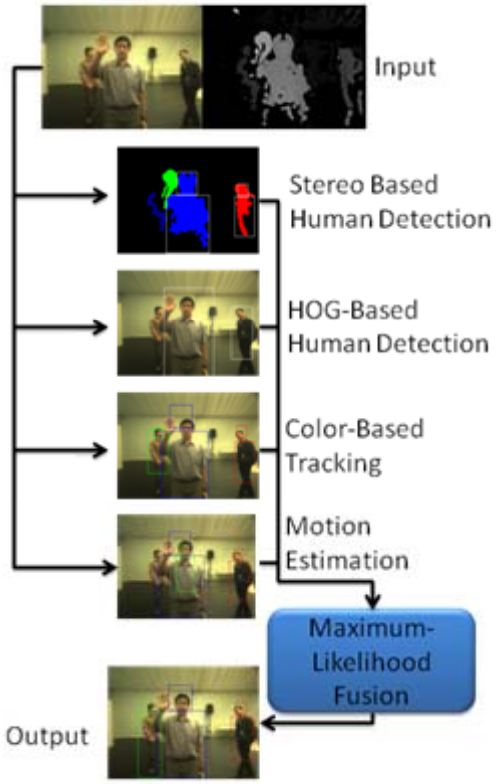
Video: Cognitive mapping in maze



Video: Cognitive mapping in office

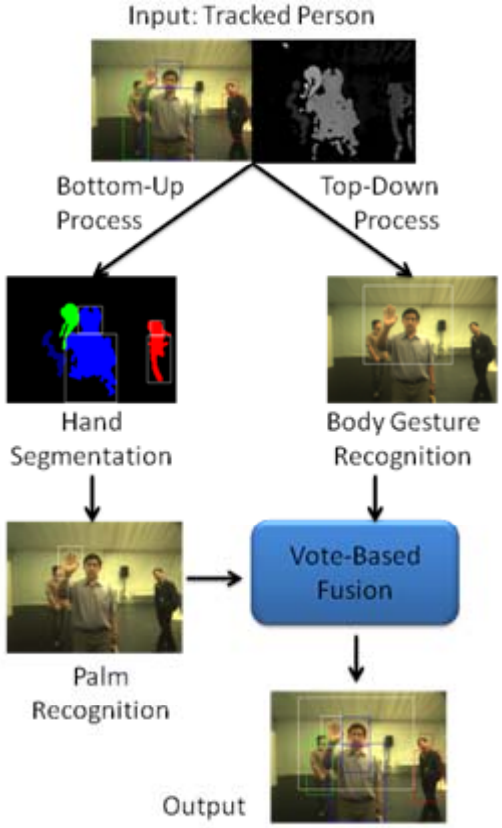
Human & Gesture Tracking

Human Tracking

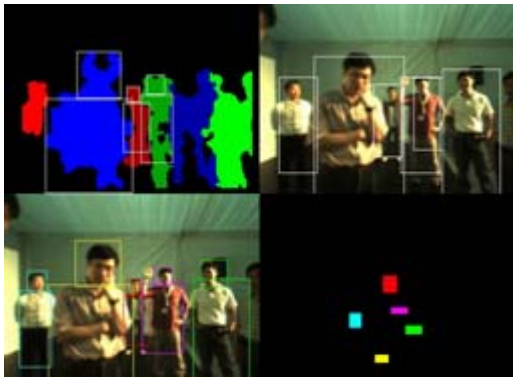


- Stereo-based human detection
- HOG-based human detection
- Robust fusion of information from 4 human detection, tracking, and estimation models

Gesture Tracking



- Bottom-up hand gesture detection & recognition
  - Stereo-based segmentation
  - Skin and palm verification
- Top-down body gesture detection
  - HOG-based body gesture detection



Video: Gesture recognition

Video: Automatic object searching

Video: Following people

Outside the lab

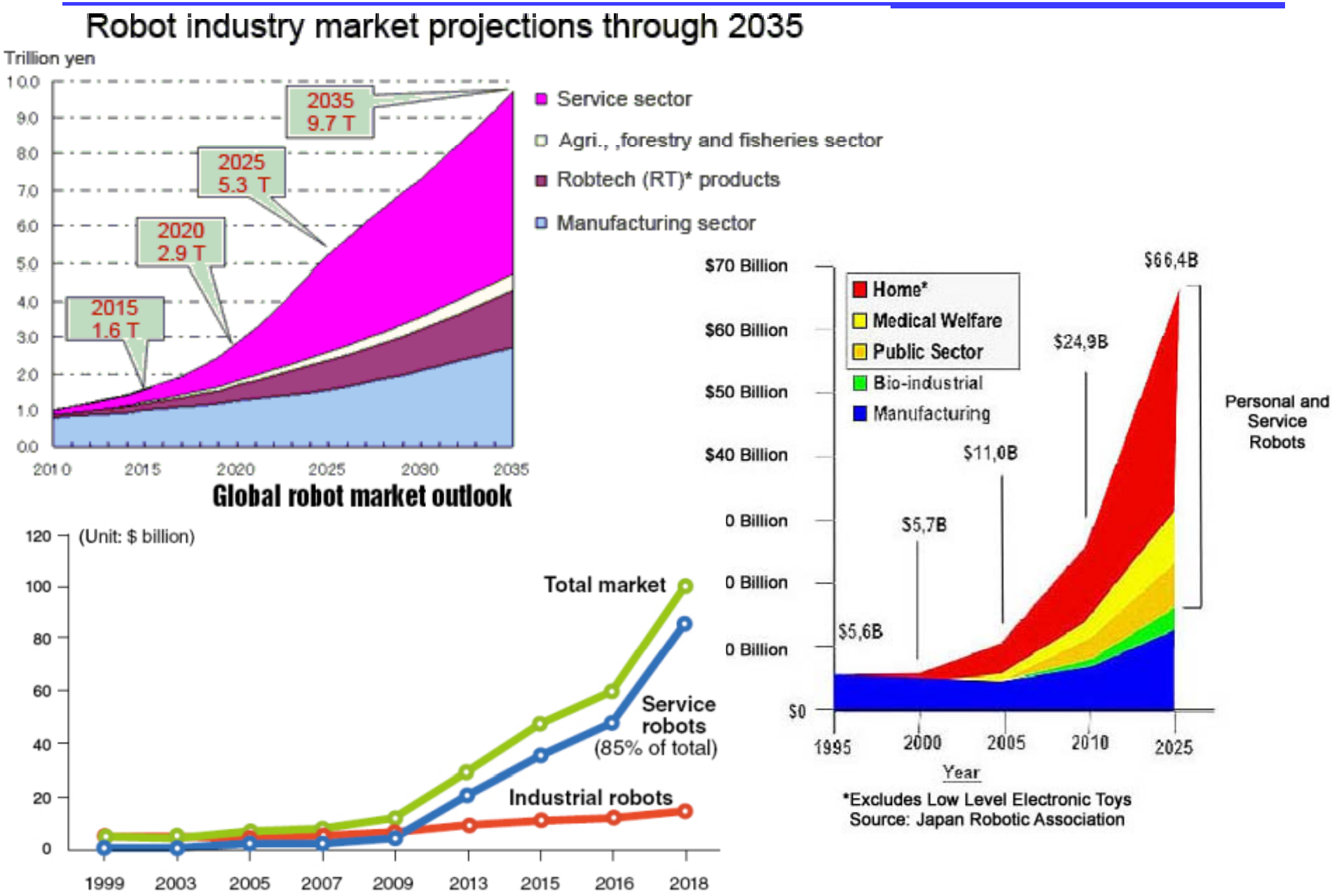
@ Sentosa

@ London

@ Serangoon Library

@ Beijing

Conclusion


Robot industry market projections through 2035
Trillion yen
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2035
9.7 T
2025
5.3 T
2020
2.9 T
2015
1.6 T
2010
2015
2020
2025
2030
2035
Service sector
Agri., ,forestry and fisheries sector
Robtech (RT)* products
Manufacturing sector
Global robot market outlook
(Unit: $ billion)
120
100
80
60
40
20
0
Total market
Service robots
(85% of total)
Industrial robots
1999
2003
2005
2007
2009
2013
2015
2016
2018
$70 Billion
$60 Billion
$50 Billion
$40 Billion
0 Billion
0 Billion
0 Billion
$0
Home*
Medical Welfare
Public Sector
Bio-industrial
Manufacturing
$66,4B
$24,9B
$11,0B
$5,7B
$5,6B
1995
2000
2005
2010
2025
Year
Personal and Service Robots
*Excludes Low Level Electronic Toys
Source: Japan Robotic Association

Future

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Thank You

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