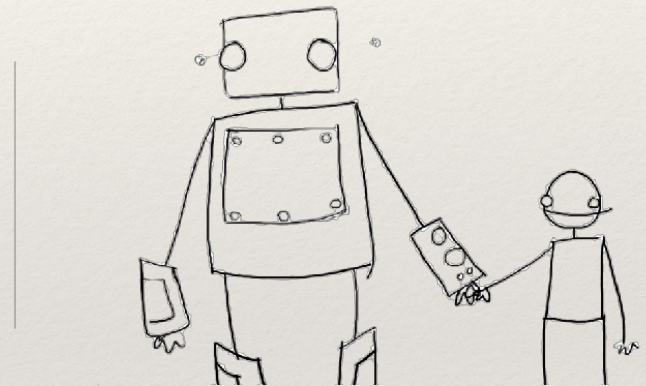


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# ROBOT VISION

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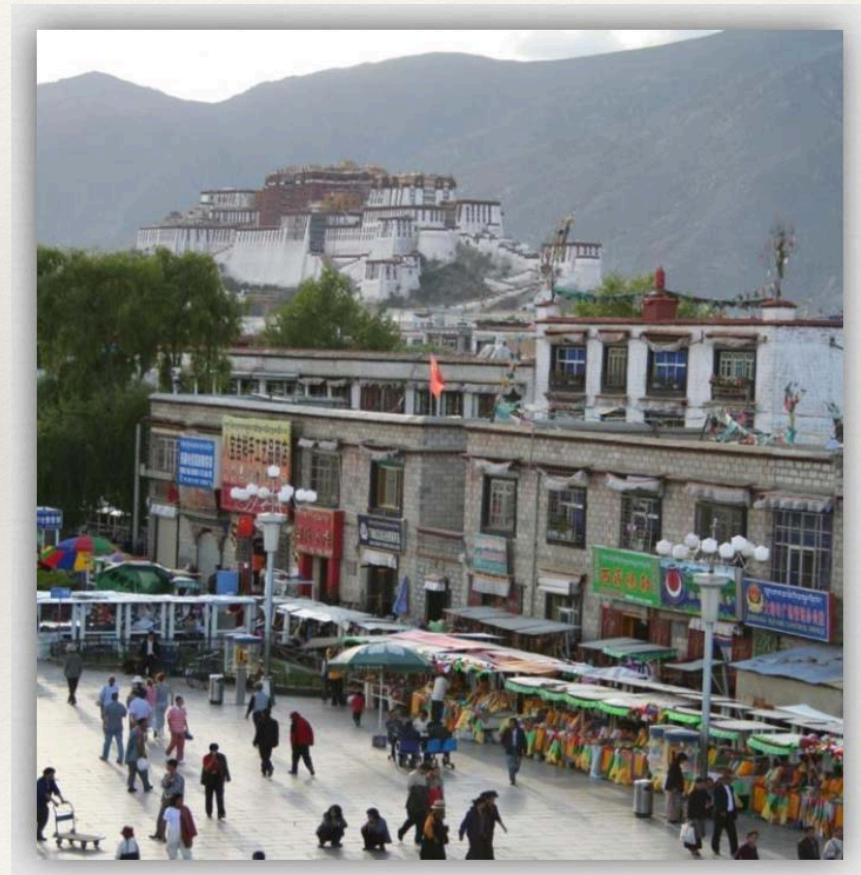
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# ROBOT VISION

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Make computers / robots understand images and video

- ❖ Specific Recognition Tasks
  - ❖ Outdoor, indoor.
  - ❖ City, forest, factory.
- ❖ Image Annotation
  - ❖ street
  - ❖ people
  - ❖ building
  - ❖ mountain
  - ❖ tourism
  - ❖ cloudy
  - ❖ brick

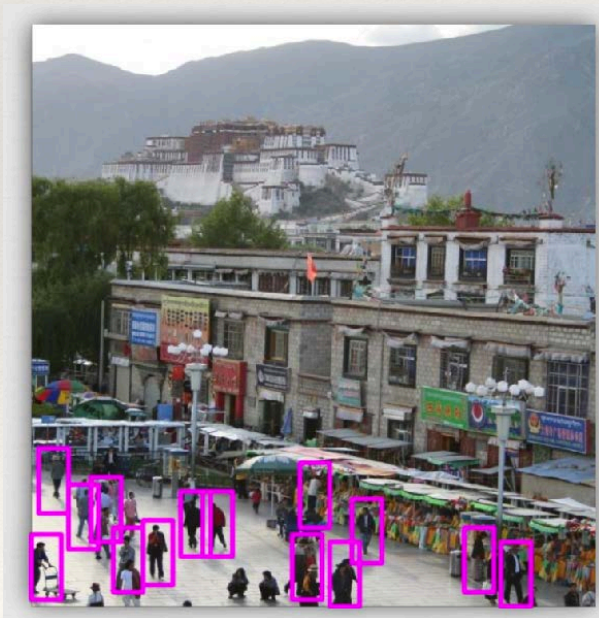




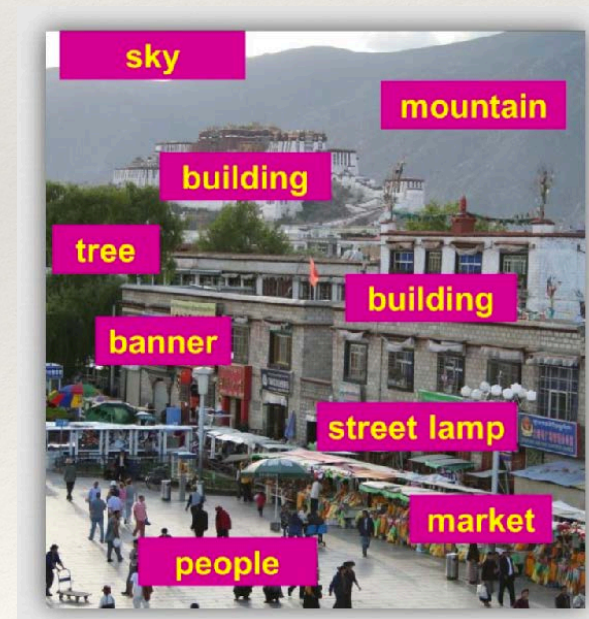
# ROBOT VISION

Make computers / robots understand images and video

- ❖ Object Detection
  - ❖ Find Pedestrian



- ❖ Image Segmentation



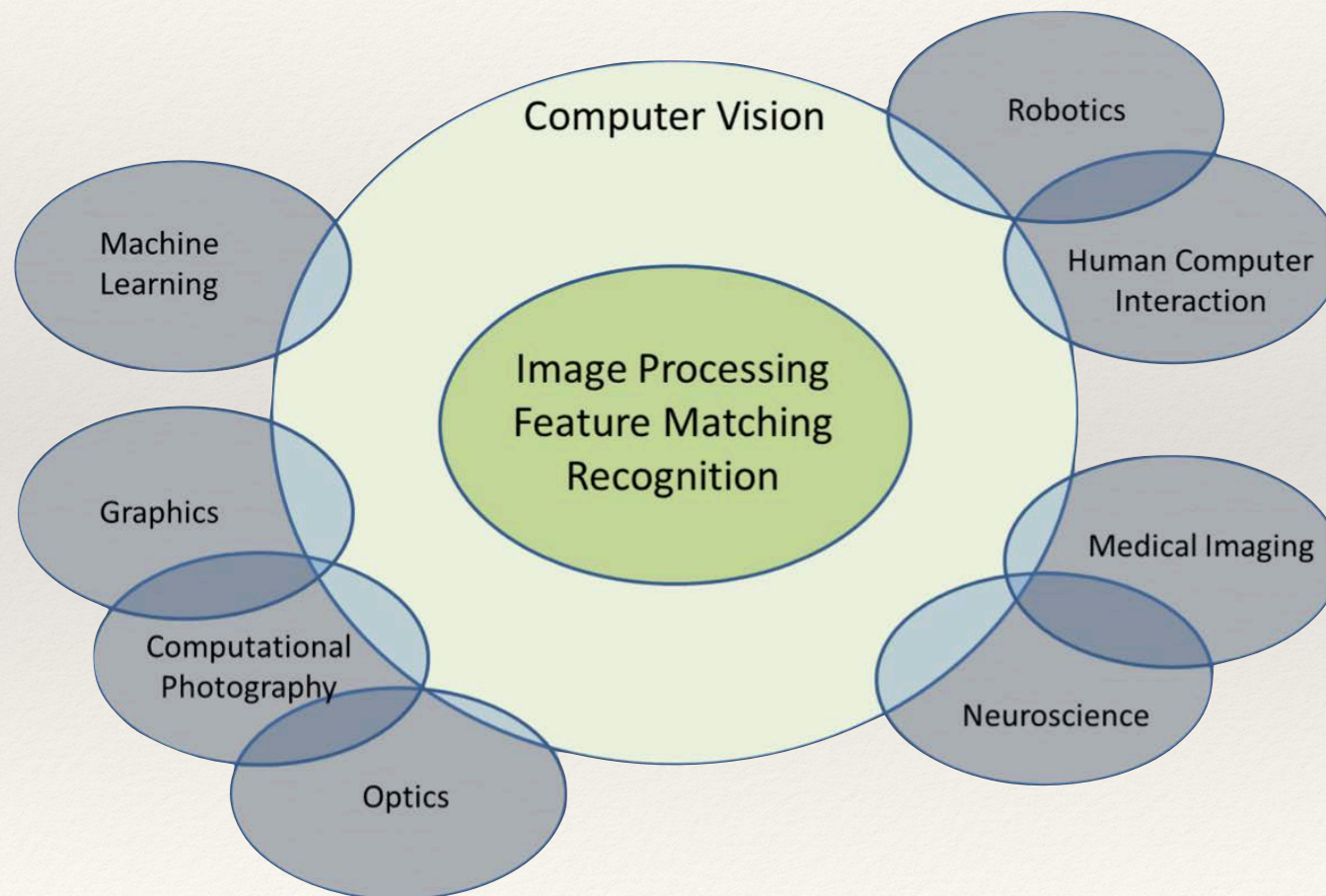


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# ROBOT VISION

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## Computer Vision Scope



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# ROBOT VISION

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Computer Vision is **Challenging...**



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# ROBOT VISION

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Computer Vision is **Challenging...very**





# ROBOT VISION

## Computer Vision is Challenging...

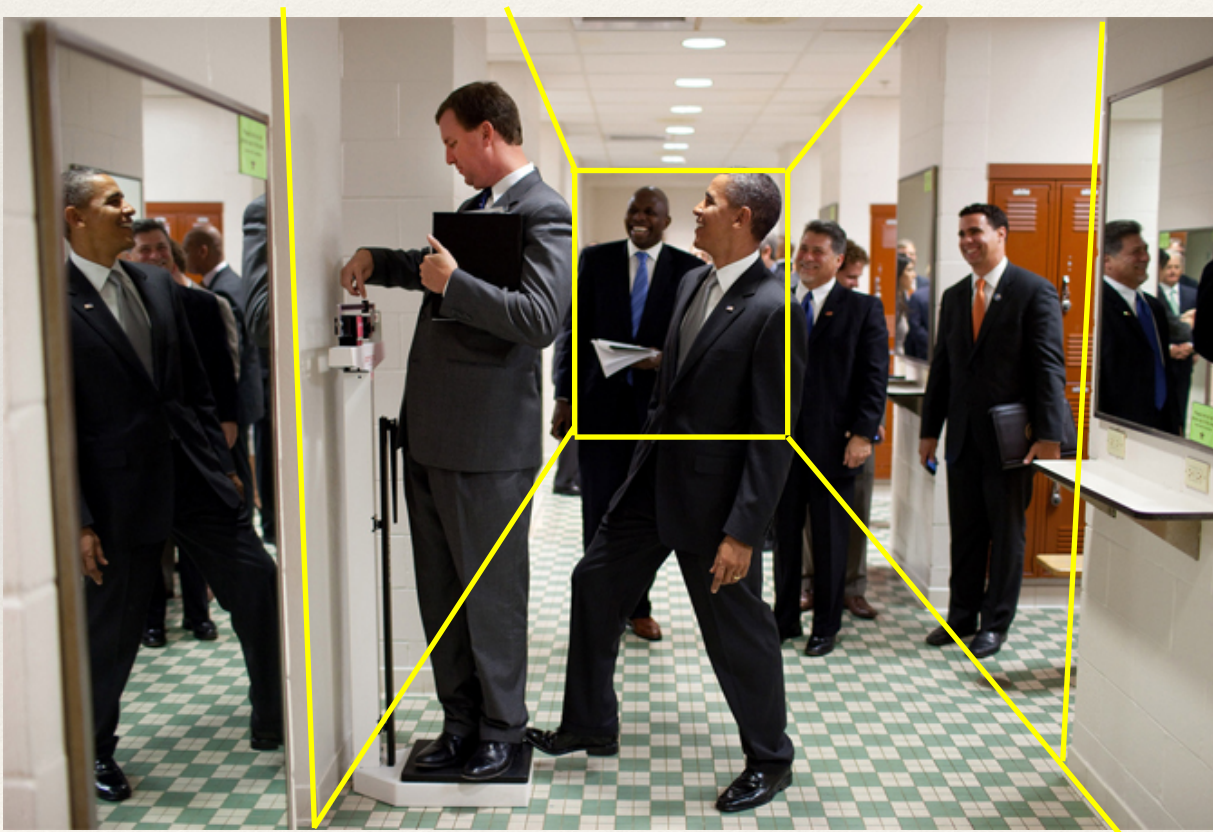


- ❖ Where was this picture taken ?
- ❖ How many people are there ?
- ❖ What are they doing ?
- ❖ What is the object the person on the left is standing on?
- ❖ Why is this a funny picture ?



# ROBOT VISION

## Computer Vision is Challenging...



- ❖ Where was this picture taken ?
- ❖ How many people are there ?
- ❖ What are they doing ?
- ❖ What is the object the person on the left is standing on?
- ❖ Why is this a funny picture ?



# ROBOT VISION

## Computer Vision is Challenging...



- ❖ Where was this picture taken ?
- ❖ How many people are there ?
- ❖ What are they doing ?
- ❖ What is the object the person on the left is standing on?
- ❖ Why is this a funny picture ?



# ROBOT VISION

## Computer Vision is Challenging...

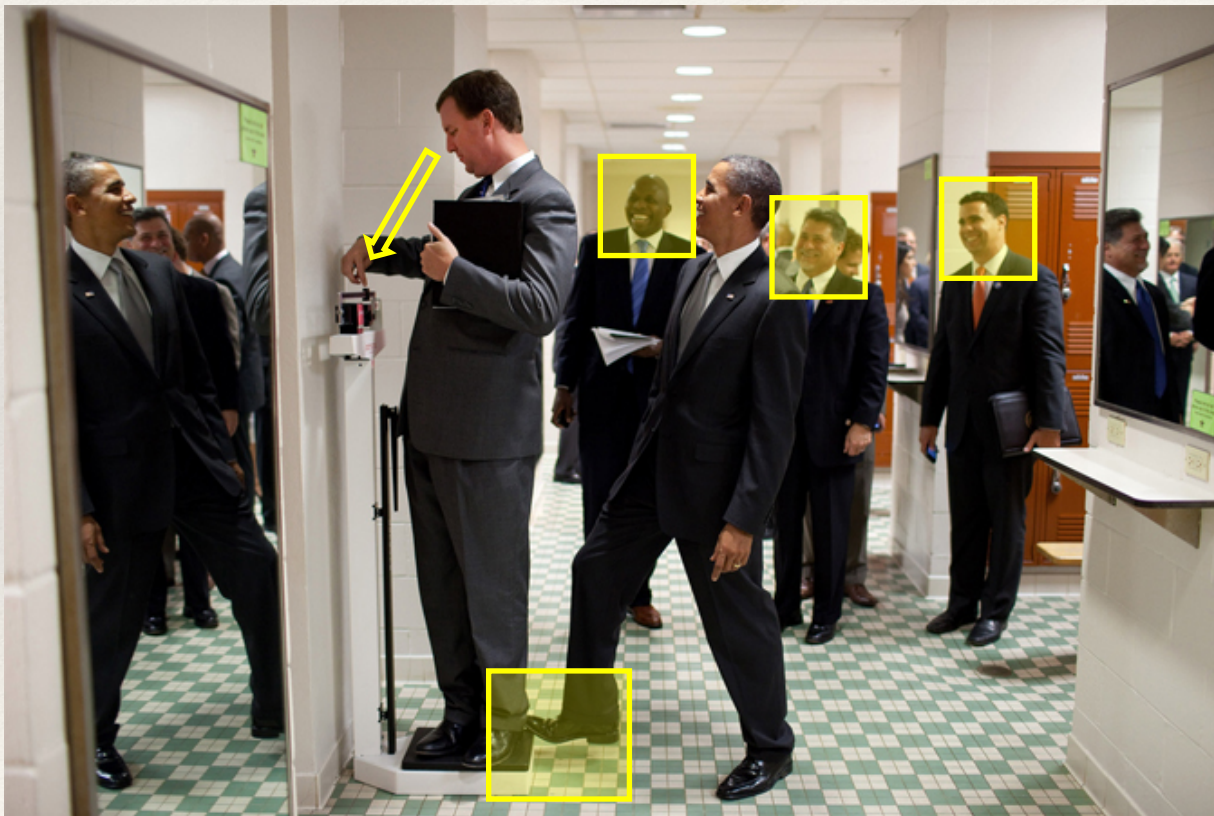


- ❖ Where was this picture taken ?
- ❖ How many people are there ?
- ❖ What is the object the person on the left is standing on?
- ❖ What are they doing ?
- ❖ Why is this a funny picture ?



# ROBOT VISION

## Computer Vision is Challenging...



- ❖ Where was this picture taken ?
- ❖ How many people are there ?
- ❖ What are they doing ?
- ❖ What is the object the person on the left is standing on?
- ❖ Why is this a funny picture ?

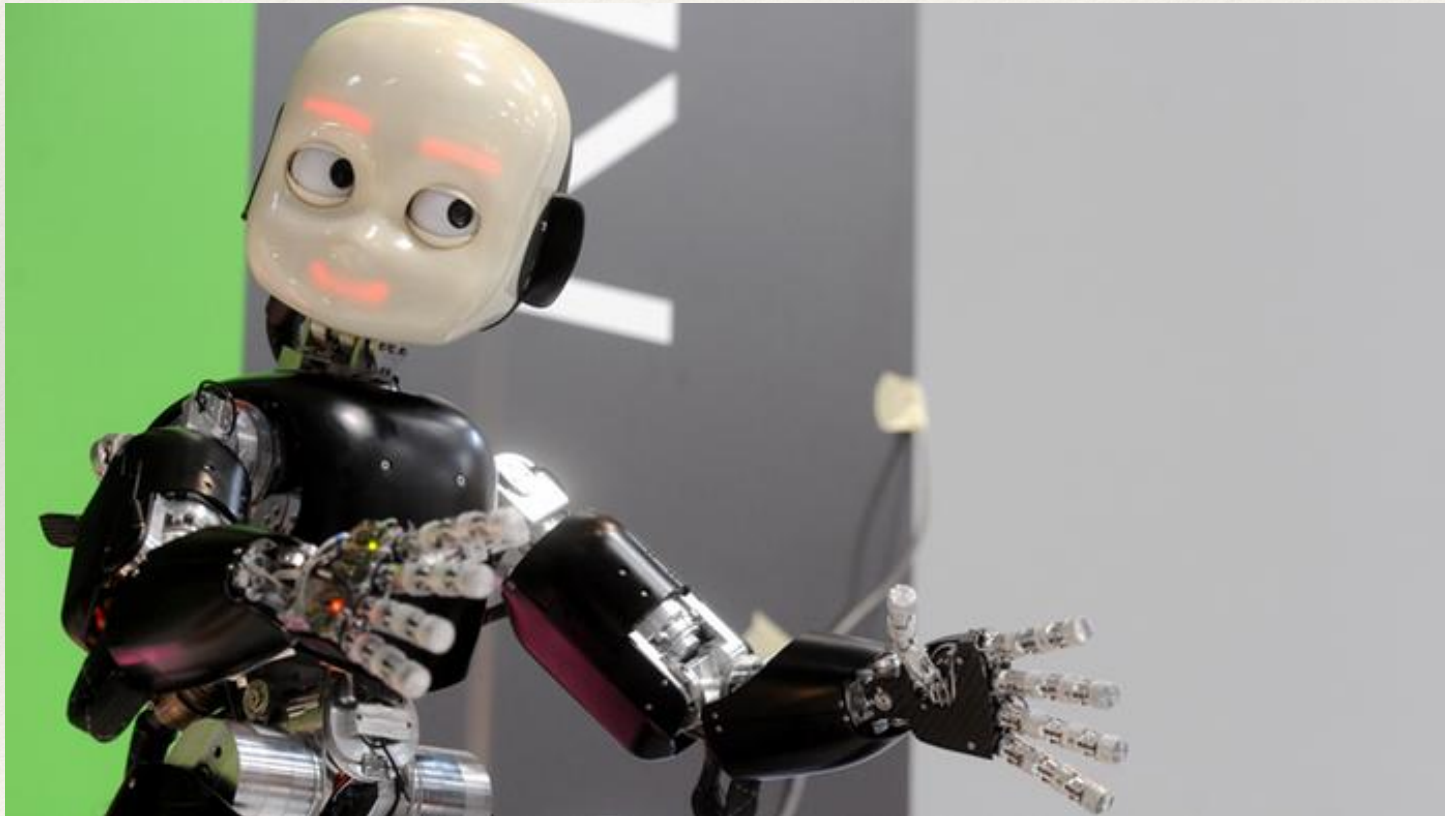


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# ROBOT VISION

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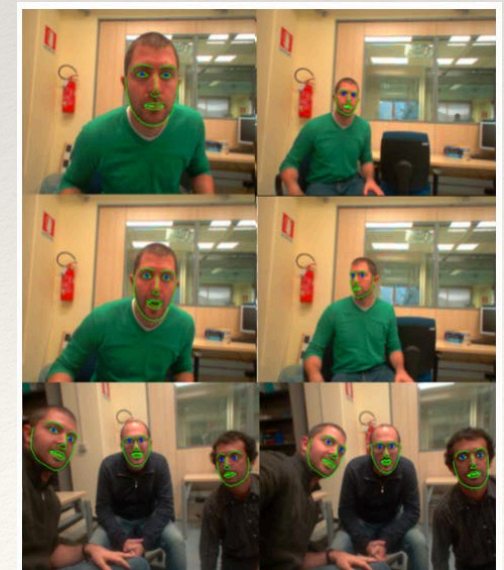
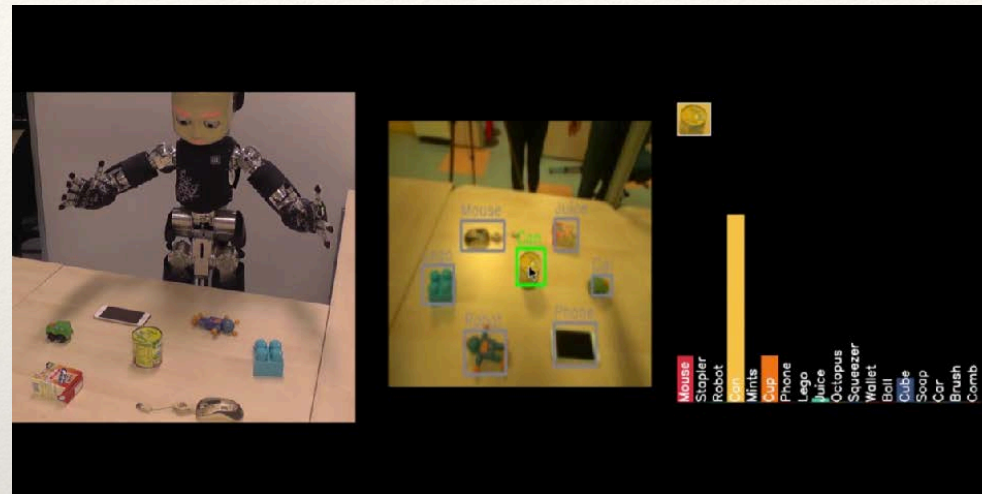
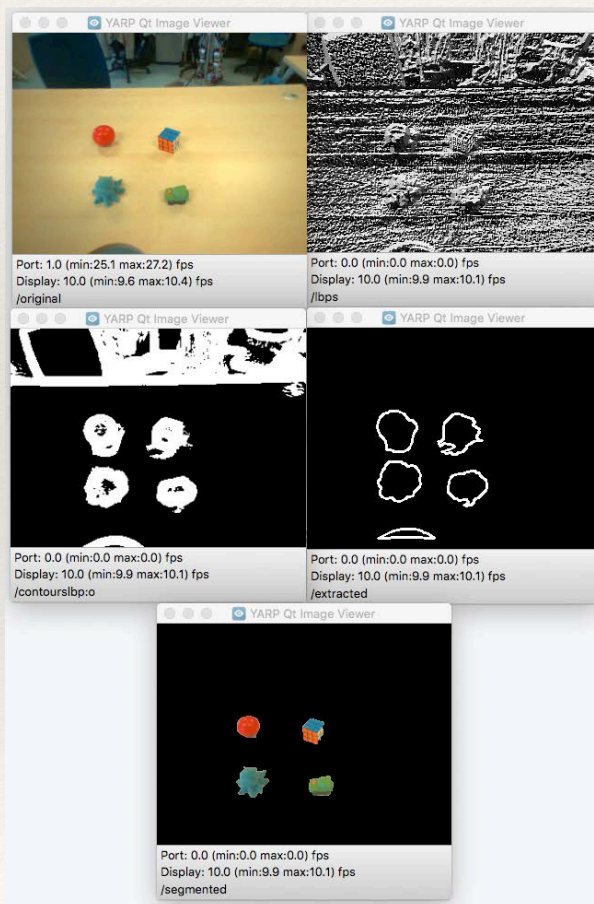
## Fundamentals and Applications - 2D Vision





# ROBOT VISION

## Fundamentals and Applications - 2D Vision



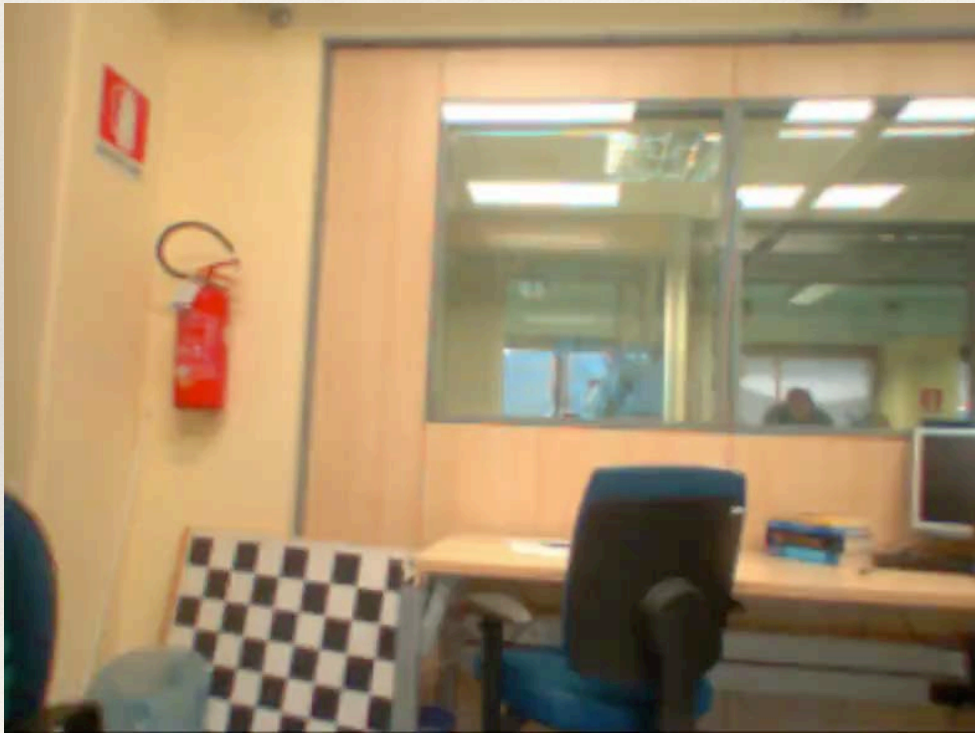


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# ROBOT VISION

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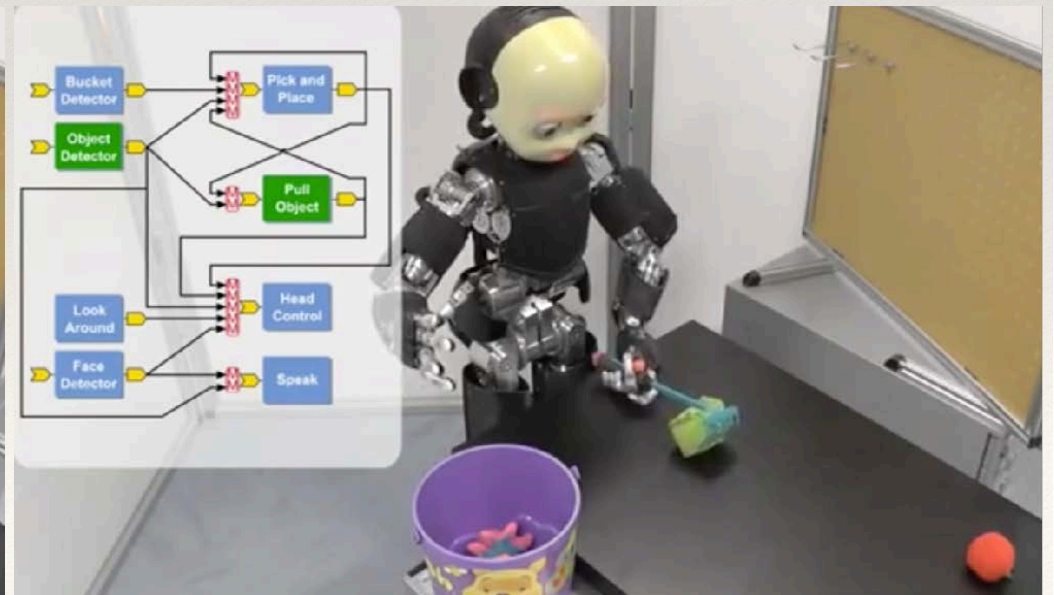
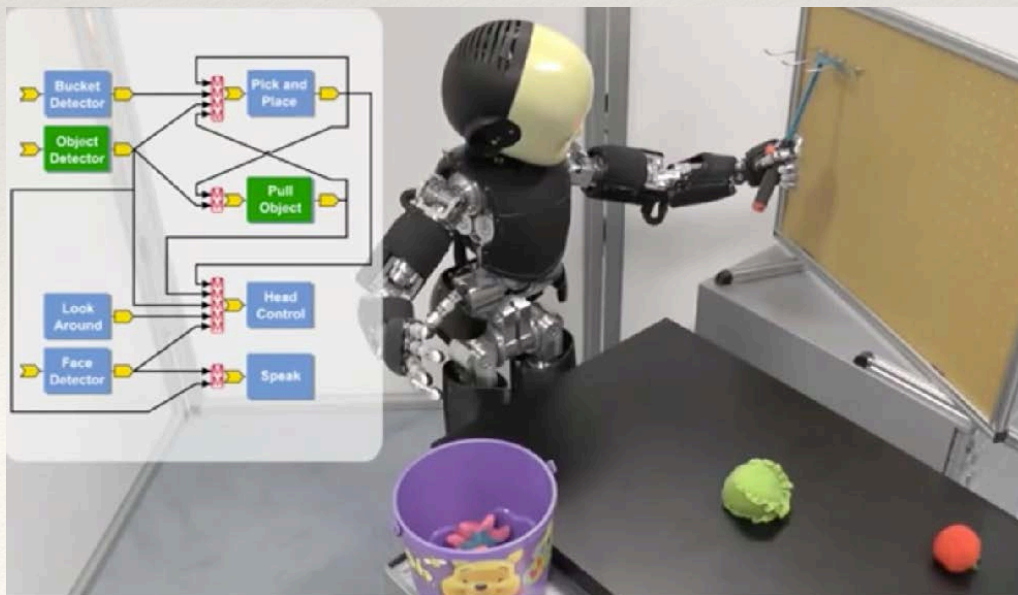
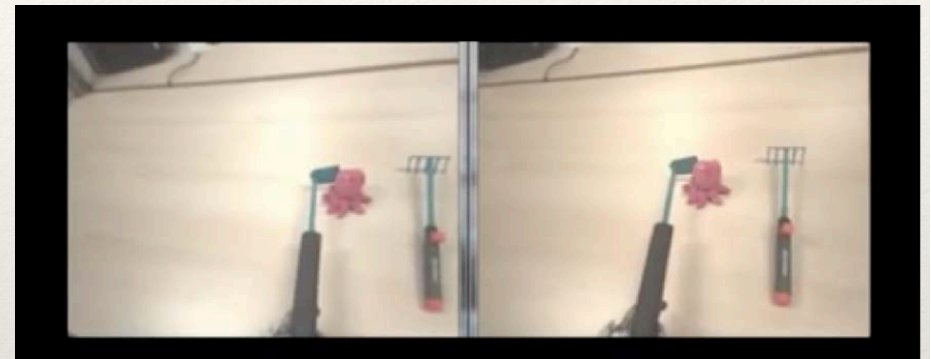
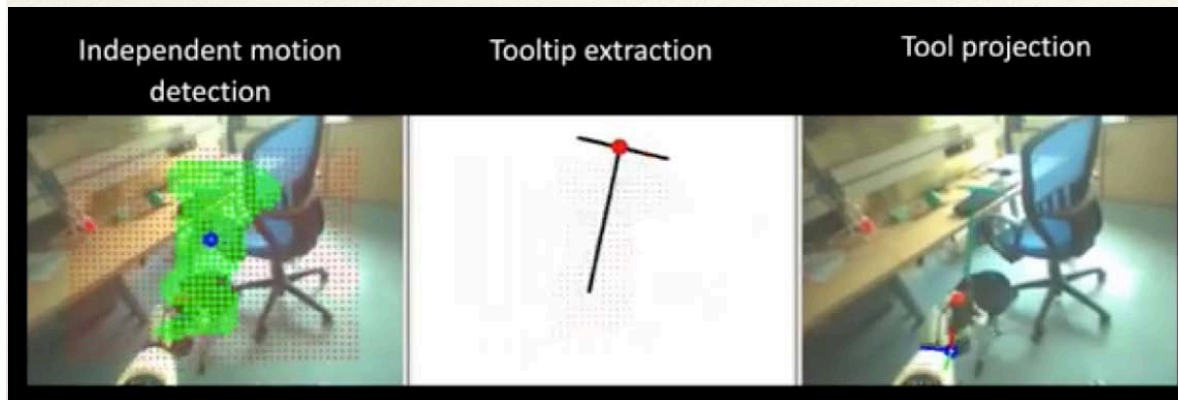
## Fundamentals and Applications - 2D Vision





# ROBOT VISION

## Fundamentals and Applications - 2D Vision



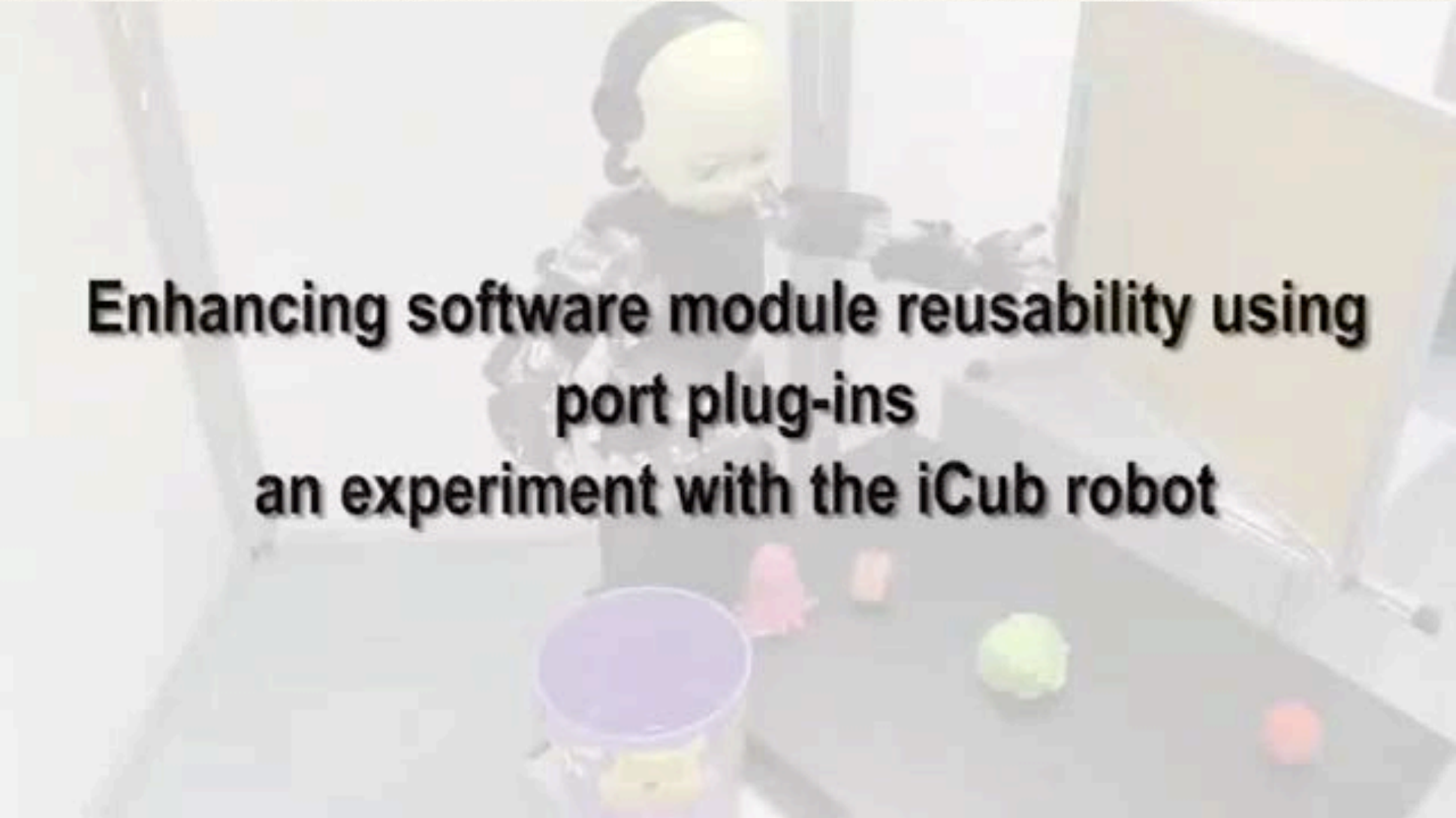


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# ROBOT VISION

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## Fundamentals and Applications - 2D Vision

The background image shows the iCub robot, a humanoid robot with a yellow head and black body, standing on a table. It is surrounded by various objects including a purple cup, a pink object, a green object, and a red object. The text is overlaid on the image in a bold, black, sans-serif font.

**Enhancing software module reusability using  
port plug-ins  
an experiment with the iCub robot**



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# ROBOT VISION

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Fundamentals and Applications - 3D Vision

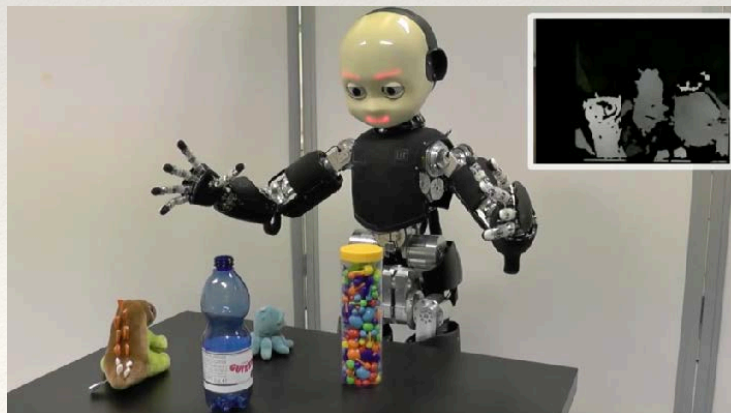
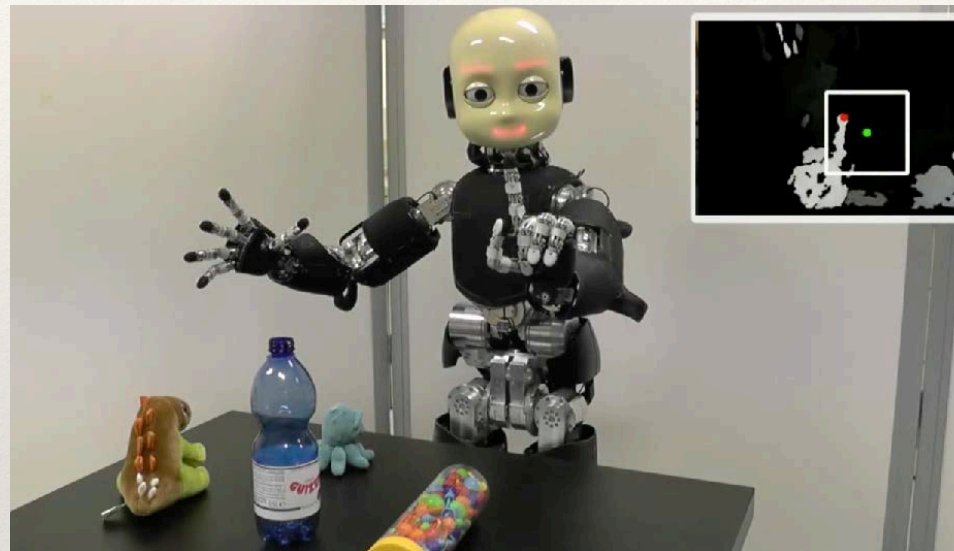


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# ROBOT VISION

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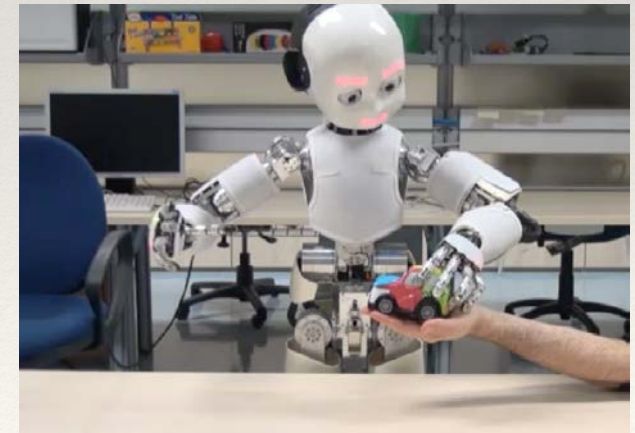
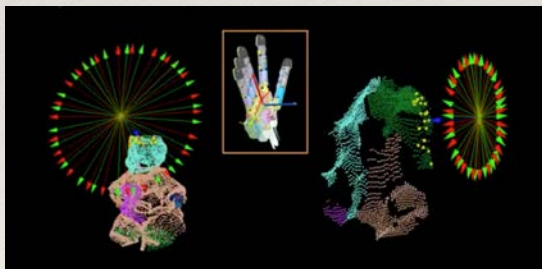
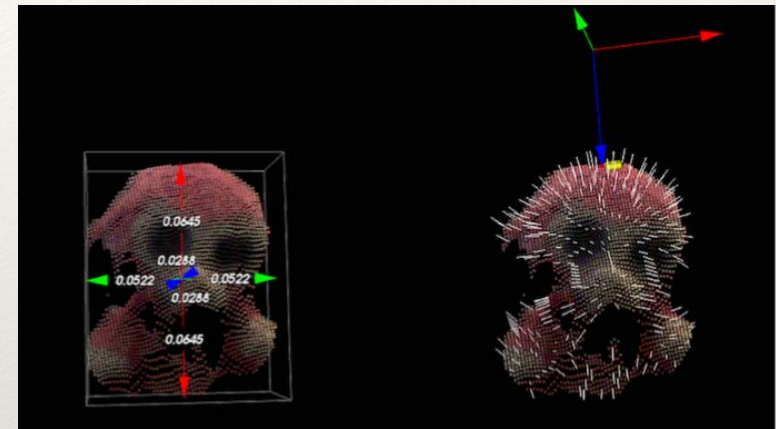
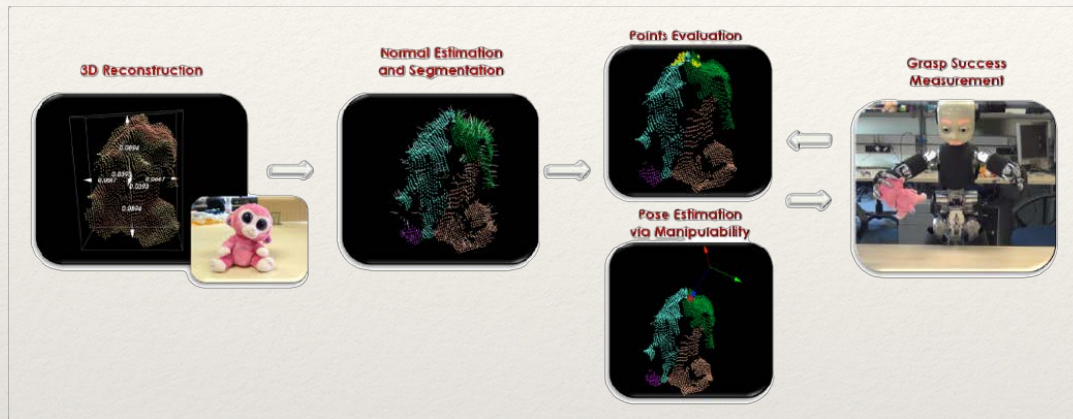
## Fundamentals and Applications - 3D Vision





# ROBOT VISION

## Fundamentals and Applications - 3D Vision



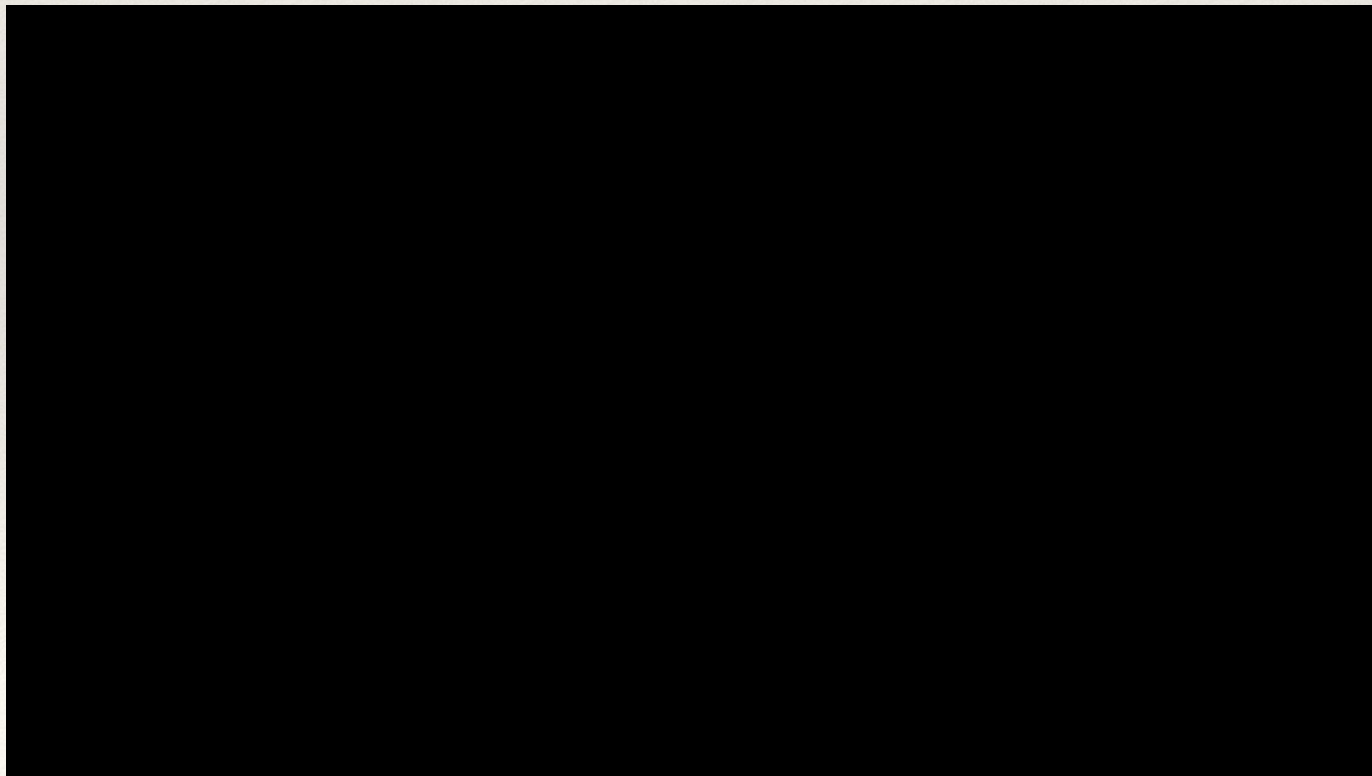
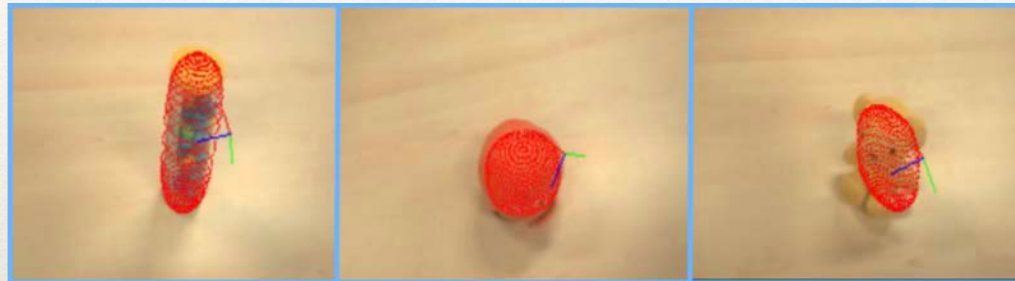


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# ROBOT VISION

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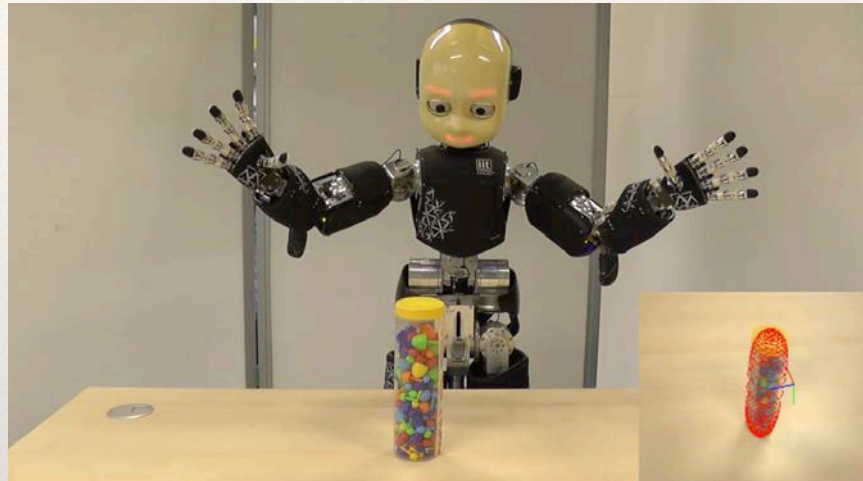
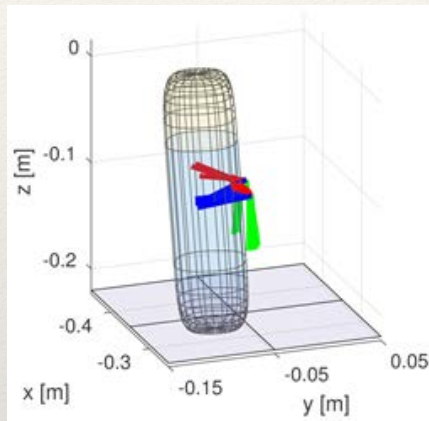
## Fundamentals and Applications - 3D Vision





# ROBOT VISION

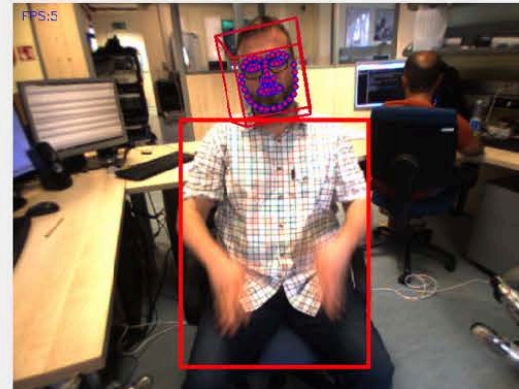
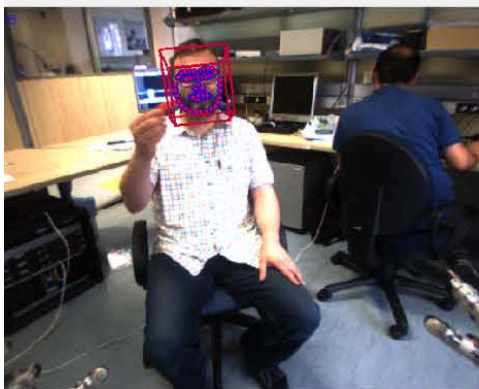
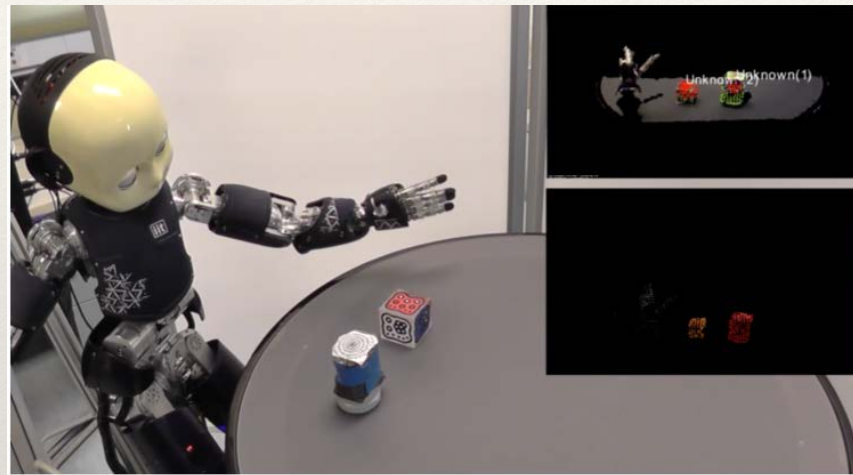
## Fundamentals and Applications - 3D Vision





# ROBOT VISION

## Fundamentals and Applications - 3D Vision

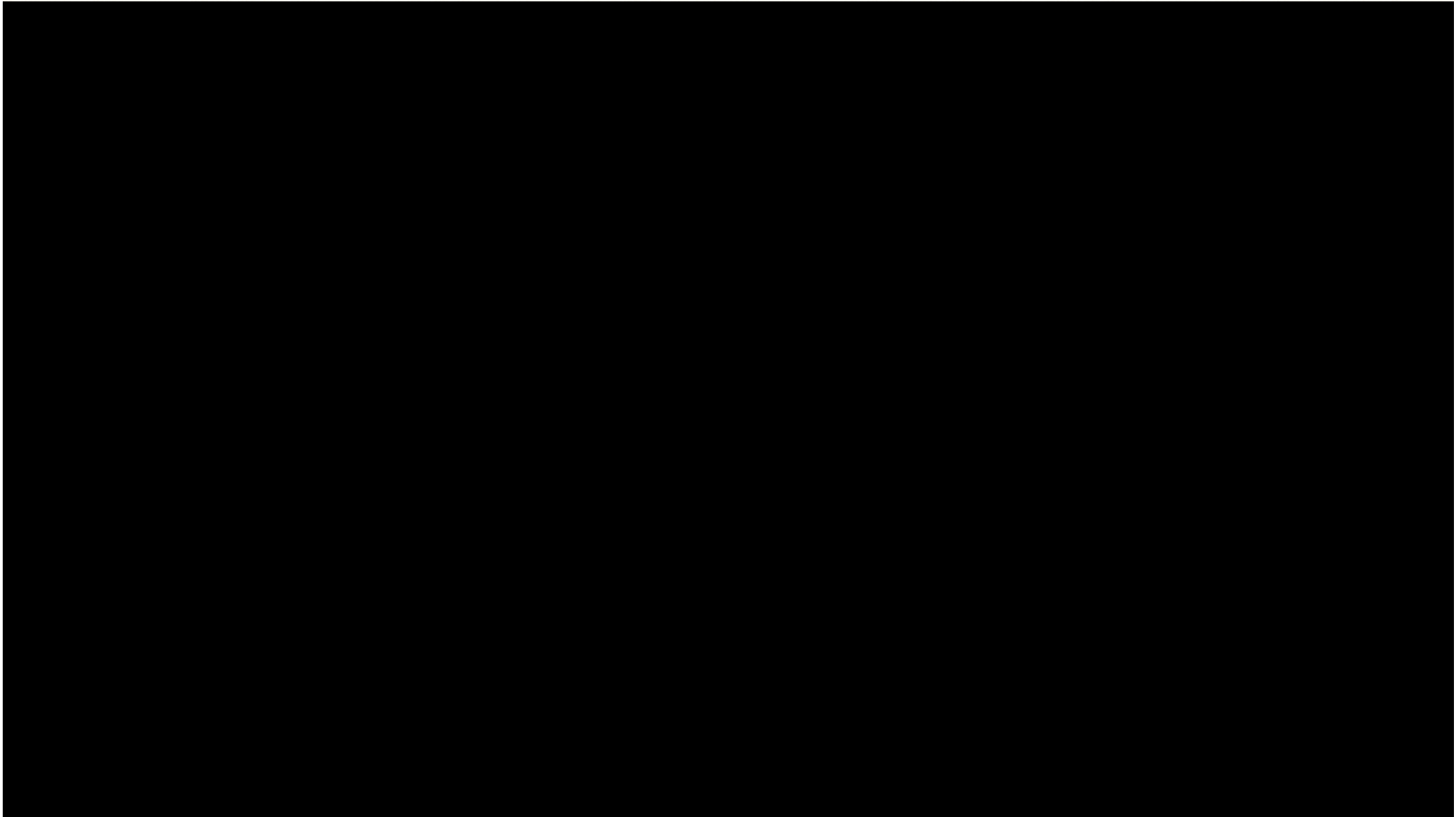




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# ROBOT VISION

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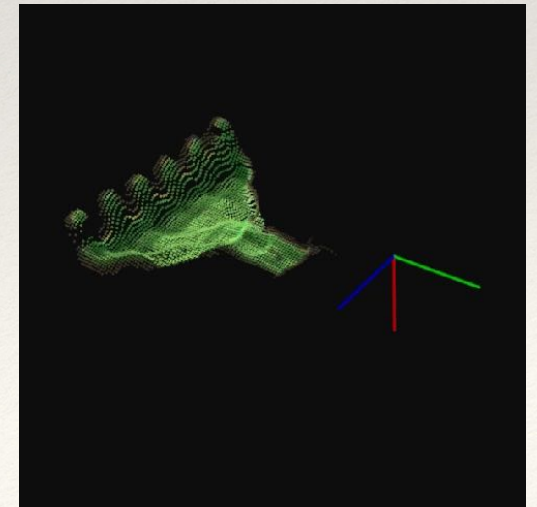
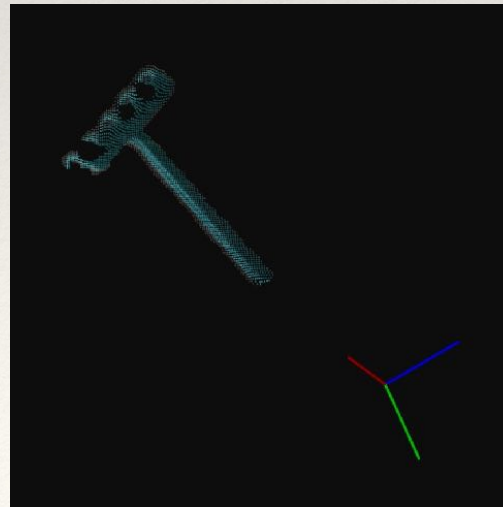
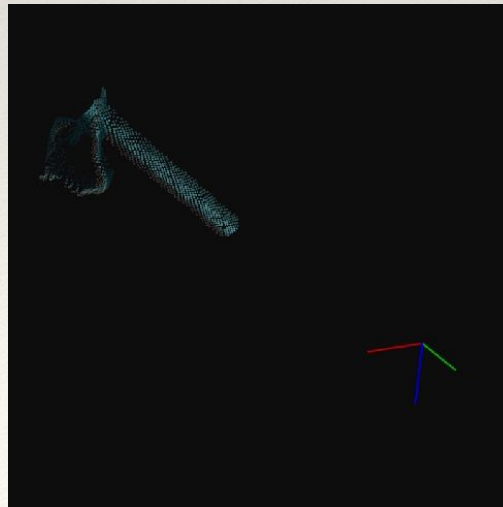
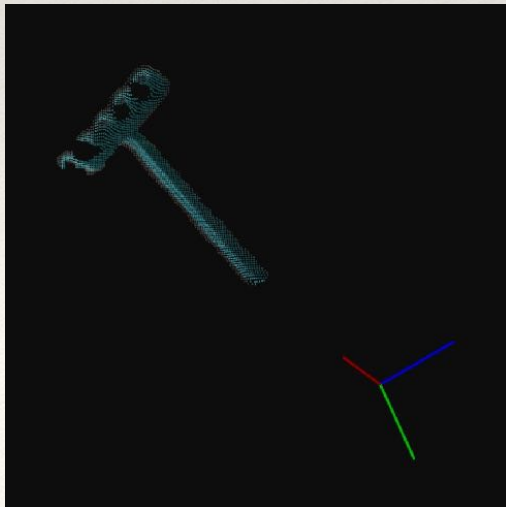
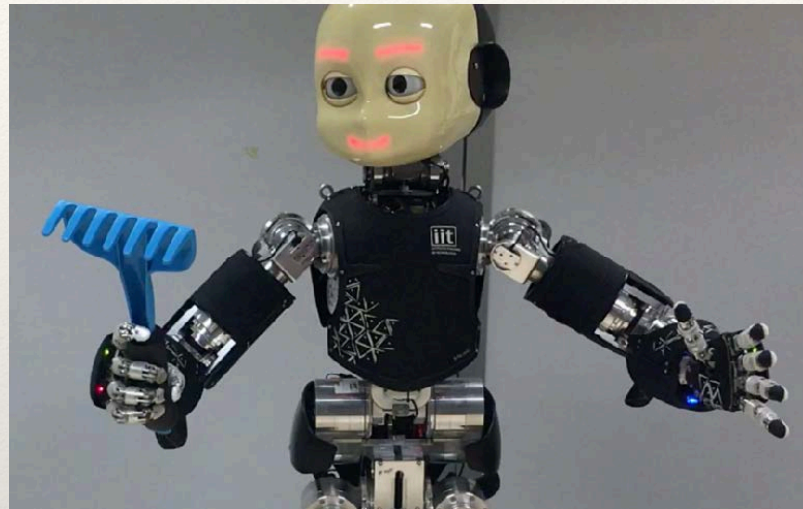


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# ROBOT VISION

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## Fundamentals and Applications - 3D Vision





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# ROBOT VISION

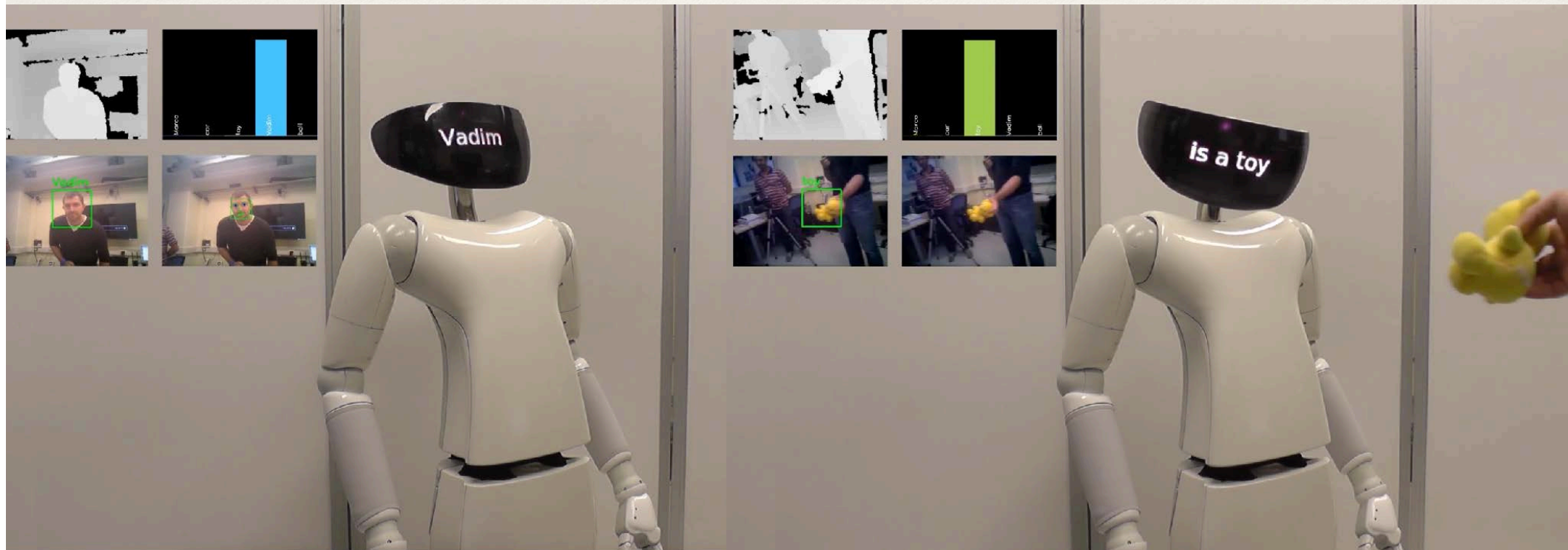
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Fundamentals and Applications - 3D Vision





# ROBOT VISION





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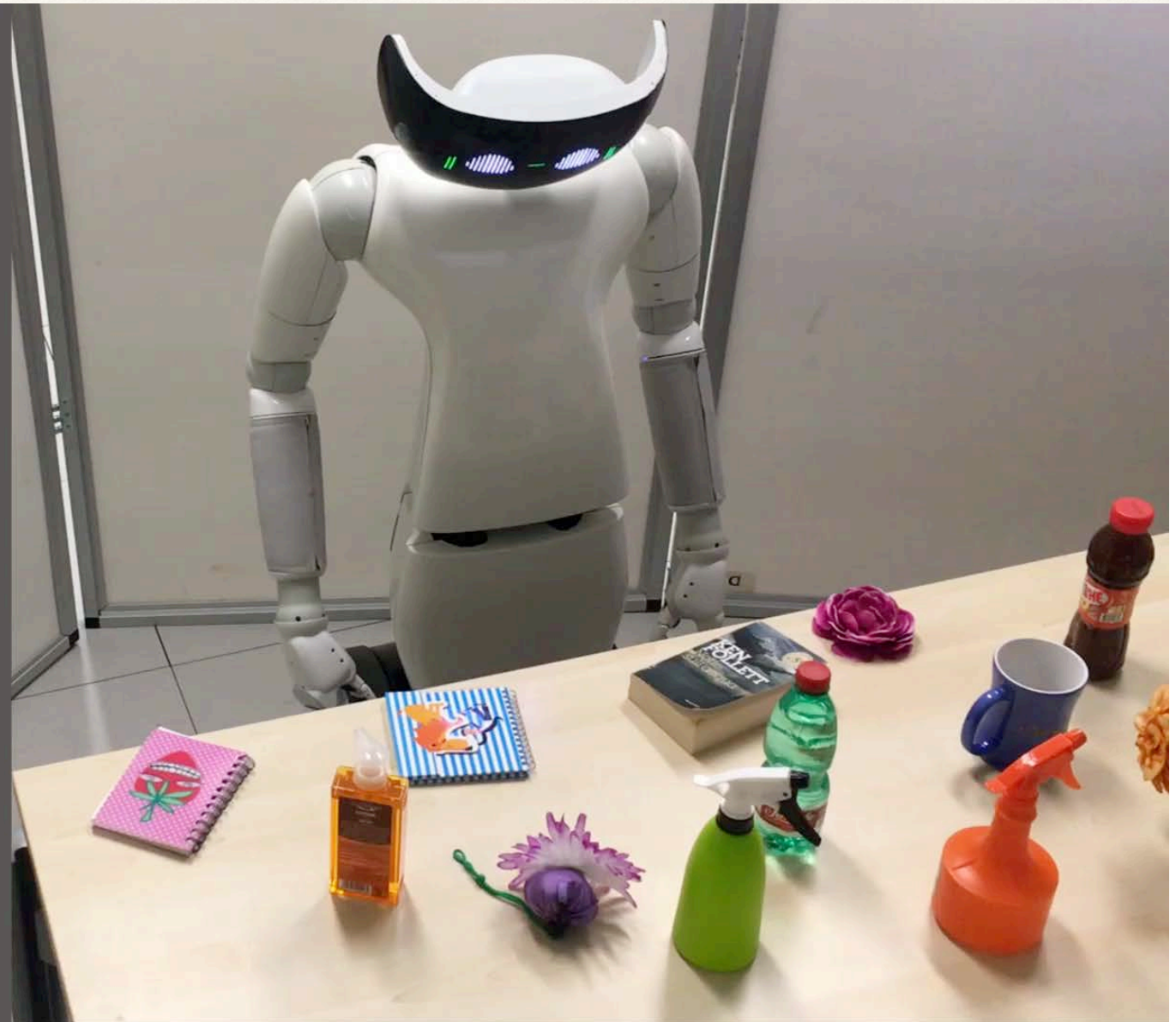
# ROBOT VISION

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Task 1: Object Identification  
*learning*



# ROBOT VISION





# ROBOT VISION



ISTITUTO ITALIANO  
DI TECNOLOGIA  
iCub FACILITY

Laboratory for Computational  
and Statistical Learning



## Online Learning Object Detection Pipeline for Humanoid Robots

Elisa Maiettini, Vadim Tikhanoff, Giulia Pasquale  
Lorenzo Natale, Lorenzo Rosasco



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# ROBOT VISION

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## Session Outline

- ❖ Assignment #1
  - ❖ Port callbacks
  - ❖ Integration of OpenCV
  - ❖ Find Closest Blob
  - ❖ Images processing
  - ❖ Play with streams of images
  - ❖ Extract closest blob



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# ROBOT VISION

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## YARP Port Callbacks

RFmodule

→ Update with fixed time

RFmodule

+

Callbacks

→ Callback depending of input

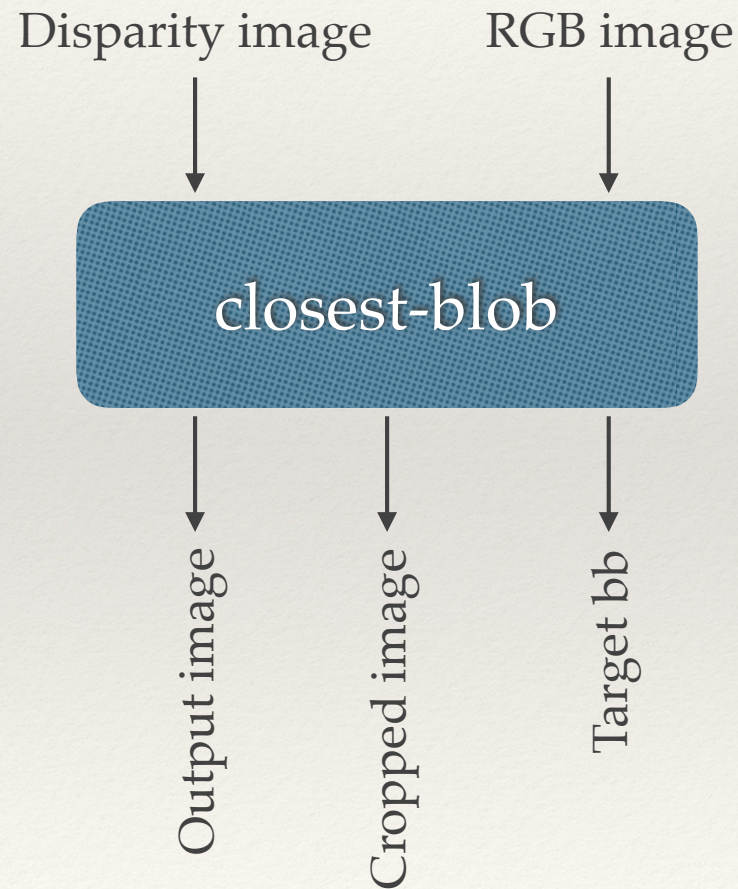


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# ROBOT VISION

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## Module Structure



# ROBOT VISION

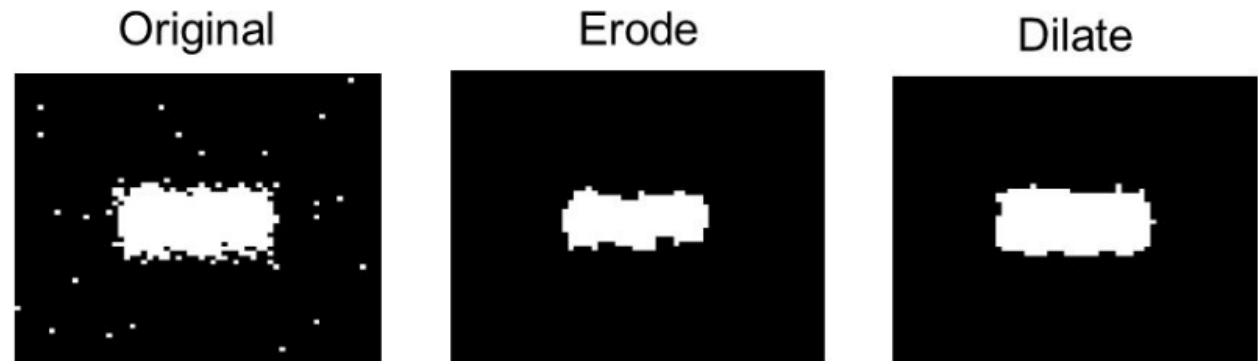
## Image Processing

Blurring image



Transforming image

- Erode original image.
- Dilate eroded image.
- Smooths object boundaries, eliminates noise (isolated pixels) and maintains object size.





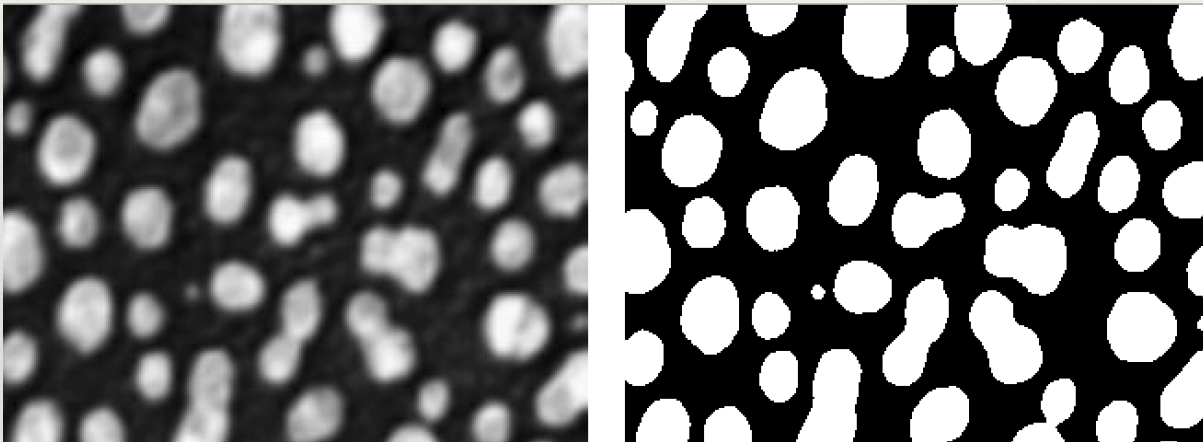
---

# ROBOT VISION

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## Image Processing

Thresholding image



Find contours in image

