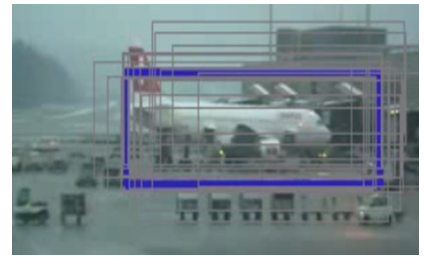
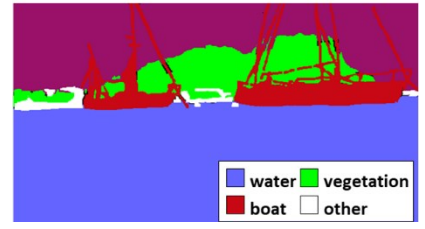






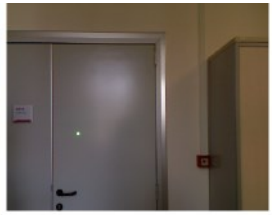
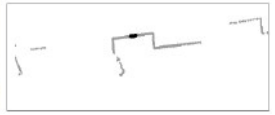
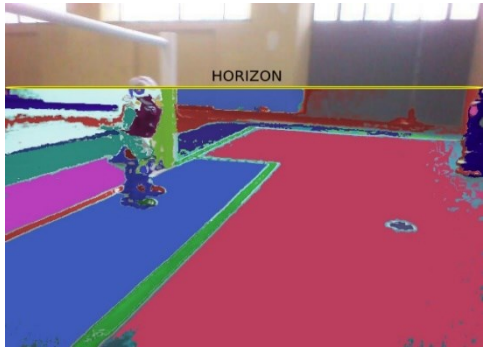


UNIVERSITÀ DEGLI STUDI DELLA BASILICATA

Corso di Sistemi Informativi
A.A. 2018/19

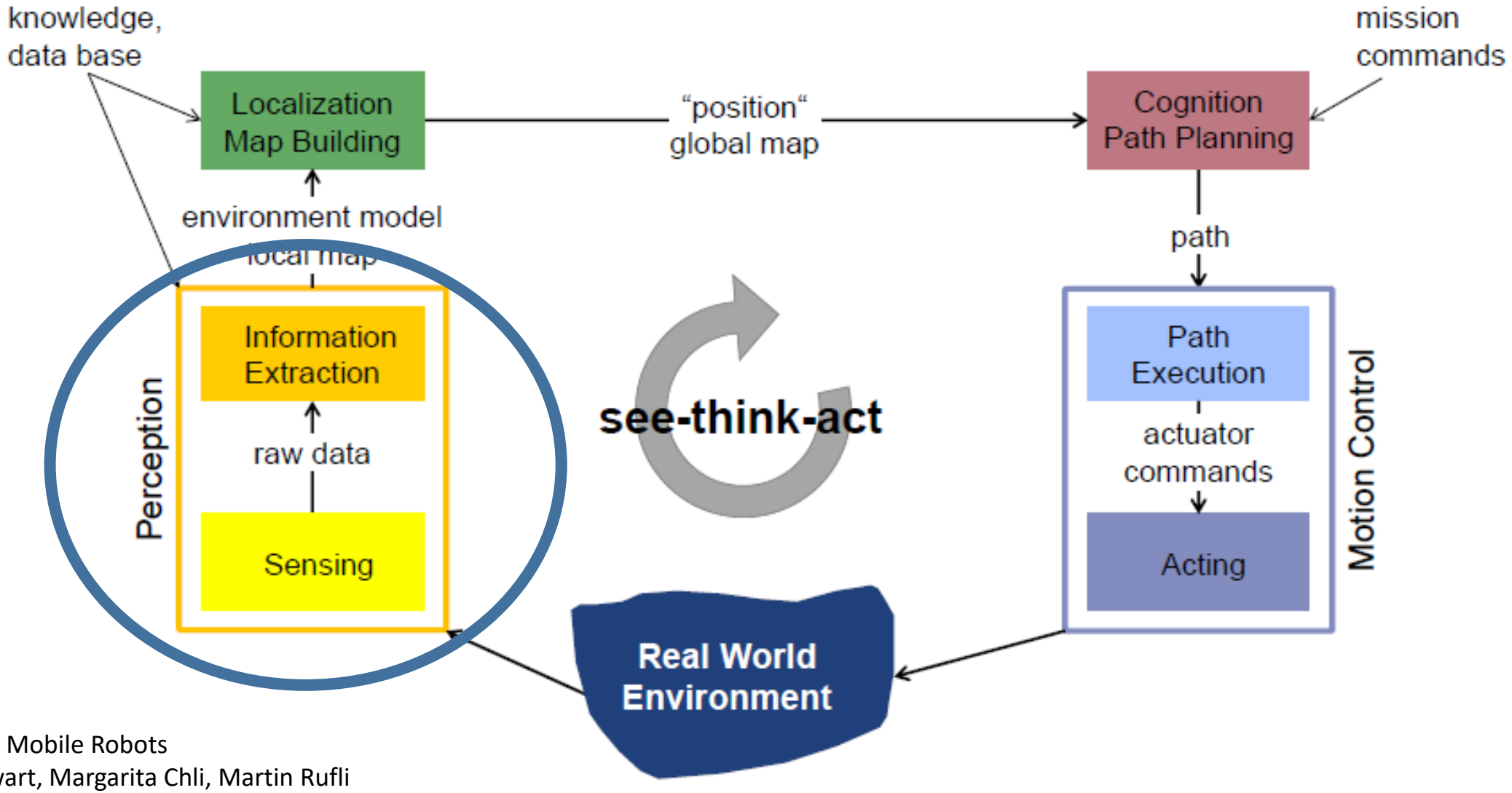
Docente
Domenico Daniele Bloisi

Percezione
Visione

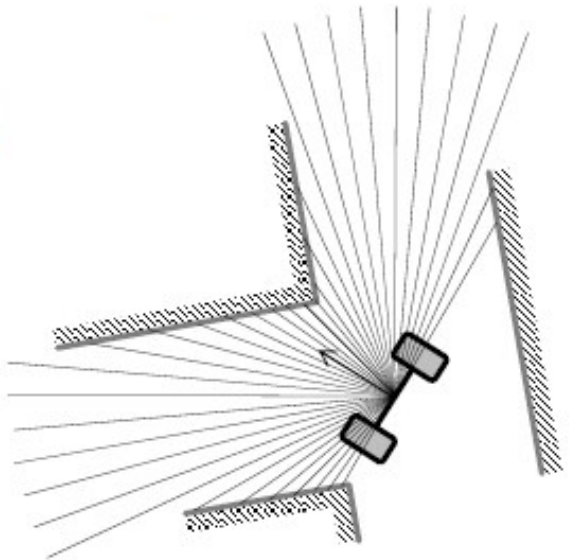

Marzo 2019

See-Think-Act Cycle

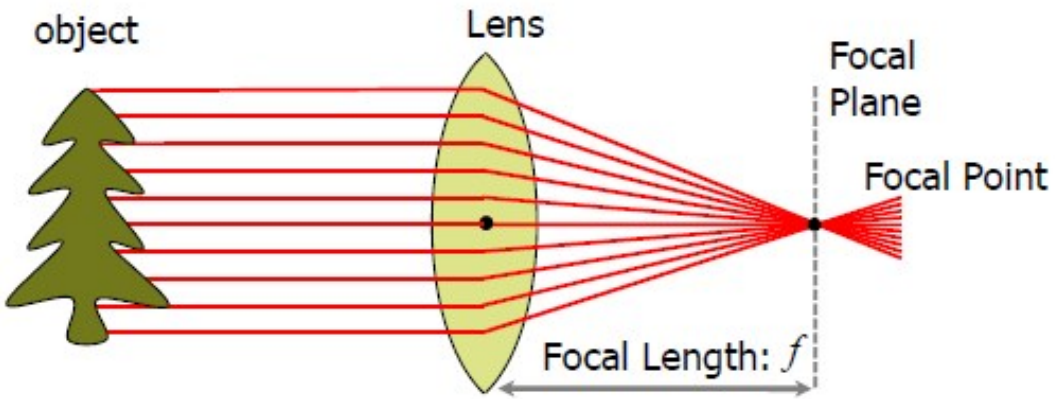


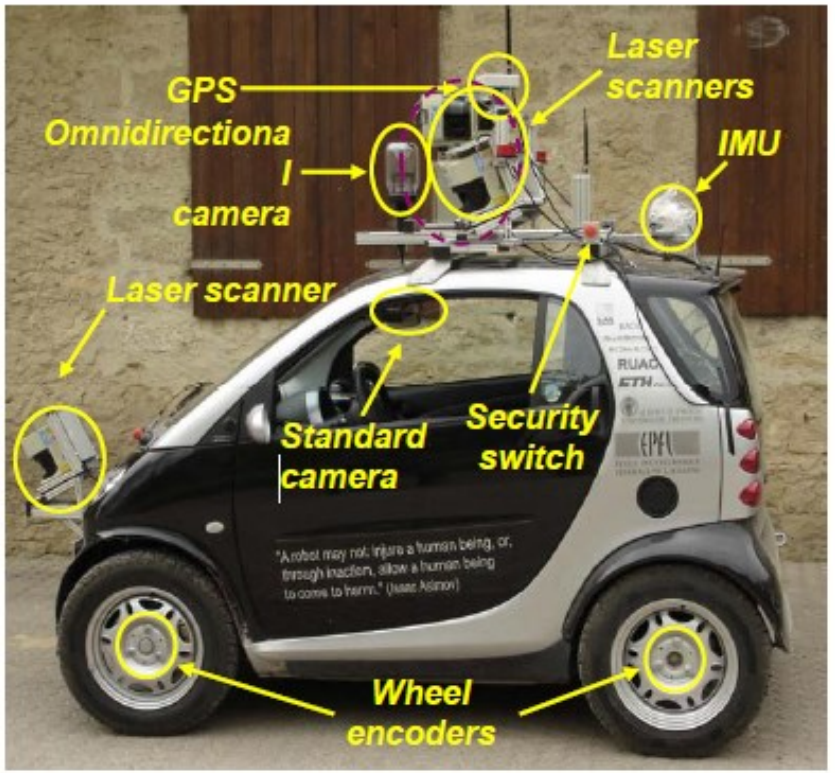
Percezione

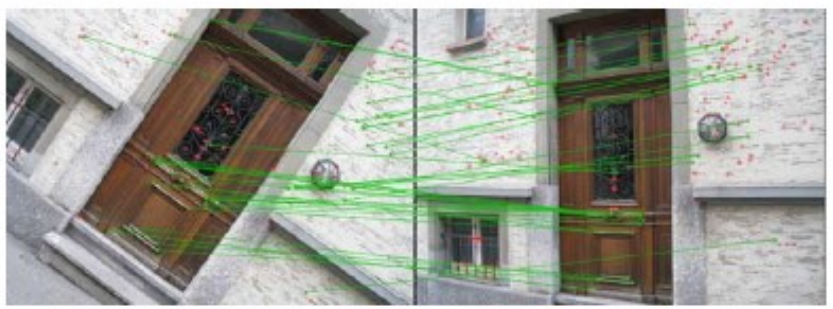
- Laser scanner
  - time of flight



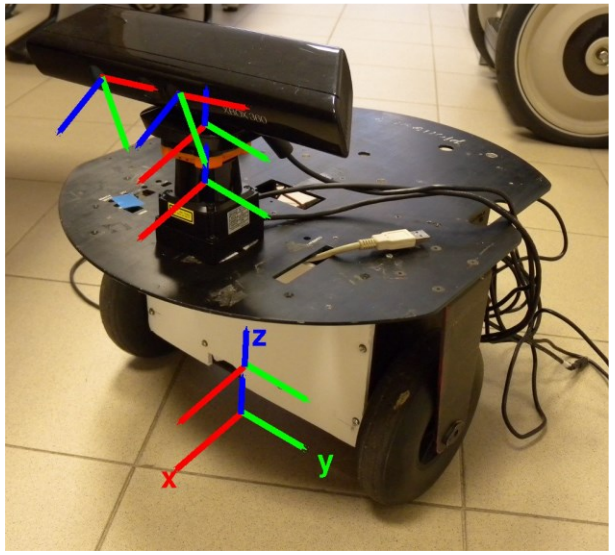
- Camera

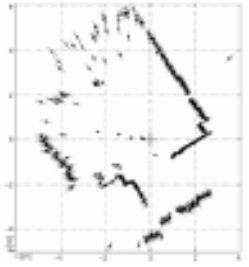






Percezione per robot mobili





Compressing Information

Places / Situations
A specific room, a meeting situation, …

Servicing / Reasoning

Objects
Doors, Humans, Coke bottle, car , …

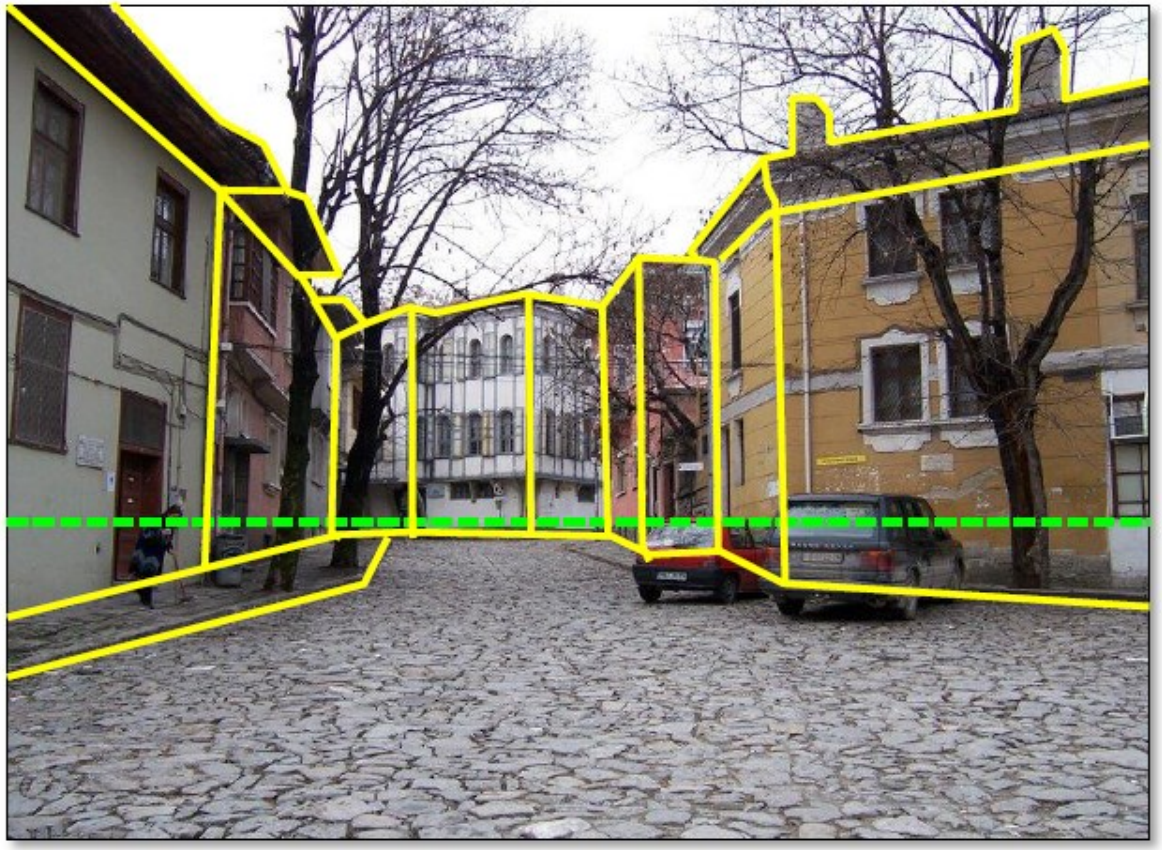
Interaction

Features
Corners, Lines, Colors, Phonemes, …

Navigation

Raw Data
Vision, Laser, Sound, Smell, …

Informazioni geometriche e semantiche



informazioni geometriche

informazioni semantiche

Percezione visuale

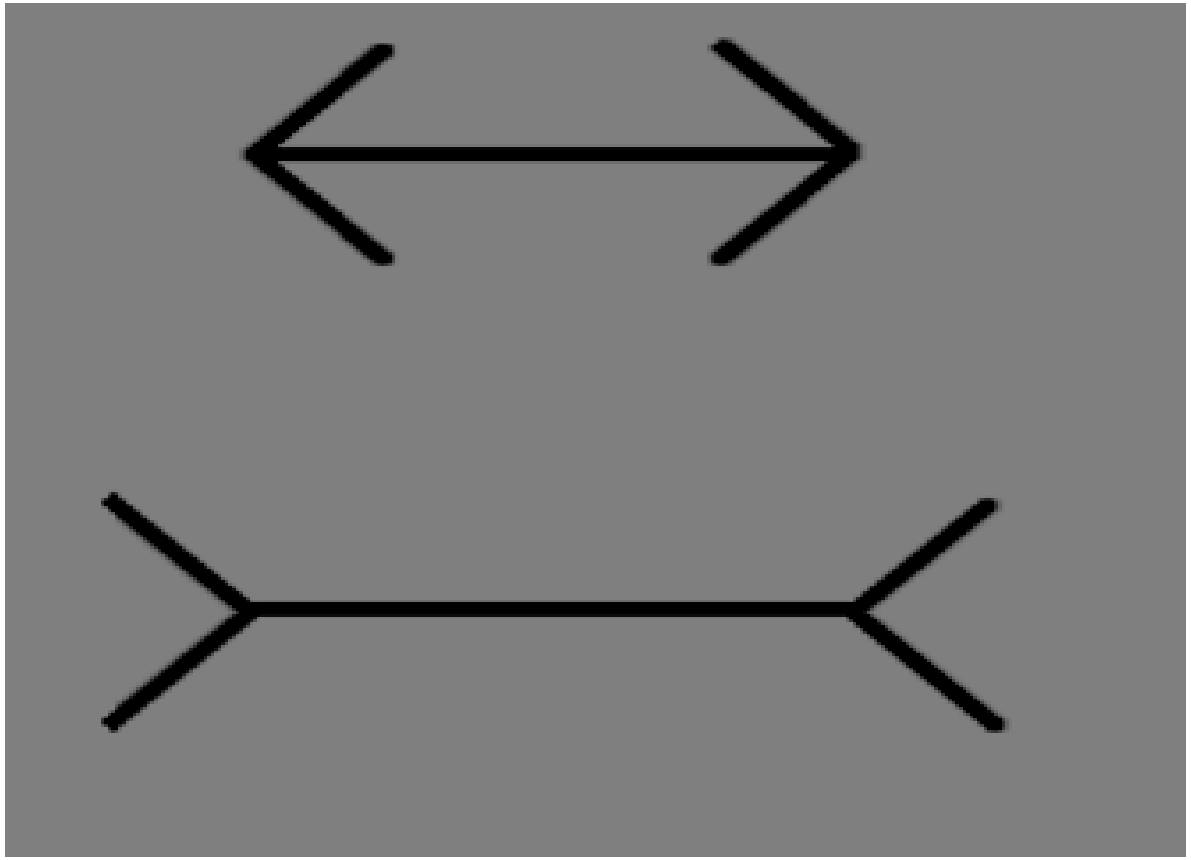


Image from Computer Vision: Algorithms and Applications

Percezione visuale

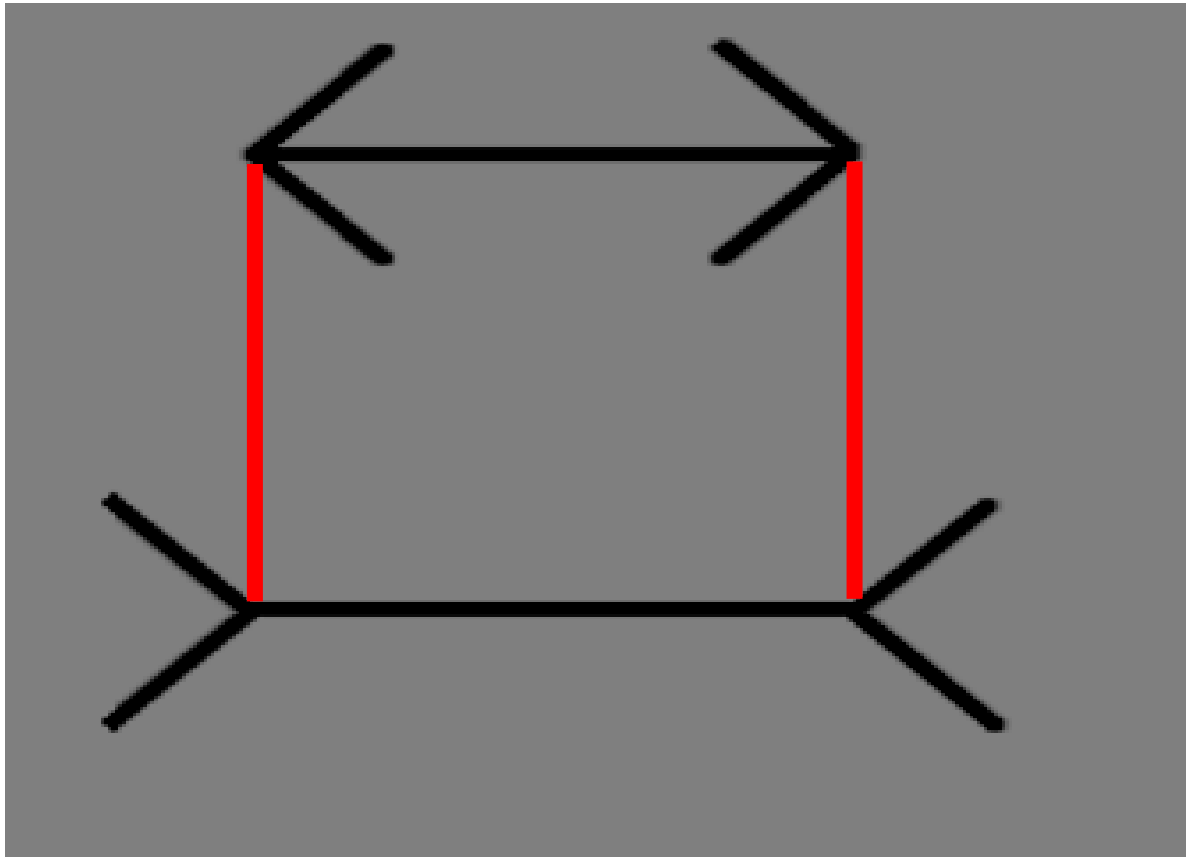


Image from Computer Vision: Algorithms and Applications

Illusioni ottiche

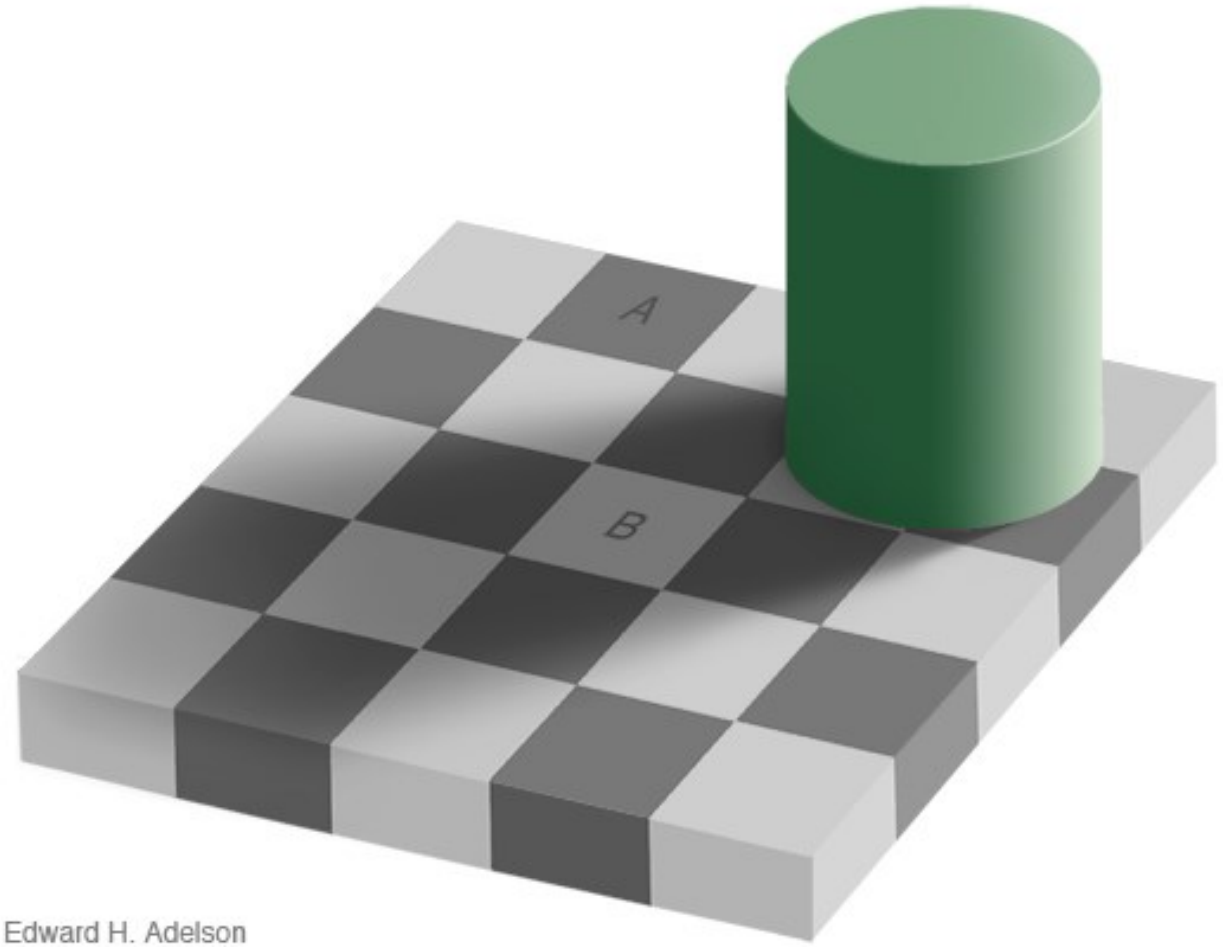


Image from Computer Vision: Algorithms and Applications

Illusioni ottiche

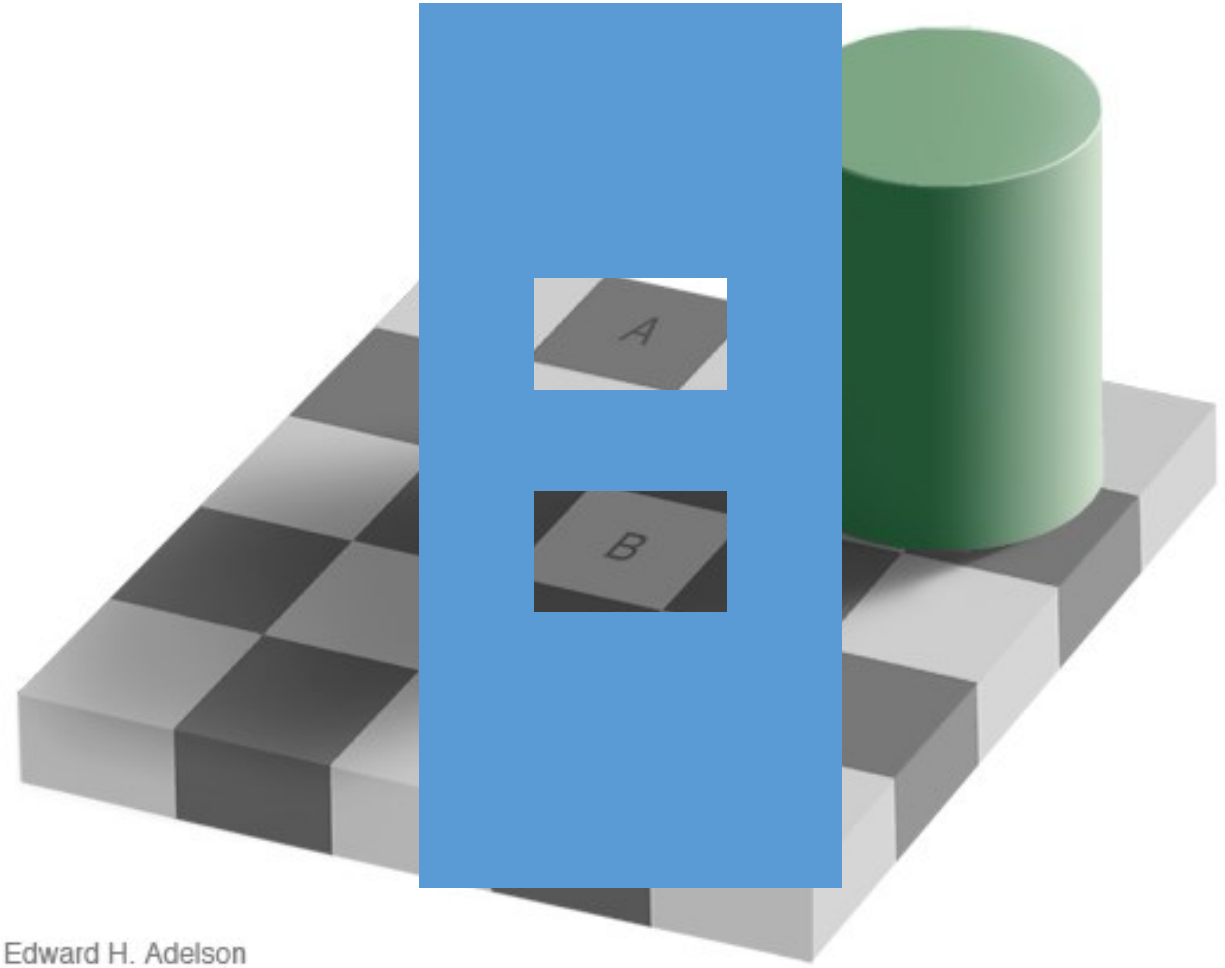
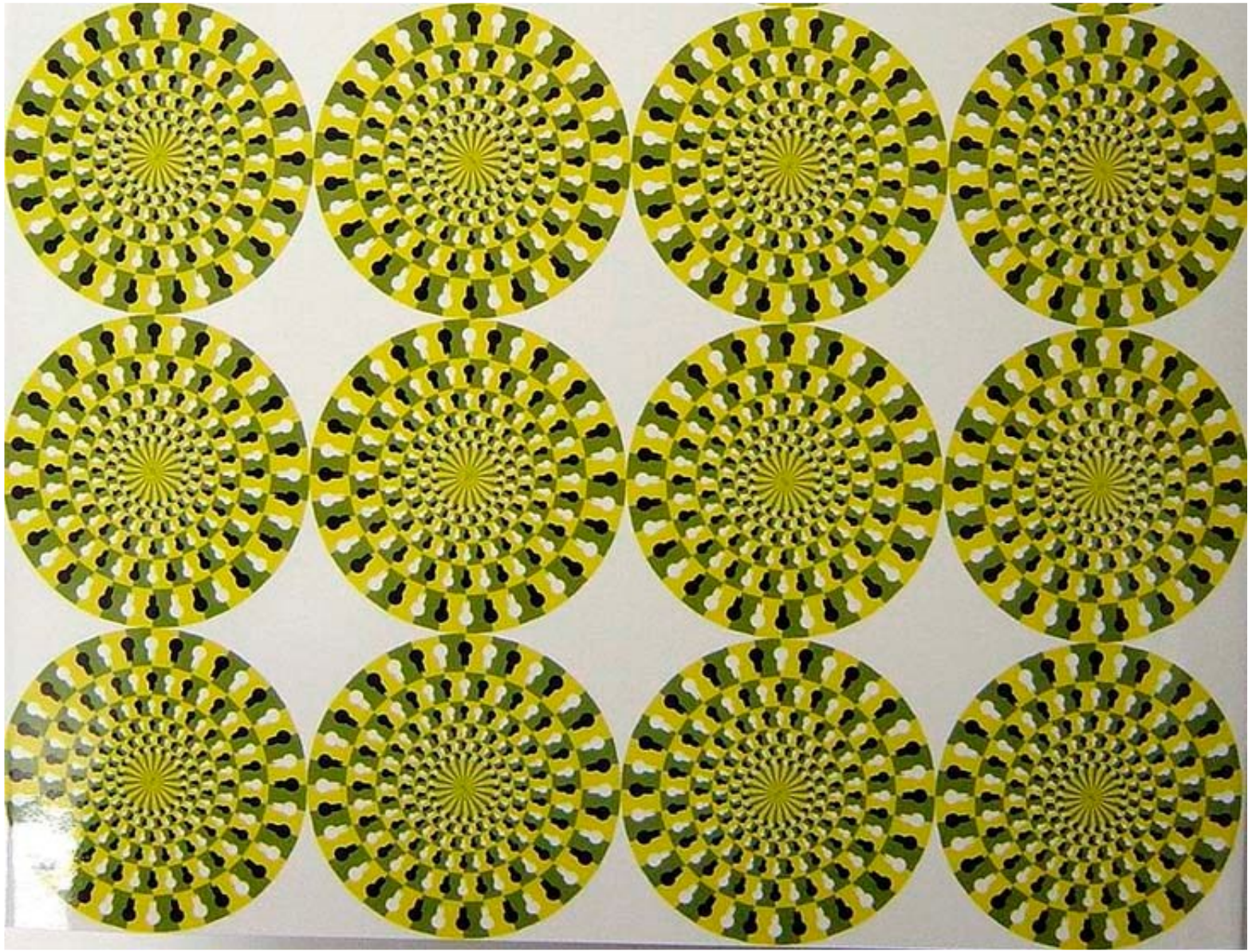


Image from Computer Vision: Algorithms and Applications

Illusioni ottiche



www.donparrish.com/FavoriteOpticalIllusion.html

Trova il punto verde

Trova il punto verde

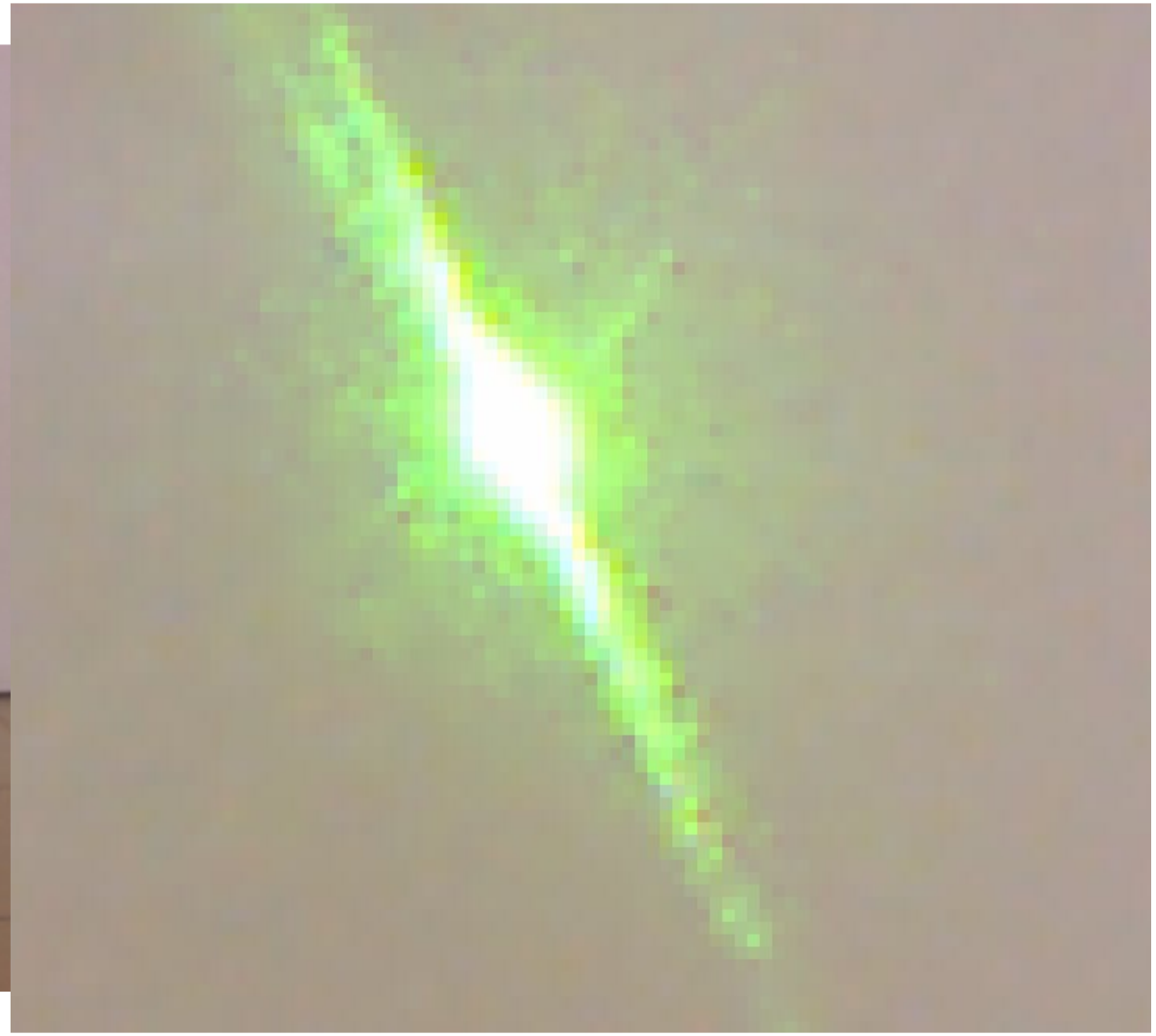
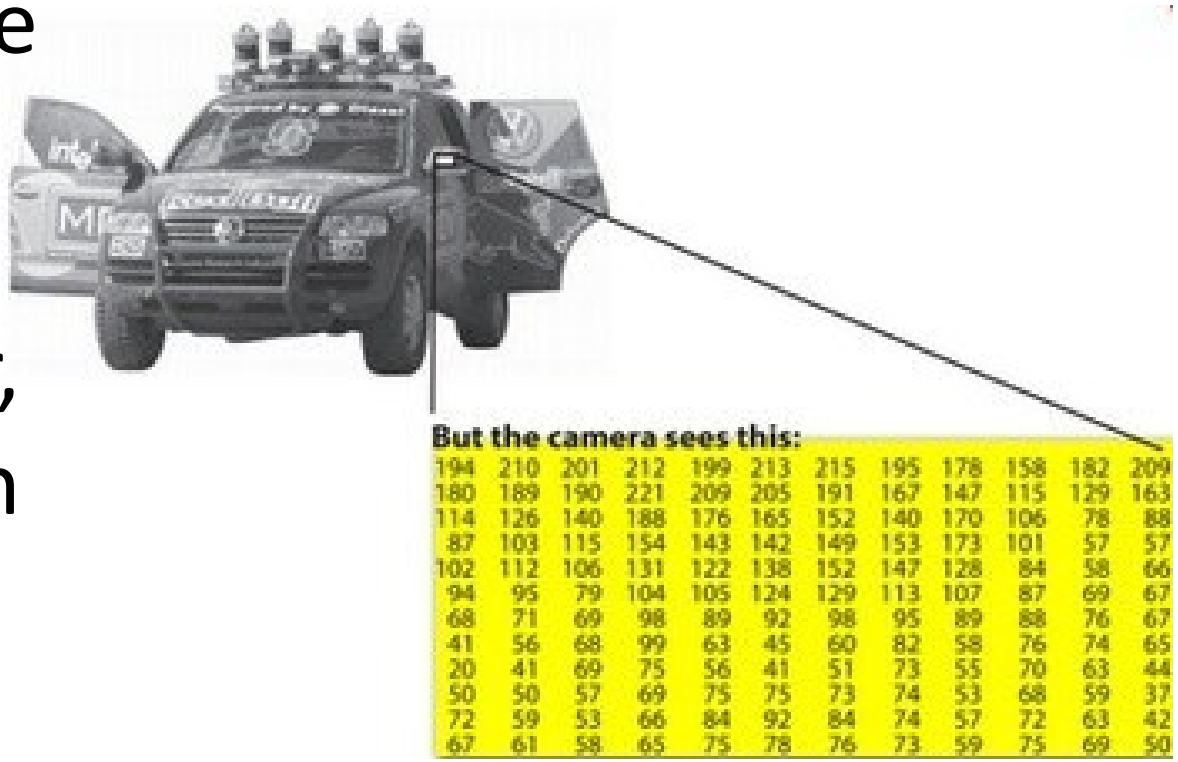


Immagine Digitale

- Una immagine digitale è una matrice di pixel
- Il termine pixel deriva da *picture element*
- Il pixel contiene l'informazione relativa alla rappresentazione della realtà che è stata catturata tramite uno scanner, una macchina fotografica o un frame grabber (per i video)



Campionamento e Quantizzazione

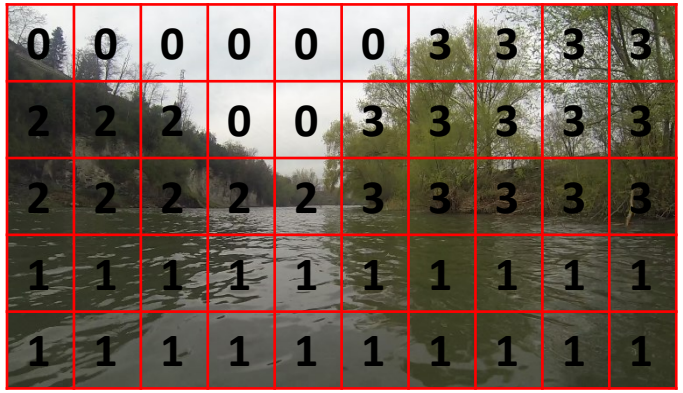
L’immagine è tradotta in un insieme di valori numerici attraverso due fasi:

1. Campionamento spaziale
2. Quantizzazione numerica

Mondo reale proiettato sul sensore di acquisizione

Campionamento

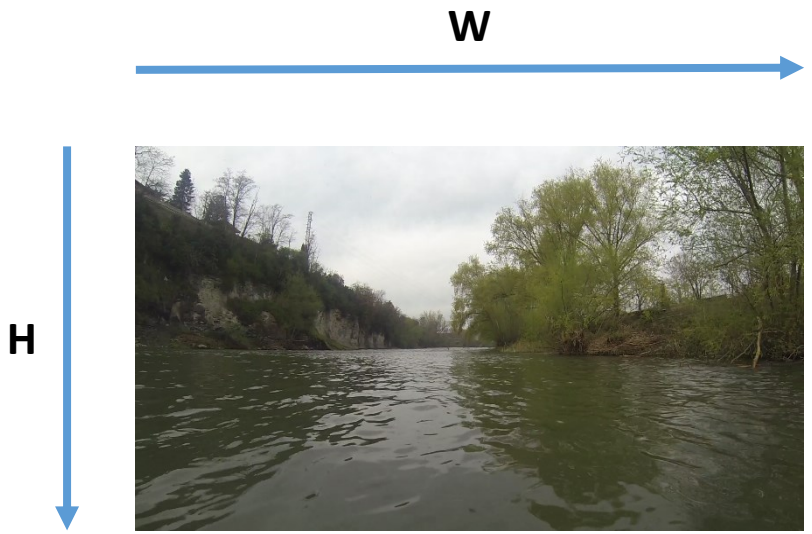
Quantizzazione
4 valori {0,1,2,3}



Dimensioni

- La dimensione dell'immagine è rappresentata dal numero dei pixel che la compongono

- Per esprimere la dimensione si usa il formato:
  WxH
  dove W indica il numero di pixel orizzontali e H il numero di pixel verticali
  Esempio: 640x480 pixel



Risoluzione

Con il termine risoluzione si indica la densità dei pixel in relazione alla dimensione del supporto di visualizzazione (per esempio un foglio di carta o uno schermo)

- Si esprime comunemente in pixel per inch (**ppi**) o dot per inch (**dpi**)
- Ad esempio, nel caso si voglia stampare una immagine potremo selezionare la risoluzione attraverso un valore del tipo *300 dpi*
- La risoluzione può essere vista come la capacità di dettaglio di una immagine. Più è grande la risoluzione migliore è la discriminazione dei dettagli.

Risoluzione: esempio pratico

24 pollici
(Grandezza dello schermo)

Dimensioni
1920×1080
cioè Full HD

Risoluzione
91,79 ppi

Dimensioni
3840×2160
cioè Ultra HD (4k)

Risoluzione
183,58 ppi

Profondità di colore

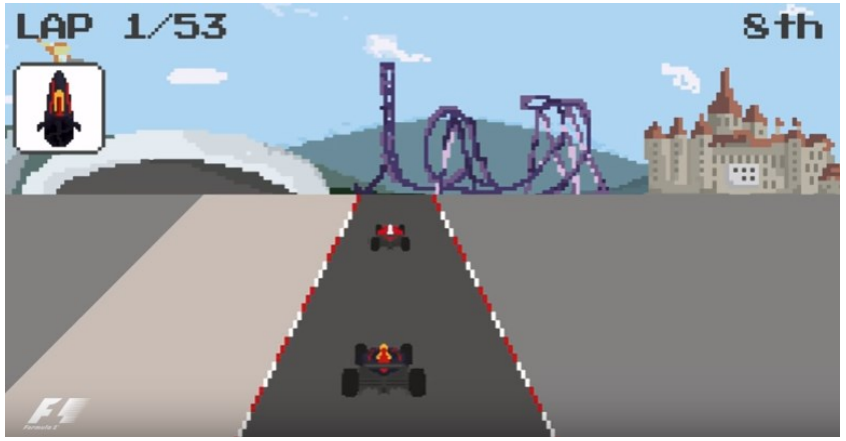
- Ogni pixel contiene un quantità di informazione che può essere espressa in **bit** (binary digit).
- il numero di bit riservati per ogni pixel viene denominato **profondità di colore**
- Data la profondità di colore N, il numero di possibili tonalità per una immagine digitale è 2^N

Esempi:

N = 1 ⇒ 2 tonalità

N = 4 ⇒ 16 tonalità

N = 8 ⇒ 256 tonalità



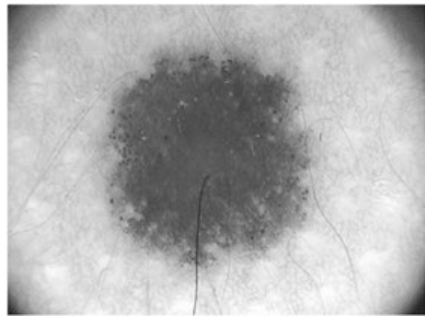
The F1 Story Of 2016: 8-Bit, Video-Game-Style!

https://www.youtube.com/watch?v=U4E9Qx5_lTY

Immagini e colori

- Immagine binaria (0 e 1)

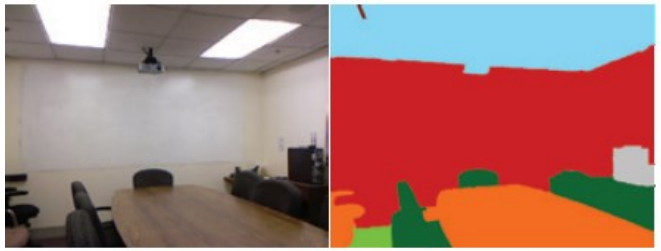
- Immagine in scala di grigi (valori da 0-255)



- Immagine a colori (canali RGB)

PH² Database
https://www.fc.up.pt/addi/ph2%20database.html

Ricostruzione 3D da immagini



Point Cloud (PC):
Depth information
Image Saliency

[Silberman et al. 2011]

Multi View (MV):
Multiple Image
Saliency

[Fukurawa et al. 2009]

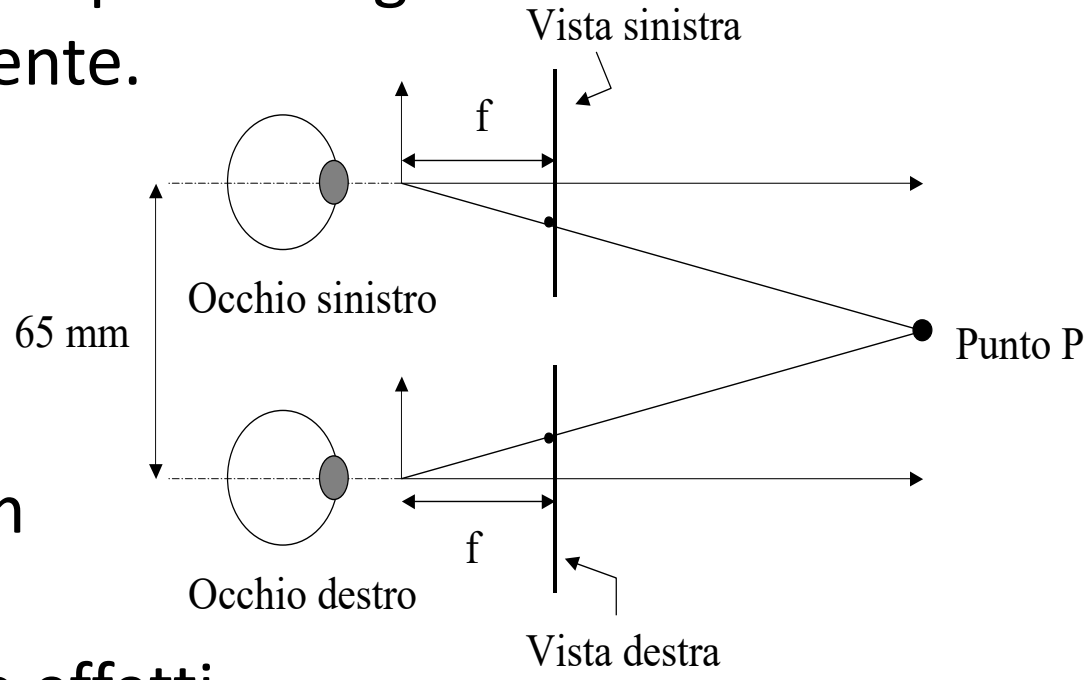
Single View (SV):
Image Saliency

[Lee et al. 2009]

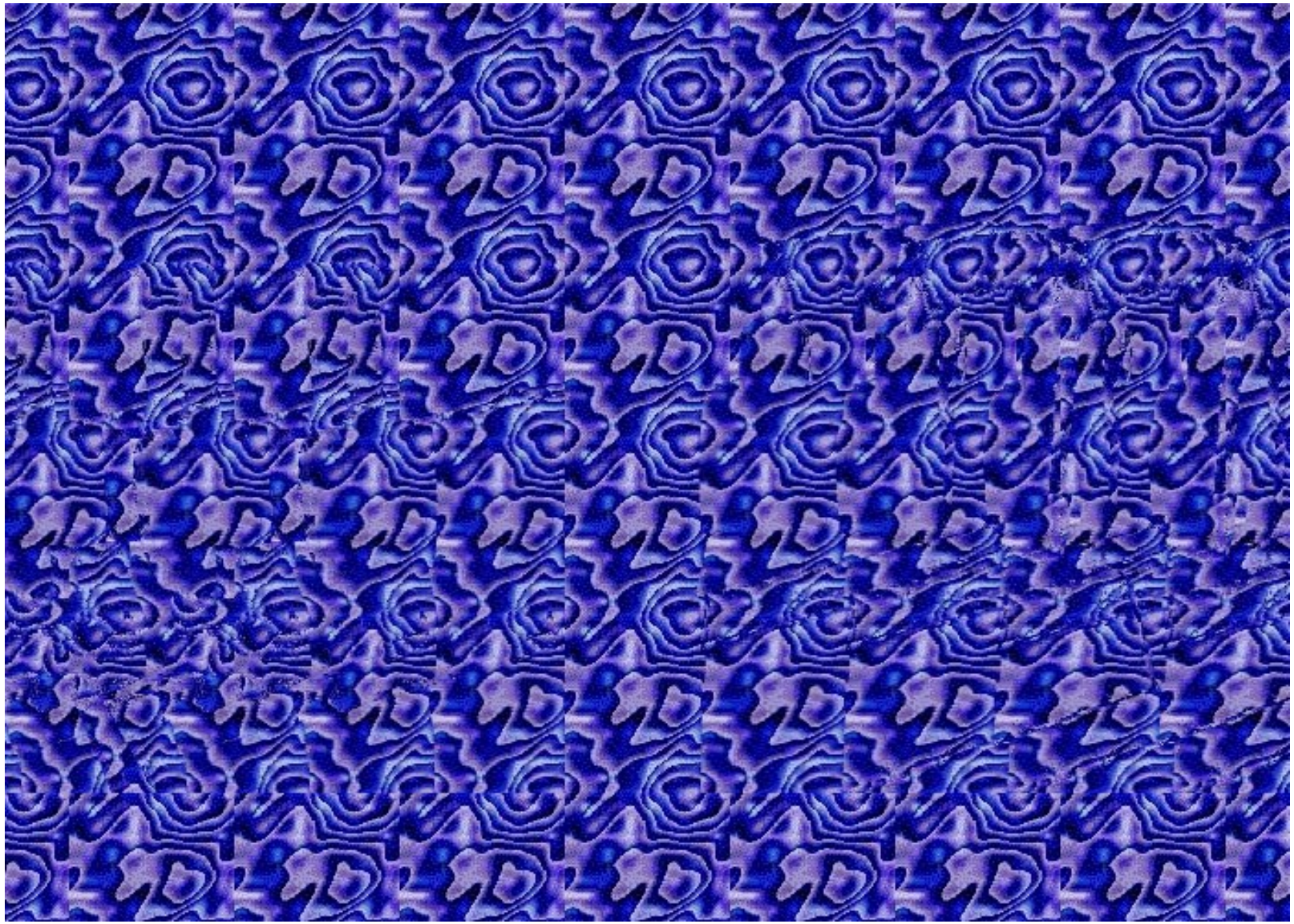
Stereo Visione

L’analisi stereo è il processo di misurazione della distanza da un oggetto, basato sul confronto di due o più immagini dell’oggetto stesso ottenute simultaneamente.

La percezione della terza dimensione, che avvertiamo attraverso i nostri occhi, deriva dal fatto che i due bulbi oculari hanno i loro assi ottici distanti circa 65 mm e forniscono due immagini leggermente diverse degli oggetti che, sommando i loro effetti, procurano il senso della profondità



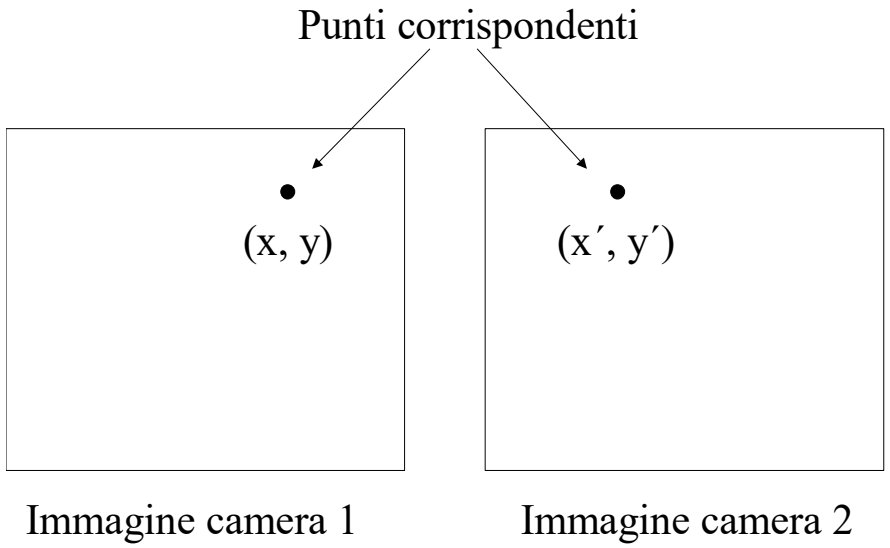
Stereogramma



http://www.segnalidivita.com/stereogrammi/locomotiva.htm

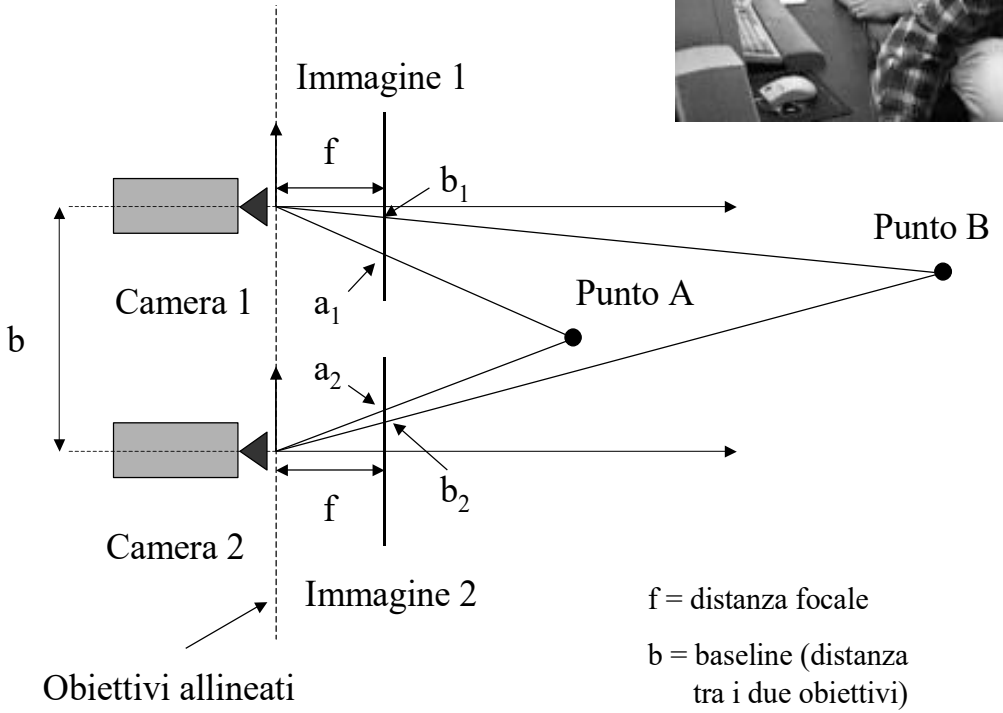
Correlazione tra punti

Il problema fondamentale nell'analisi stereo è quello di trovare la corrispondenza tra gli elementi delle varie immagini disponibili.
Una volta che tale corrispondenza è stata scoperta, la distanza dall'oggetto può essere ottenuta tramite l'ottica geometrica.



La coppia di locazioni (x, y) e (x', y') è unica. Proprio perché tale coppia è unica, se si riescono a trovare le due locazioni che corrispondono allo stesso identico punto nello spazio, allora è possibile risalire alle coordinate tridimensionali di detto punto.

Correlazione area-based



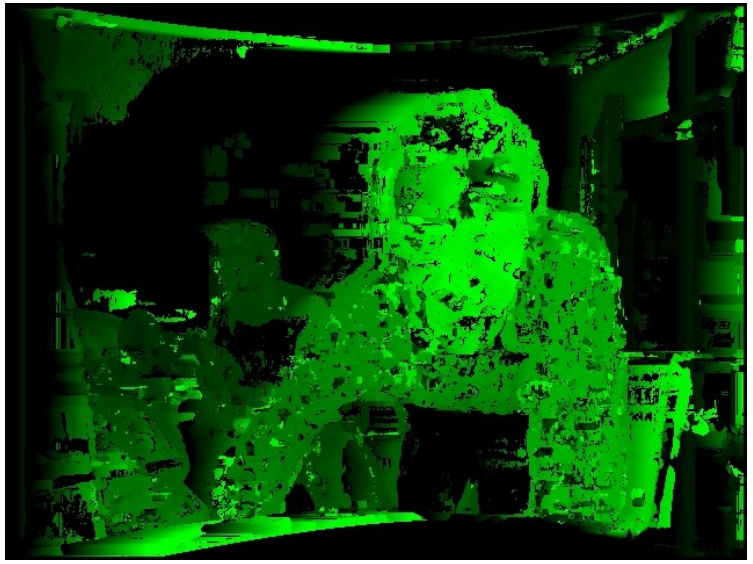
disparità per il punto A: $d(A) = a_1 - a_2$

disparità per il punto B: $d(B) = b_1 - b_2$

Troviamo $d(A) > d(B)$, poiché $a_1 > b_1$ e $a_2 < b_2$

Rettificazione e Mappa di disparità

Coppia stereo rettificata



Mappa di disparità

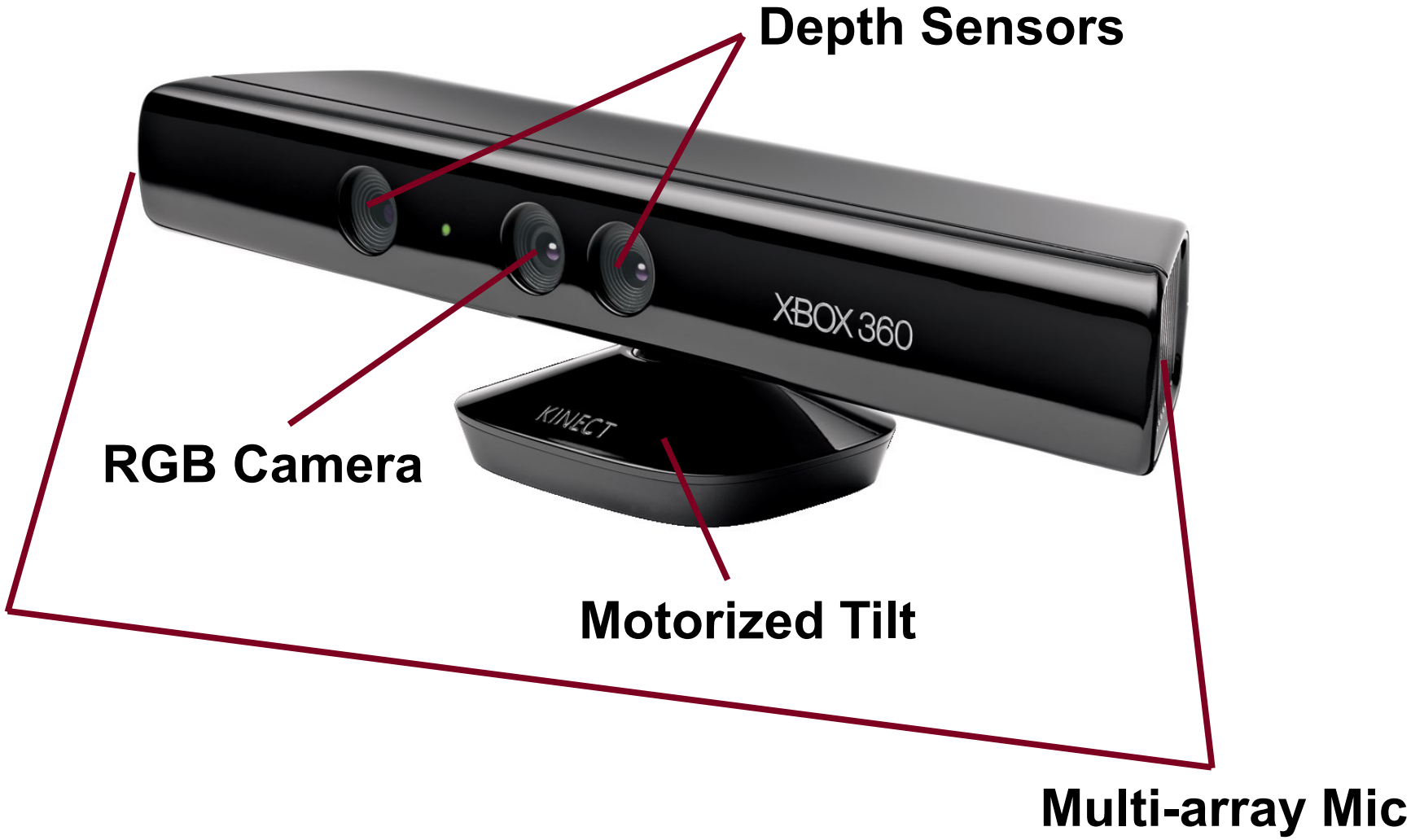
Ricostruzione 3D con stereo visione

https://sites.google.com/a/dis.uniroma1.it/iocchi/home

Microsoft Kinect

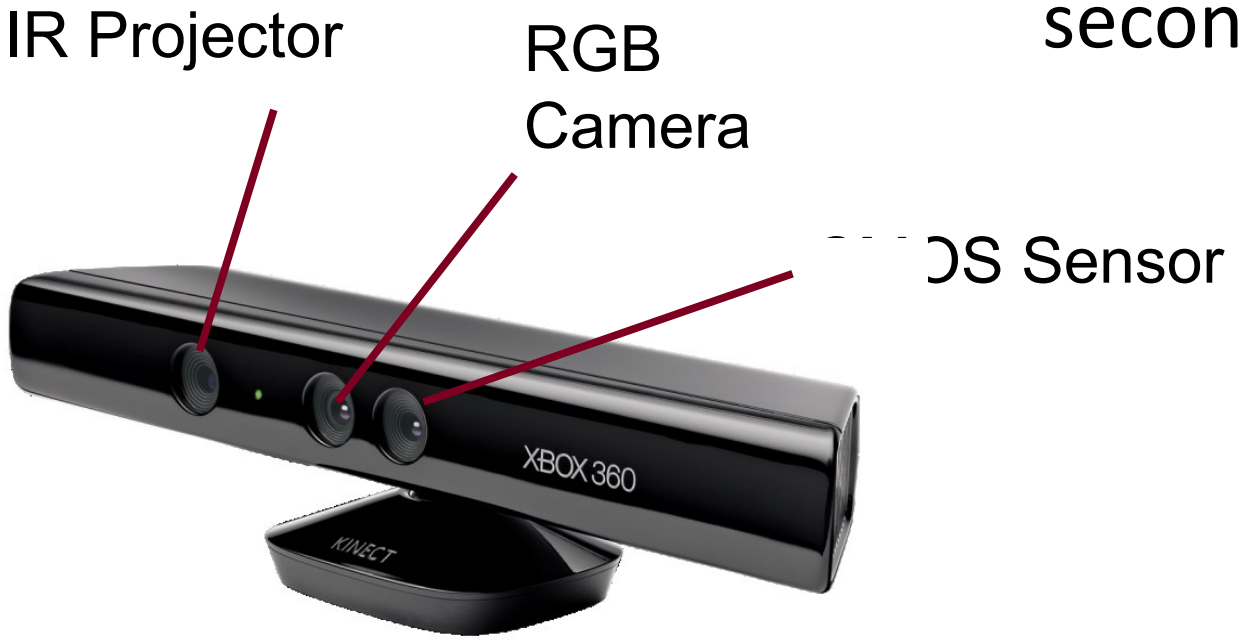
- Il sensore Kinect è stato lanciato in Nord America il 4 Novembre 2010
- Il Kinet è un sensore di movimento in grado di fornire informazioni 3D

Sensori del Kinect



Sensori di Disparità

- Consiste in un proiettore di raggi infrarosso (IR) e un sensore CMOS
- L'IR beam riflette sul soggetto e viene catturato dal sensore CMOS
- 640x480 pixel a 30 frame al secondo (fps)



Stima della disparità

http://graphics.stanford.edu/~mdfisher/Kinect.html

Il tempo di ritorno viene usato per misurare la distanza degli oggetti dal sensore

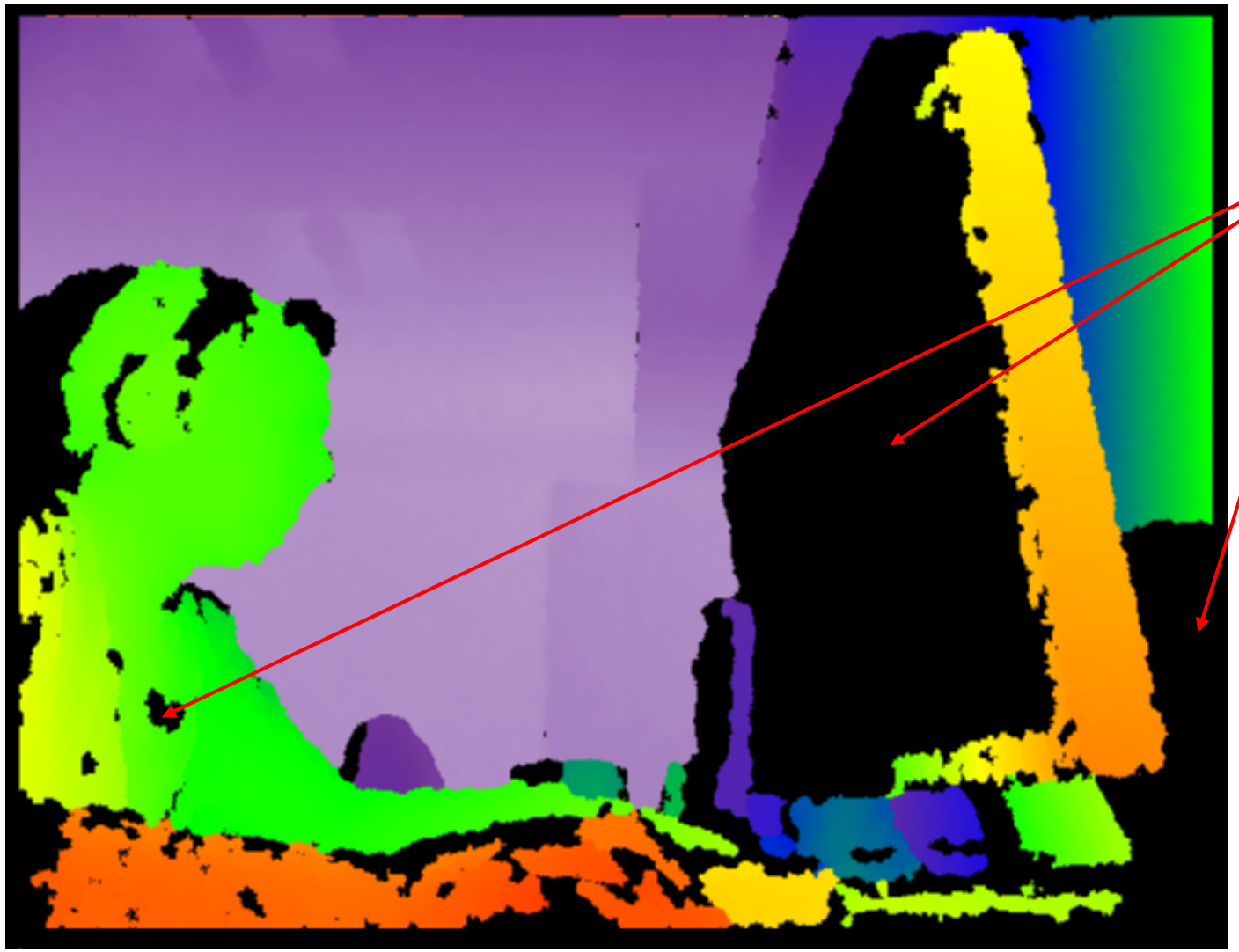
http://www.wired.com/gadgetlab/2010/11/tonights-release-xbox-kinect-how-does-it-work

Immagine a colori + immagine di disparità

24-bit RGB data **11-bit depth data**

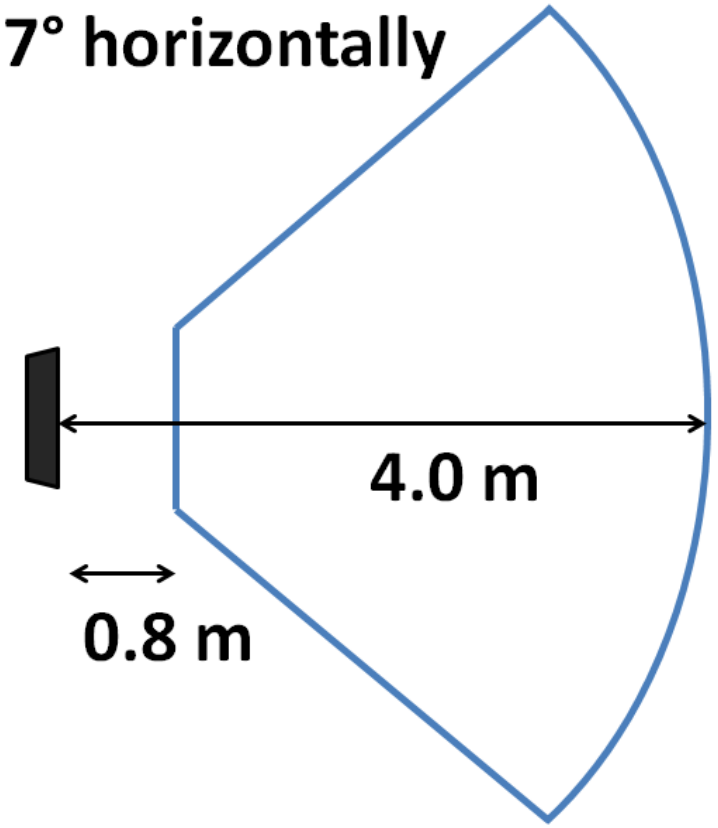
http://graphics.stanford.edu/~mdfisher/Kinect.html

Mappa di disparità densa

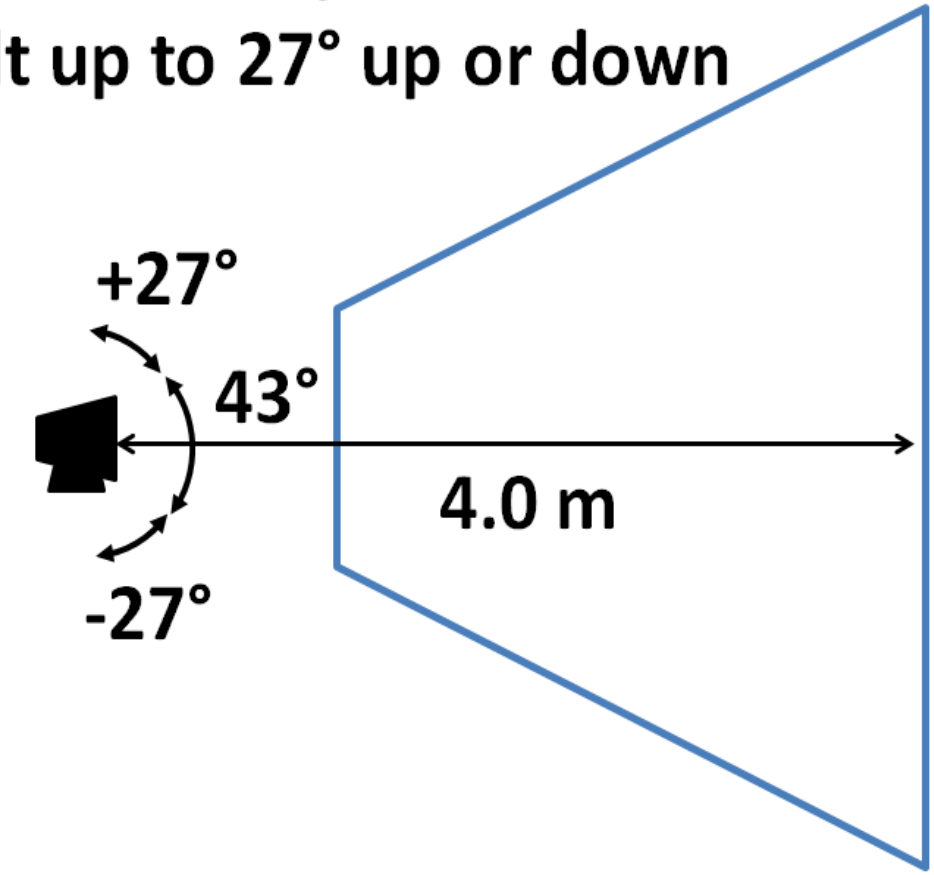


Limiti fisici del Microsoft Kinect

Angular field of view:
57° horizontally



Angular field of view:
43° vertically
Tilt up to 27° up or down

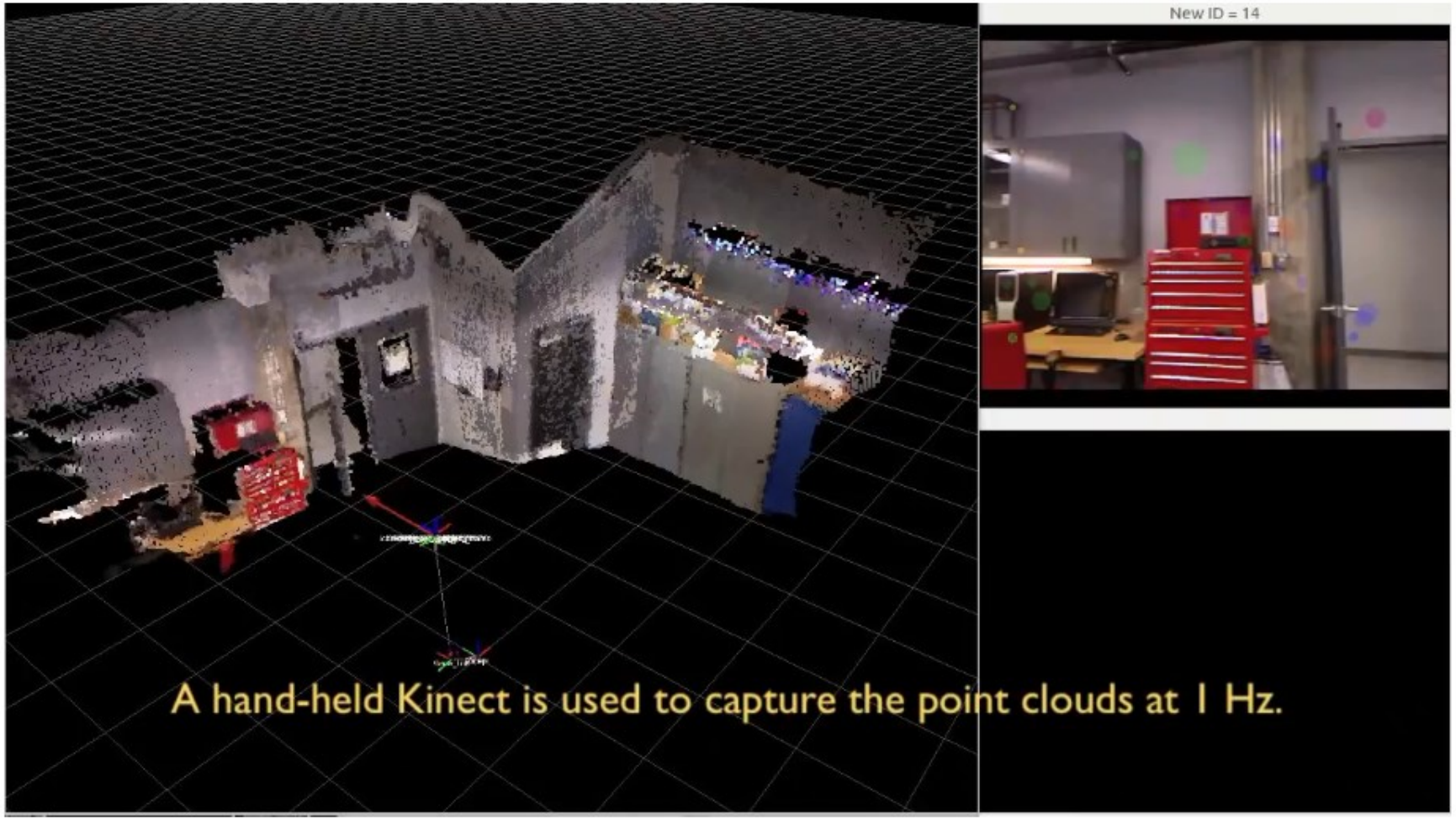


Ricostruzione 3D con Microsoft Kinect

http://graphics.stanford.edu/~mdfisher/Kinect.html

point cloud

Esempio Kinect



https://www.youtube.com/watch?v=AMLwjo80WzI

Kinect 2.0 & Intel RealSense

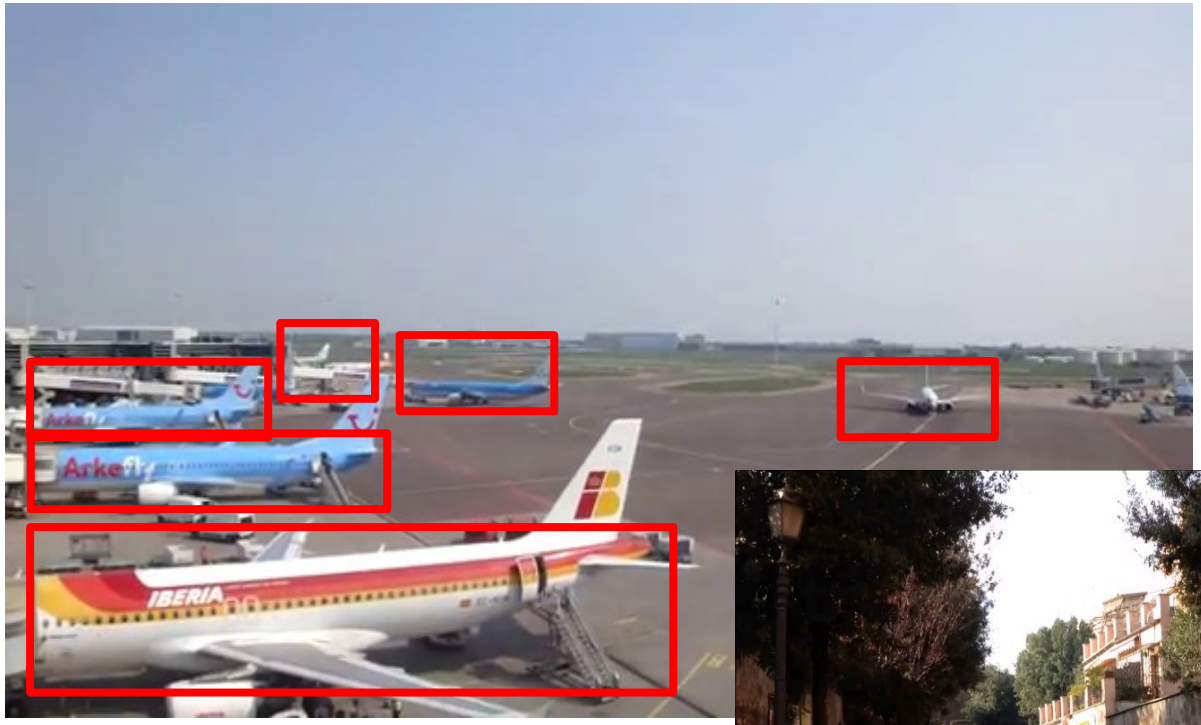
- Typical characteristic
  - Resolution 1920x1080 pixels
  - Field of view: 70 deg (H), 60 deg (V)
  - Claimed accuracy: 1 mm
  - Claimed max range: 6 meters

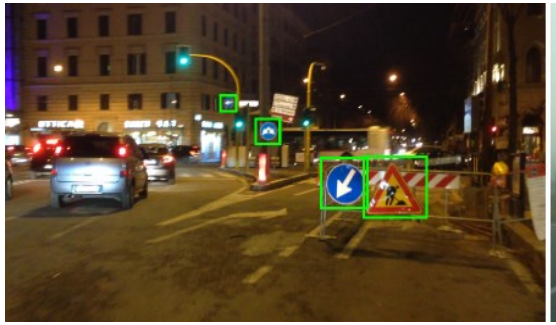
Google Project Tango

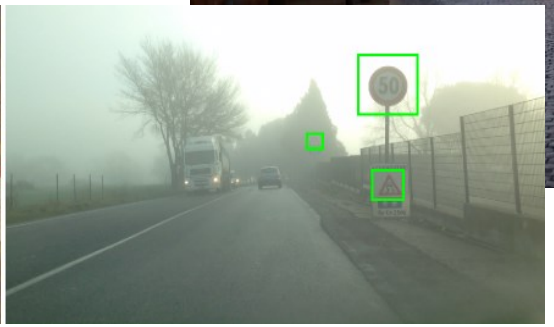
https://www.youtube.com/watch?v=yvgPrZNp4So

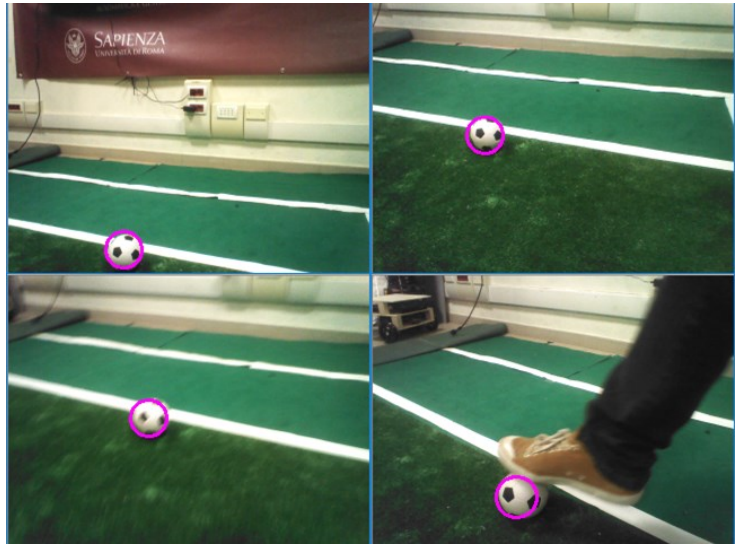
intel REALSENSE TECHNOLOGY

Riconoscimento di oggetti nelle immagini



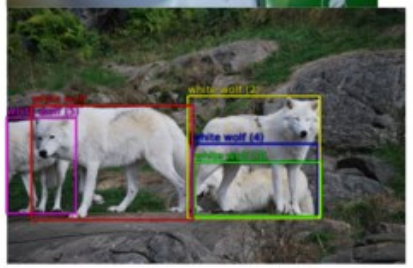


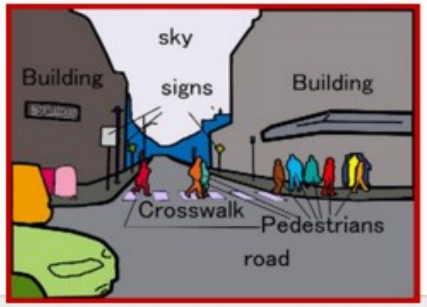


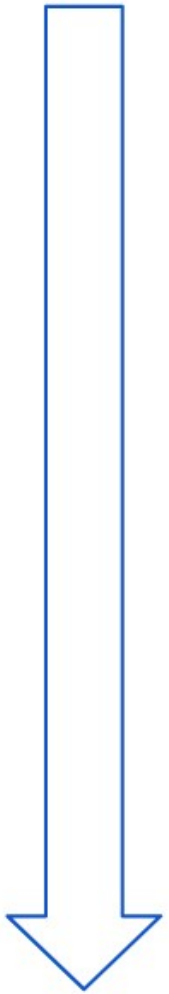


Classificazione, localizzazione, detection e segmentation

- classification
- localization
- detection
- segmentation





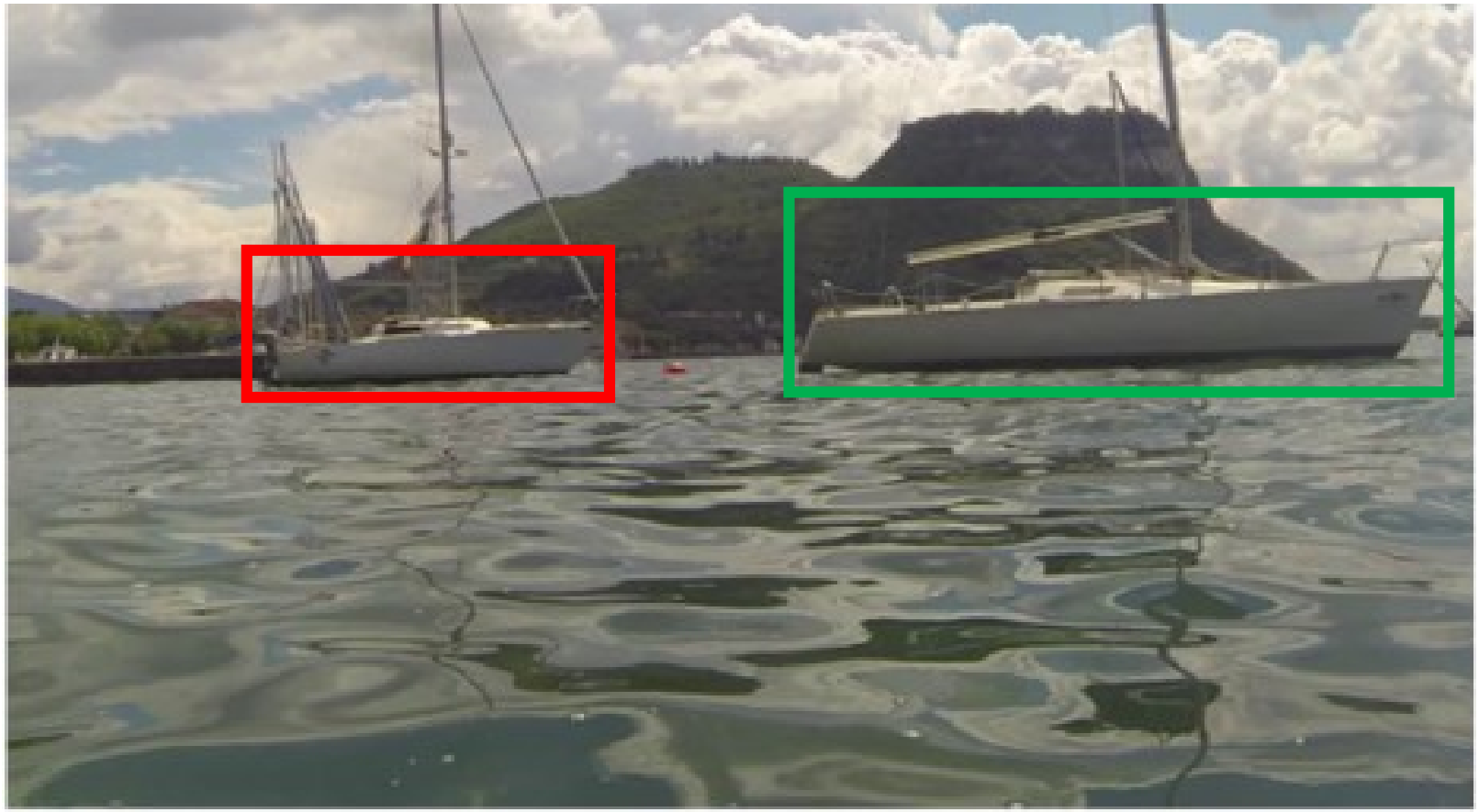


slide from 2014 - CVPR Tutorial on Deep Learning for Vision - Object Detection

Classificazione

Barca
Lago
Acqua
Nuvole

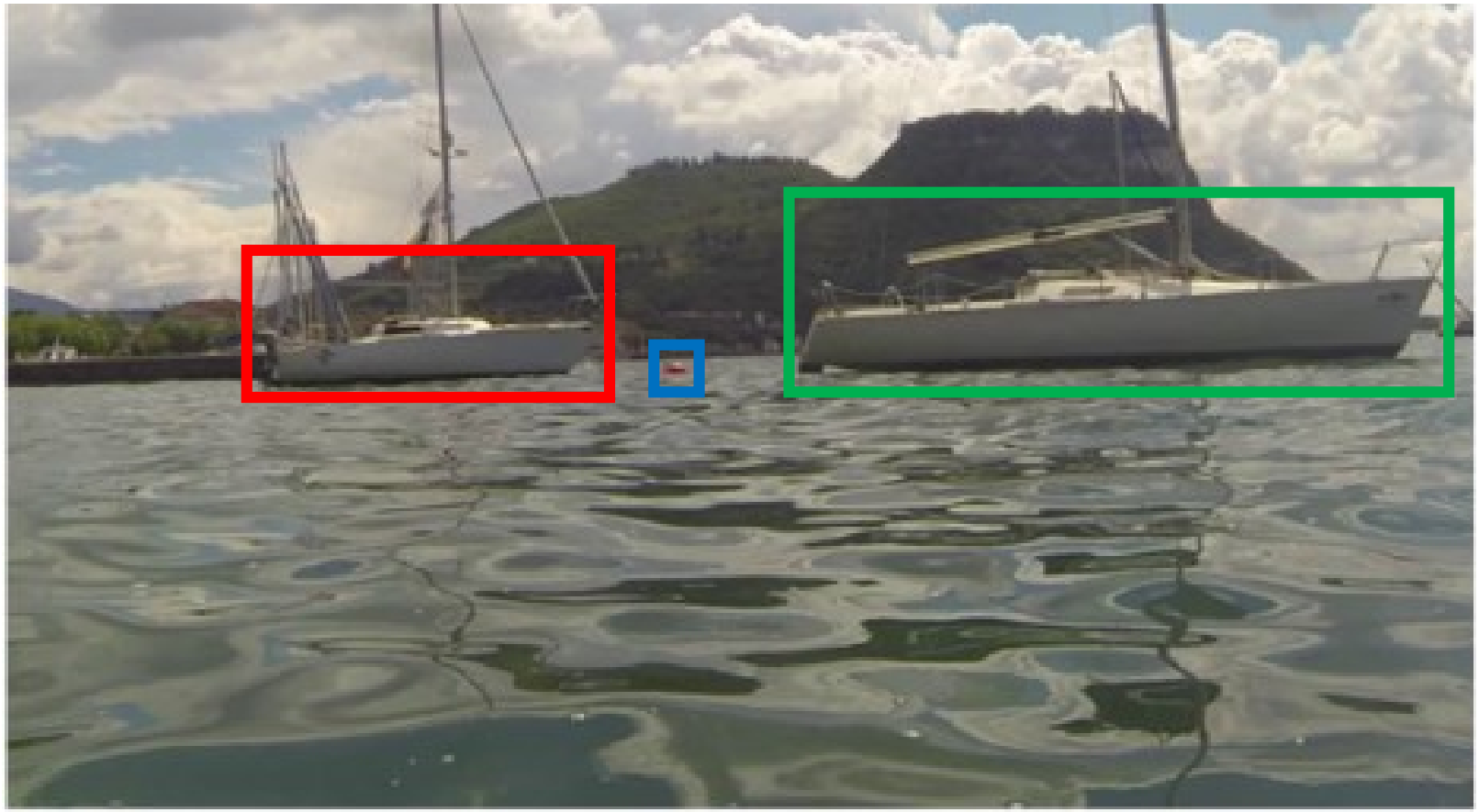
Localizzazione



Barca 1

Barca 2

Detection

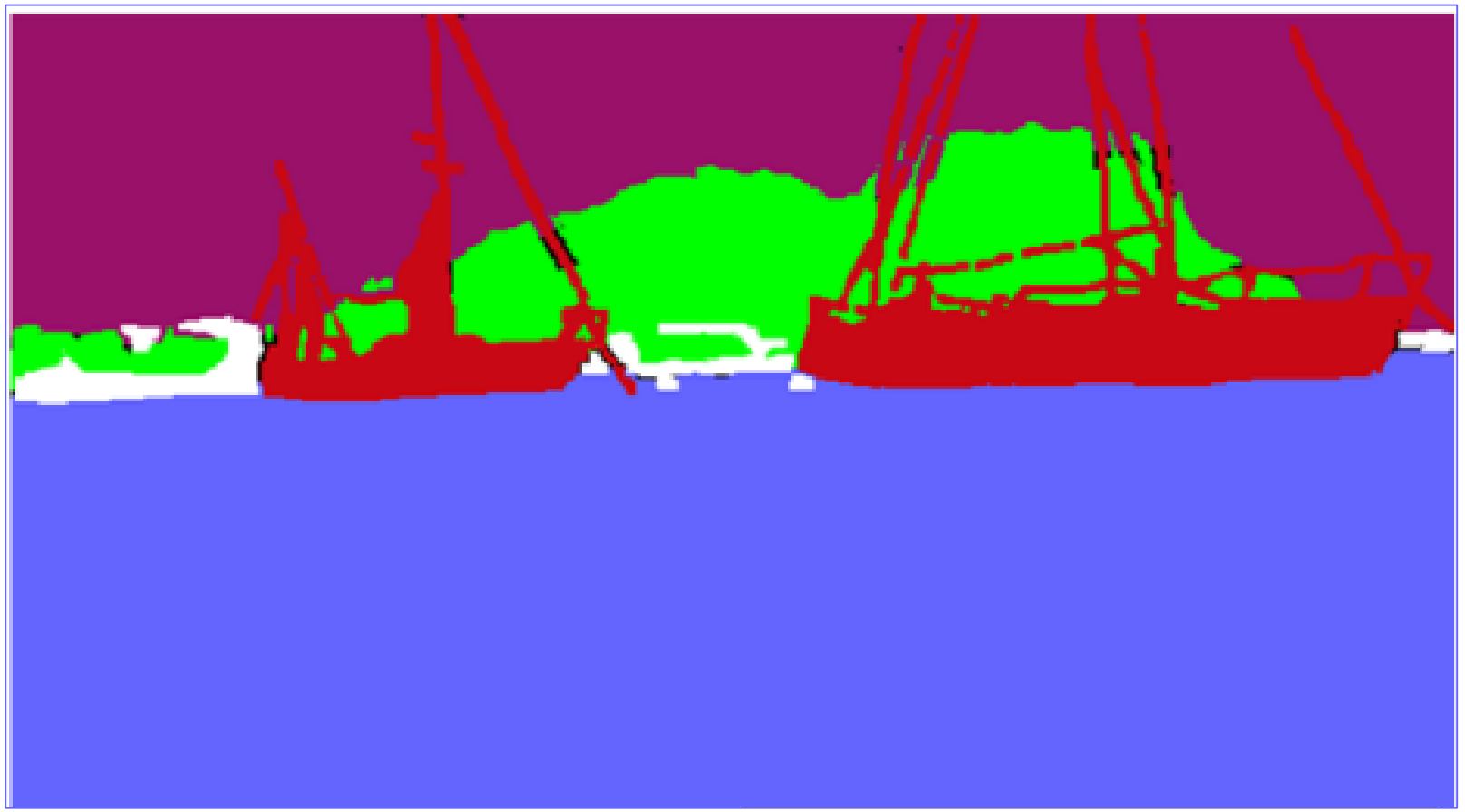


Barca 1

Barca 2

Boa 1

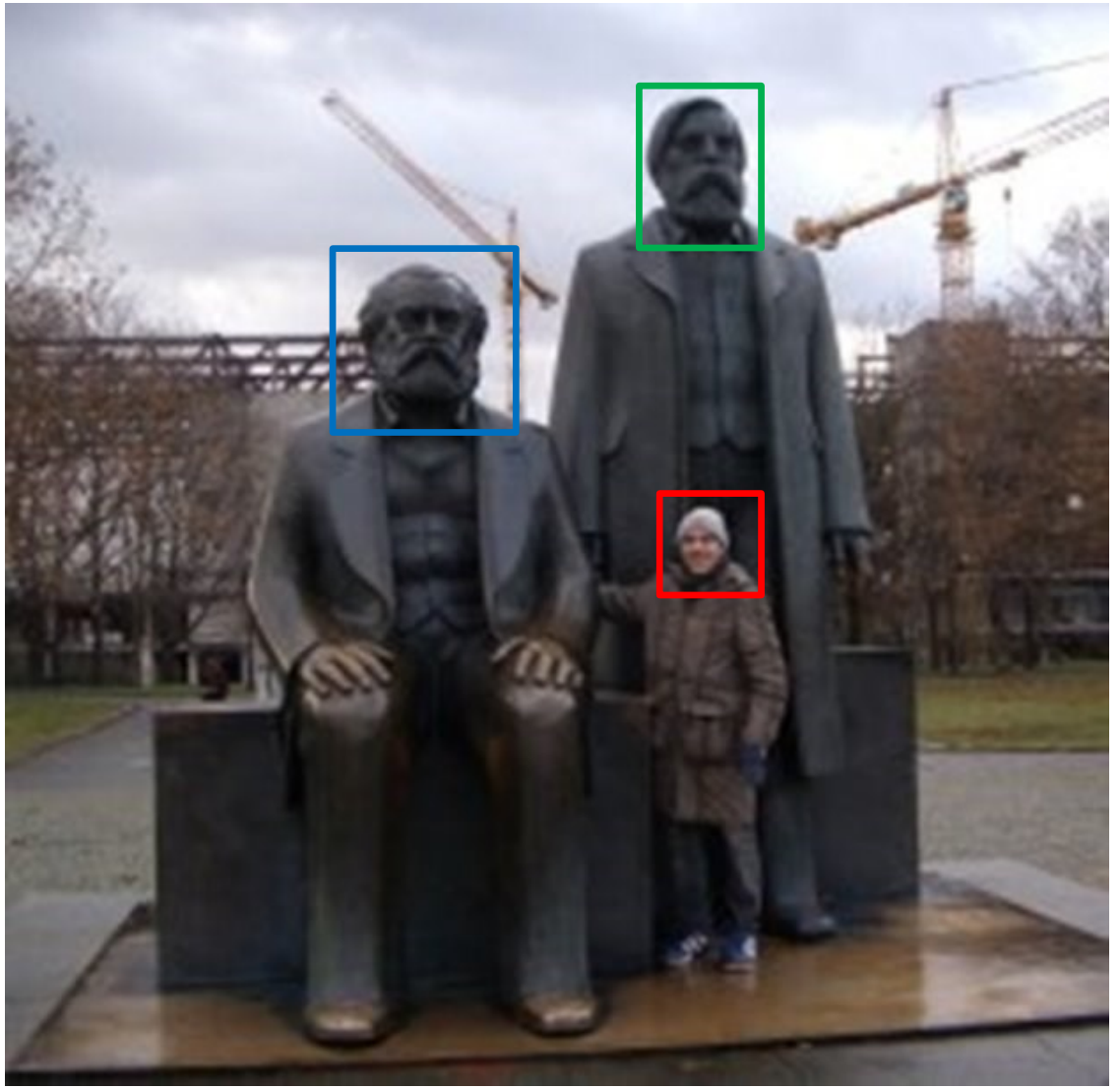
Segmentation



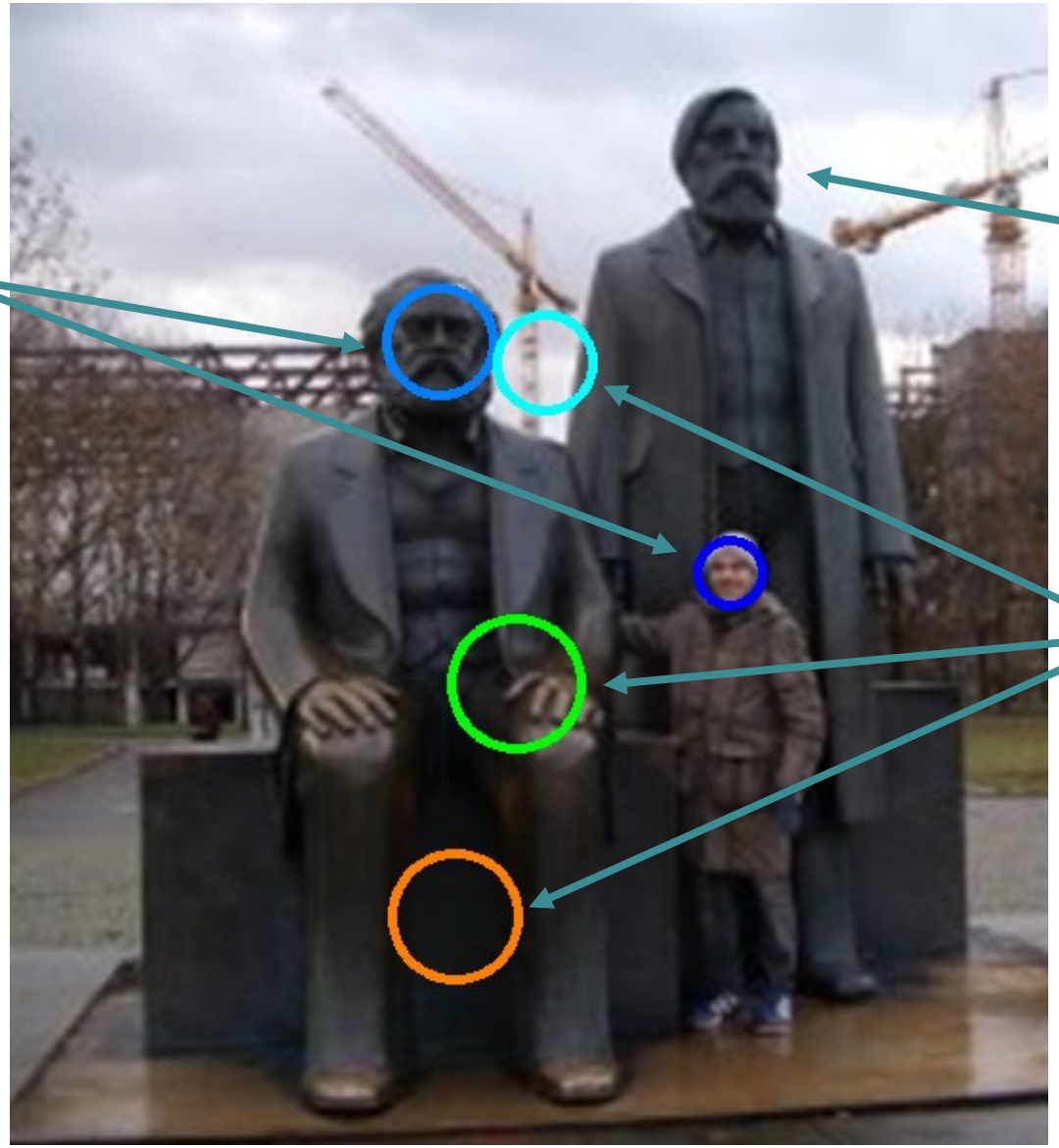
water
boat
vegetation
other

Face Detection Problem

Trovare le regioni dell'immagine contenenti una istanza della classe "faccia"

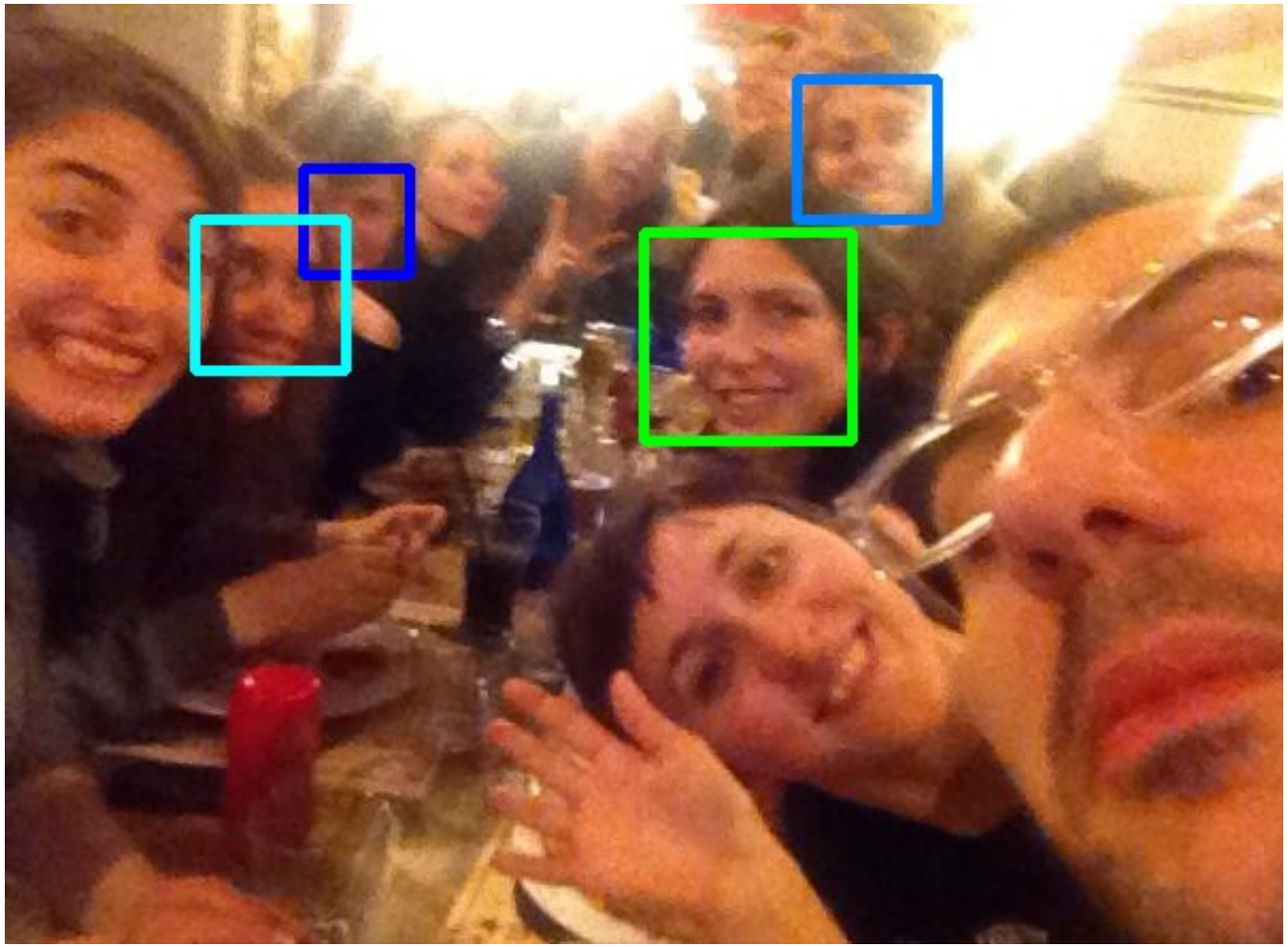


Problematiche nel Face Detection

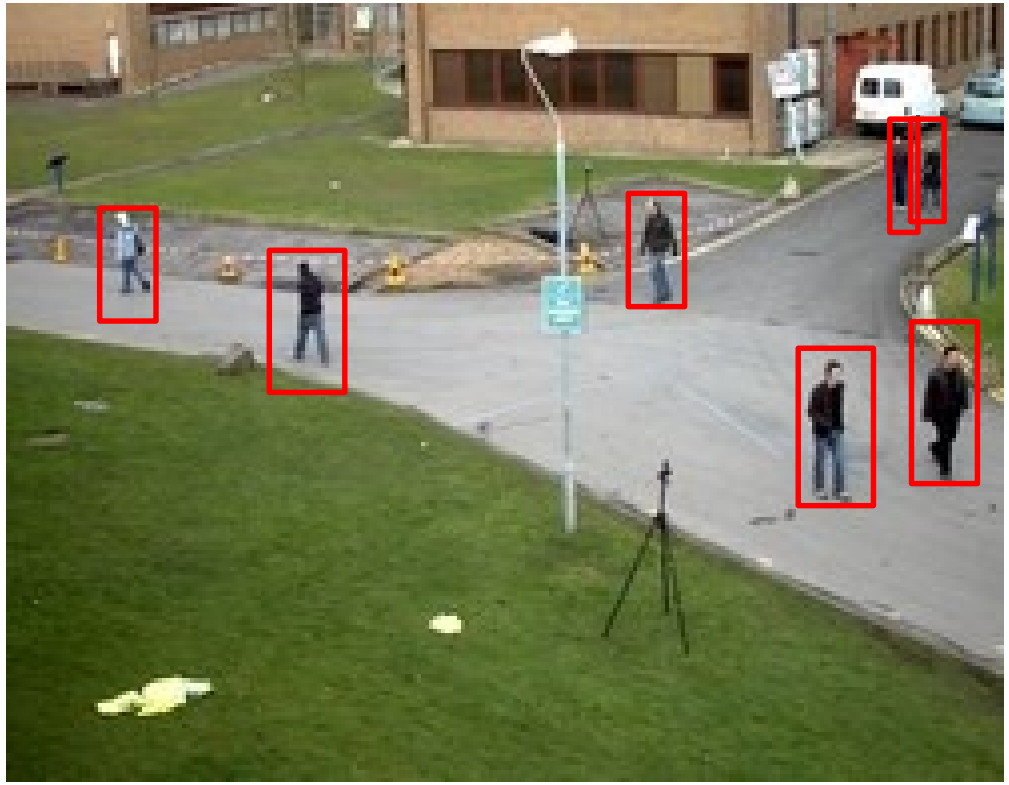


Problematiche aggiuntive

- Rotazione
- Blurring
- Illuminazione
- Occlusioni
- Occhiali
- …



Detection vs Identification

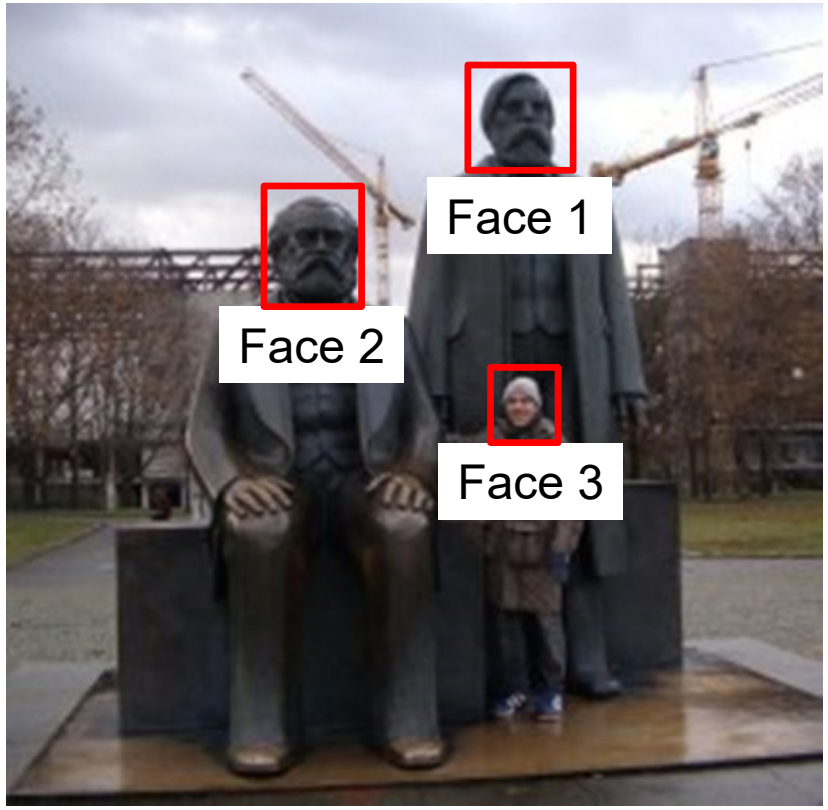


detection

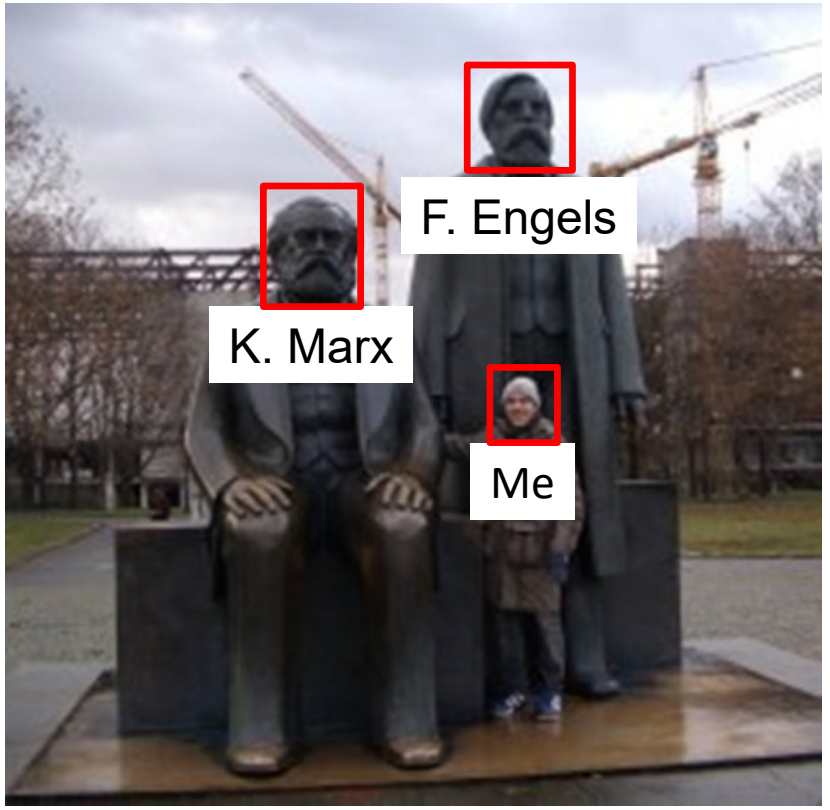
identification

PETS 2009 dataset
http://www.cvg.rdg.ac.uk/PETS2009

Detection vs Recognition



detection

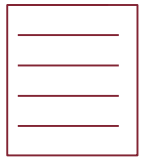


recognition

Detection & Recognition

Input

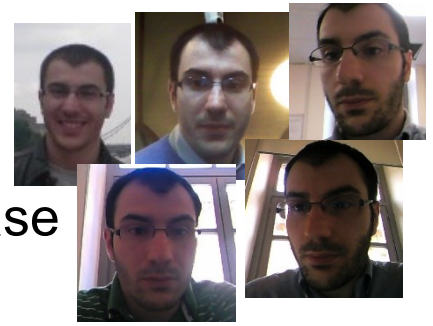
image



classifier's parameters

FACE DETECTION

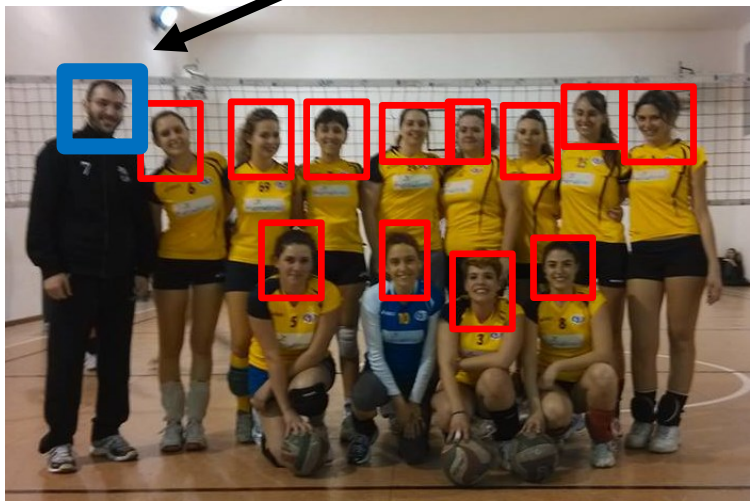
face database



FACE RECOGNITION

Output

ME



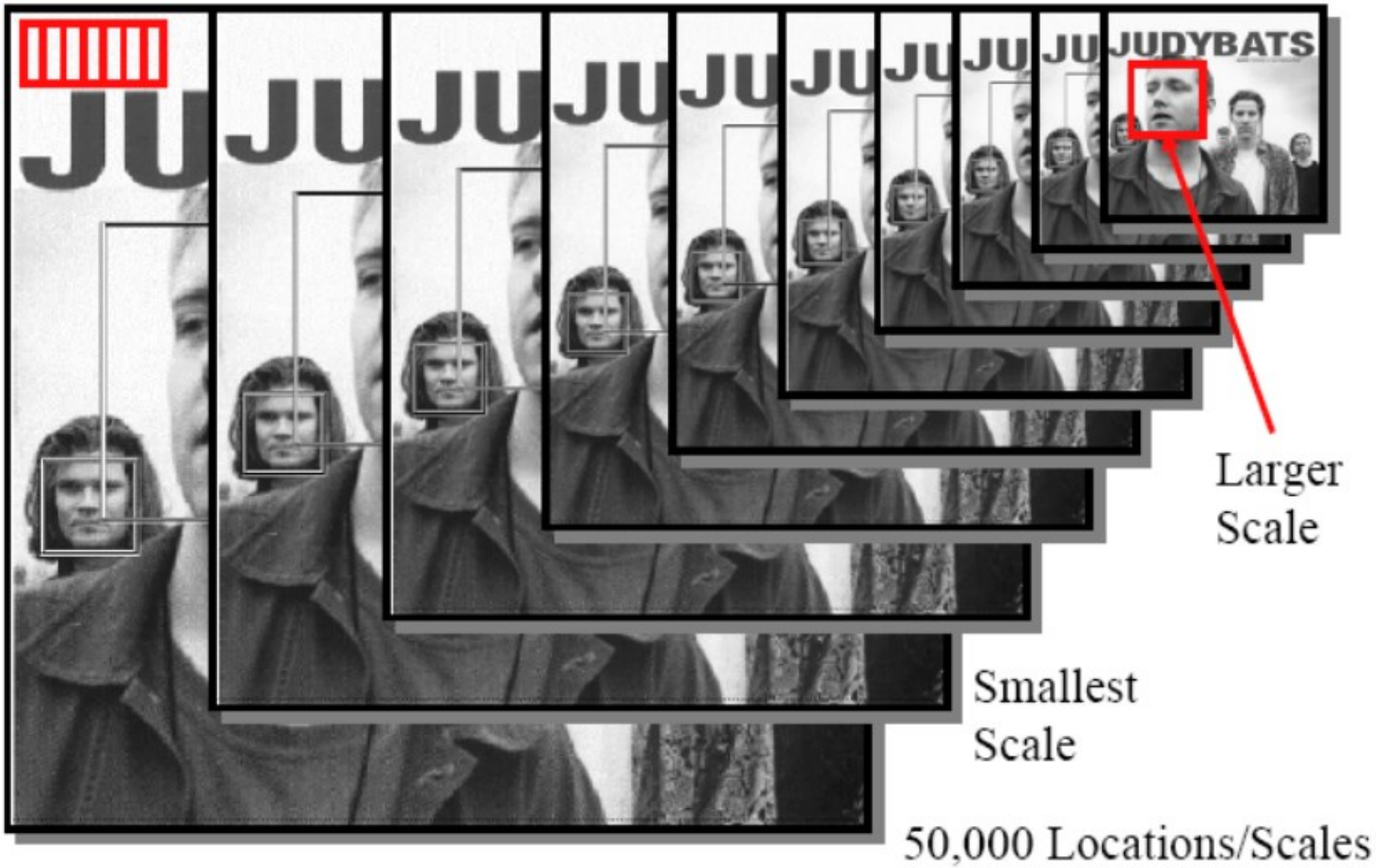
Ricerca con finestra mobile

- Si fa scorrere una finestra (per esempio 30x30) sull'immagine e si valuta se la porzione di immagine nella finestra sia corrispondente al modello dell'oggetto che si sta cercando
- L'operazione deve essere ripetuta in posizioni situate lungo tutta l'immagine
- Si assume che il numero di possibili oggetti nell'immagine sia limitato rispetto al numero delle posizioni visitate

Ricerca multiscala

Ricerca multiscala: resize dell’input

Piramide di immagini



Passi per la object detection

1. **Feature Computation**

   What features?
   How can they be computed as quickly as possible?

2. **Feature Selection**

   What are the most discriminating features?

3. **Detection (in real time)**

   Must focus on potentially positive areas

Algoritmo di Viola and Jones

- **Very popular method**
- **Recognition is very fast**
  (e.g., real-time for digital cameras)

Training may take a long time

- **Key contributions**
  1. **Integral image for fast feature extraction**
  2. **Boosting (Ada-Boost) for face detection**
  3. **Attentional cascade for fast rejection of non-face sub-windows**

P. A. Viola, M. J. Jones. Rapid object detection using a boosted cascade of simple features, CVPR, pp.511-518, 2001
P. A. Viola, M. J. Jones. Robust Real-Time Face Detection. IJCV 57(2), pp. 137-154, 2004

Passi nell’algoritmo di Viola and Jones

1. **Feature Computation**

Quick Feature Computation
Rectangle features
Integral image representation

2. **Feature Selection**

Simple and Efficient Classification
Ada-Boost training algorithm

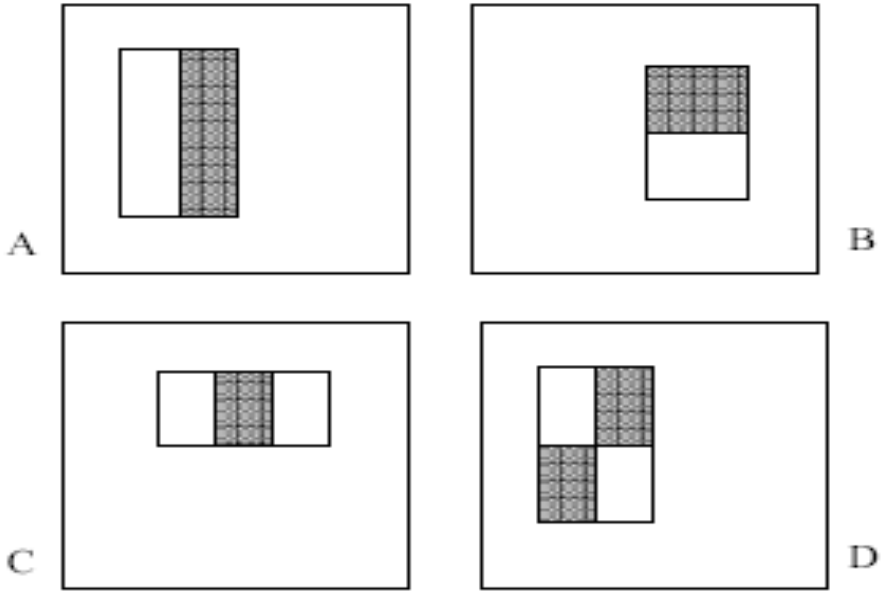
3. **Detection (in real time)**

Real-timeliness
A cascade of classifiers

Features

Four basic types

- Easy to calculate
- White areas are subtracted from the black ones
- Integral image representation makes feature extraction faster



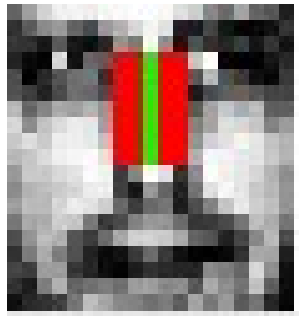
Features rettangolari

La principale motivazione dietro l’uso di features rettangolari, rispetto a filtri più espressivi, è data dalla grande efficienza computazionale che si può raggiungere usando immagini integrali

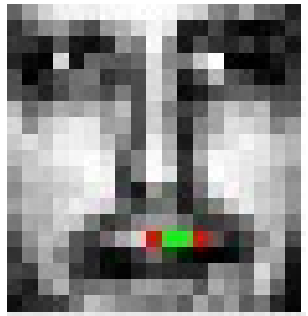
Selezione delle Features

At test time, it is impractical to evaluate the entire feature set

We want a subset of relevant features, which are informative to model a face



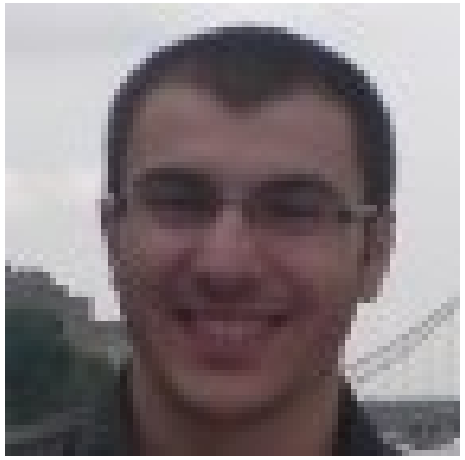
Relevant feature



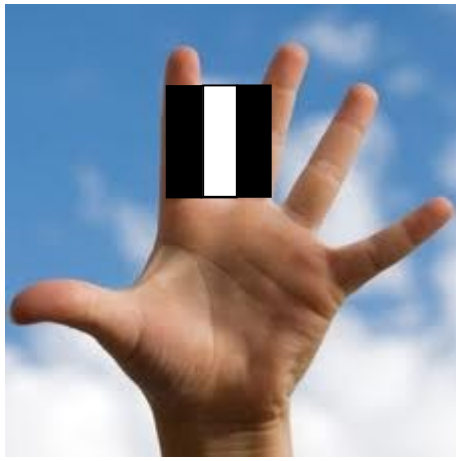
Irrelevant feature

- Can we create a good classifier using just a small subset of all possible features?
- How to select such a subset?

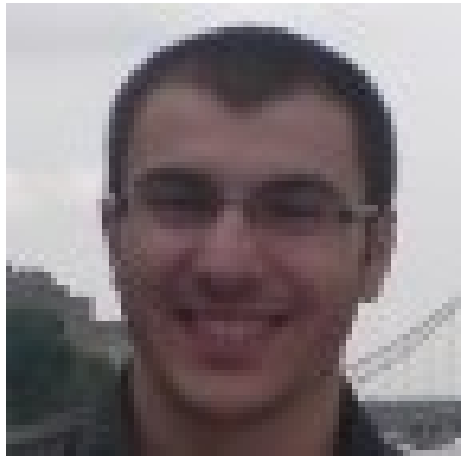
Features Rettangolari



Value = ∑ (pixels in white area) – ∑ (pixels in black area)

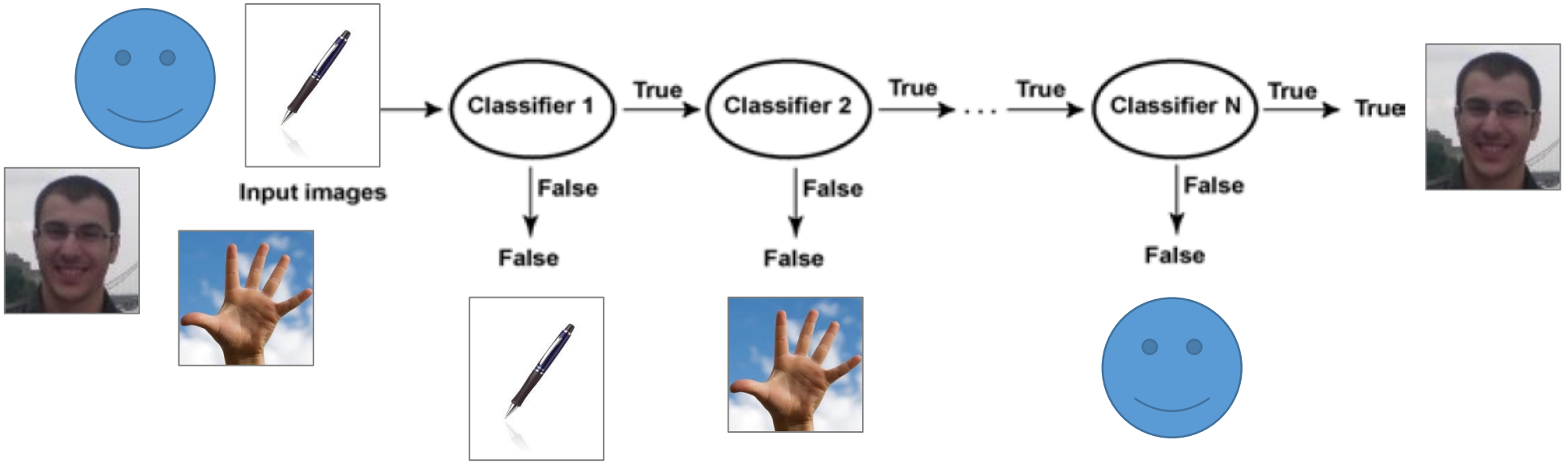


Features Rettangolari



Value = ∑ (pixels in white area) – ∑ (pixels in black area)

Cascata di classificatori



- A chain of classifiers that each reject some fraction of the negative training samples while keeping almost all positive ones
- Each classifier is an AdaBoost ensemble of rectangular Haar-like features sampled from a large pool

Face detection in fb

Face Alignment

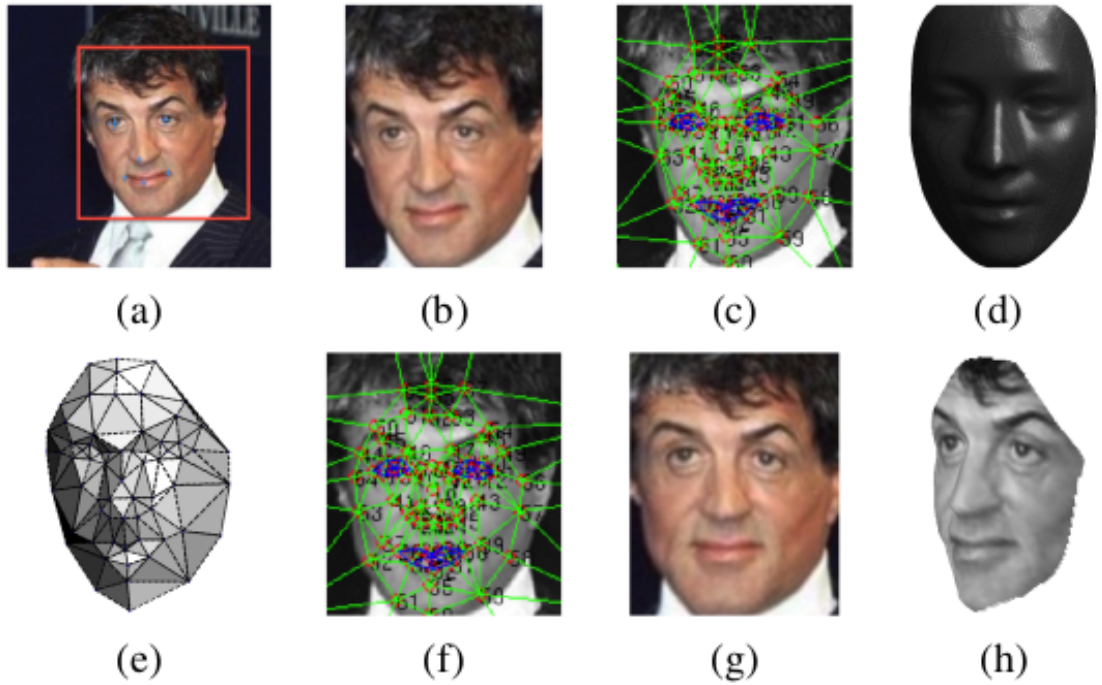


Figure 1. **Alignment pipeline.** (a) The detected face, with 6 initial fiducial points. (b) The induced 2D-aligned crop. (c) 67 fiducial points on the 2D-aligned crop with their corresponding Delaunay triangulation, we added triangles on the contour to avoid discontinuities. (d) The reference 3D shape transformed to the 2D-aligned crop image-plane. (e) Triangle visibility w.r.t. to the fitted 3D-2D camera; darker triangles are less visible. (f) The 67 fiducial points induced by the 3D model that are used to direct the piece-wise affine warpping. (g) The final frontalized crop. (h) A new view generated by the 3D model (not used in this paper).

Image from
DeepFace: Closing the Gap to Human-Level Performance in Face Verification

Deep Face

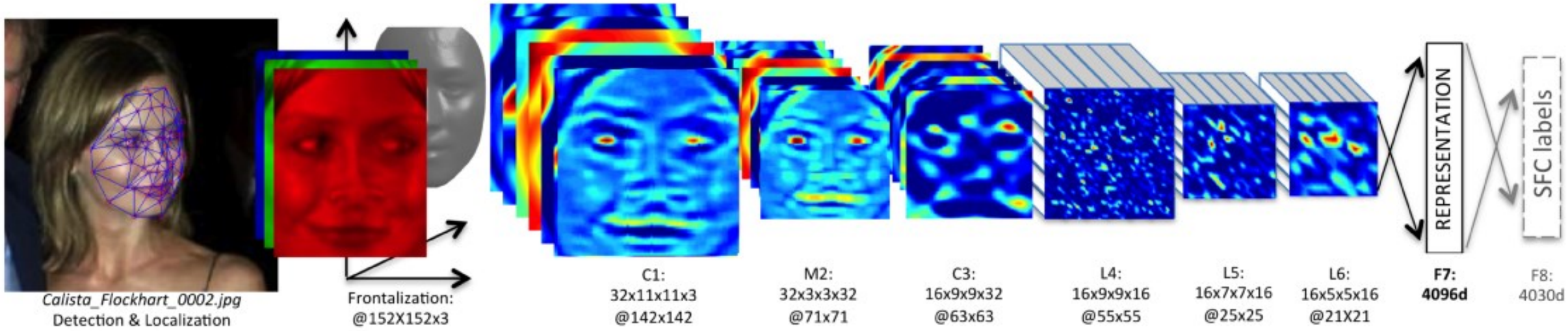


Figure 2. **Outline of the *DeepFace* architecture**. A front-end of a single convolution-pooling-convolution filtering on the rectified input, followed by three locally-connected layers and two fully-connected layers. Colors illustrate feature maps produced at each layer. The net includes more than 120 million parameters, where more than 95% come from the local and fully connected layers.

Lettura consigliata

Y. Taigman, M. Yang, M. Ranzato, L. Wolf, "DeepFace: Closing the Gap to Human-Level Performance in Face Verification," in IEEE Conference on Computer Vision and Pattern Recognition, pp. 1701-1708, 2014

References and Credits

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- Using Custom Design Space Exploration”
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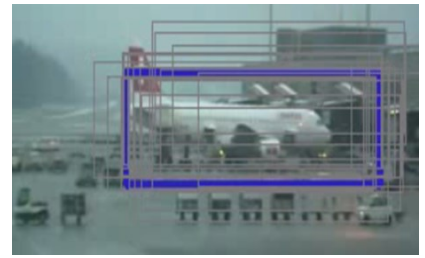
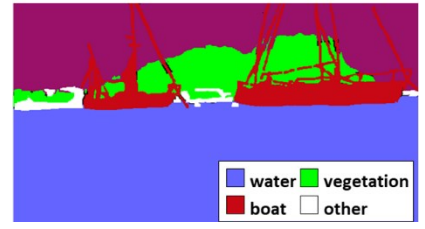


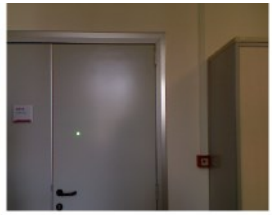
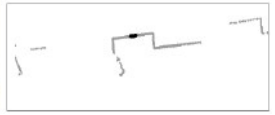
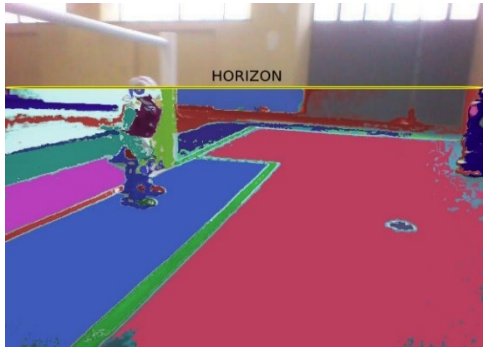


UNIVERSITÀ DEGLI STUDI DELLA BASILICATA

Corso di Sistemi Informativi
A.A. 2018/19

Docente
Domenico Daniele Bloisi

Percezione
Visione


Marzo 2019