COMPUTER VISION

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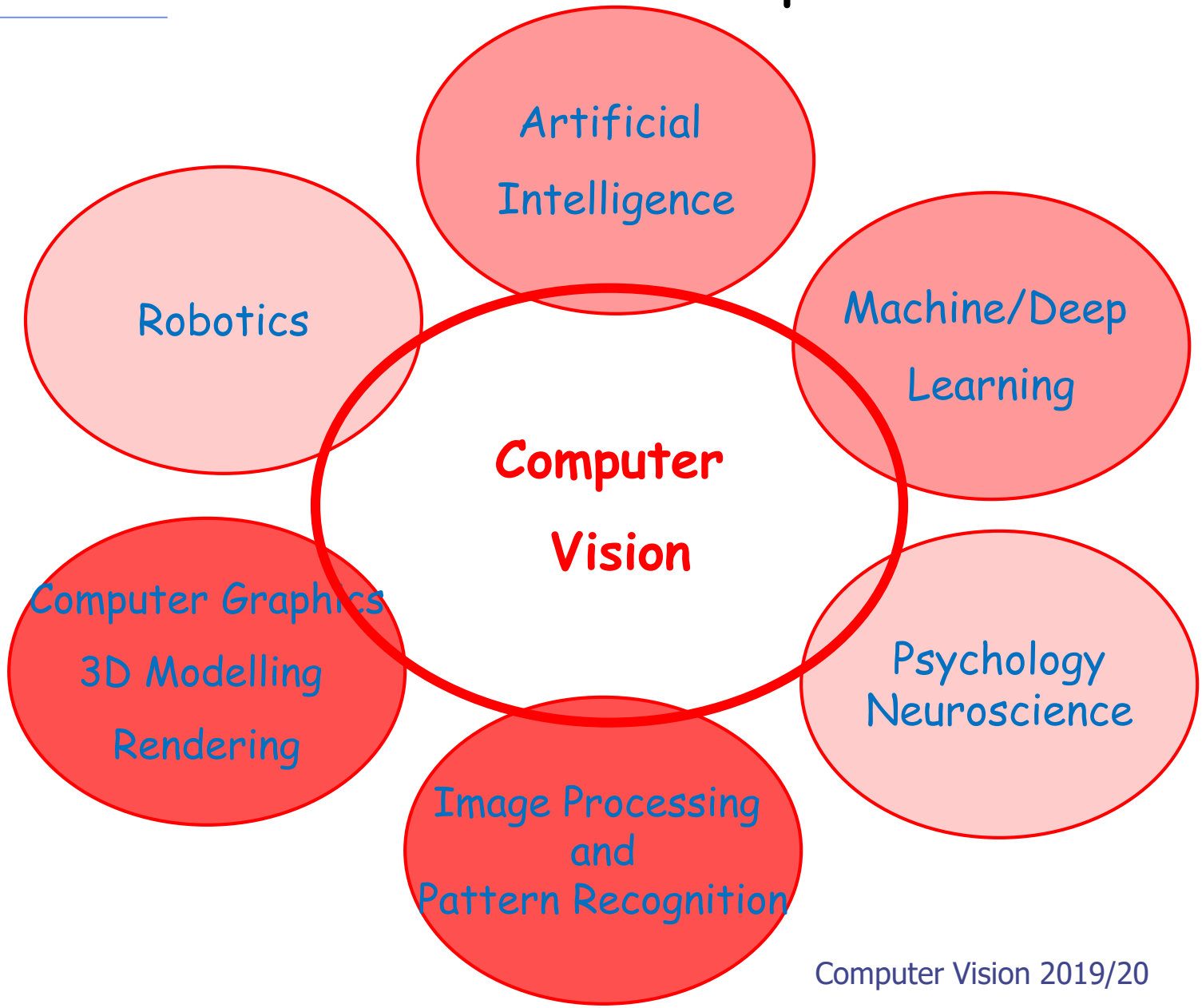
3C Vision

cues, contexts and channels
Elsevier (April 2011)
V. Cantoni, S. Levialdi, B. Zavidovique
Universities of Pavia, Roma, Paris XI

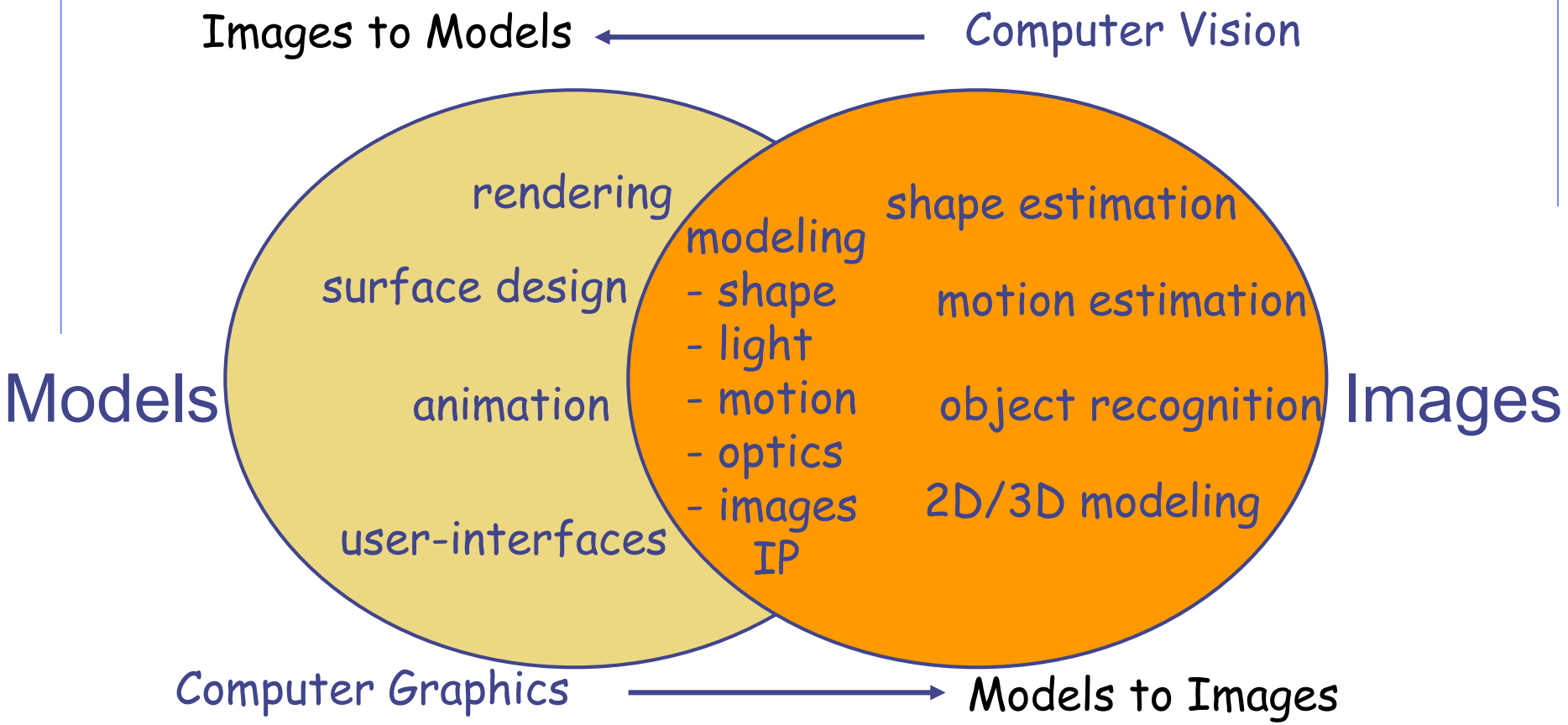
Sito del corso: http://vision.unipv.it/CV/

Michelangelo 1528

Connections to other disciplines



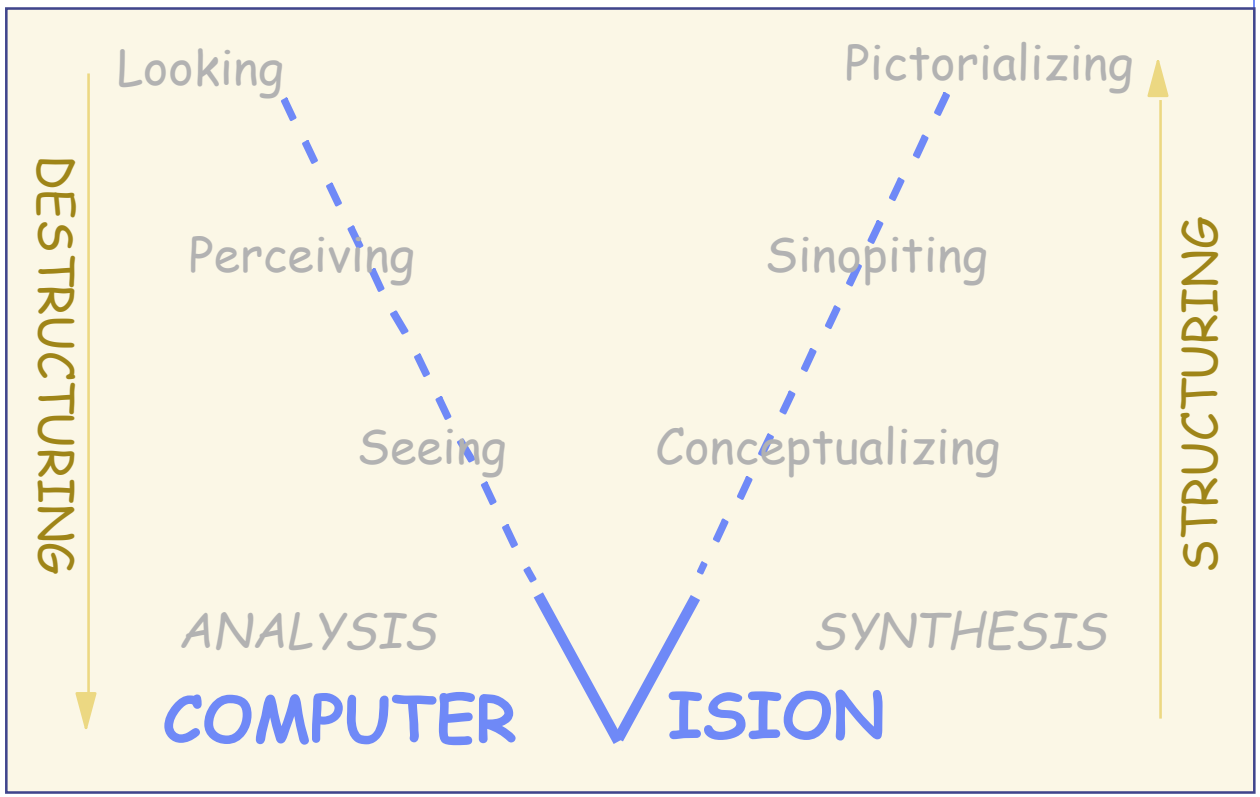
Vision and Graphics



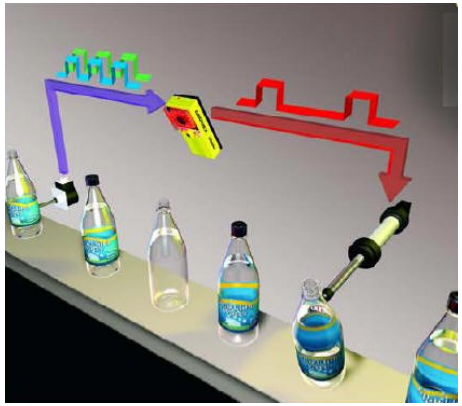
Two inverse problems: analysis and synthesis

Dual aspects of vision: analysis and synthesis

Signal processing '50
Computer Graphic '60
Pattern Recognition '70
Computer Vision '80
Multimedia '90
Machine Learning '00
Deep Learning '10

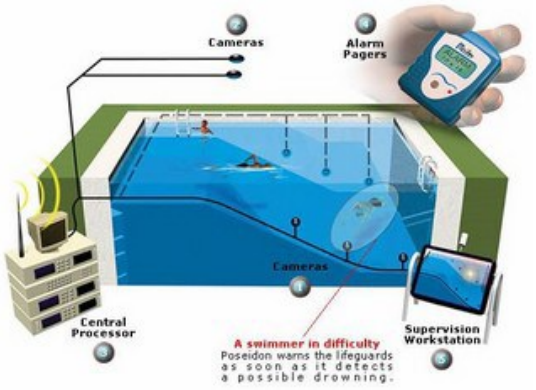


Applications of computer vision



Factory inspection

Reading license plates, checks, ZIP codes



Monitoring for safety (Poseidon)

Surveillance

Autonomous driving, robot navigation

Driver assistance
(collision warning, lane departure warning, rear object detection)

Applications of computer vision

Assistive technologies

Entertainment

Movie special effects

[Face priority AE] When a bright part of the face is too bright

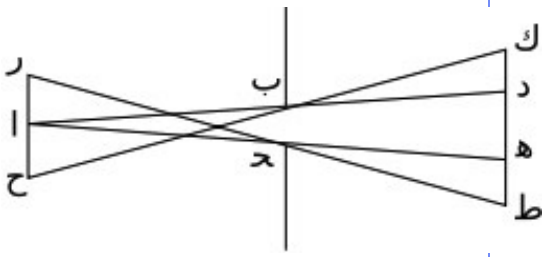
Digital cameras (face detection for setting focus, exposure)

Visual search (MSR Lincoln)

For more information on the computer vision industry: http://www.cs.ubc.ca/spider/lowe/vision.html

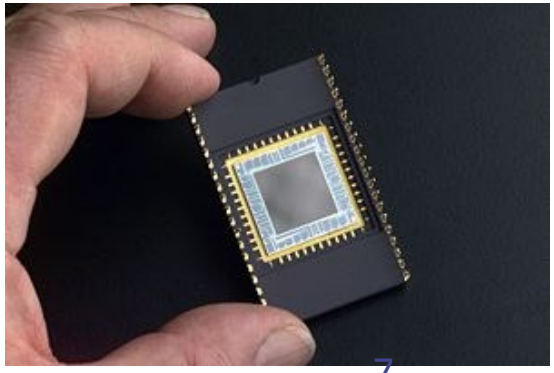
Historical context

- **Pinhole model:** Mozi (470-390 BCE), Aristotle (384-322 BCE)
- **Principles of optics (including lenses):** Alhacen (965-1039 CE)
- **Camera obscura:** Leonardo da Vinci (1452-1519), Johann Zahn (1631-1707)
- **First photo:** Joseph Nicephore Niepce (1822)
- **Daguerréotypes** (1839)
- **Photographic film** (Eastman, 1889)
- **Cinema** (Lumière Brothers, 1895)
- **Color Photography** (Lumière Brothers, 1908)
- **Television** (Baird, Farnsworth, Zworykin, 1920s)
- **First consumer camera with CCD**: Sony Mavica (1981)
- **First fully digital camera:** Kodak DCS100 (1990)



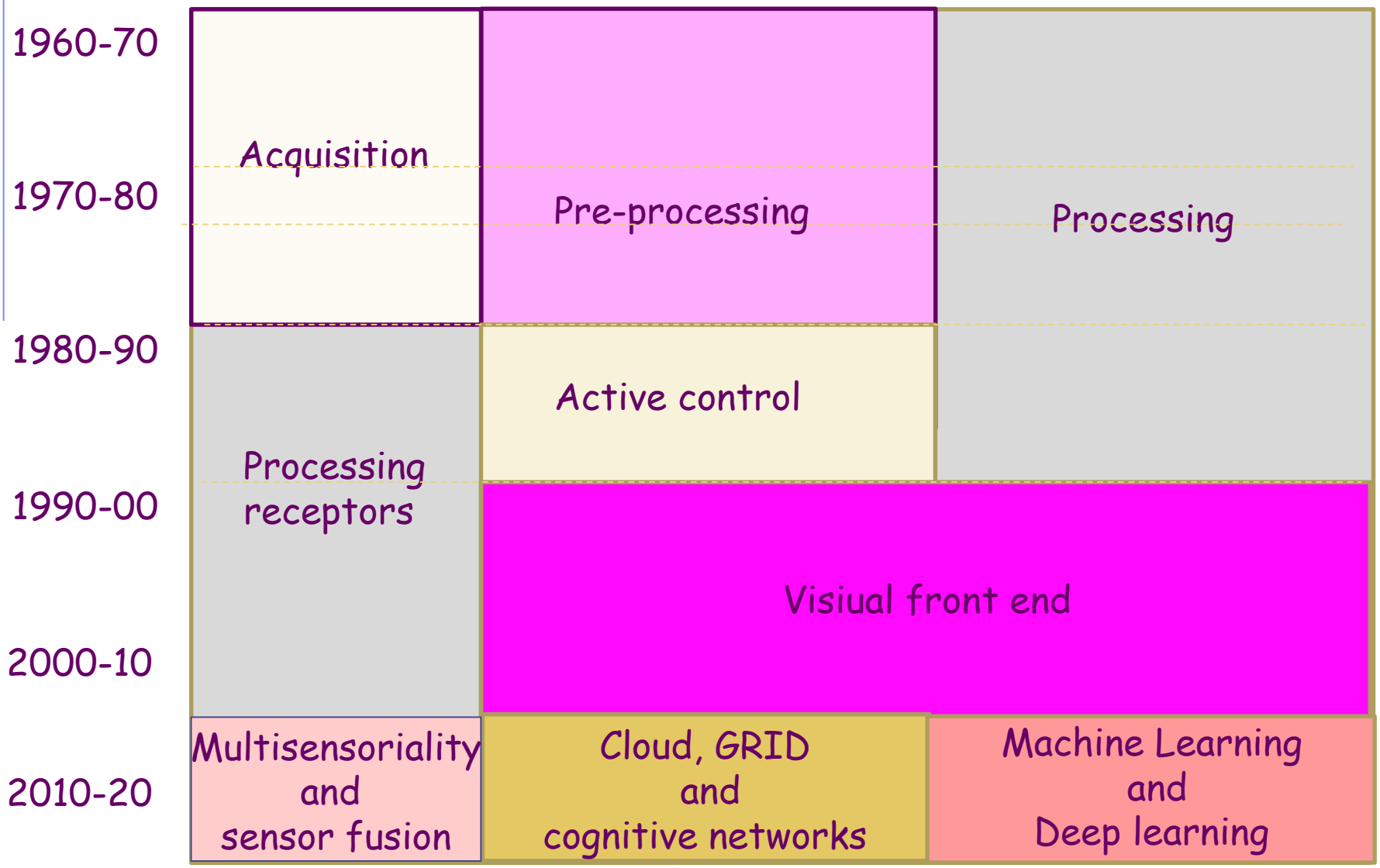
Alhacen's notes

Niepce, "La Table Servie," 1822



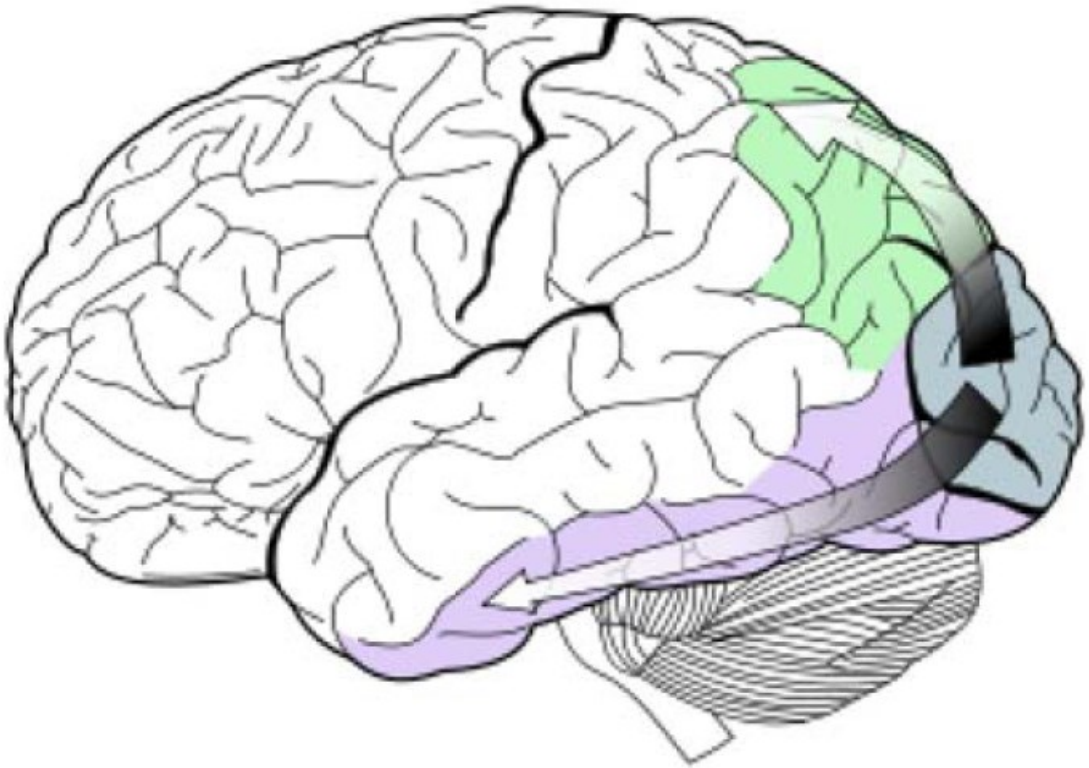
CCD chip

Machine vision phylogenesis



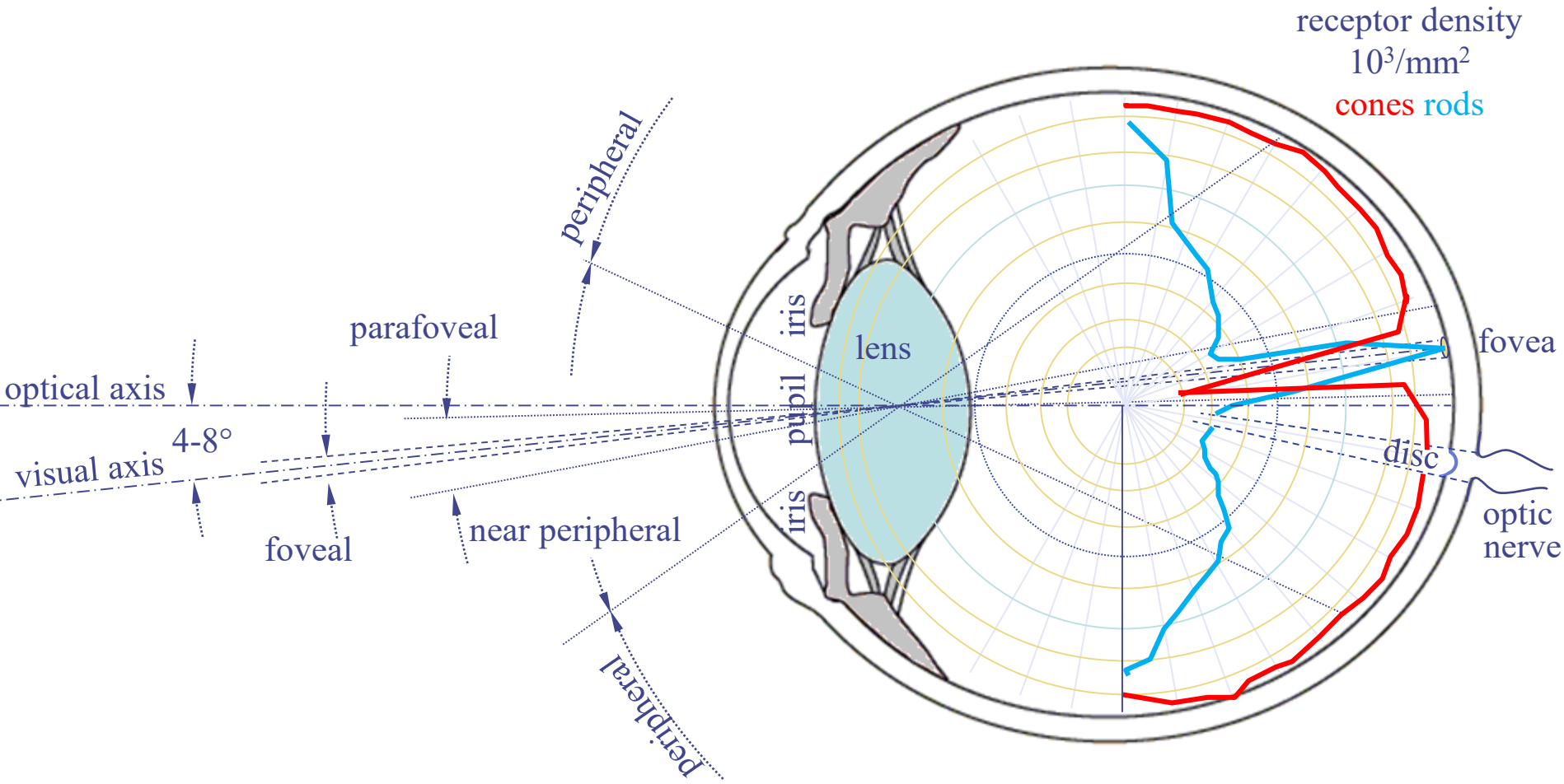
"Two pathways"

- Visual pathways in the human brain. The ventral stream(purple) is important in color recognition. The dorsal stream(green) is also shown. They originate from a common source in the visual cortex.
- "what" vs "where"



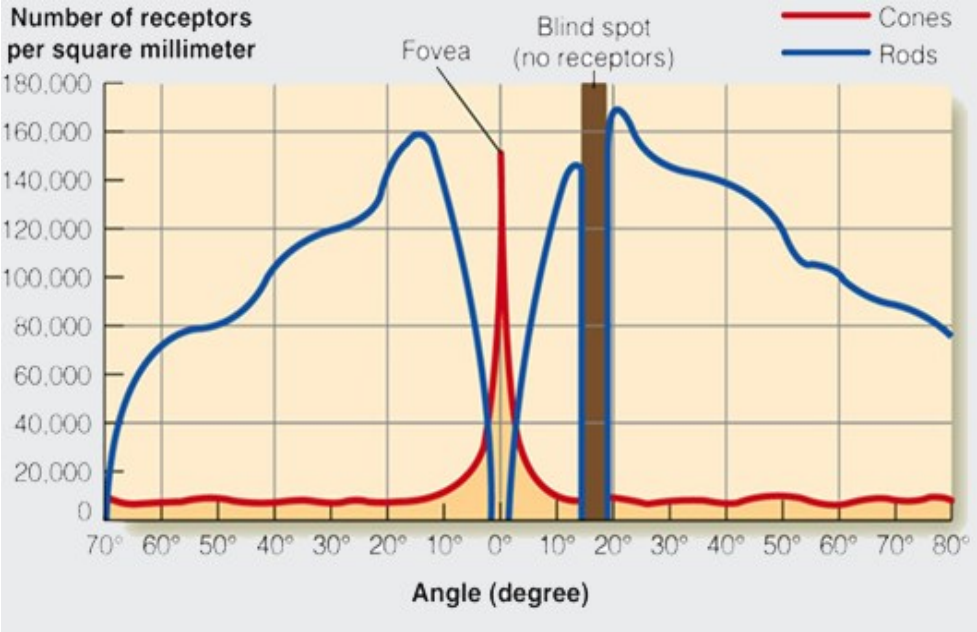
en.wikipedia.org/wiki/Color_vision

The human eye anatomy and visual field



The retina structure

Density distribution of **rod** and **cone** receptors

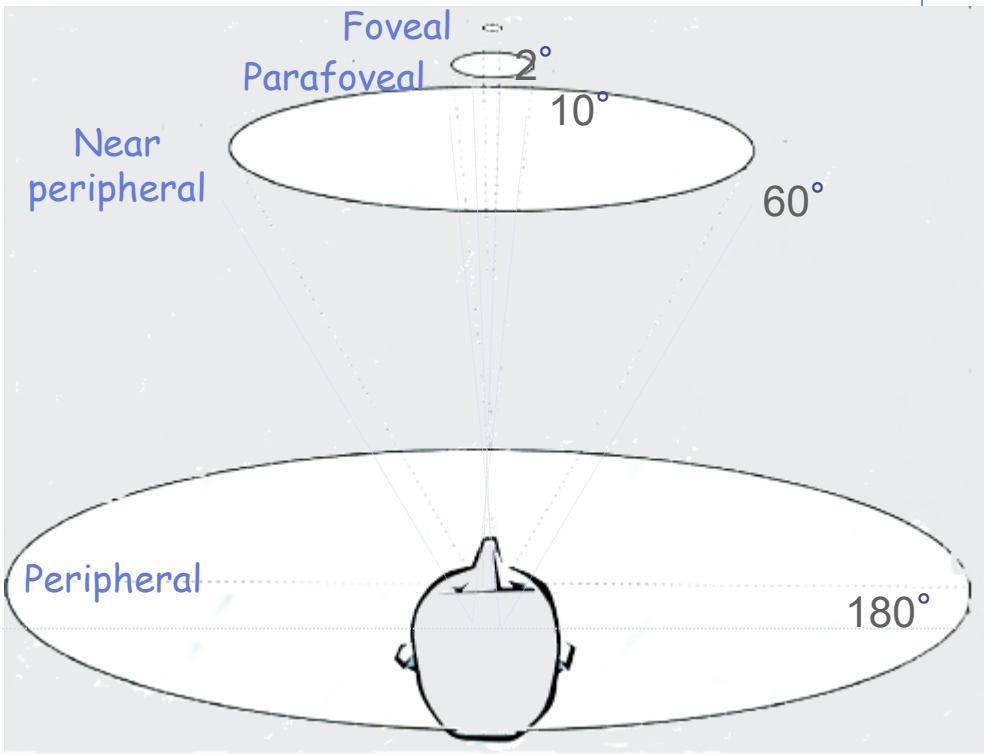


Loss of resolution with eccentricity in retina

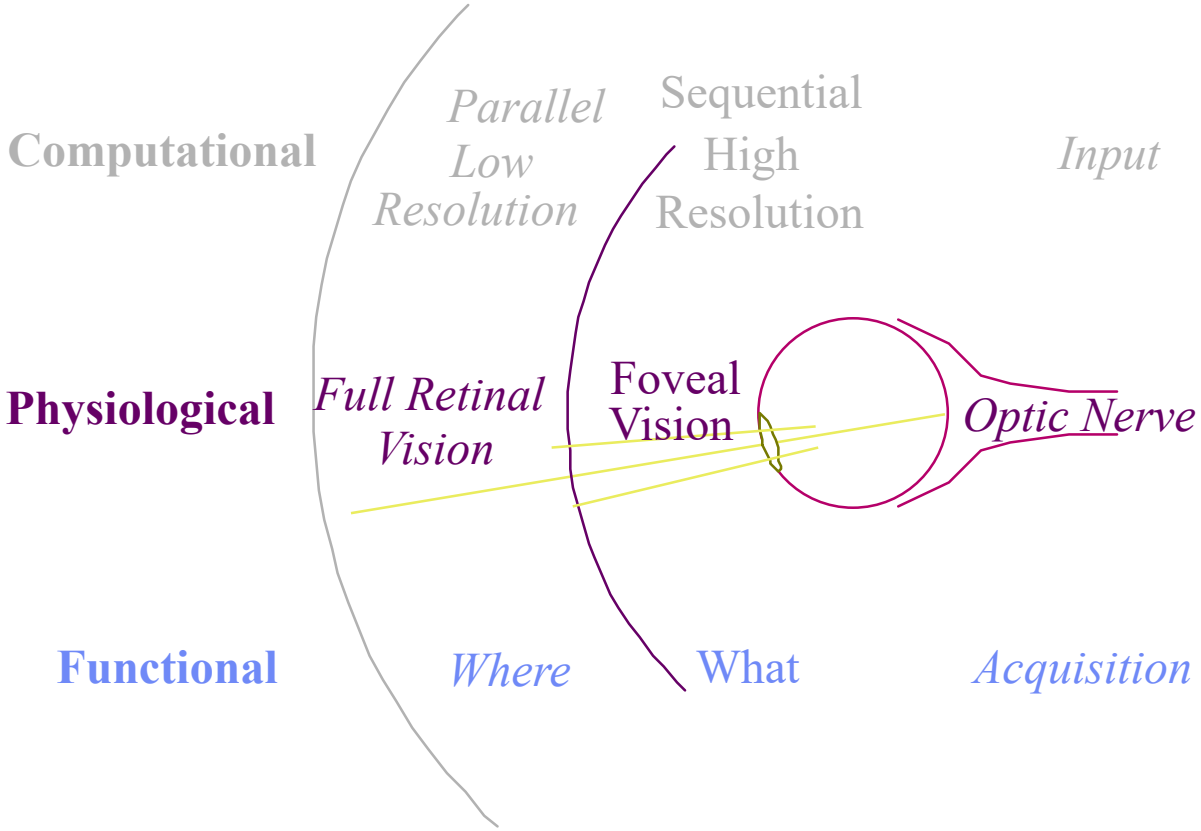
Derived from Duchowski 2002, p. 34

The functional field of view (FFoV)

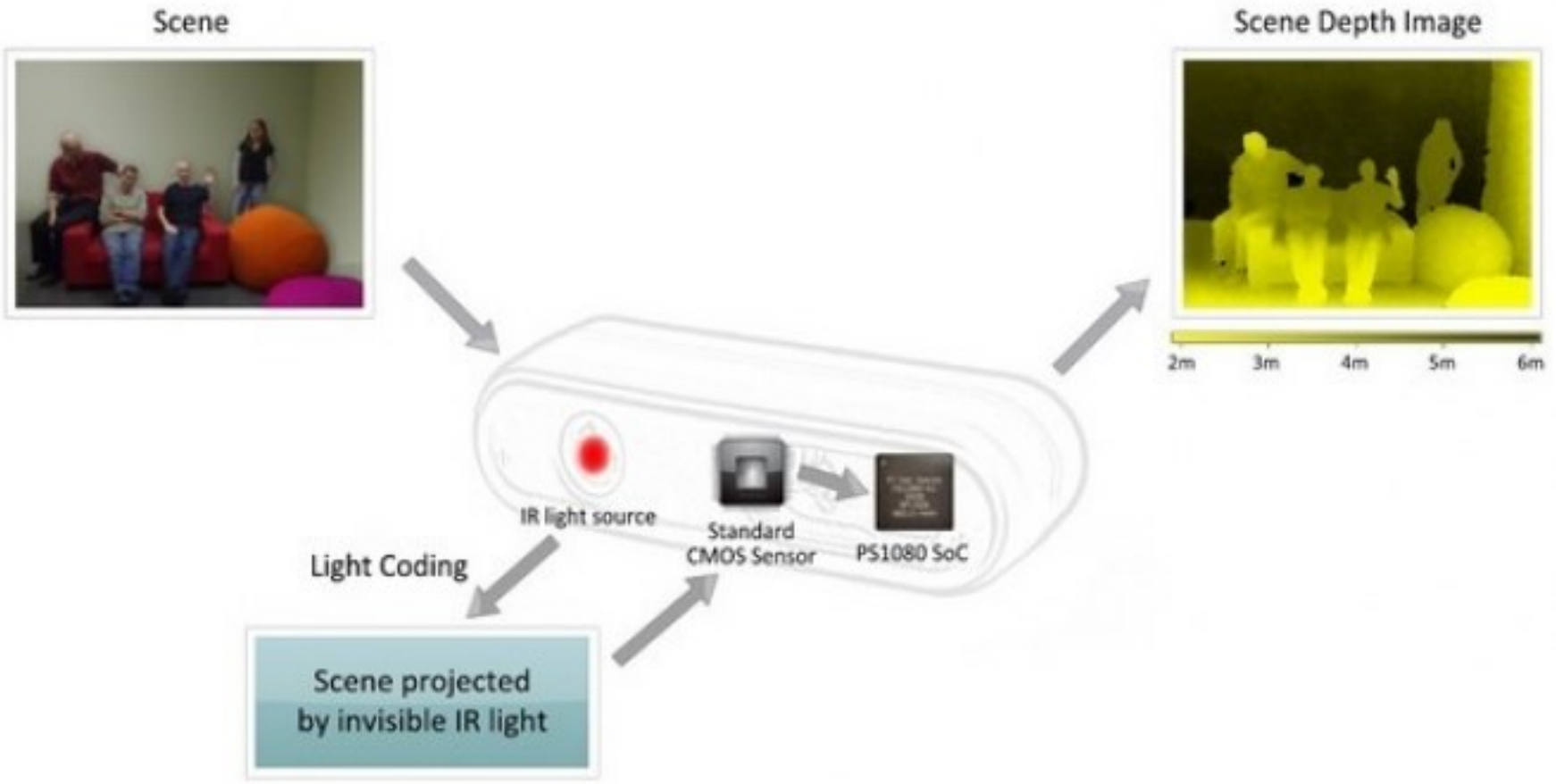
- *Fovea*: central area of retina – provides the sharpest vision; when we are looking at something, we are directing our eyes so image is projected onto fovea
- *Parafoveal*: region surrounding fovea corresponding to retinal area from 2° to 10° off-centre; previews foveal information
- *Peripheral*: region of retina outside the 10° area – increased sensitivity to motion detection; reacts to flashing objects and sudden movements
- The regions are asymmetric, e.g. in reading the so-called perceptual span (size of the effective vision), is 3-4 letter spaces to the left of fixation and 14-15 letter spaces to the right; 10° of visual angle is roughly equivalent to 3-4 letter spaces



“what” vs “where”

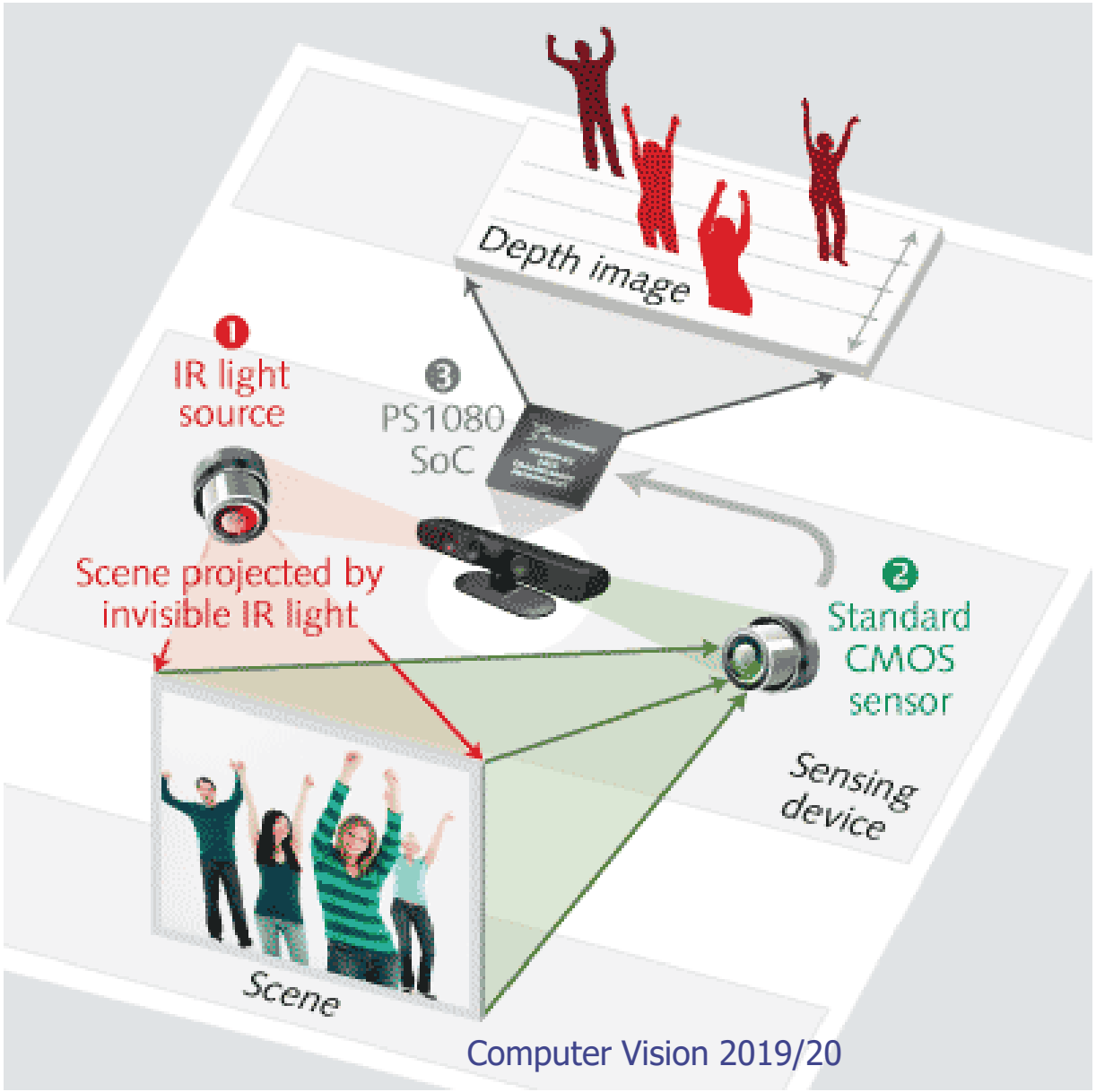


Kinect sensor

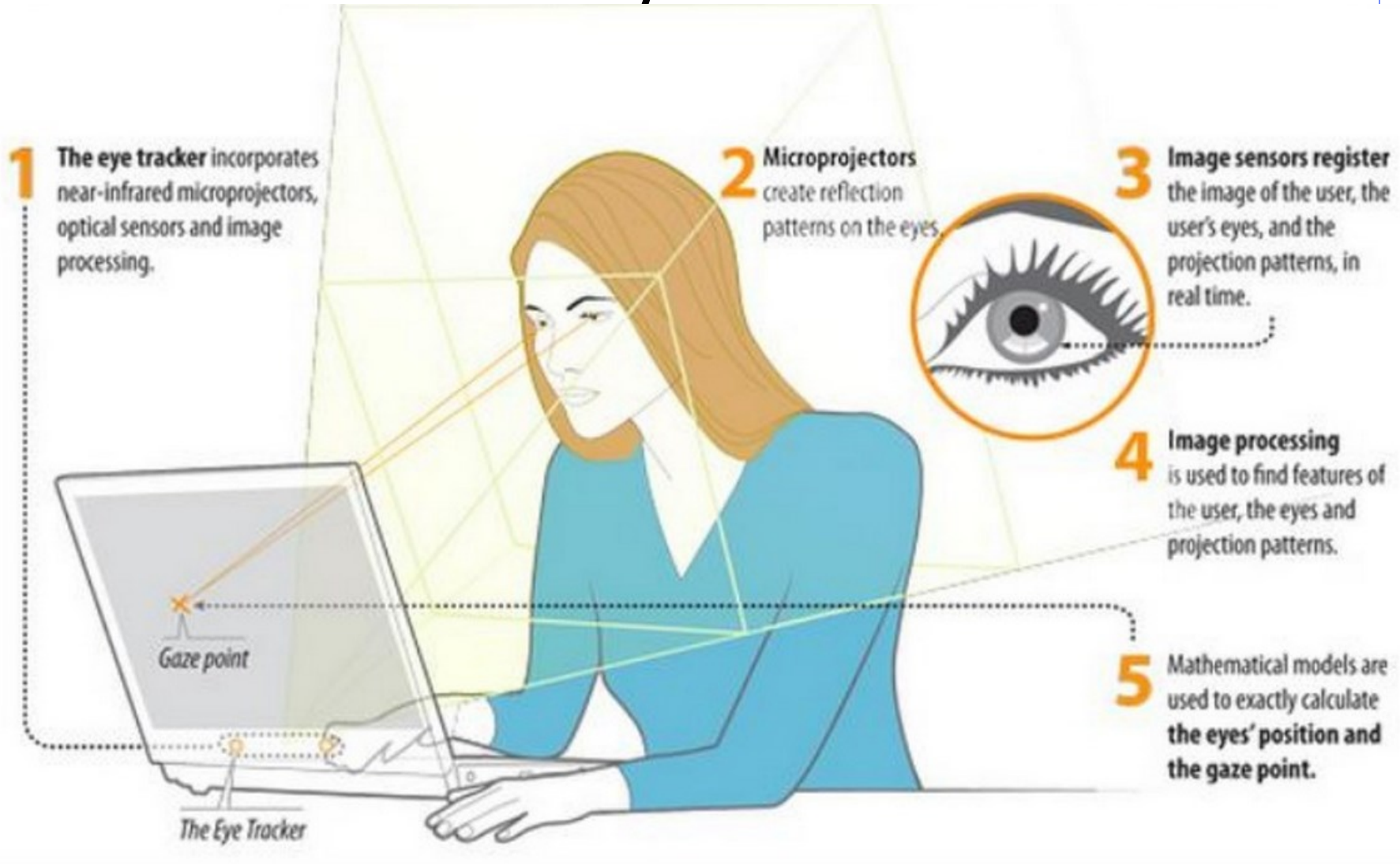


http://www.laserfocusworld.com/articles/2011/01/lasers-bring-gesture-recognition-to-the-home.html

Kinect sensor



Eye tracking underlying technology: corneal reflection system



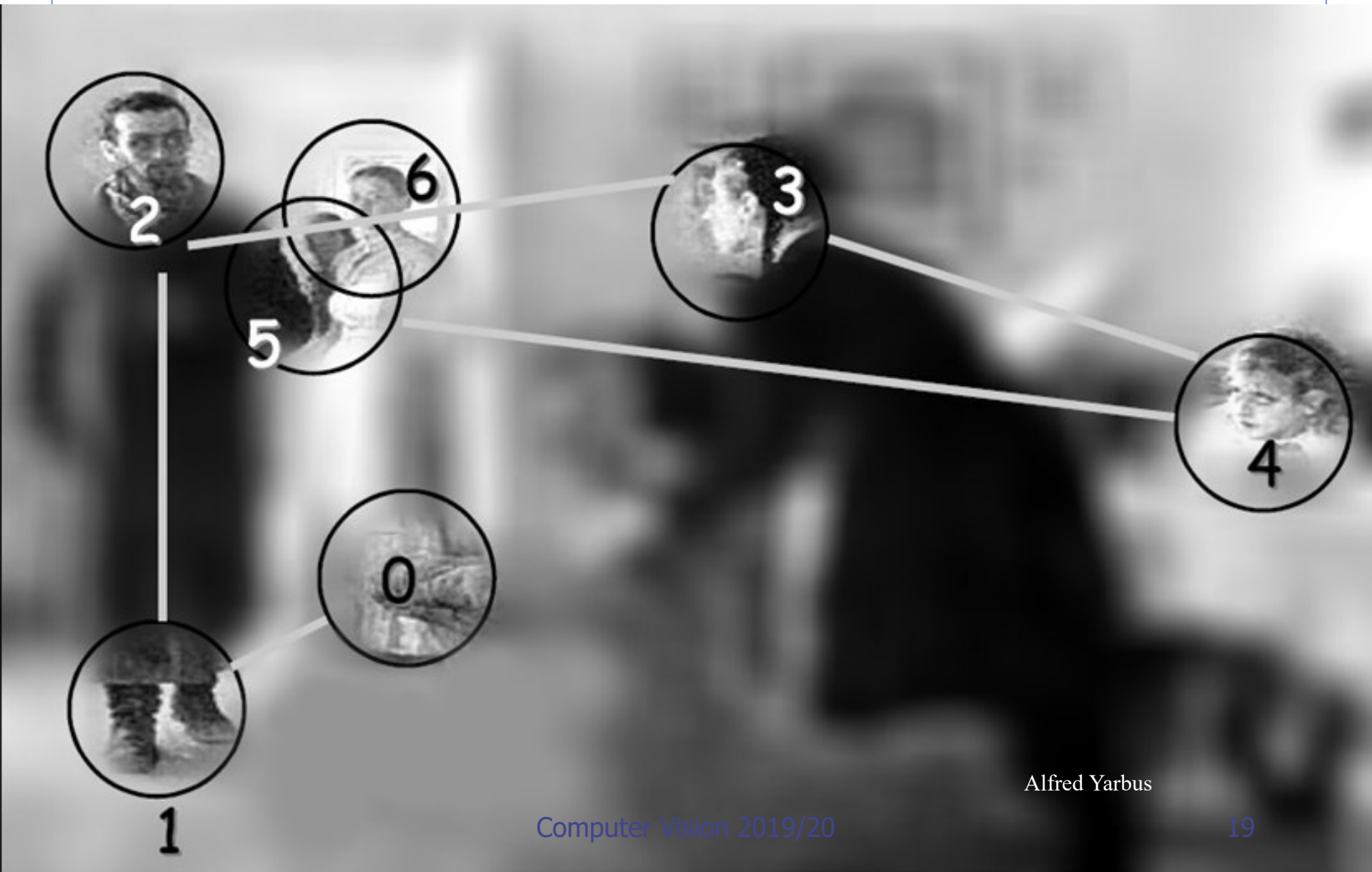
Low cost technology: the Eye Tribe

- The Eye Tribe has broken the record for smallest eye tracker device in the world, measuring in at 20 × 1.9 × 1.9 cm
- It works with an infrared LED and a front-facing camera. The LED lights up the eye, and the camera picks up an image that is interpreted by the software to show where the user is looking.
- The tracker has an average accuracy of about 0.5° of visual angle and can identify and follow the movement of an eye with sub millimeter precision in a tracking area of 40 cm × 30 cm at 65 cm distance.

Eye tracking and cognitive science

- "The eyes are the windows to the soul", can their movements tell us something about higher cognitive processes?
- Scan patterns give delayed information about the mental processes that are developing in a person's mind and reveal what visual information is (going to be) used by these processes.
- For more than a century psychologists have utilized eye tracking as a window into how we think and how we feel, and to test theories of the mind and its mental processes.
- In fact, eye tracking has a great deal of potential for informing us about strategies and identifying gaze patterns and what they signify but much work is required to determine the best ways to interpret the wealth of information gaze data affords.
- The way you view the world is unique, so why not use it to identify you?

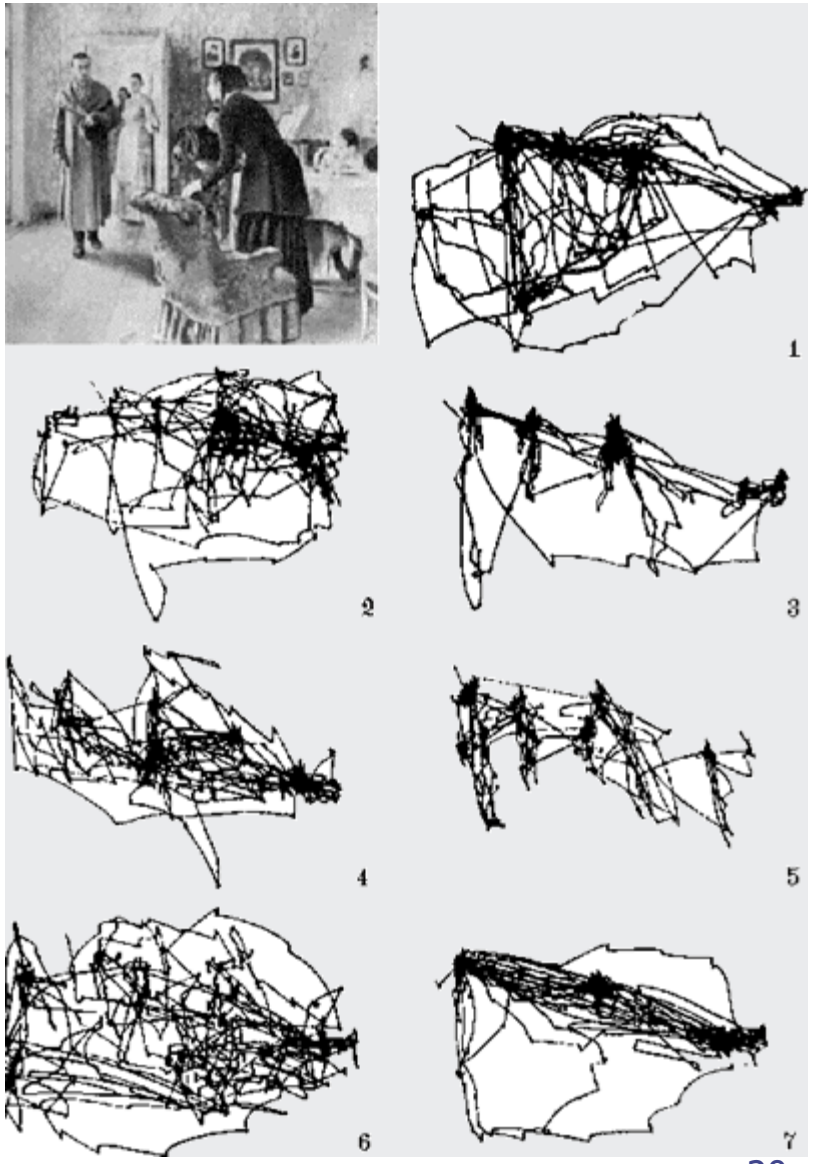
Scan-path & visual field



Alfred Yarbus

Eye-Movement Studies: cognitive processes

- In the 1950s, Alfred Yarbus wrote about the relation about fixations and interest
- Examples of eye movements that evidence on how the task have a very large influence:
  - trace 1: free examination
  - trace 2: estimate wealth
  - trace 3: estimate ages
  - trace 4: guess previous activity
  - trace 5: remember clothing
  - trace 6: remember positions
  - trace 7: time since last visit



Strong eye-mind Hypothesis

- Alfred L. Yarbus, 1967:
  - The *scan-path* "is dependent not only on what is shown on the picture, but also on the problem facing the observer and the information that he hopes to gain from the picture"
  - "Eye movement reflects the human thought processes; … It is easy to determine from these records which elements attract the observer's eye (and, consequently, his thought), in what order, and how often"
- Just and Carpenter, 1980
  - The *Strong eye-mind Hypothesis*, "there is no appreciable lag between what is fixated and what is processed": when a subject looks at a word or object, he or she also thinks about (process cognitively), and for exactly as long as the recorded fixation. It is a hypothesis that is today much too often taken for granted by many beginning eye tracker researchers.
  - During the 1980s, the eye-mind hypothesis was often questioned in light of covert attention, the attention to something that one is not looking at, which people often do

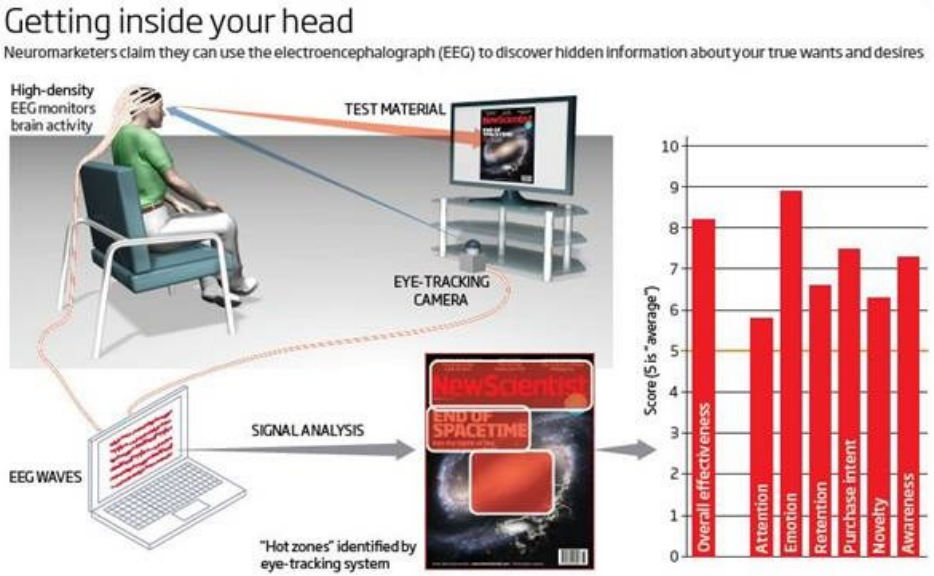
Integrating visual information across multiple gazes

- During the 1980s, the eye-mind hypothesis was often questioned, in the light of ***covert attention***, i.e. you can attend to something different than what you are looking at. If covert attention were to be common during eye tracking recordings, the resulting scan path and fixation patterns would often show not where our attention has been, but only where the eye has been looking.
- According to Hoffman, 1998, *current consensus is that visual attention is always slightly (100 to 250 ms) ahead of the eye*. But as soon as attention moves to a new position, the eyes will want to follow

Where to look next?

- People give ***attention*** with foveal vision. The perception of a scene involves a pattern of fixations, where the eye is held (fairly) still, and saccades, where the eye moves to foveate a new part of the scene
- Information is also partially processed in the periphery of the visual field. With peripheral vision, people can choose what to give attention to and what to screen out because
  - got enough info peripherally (animation)
  - don't believe the item is needed now (search bar, ads, items that look like ads) *this is sometimes a defense mechanism*
- The main issue is "Where to look next?" Answer may be that perception is influenced with
  - Cognition, *e.g.* "meaningful" parts previewed with parafoveal vision
  - Visual cues; highly attractive areas selected by peripheral vision

Neuromarketing

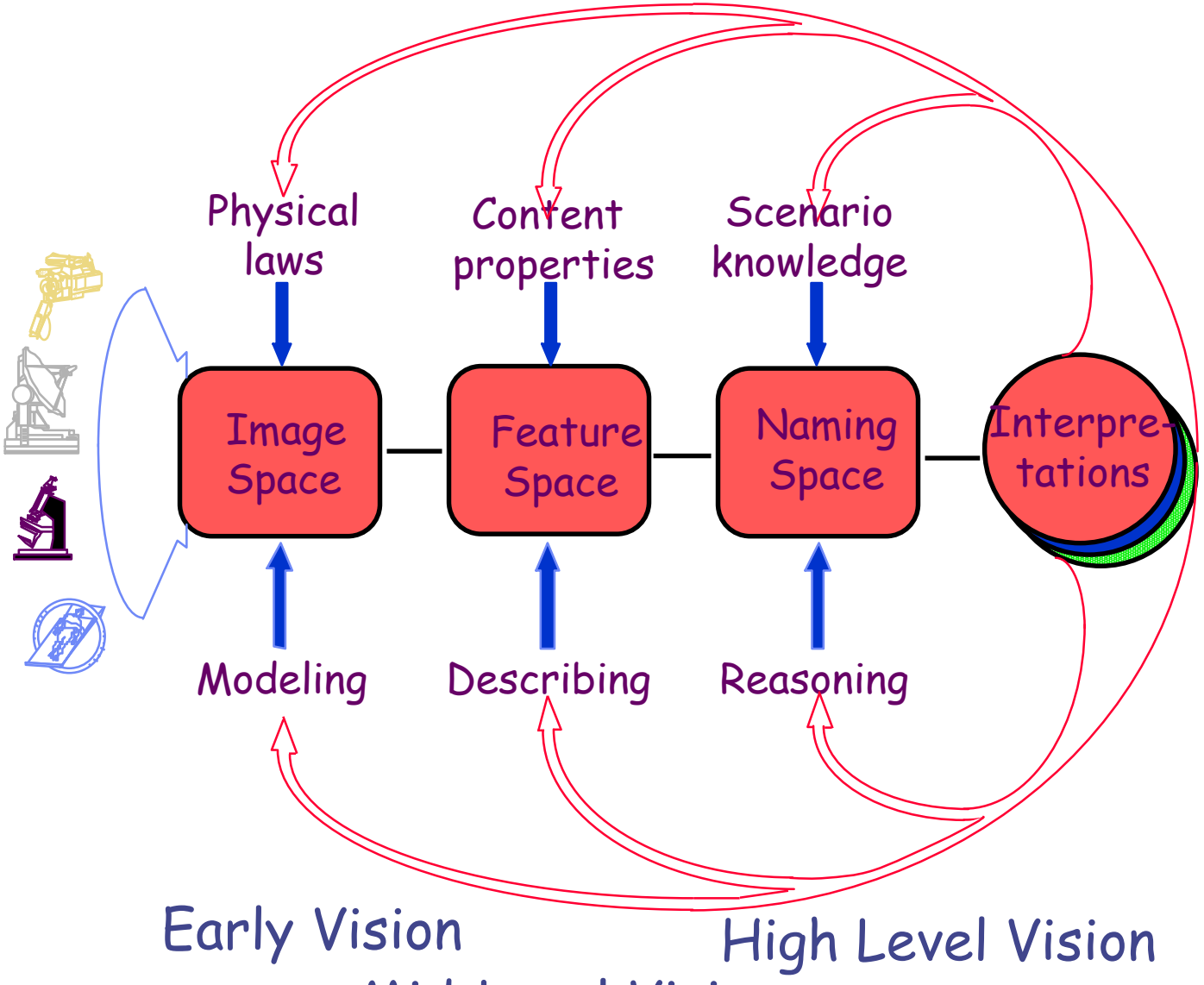


- Private research that promotes NM does not require peer review, results are proprietary, results are usually framed in ROI not comprehensive, and promises exceed evidence.
- Should marketers have access to our unconscious minds?
- Should the technologies be restricted to adult consumers?
- Who should determine standards & regulations?
- Should businesses be required to disclose use?
- How can businesses be protected from faulty claims and large expenditures of money?

Stop Neuromarketing! (7:34")
Beware Neurobunk (11:18")

- Advertising Research Foundation (ARF) NeuroStandards Collaboration Project conducted an examination of several methods. It concluded that more research is needed; that while there are important insights, results are not definitive.
  - As a business, it may engage science to adopt it
  - It must be simpler & reduce "noise"
  - Its quantitative and qualitative methods must be combined with other methods
  - Utility will be based on broad samples and populations (may not be as applicable for individuals)
  - Combining methods of monitoring may be more useful and accurate

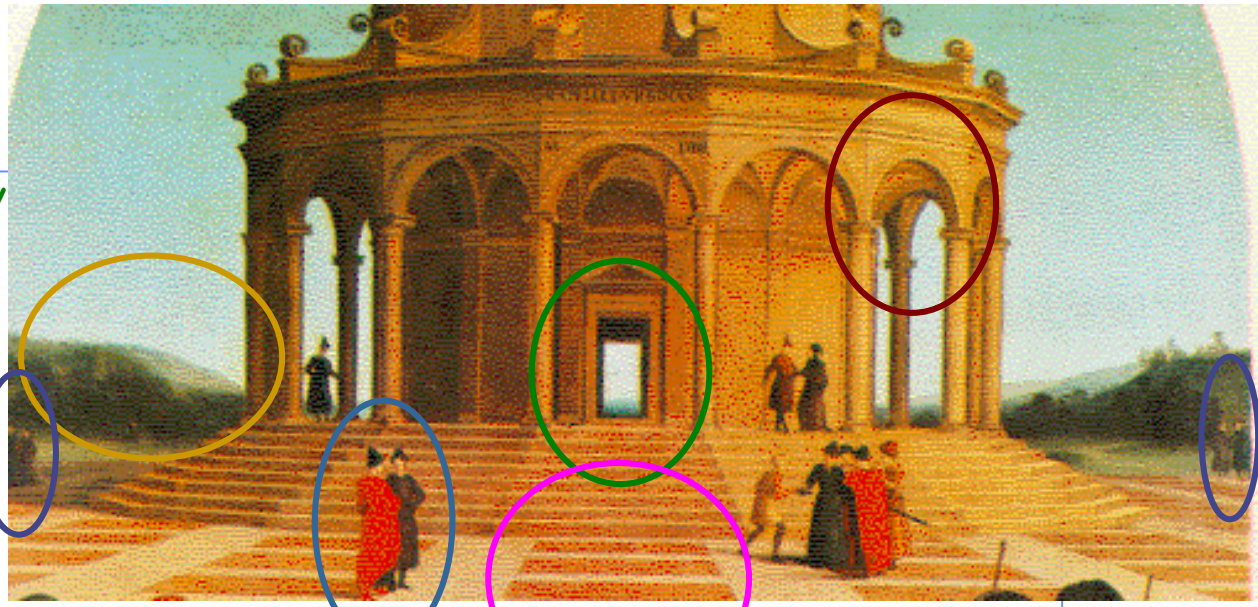
The image/video analysis and interpretation process



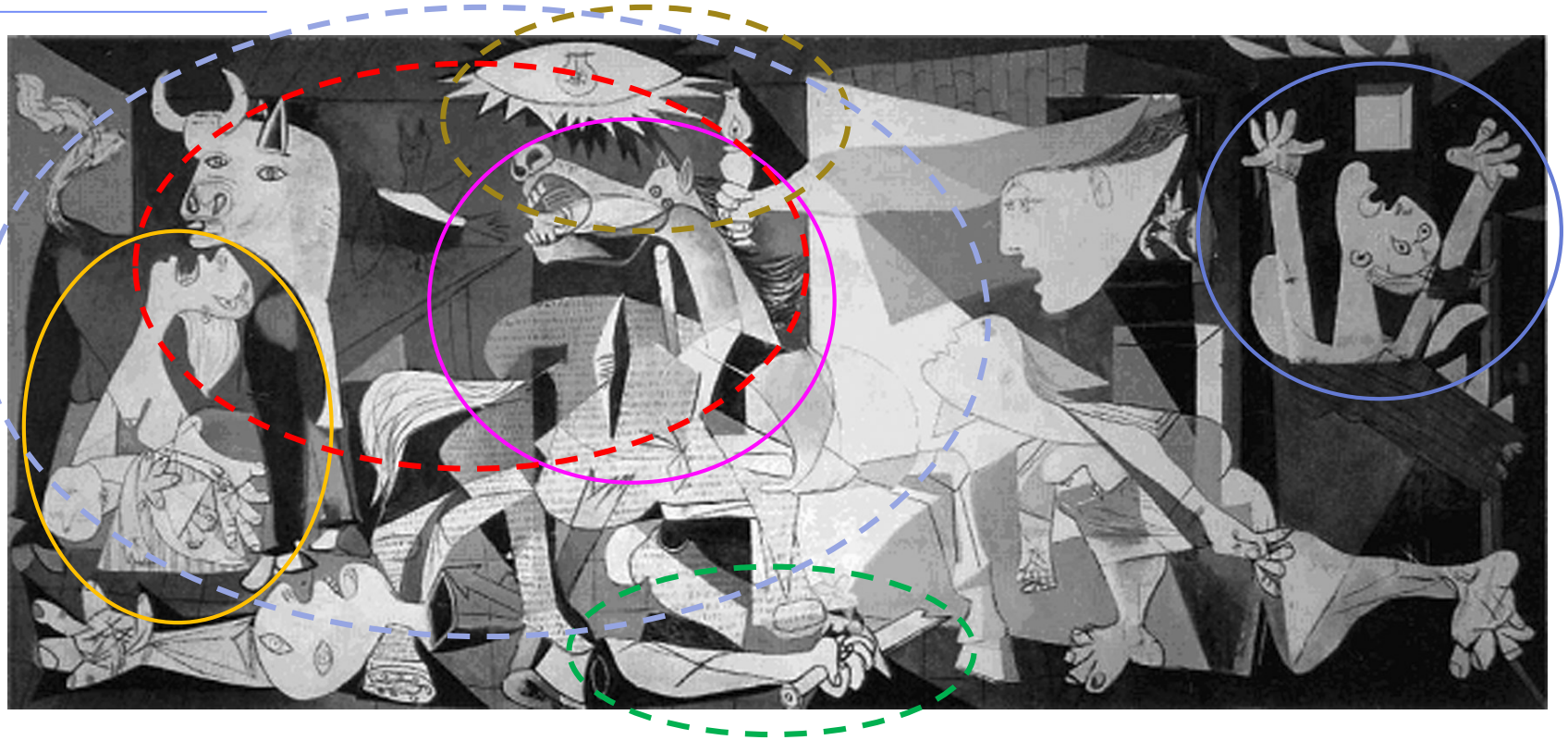
Visual cues – The human headway

- Overlapping objects
- Quantized scenes
- Perspective geometry
- Depth from shading
- Multi-presence
- Depth from texture
- Height in the field of view

Lo sposalizio della Vergine Raffaello Sanzio – Pinacoteca di Brera

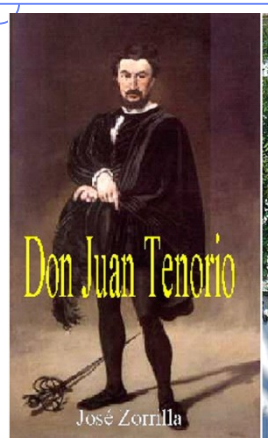


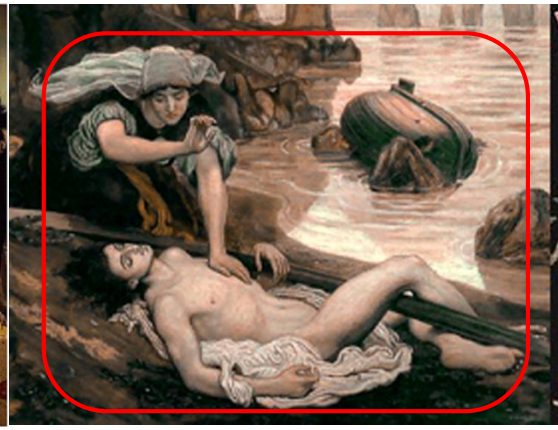
The role of context

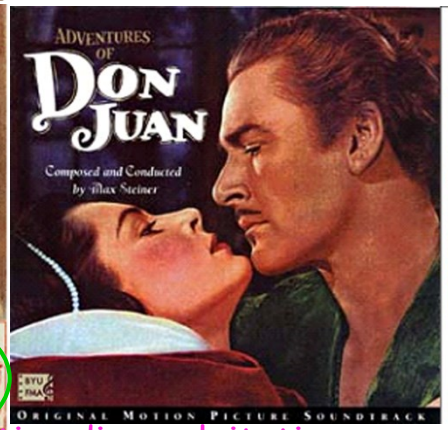


- Direct Retrieval
  - Metadata
  - Explicit cues
- Recognition-Based Retrieval
  - Literature motif
  - Image motif
  - Extended motif
- Search-Based Retrieval
  - Form contrast
  - Justaposed components
  - Paradox and surprisal
  - General set up

Filling the channels







- Icons and Metaphores
- Content structure
- Role rendering
- Social interaction

- Multimedia exploitation:

Don Juan has inspired many art pieces ranging from paintings (Auguste Leroux) and books (Lydia Flem), up to movies (Federico Fellini, Joseph Losey, Carlos Saura, etc.), even music (Richard Strauss), theater plays (Molière) and operas (Wolfang Amadeus Mozart) and many intellectuals (Ernst Hoffmann, Alexander Pushkin, Søren Kierkegaard, George Bernard Shaw, Albert Camus, etc.)

Pavia, 22 ottobre 2019

VISIONE INDUSTRIALE

In collaborazione con:

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Con il patrocinio di:

Facoltà di Ingegneria Università degli Studi di Pavia

ANIE AUTOMAZIONE · IMVG · AIS · ISA Italy Section · AAM

PRIMO INCONTRO SULLA VISIONE INDUSTRIALE: la figura professionale dell'ingegnere

Dove: Università di Pavia - Polo Scientifico Cravino - Facoltà di Ingegneria - Aula 4 - Via Ferrata 5 Pavia
Quando: 12 Marzo 2018 - dalle ore 14:00 alle ore 18:00

PROGRAMMA

14:00 Registrazione dei partecipanti

14:15 Saluto di benvenuto:
- Prof. Paolo Arcioni Direttore del Dipartimento di Ingegneria Industriale e dell'Informazione
- Prof. Lalo Magni Presidente della Facoltà di Ingegneria dell'Università di Pavia

14:25 Introduzione all'incontro:
- Prof. Virginio Cantoni Direttore del Computer Vision & Multimedia Lab (CVML) Dipartimento di Ingegneria Industriale e dell'Informazione Università degli Studi di Pavia
- Ing. Carlo Marchisio- Coordinatore progetto Visione Industriale
- Dott. Marco Vecchio - ANIE Automazione

14:30 Presentazioni a cura delle Aziende: Antares Vision; Baumer; Net Italia; Sea Vision

17:00 Discussione e chiusura dei lavori

AGGIORNAMENTI E INFORMAZIONI

https://www.visioneindustria.it/
https://www.facebook.com/visioneindustria/?fref=ts
+39.02.95784238
Carlo Marchisio
email: automation@carlomarchisio.it
cell: 3382025949

La tecnologia della visione industriale ha vissuto in anni recenti una fase di crescita ed evoluzione, occupando un ruolo sempre più rilevante nell'industria sia in ambito produttivo che dei servizi. Anche in Italia si assiste all'introduzione di queste tecnologie in aree applicative sempre più ampie; al tempo stesso i sistemi di visione richiedono alle aziende un impegno economico minore rispetto al passato. La produzione a zero difetti, la riduzione delle dimensioni dei componenti e il ricorso a metodologie produttive sempre più automatizzate e flessibili rappresentano una prospettiva molto favorevole per l'ulteriore diffusione dei sistemi di visione nella realtà industriale italiana. Nel frattempo emergono nuovi approcci, nuove metodologie e soluzioni tecnologiche innovative e si aprono notevoli spazi di miglioramento delle prestazioni mentre nuove applicazioni diventano possibili.

L'ipertesto Visione Industria è dedicato ai sistemi di visione industriali.
Intende ricostruirne la storia, offrire materiale di documentazione, proporre supporti per la formazione, segnalare e mettere in collegamento i principali attori in campo industriale, nella ricerca e nei diversi enti e organizzazioni.
Si rivolge a tutti coloro che si occupano, a vari livelli, di organizzazione, di gestione e di analisi dei processi produttivi, ai costruttori di macchine e impianti, ai responsabili della qualità, della logistica e della manutenzione ma anche a ricercatori, studenti, operatori della comunicazione.
Il progetto, avviato col sostegno di aziende di primo piano del settore e col supporto di un qualificato Comitato Scientifico, verrà via via integrato e periodicamente aggiornato seguendo gli sviluppi tecnologici e di mercato del settore nei prossimi anni.

Un'opportunità per gli ingegneri di domani.
Come attività integrante di questo progetto, su indicazione di alcune aziende che operano nel settore della visione industriale, sono stati attivati incontri con le Università Italiane per mettere in contatto i fornitori di tecnologie con i futuri ingegneri, per segnalare occasioni di lavoro, con una tecnologia che avrà sempre di più impiego nella produzione industriale.
Per favorire una partecipazione attiva, dopo le presentazioni delle aziende intervenute, l'incontro prevede ampio spazio per un dibattito con gli studenti.

L'iscrizione all'evento è gratuita e sono invitati gli studenti, giornalisti e le aziende che producono e commercializzano sistemi di visione industriale.

Ordina il tuo biglietto al seguente link:
https://www.eventbrite.com/e/primo-incontro-sulla-visione-industriale-tickets-42781482566

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VISIONE INDUSTRIALE

INIZIATIVA *VISIONE INDUSTRIA*
CULTURA E FORMAZIONE

VISIONE INDUSTRIALE

Milano 6 settembre 2019. L'iniziativa *Visione Industria*, giunto al suo secondo anno è dedicata ai **sistemi di visione industriali**: intende ricostruirne la storia, offrire materiale di documentazione, proporre supporti per la formazione, segnalare e mettere in collegamento i principali attori in campo industriale, nella ricerca e nei diversi enti e organizzazioni. Si rivolge a tutti coloro che si occupano, a vari livelli, di organizzazione, di gestione e di analisi dei processi produttivi, ai costruttori di macchine e impianti, ai responsabili della qualità, della logistica e della manutenzione ma anche a ricercatori, studenti, operatori della comunicazione.
L'iniziativa, avviata col sostegno di aziende di primo piano del settore e col supporto di un qualificato **Comitato Scientifico**, ha visto la messa in rete di un **website** (https://www.visioneindustria.it/) periodicamente aggiornato seguendo gli sviluppi tecnologici e di mercato, ed è proseguita con una serie di **incontri nelle Università** italiane. Sono già stati attivati **sette** incontri nelle Università di Pavia, Parma, Brescia, Modena, Ancona, Bologna e Bari, con presenza media di 60/80 studenti, con l'obiettivo di diffondere la tecnologia della visione industriale mettendo in contatto Università ed industria.
L'attività si svolge col patrocinio di Anie Automazione, AIS, ISA Italy Section, Italian Machine Vision Group, Associazione Italiana di Automazione Meccatronica.
I prossimi incontri:

- **martedì 22 ottobre 2019 ore 14-18 Università di Pavia**

saranno presenti gli studenti del corso di Computer Vision , frequentato da informatici e scelto anche da studenti di matematica e di altre specializzazioni dell'ingegneria;

- **martedì 12novembre 2019 ore 14-18 presso Università La Sapienza Roma**

i temi della visione industriale sono di interesse per gli studenti delle due lauree magistrali in Artificial Intelligence & Robotics e Control Engineering.
Il programma degli incontri prevede:

- relazione di aziende fornitrici di soluzioni/sistemi per la visione industriale;
- dibattito aperto con gli studenti;
- possibilità di incontri degli studenti con i docenti e le aziende relatrici.

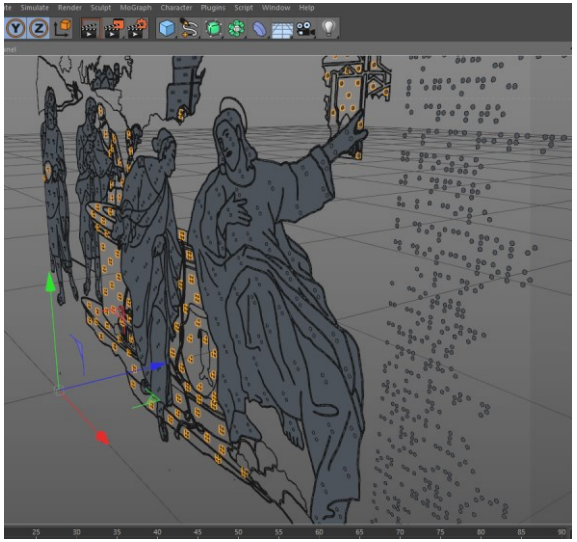
Per informazioni e aggiornamenti:
Carlo Marchisio
email: automation@carlomarchisio.it
cell: 338 2025949
https://www.facebook.com/visioneindustria/?fref=ts

Prof. Emanuel Aldea Univ. Paris Saclay

Corso di 12 ore: ottobre 28-30 e Novembre 25-27,
nelle ore di lezione e il mercoledì 30/10 e 27/11 dalle 9 alle 11

- Ego-motion estimation in robotic vision
  - Quick reminder on the projection matrix
  - Interest points
  - Matching and the fundamental matrix
  - Ego-motion by F decomposition
  - Matching and the homography matrix
  - Ego-motion by H decomposition
- Intro to non-linear optimization for computer vision
  - Levenberg-Marquardt and levmar library
  - Non linear optimization for F
  - Non linear optimization for 3D triangulation
- Optimization techniques for multiple view stereo
  - Introducing the problem
  - Bundle adjustment and efficient solvers
  - Application 1: 3D sparse reconstruction
  - Application 2: real time robotic navigation

And the near future?



Tactile images

Original version and re-elaboration for tactile version of the tapestry depicting the advance of the Imperial army and the attack of the French gendarmerie led by Francis I. All levels are shown (white h=0: bottom and inner contours in full figures; red h=1: external contours of all, black h=1: internal boundaries and Braille in hollow figures, and full figures; green h=2: Braille in full figures).

Legend: Francis I F (horse F); Guillaume Gouffier G; Antoine des Prez N; René de Mont-Jehan W; Galeazzo Sanseverino O; Charles III of Borbone C; Imperial cavalry B and B; Imperial Infantry E and E

Tactile images: The samaritan woman at the Jacob's well

Tactile images: detail

Pinacoteca of Brera: Christ and the Samaritan Woman