Computer Vision and Multimedia Lab

Department of Electrical, Computer and Biomedical Engineering
University of Pavia

It has been active since the early 70s. The group's initial research activities concentrated on **image enhancement and restoration techniques**; since the early 80s a new stream of research has been actively followed in the field of **parallel architectures for vision and image processing,** and then skills in *high-level image processing domains*, such as scene segmentation and shape characterization and the management of knowledge description and learning capabilities for vision tasks, has been developed.

Recently new research areas have been activated on:

- **Eye Tracking**
- **Digital Humanities**
- **Deep Learning**
- **Proteomics**
- **Social Media Analysis and Mobile Mapping**

ADDRESS

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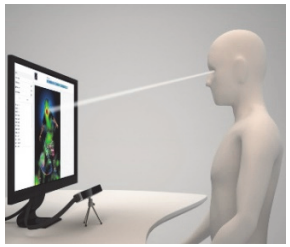
- *Researcher* – Mauro Mosconi
- *Technician* – Alessandra Setti
- *Contract professors* – Roberto Marmo, Marco Piastra
- *Post-doc researchers* – Piercarlo Dondi, Mirto Musci
- *PhD students* – Gianluca Gerard, Iman Abu Hashish

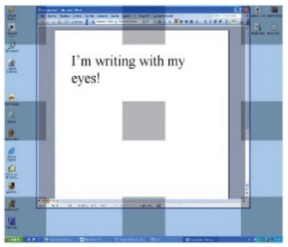
Eye Tracking

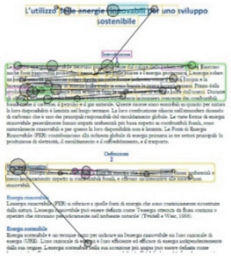
Explicit and Implicit Gaze-Based Communication

Info: marco.porta@unipv.it

An **eye tracker** is a device for measuring eye positions and eye movement





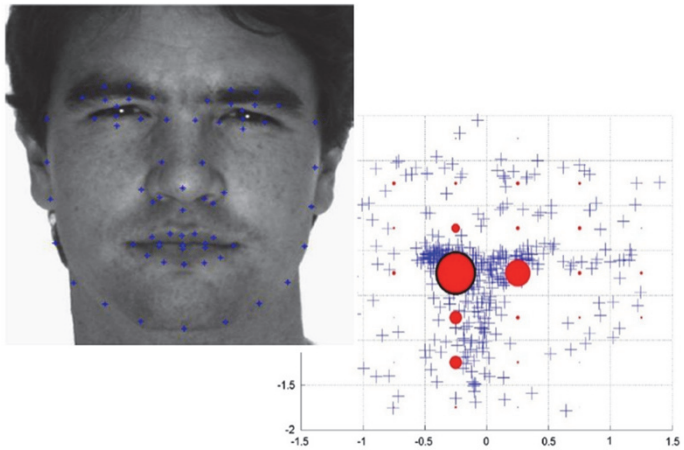


Gaze Input

Using eye tracking as an assistive technology or as an additional input channel (besides keyboard, mouse, etc.)

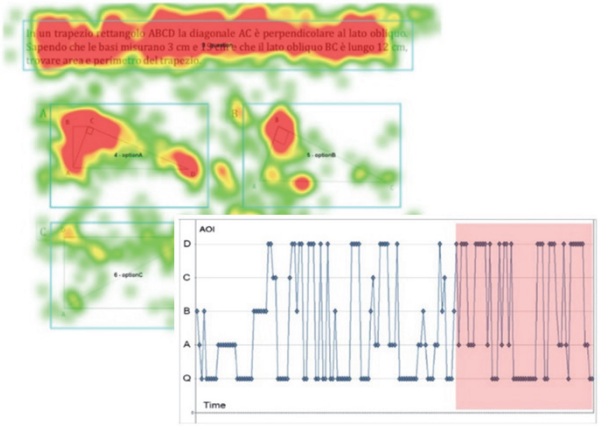
Soft Biometrics

Identifying or verifying the identity of people from the way they look at specific stimuli (e.g., faces)



E-Learning

Understanding learners' behavior and detecting possible comprehension problems



Automotive

Studying the driver's performance through cheap eye tracking solutions

Eye Tracking

Assistive and Persuasive Technologies

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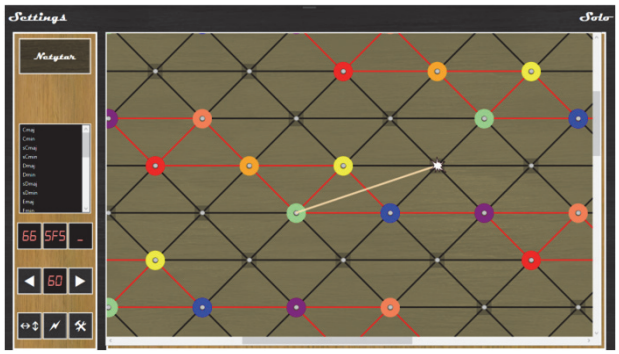
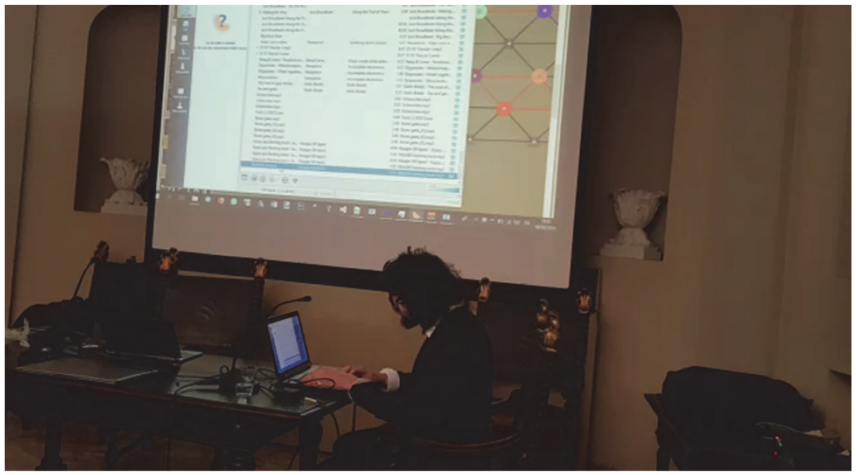
Assistive Technologies

Graphical Interfaces for
Eye-Controlled Musical Instruments





Persuasive Technologies

are designed to change attitudes or behaviors of the users through persuasion(*)

E.g., an electronic book to encourage children to read: with the eye-tracking it detects if the user has read a part of text and rewards him/her with special effects, at the right time

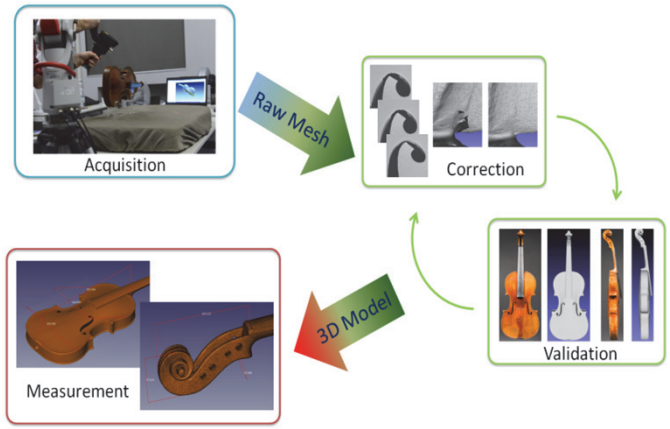
(*) three «basic ways that people view or respond to computing technologies (B.J. Fogg): - 1. increase people's ability to perform a target behavior by making it easier (*tools*) - 2. create persuasive experiences that support rehearsing a behavior, empathizing, or exploring causal relationships (*media*) - 3. apply ... social influence (*social actors*)»

Digital Humanities

Image processing and 3D models of historical instruments

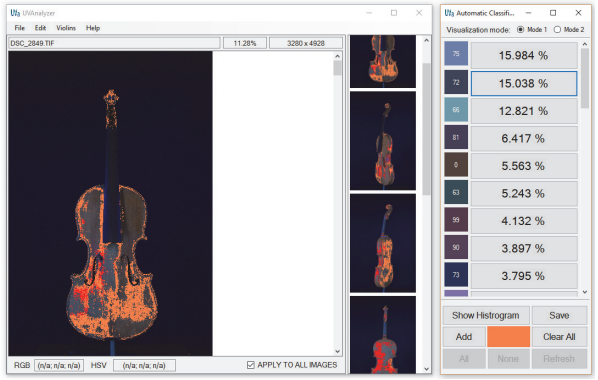
Info: piercarlo.dondi@unipv.it, luca.lombardi@unipv.it

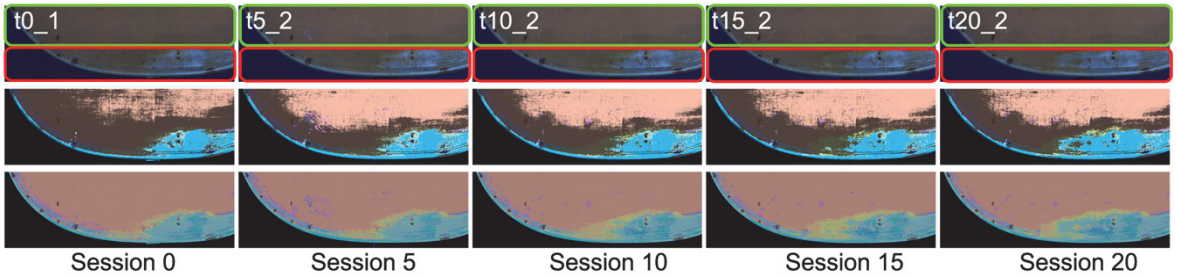
3D scan and 3D modeling



Augmented Reality and Interactive Applications for museums

Analysis of visible and UV induced fluorescence UV (UVIF) images





Digital Humanities

3D for dissemination, promotion, and accessibility of artistic heritage

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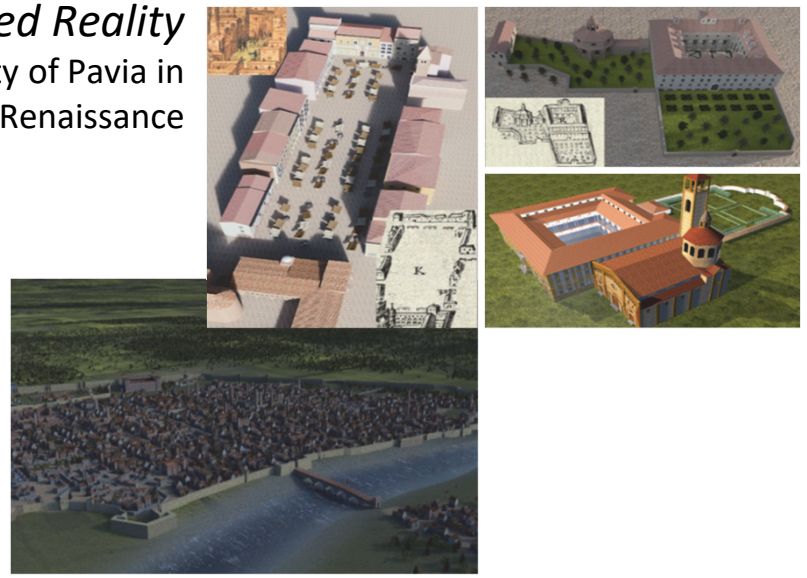
Tactile Images
for art accessibility

3D Modeling
E.g., a Certosa portal bas-relief

Augmented Reality
E.g., the city of Pavia in the Renaissance



Frescoes Reconstruction
for artistic heritage restoration

Deep Learning

Deep Reinforcement Learning for Collaborative Robotics

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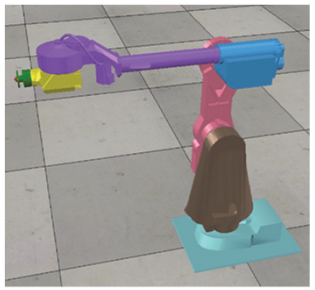
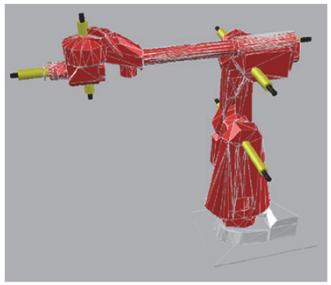
Virtualization of a real-world robot

COMAU

3D mesh

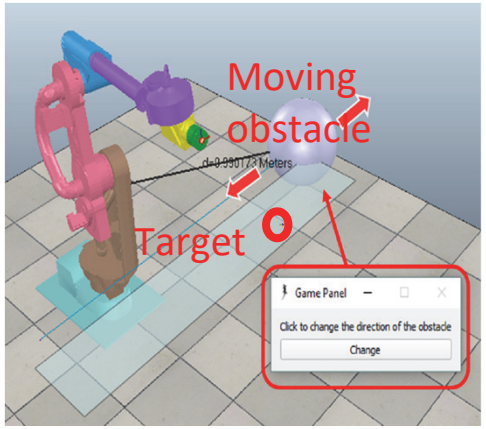


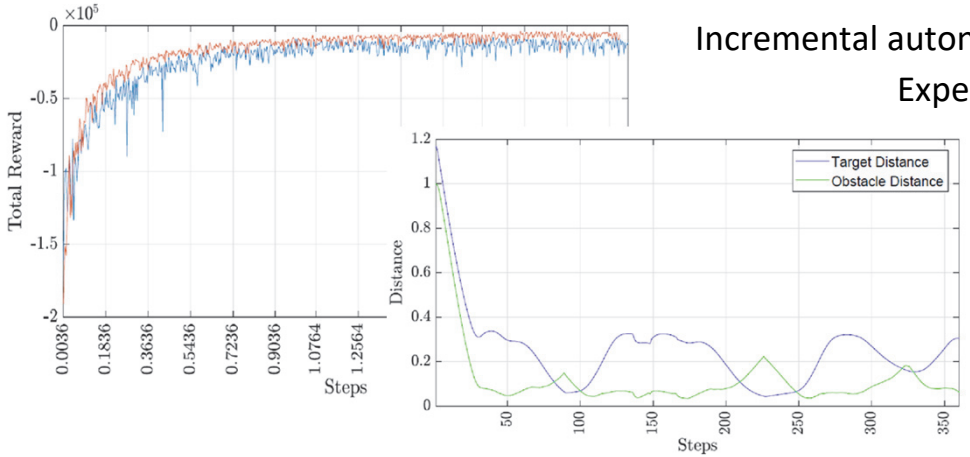
Movable parts



Joints and direct kinematic chain

Learning to reach a target while avoiding obstacles in a simulation environment





Incremental autonomous learning

Experience transfer

Robust avoidance strategy

Deep Learning

Fall detection with recurrent neural networks

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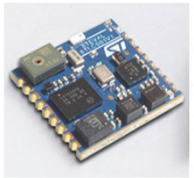
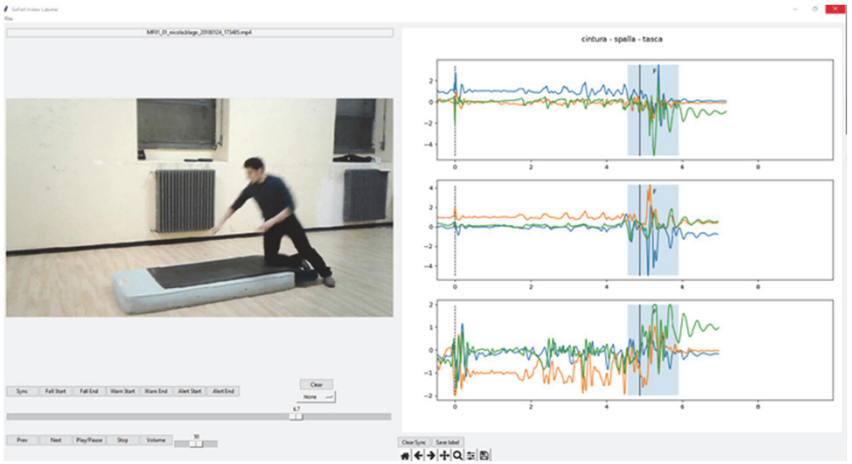
Accidental falls: an enormous human cost, especially for elderly people. Need for automatic fall detection techniques for timely warnings. Use of “smart” wearable devices.

Innovative technique: deep learning on embedded. Implementation challenge: limited computing and memory resources; battery life for continuous use 24x7.



Collection of datasets with simulated falls by volunteers.
Seven carry positions, 17 different activities, 40 volunteers, over 5000 tracks. Manual annotations on videos, basic for training.



Deep Learning

For the diagnosis of breast cancer metastases in lymph nodes

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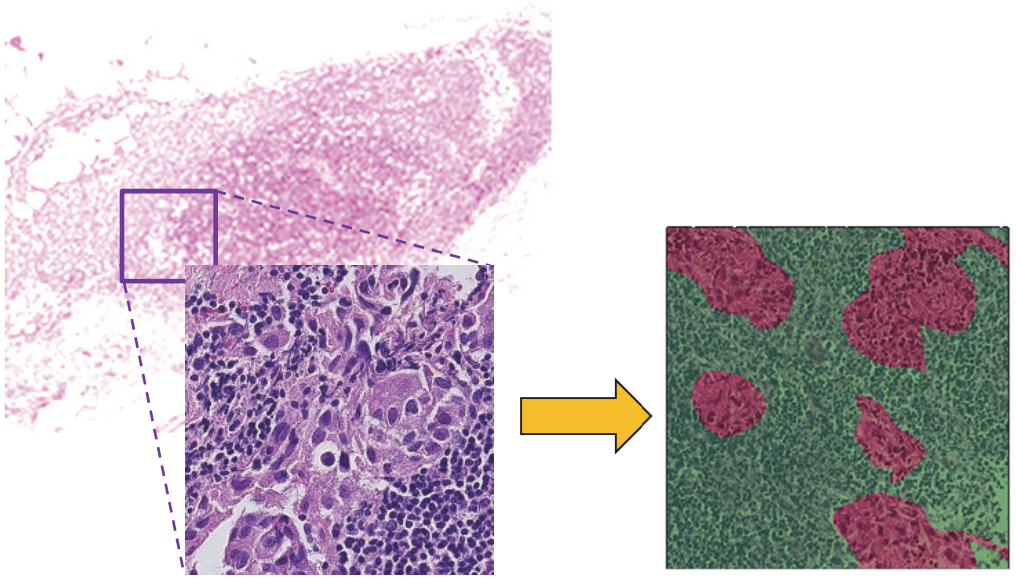
Breast cancer is the most common form of cancer among Italian women

- Diagnosis is usually made through a visual analysis of slides containing sentinel lymph node biopsy

The laboratory is currently carrying out a research project that uses the most modern **Deep Learning** techniques for the automatic screening of digital slides

Automatic segmentation of injuries



Proteomics

Geometrical motif extraction in the secondary structure of proteins

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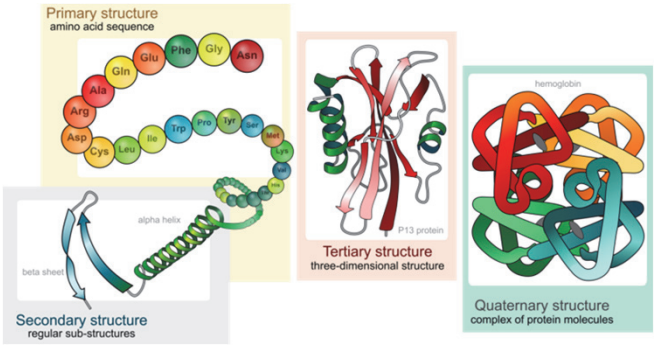
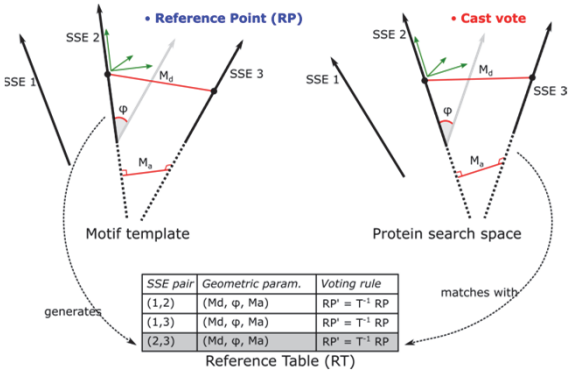
Protein structure defines its biological behavior.
We work at second level to identify recurrent motifs.

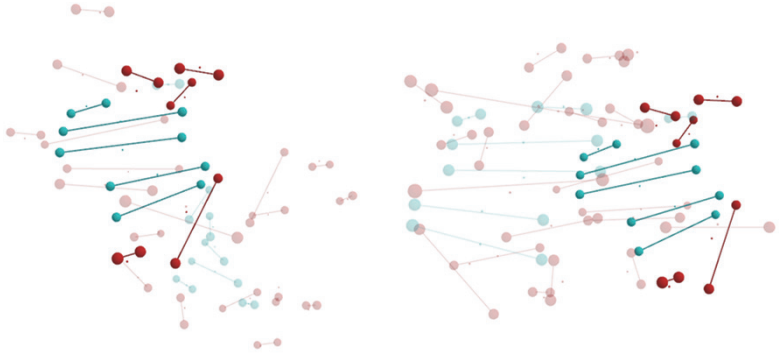


Using Hough Transform we developed the Cross Motif Search algorithm with MP and MPI for parallelism.

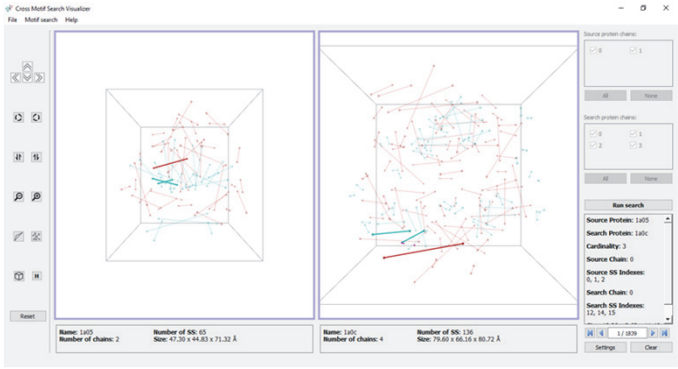


SSE pair	Geometric param.	Voting rule
(1,2)	(Md, φ, Ma)	RP' = T⁻¹ RP
(1,3)	(Md, φ, Ma)	RP' = T⁻¹ RP
(2,3)	(Md, φ, Ma)	RP' = T⁻¹ RP

We view proteins as a cloud of segments, we expect *big data*. Goal: discover new motifs with an innovative geometrical method.



Motif Visualizer: Open Source OpenGL GUI to improve usability collaboration and validation with biologists.



Social Media Analysis and Mobile Mapping

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- Network analysis
- Visual recognition of objects
- Analysis and in-depth analysis
- Social commerce
- Customer segmentation
- Malware detection
- Social Media Mining
- Sentiment analysis, opinion mining

High-precision 3D mobile measuring system mounted on vehicle:

- Recognition of road and railway signs
- Tunnel inspection
- Intelligent vehicle
- Laser scanner
- Georeferenced images