An Introduction to the Machine Perception Laboratory.

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1. MPLab Personnel (April 2005):

- Principle Investigators
  - Javier R. Movellan.
  - Marian Stewart Bartlett.
  - Gwen Littlewort.
  - Peter Rowat
- Postdoctoral Researchers:
  - Claudia Lainscsek.
  - Dirk Beer.
- Graduate Students:
  - Tim Marks.
  - Ian Fasel.
  - Jonathan Nelson.
- Research Associates:
  - Kazuki Aisaka
  - Fumihide Tanaka
- Staff Researchers:
  - Katherine Kern.
  - Bret Fortenberry.
  - Jake Whitehill.
- Staff System Administrator:
  - Luis Palacios.
- Undergraduate Research Assistants:
  - Micah Rye.
  - Paul Miller.
  - Katie Krage.
  - Jelisa Thomas.
  - Lisa Okuda.

2. Goals of the MPLab

We focus on systems that perceive and interact with humans in real time using natural communication channels (e.g., visual, auditory, and tactile information). We are integrating these primitives into a new generation of personal robots designed to interact and communicate with humans in everyday life.

We rely on state of the art machine perception and machine learning techniques and large datasets of human behavior to train automatic systems. While doing so we try to infuse knowledge from computational neuroscience about how the brain solves perceptual problems.

3. Projects

Examples of our ongoing projects include:

- Full automation of the Facial Action Coding System
- Real time face detection and tracking
- Social robots for classroom environments
- Affective computing in automatic teaching agents;
- Automatic analysis of facial behavior for detection of deceit;
- Recognition of facial expressions for clinical diagnosis and monitoring;
- Development of machine learning algorithms for unsupervised discovery of object categories;
- Audiovisual speech recognition;

- Multimodal detection of humans.

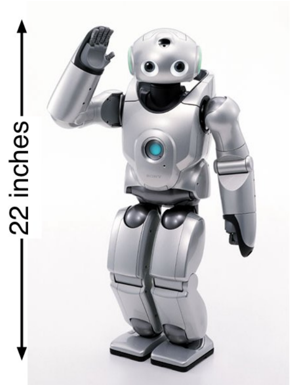
We have received funding from the NSF, NIH, DARPA, UC/DIMI, UC Discovery, Microsoft Research, SONY and Homeland Security.

Following pages display images from some current representative projects.

3.1. RUBI Project

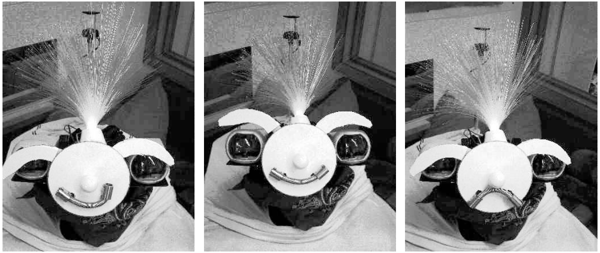
Funding: UC Discovery/ Sony

The goal of this project is to accelerate progress on social robotics by addressing the problem at multiple levels, including the development of new scientific methods, formal approaches, and scientific agenda. Two prototype robots, one developed by Sony and one by our laboratory are being tested on a daily basis (1 hour a day) at UCSD's Early Childhood Education Center. This is part of a 4 year long collaboration with Sony under the umbrella of the UC Discovery Program.



Left: QRIO, a prototype humanoid developed by Sony. Right: RUBI, a prototype humanoid developed at our laboratory.

RUBI is teaching children age specific material targeted by the California Department of Education.



RUBI's facial expressions are controlled by 2 mouth servos, and 2 eyebrow servos. In addition she has fiber-optic hair which can take different colors to express emotion.

3.2. Automatic Recognition of Facial Expressions

Current Funding: Homeland Security / NRL
Previous Funding: ONR & NSF

The goal of this project is to develop automatic recognition of facial expressions and facial expression dynamics. This is done within the framework of Paul Ekman's Facial Action Coding System. This system describes facial behavior in terms of 46 muscle movements components (AUs), for a total of 2^{46} possible expressions. There is experimental evidence that this framework provides important information for the detection of deceit.

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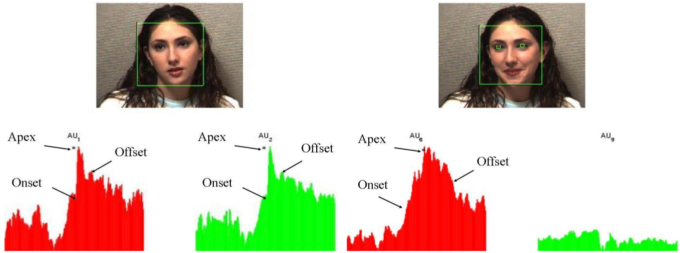


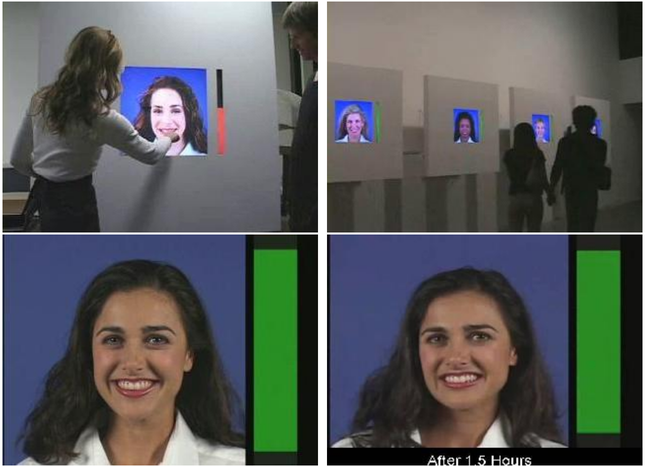
Left: Sample system outputs for a 10-second segment containing a brow raise (FACS Code 1+2). System outputs for AU 1(left) and AU 2 (right) are shown. Human codes are overlaid for comparison (onset, apex, and offset). Right. Sample system outputs for a sequence containing orbicularis oculi contraction (AU 6). System outputs are shown for AU 6 (left) and AU 9 (right). This sequence did not contain AU 9.

Automatic Tracking of Rigid Head Motion and Facial Expression Using Conditionally Gaussian Particle Filters

3.3. Connecting Art and Technology

Our Expression Recognizer was part of an interactive art project in Pasadena, California (see next page)

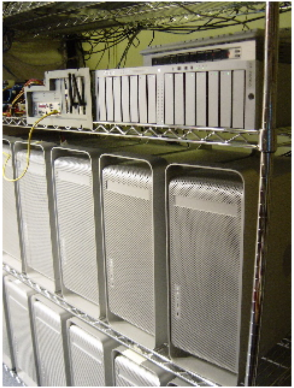
On camera, six actresses try to hold a smile for as long as they could, up to one and half hours. Each ongoing smile is scrutinized by a emotion recognition system and whenever the display of happiness fell below a certain threshold, an alarm alerted them to show more sincerity. The piece creates a concert of alert signals within an ambience of forced friendliness and irritating melancholy telling that the performance of sincerity is hard work.



Our emotion recognition system was displayed at the Pasadena Art Center.

3.4. Self-Supervised Discovery of Object Categories

Current face recognition technology requires humans to label large databases of images. In this project we are testing new self-supervised learning methods for robots to actively explore the environment and learn the object categories that are important to operate in everyday life environments.



While interacting with children RUBI sends images to a computer cluster at our laboratory. The cluster works full time finding relevant object categories in RUBI's environment.