Human-Robot Interaction

15-494 Cognitive Robotics
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Human-Robot Interaction Topics

- Awareness of humans

  - Person tracking

  - Face detection; gaze tracking

  - Face recognition

  - Human's "perspective" considerations

- Gesture recognition

  - pointing

  - hand motions

- Social interaction

  - Gaze as indicator of attention

  - Facial expressions (e.g., Kismet)

  - Sound effects (R2D2, AIBO) vs. speech
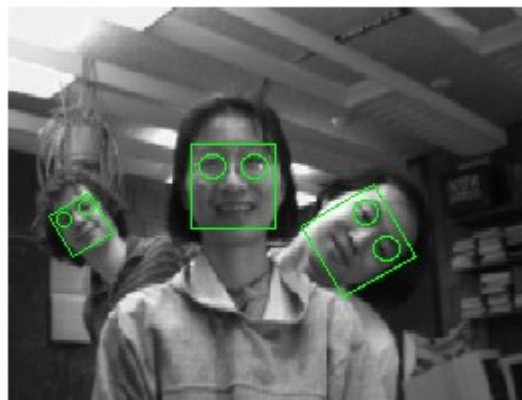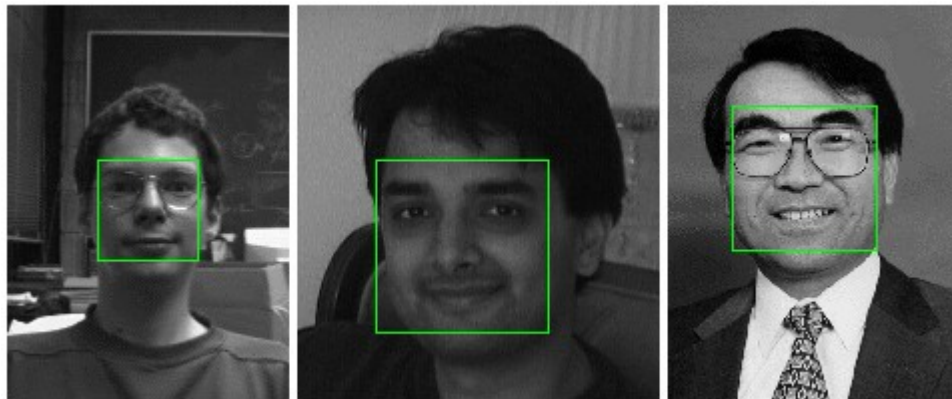
  - Use of displays (Looking Glass project)

Awareness 1: Person Tracking

- Be aware of human presence

  – Follow a human (robot assistant)

  – Avoid the humans

  – Interact with humans (museum tour guide robots)

- Use skin color; look for legs (rangefinder); etc.
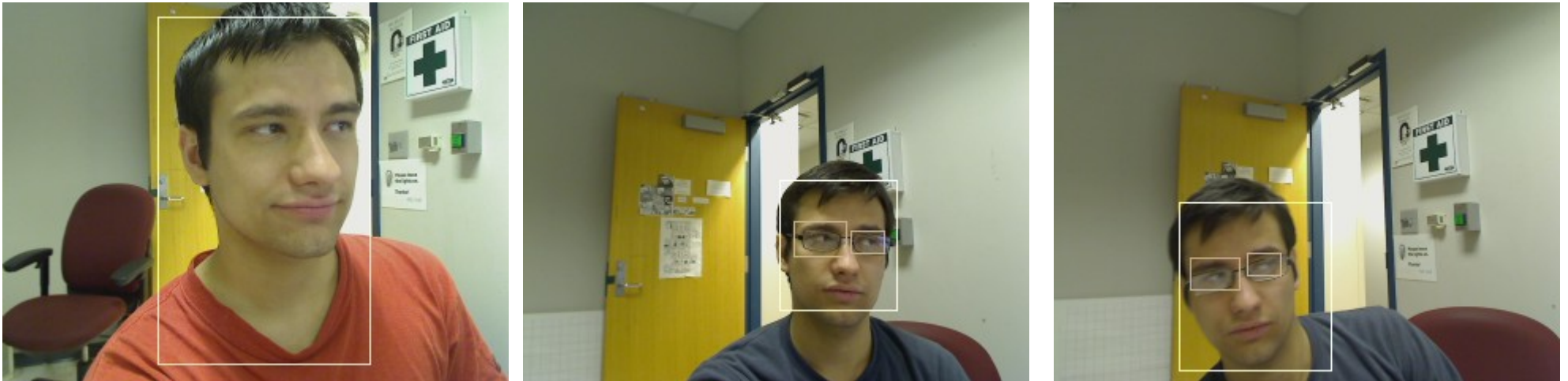
Awareness 2: Face Detection

- Rowley, Baluja, and Kanade (1998) used a neural net:

(movie)

OpenCV Face Detector

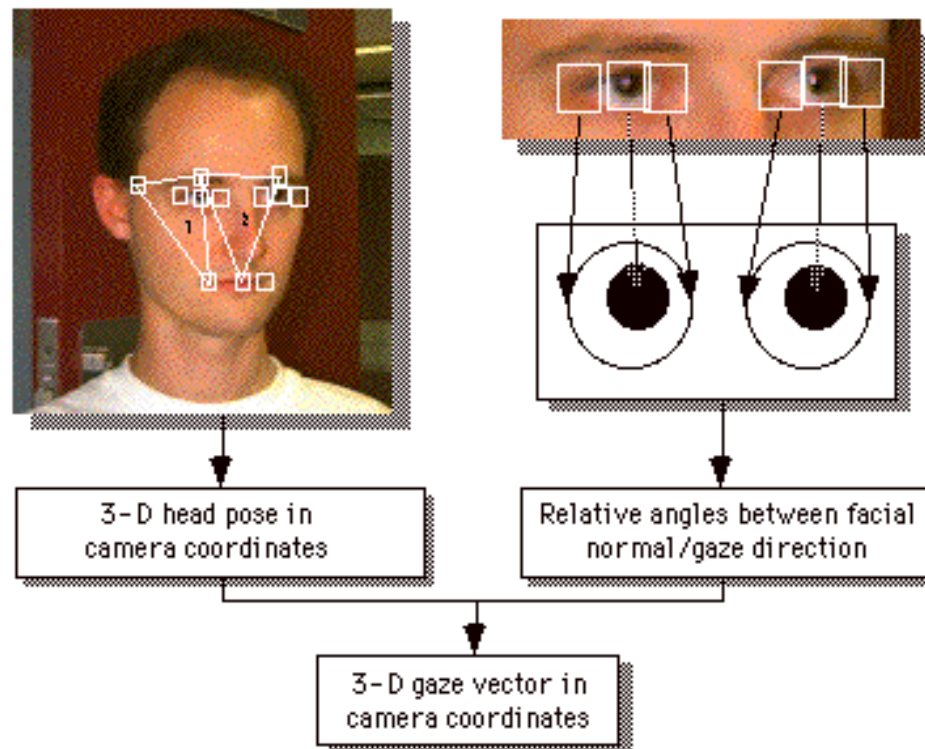- Ilya Matiach ported the OpenCV face detector to Tekkotsu in 2009 to run on the Chiara.

- For more information:

 http://opencv.willowgarage.com/wiki/FaceDetection

Awareness 3: Gaze Tracking

- What is the human looking at?

- Gaze has high social significance among primates.

- For robots, hard to measure gaze at a distance.

3-D head pose in camera coordinates

Relative angles between facial normal/gaze direction

3-D gaze vector in camera coordinates

Awareness 4: Face Recognition

- Which human is this?

- Lots of work in this area now for security applications.

- Sony's AIBO, QRIO robots had face recognition modules.

- Digital cameras now do face recognition, smile detection.
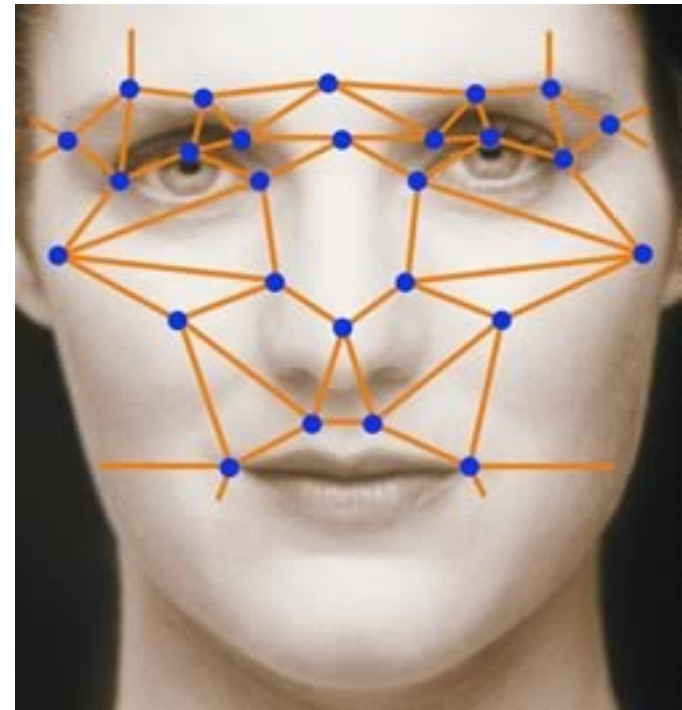
Awareness 5:
The Human's Perspective

- What can the human see from his present location?

- Trafton et al.: "Give me the wrench."

- Robot sees two wrenches, but knows that the human can only see one.
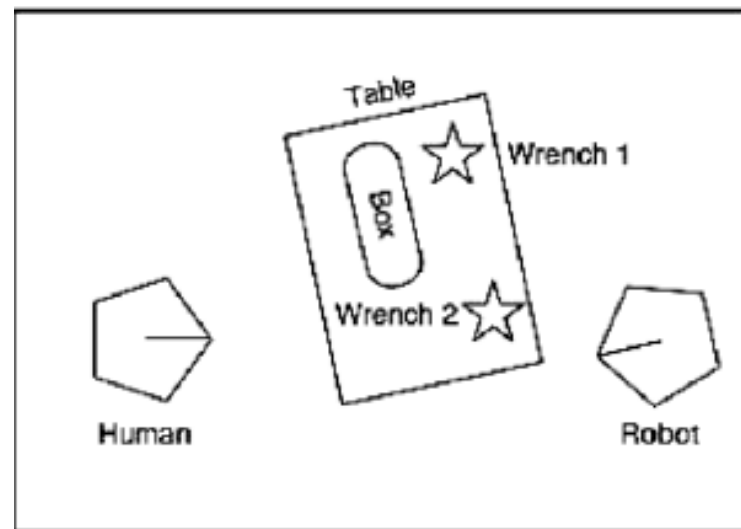
Gesture Recognition

- Pointing
  - Point at objects to designate them to the robot
  - Point in a direction, or towards a goal location

- Hand gestures
  - "Come here" / "Come closer" / "Back off"
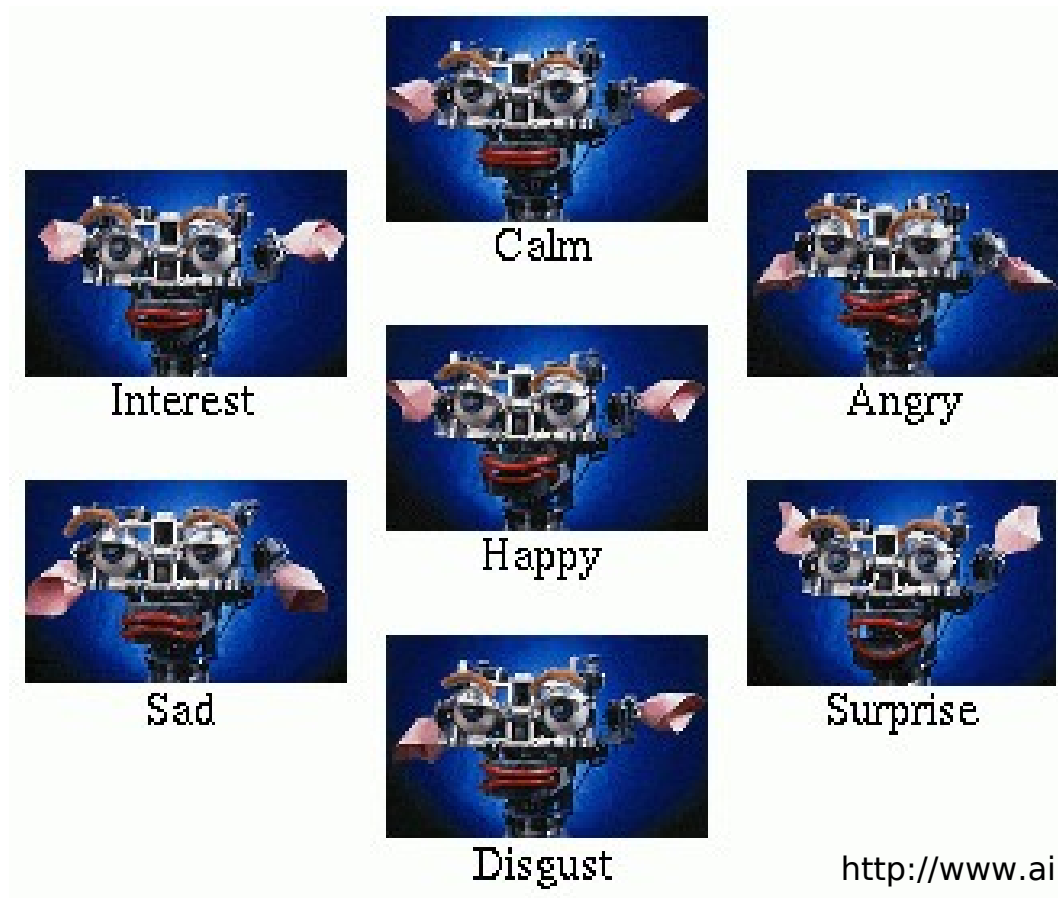 - "Stop"
  - "Put that there"
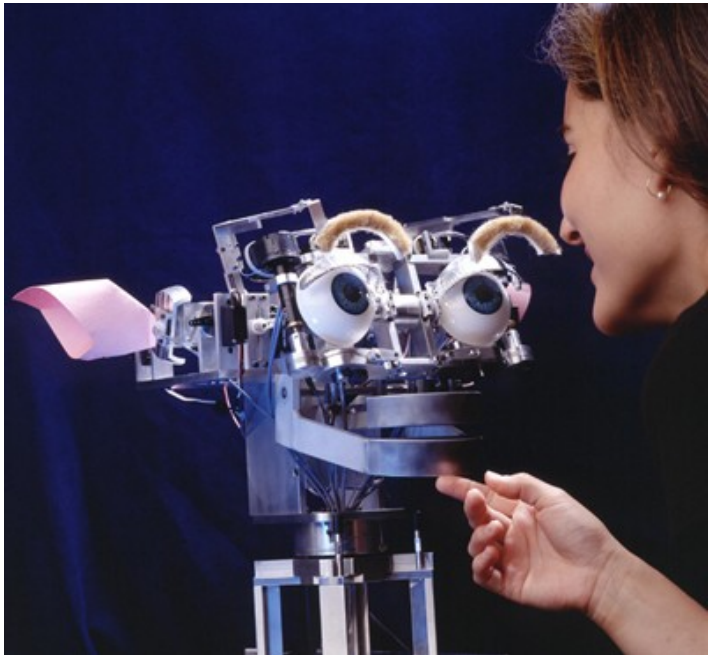
Social Interaction

- Do robots need heads?

- What are heads used for?

  - Indicate focus of attention by gaze direction

DARPA Little Dog

  - Gestures such as nodding agreement

  - Anthropomorphism makes robots more acceptable to humans
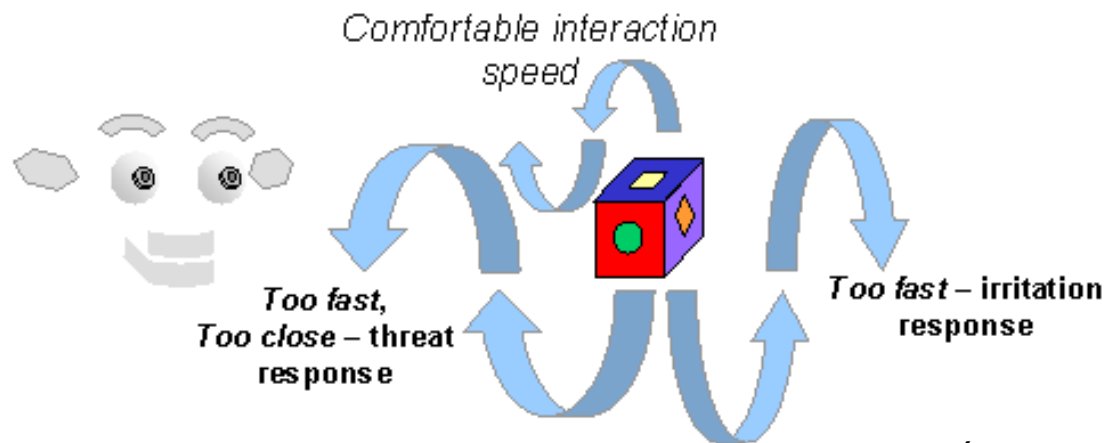
- Headless robots are creepy.

Facial Expressions: Kismet

- Cynthia Breazeal, ca. 1999-2000

Interest

Sad

Calm

Happy

Disgust

Angry

Surprise

http://www.ai.mit.edu/projects/sociable/facial-expression.html

Kismet Social Interactions

Person backs off | Person draws closer

Too close – withdrawal response | Comfortable interaction distance | Too far – calling behavior | Beyond sensor range

Comfortable interaction speed

Too fast, Too close – threat response | Too fast – irritation response
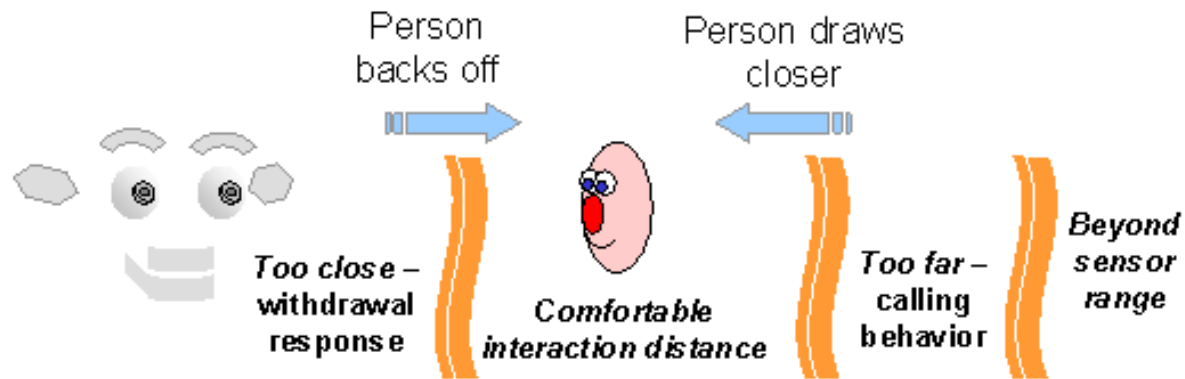
(see movies)

Communicating with Humans

- Should robots talk?

  - R2D2 used sound effects to convey emotion

  - AIBO and Kismet do likewise

- Use of canned messages:

  - "Excuse me, you're blocking my path."

  - Roboceptionist: "How may I help you?"

- Will people expect to be able to talk back?

  - Voice recognition gets harder when the robot is noisy.

- Use of lights to communicate status, mood.

Speech in Tekotsu

#include "Sound/SoundManager.h"

sndman->speak("Please charge my battery.");

SpeechNode($,"Take me to your leader!")

Tekkotsu uses the Mary text-to-speech system:

http://mary.dfki.de

Project idea: enhance the Mary interface to permit control of volume and tempo, use of audio filters for sound effects, etc. (These functions are already built in to Mary, we just need a way to access them.)

Communication via a Detached Display

- AIBO's Magic Looking Glass (Kirtane & Libby, 2005)

- Question: how can you use a robot-controlled flat-panel display to mediate human-robot interactions?

Looking Glass Applications

- Display instructions for a game.

- Keep score.

- Display a landmark the robot can use for navigation.

- Display robot's view of the world.

- Serve as a backdrop for a dramatic presentation:

  - Display background scenery

  - Display objects the robot is talking about

  - Display another agent the robot can interact with

Display as Input Device

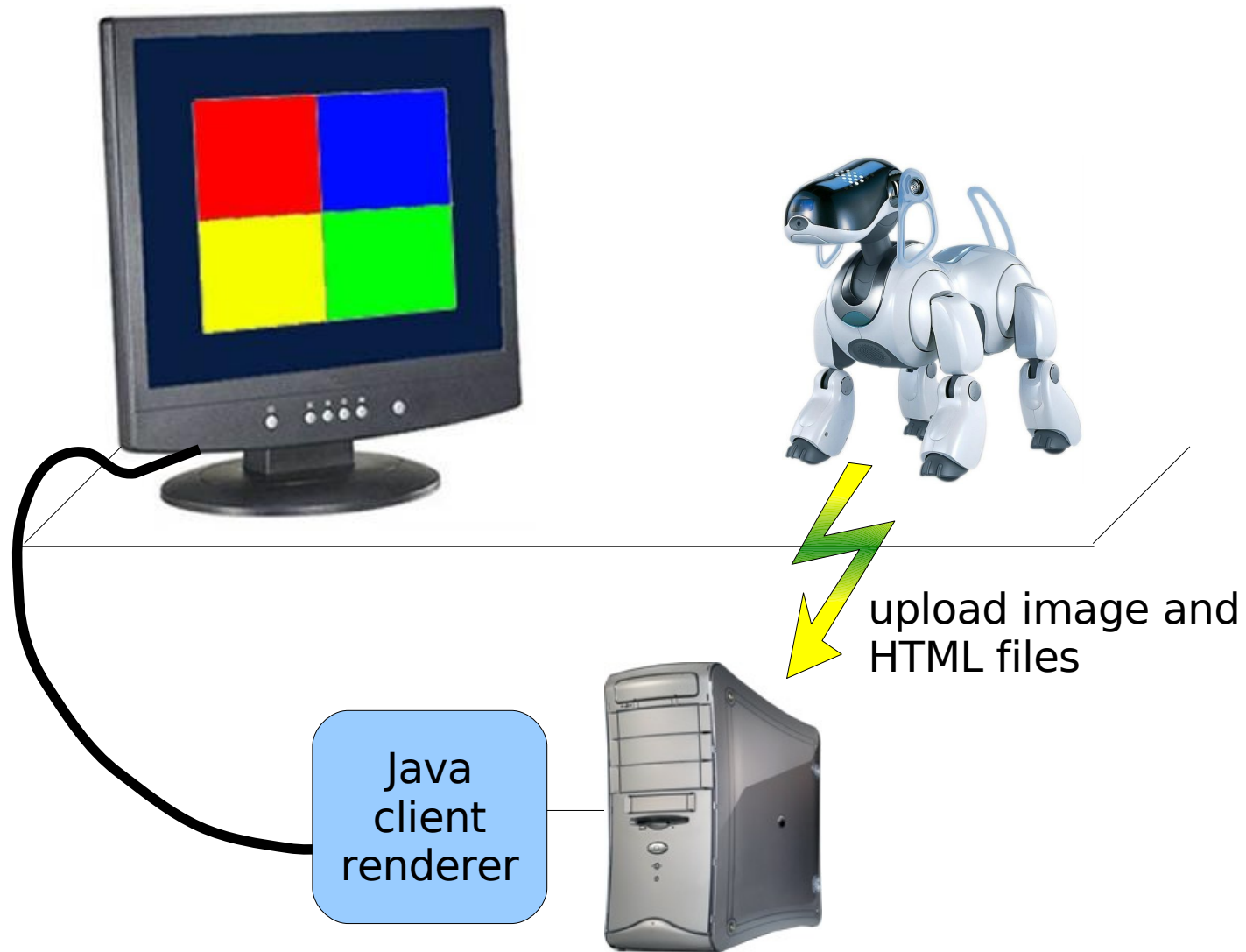- User points at display to indicate their choice.

La Traviata

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Virtual Violetta

(movie)

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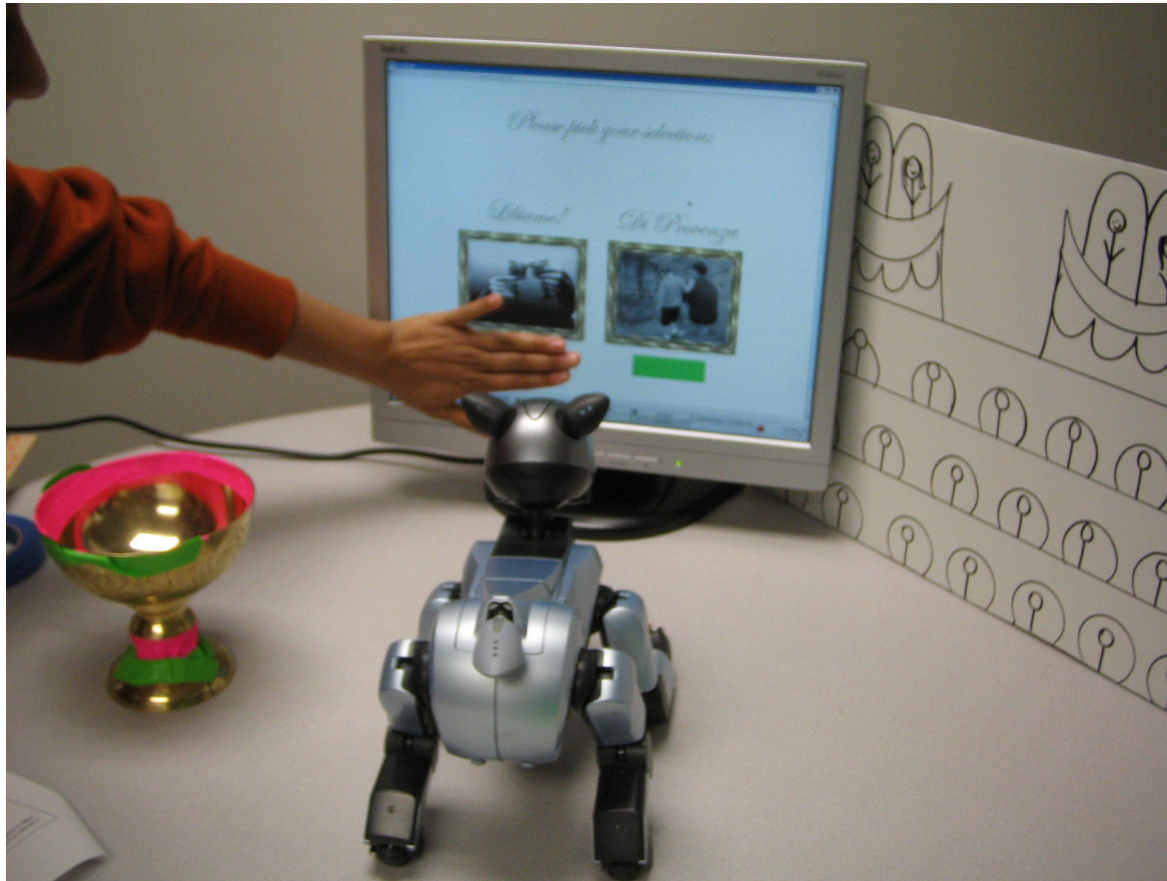
A Visual Joke

At the end of the performance, the user's picture is inserted into an audience shot.

How Looking Glass Works

upload image and
HTML files

Java
client
renderer

Looking Glass Example

```
#include "Behaviors/StateMachine.h"

#nodeclass LGdemo : StateNode

  #shortnodeclass DisplayMessage : LGNode : DoStart
    displayHtmlText("<html><body>Hello world!</body></html>");

  #nodemethod setup
    #statemachine
      StateNode =B(GreenButOffset)=> DisplayMessage

#endnodeclass

REGISTER_BEHAVIOR(LGdemo);
```

Looking Glass Functions

- uploadFile(string filename)

- displayHtmlFile(string remoteFilename)

- displayImageFile(string remoteFilename)

- displayHtmlText(string text)

- uploadCameraImage(string remoteFilename)

- uploadSketch(Sketch<uchar> sketch,
                        string remoteFilename)