

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)

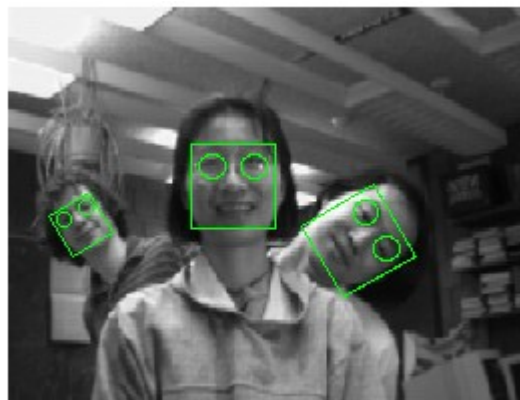
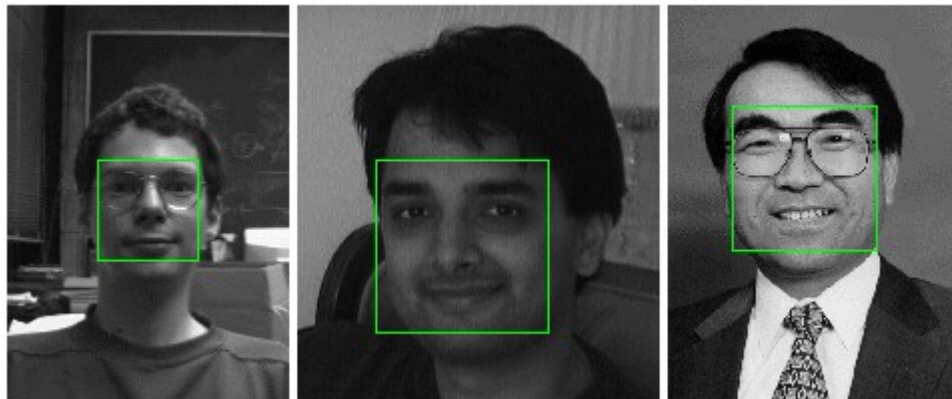
Awareness 1: Person Tracking

- 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

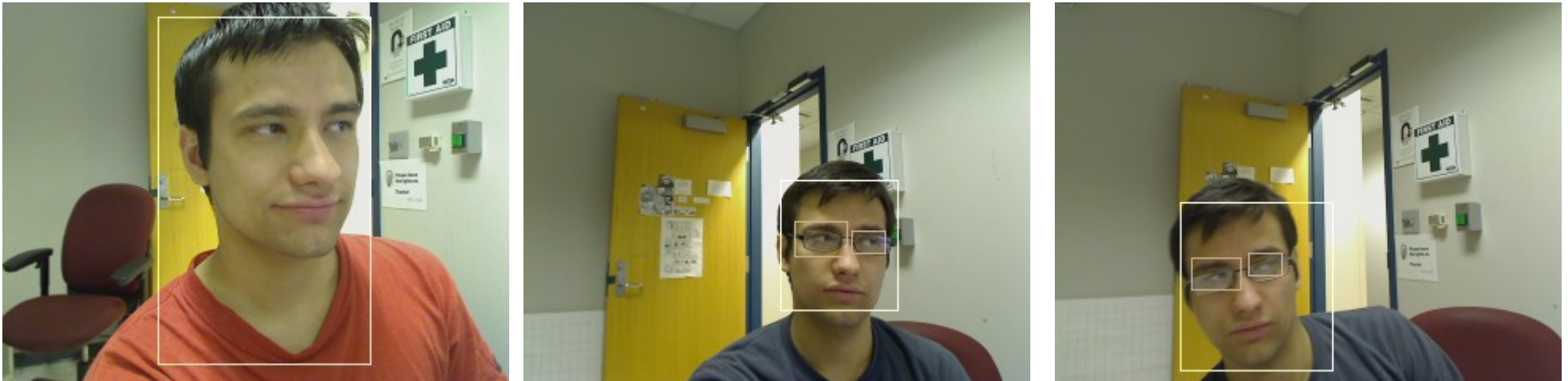
- Rowley, Baluja, and Kanade (1998) used a neural net:



(movie)

OpenCV Face Detector

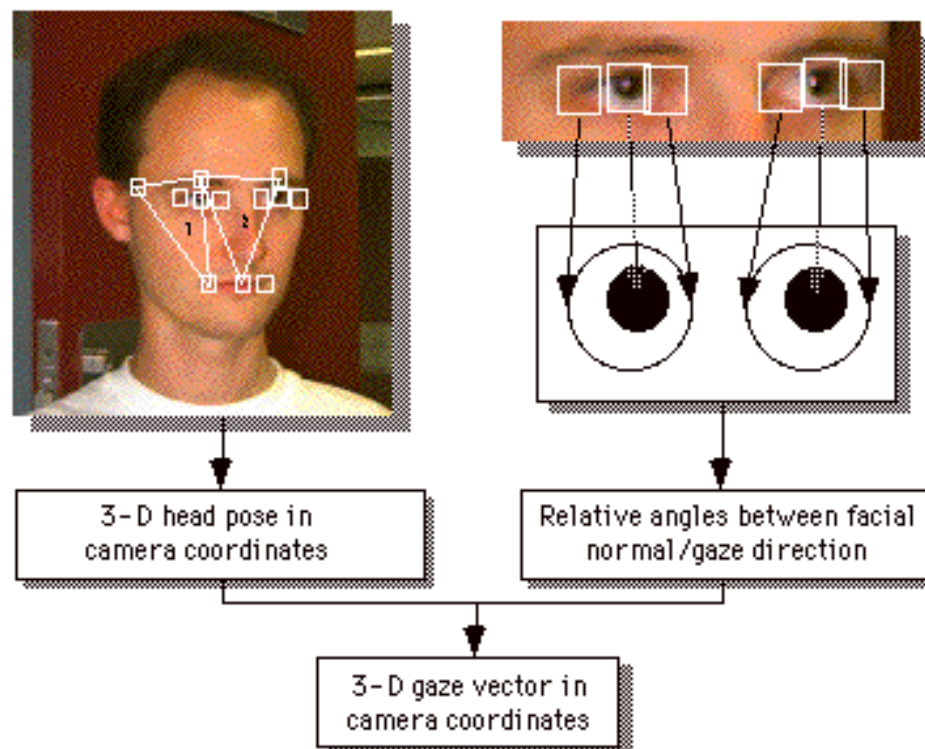
- Ilya Matiach ported the OpenCV face detector to Tekkotsu in 2009 to run on the Chiara.



- For more information:
<http://opencv.willowgarage.com/wiki/FaceDetection>
- Digital cameras now do face and smile detection.

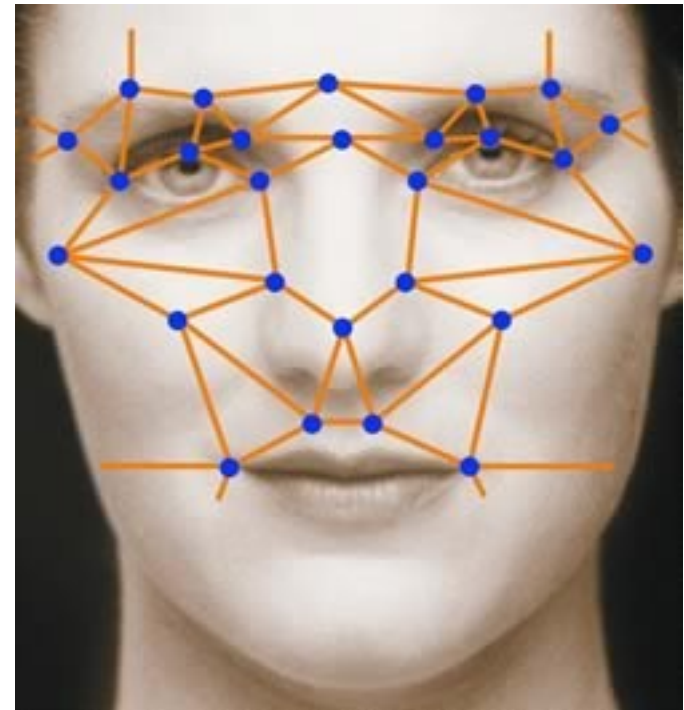
Awareness 3: Gaze Tracking

- What is the human looking at?
- Gaze has high social significance among primates.
- For robots, hard to measure gaze at a distance.



Awareness 4: Face Recognition

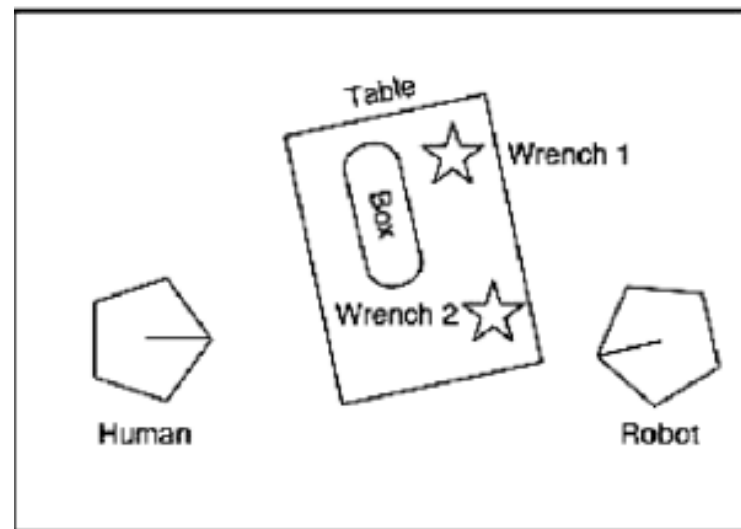
- Which human is this?
- Lots of work in this area now for security applications.
- Sony's AIBO, QRIO robots had face recognition modules.



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

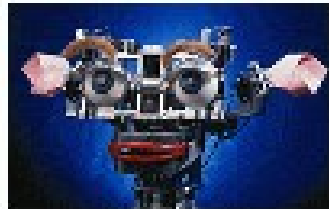
- Do robots need heads?
- What are heads used for?
 - Indicate focus of attention by gaze direction
 - Gestures such as nodding agreement
 - Anthropomorphism makes robots more acceptable to humans
- Headless robots are creepy.



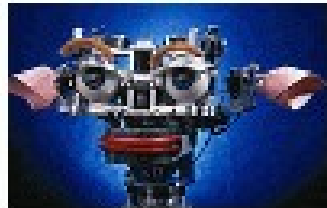
DARPA Little Dog

Facial Expressions: Kismet

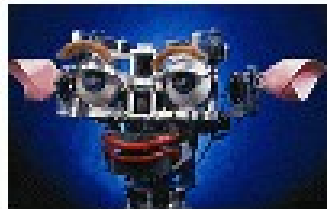
- Cynthia Breazeal, ca. 1999-2000



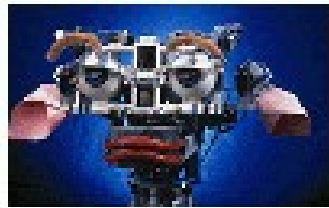
Interest



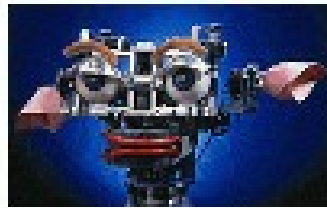
Calm



Happy



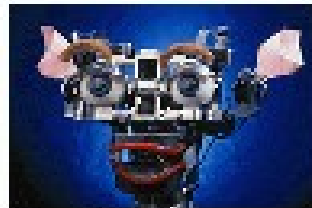
Sad



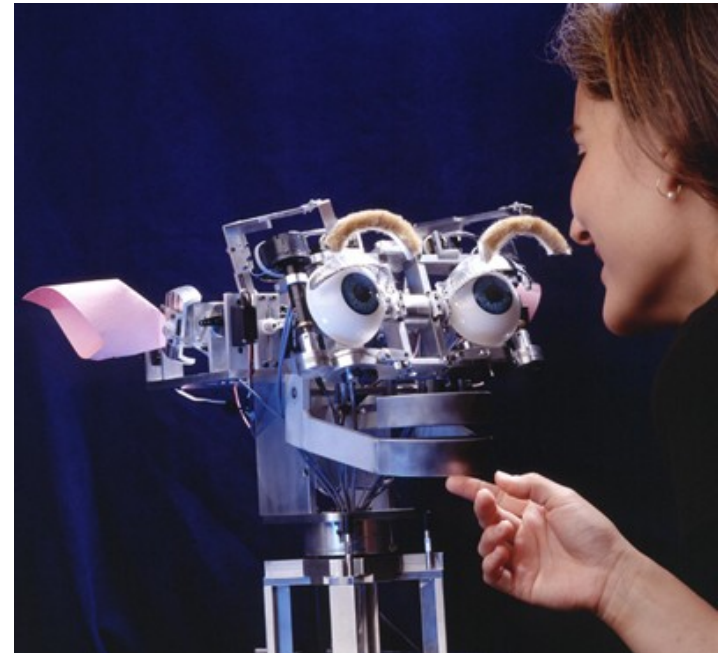
Disgust



Angry

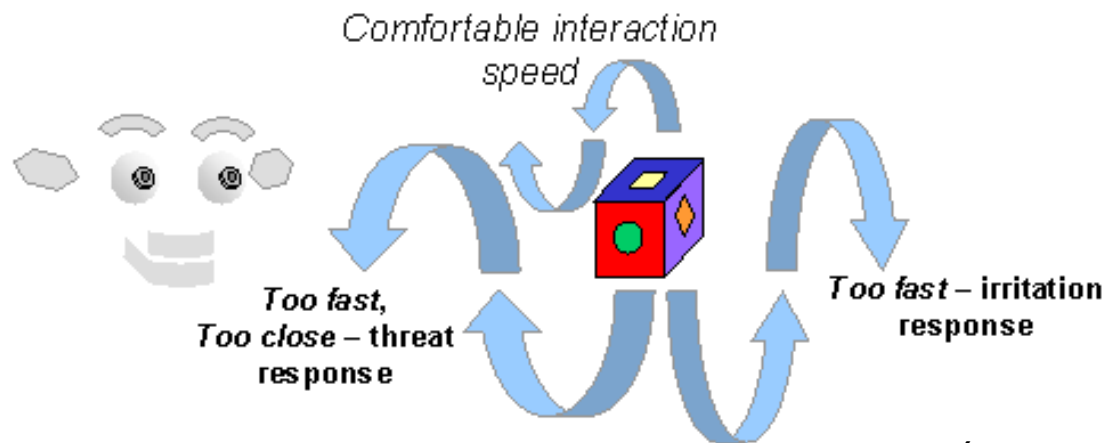
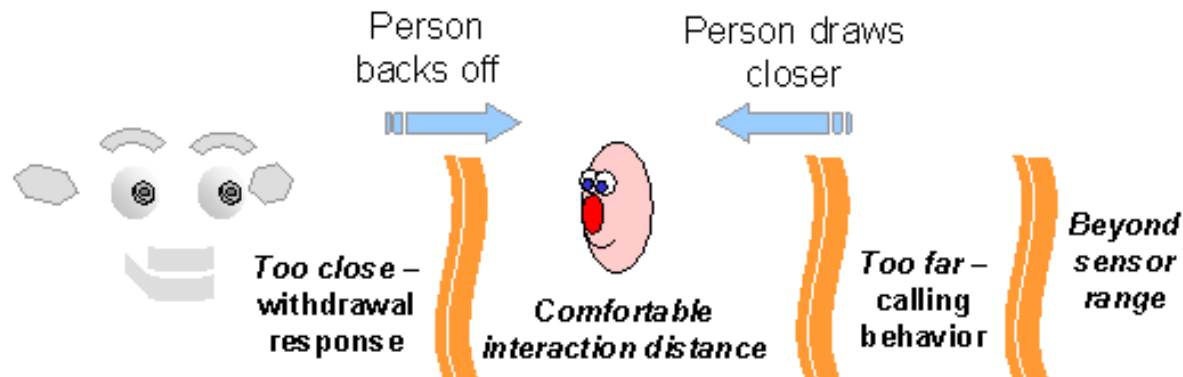


Surprise



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

Kismet Social Interactions



(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

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

```
$nodeclass CountObjects : SpeechNode : doStart {  
  textstream << "I saw "  
    << worldShS.allShapes().size()  
    << " objects";  
}
```

Speech in Tekotsu

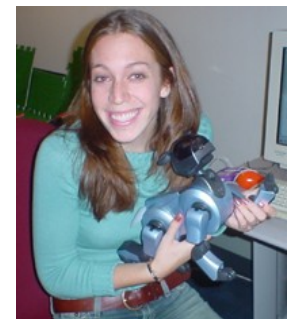
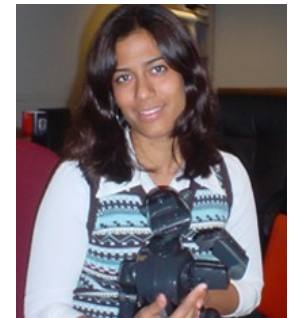
```
#include "Sound/SoundManager.h"  
sndman->speake("Please charge my battery.");
```

Tekkotsu uses the Mary text-to-speech system:

<http://mary.dfki.de>

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?

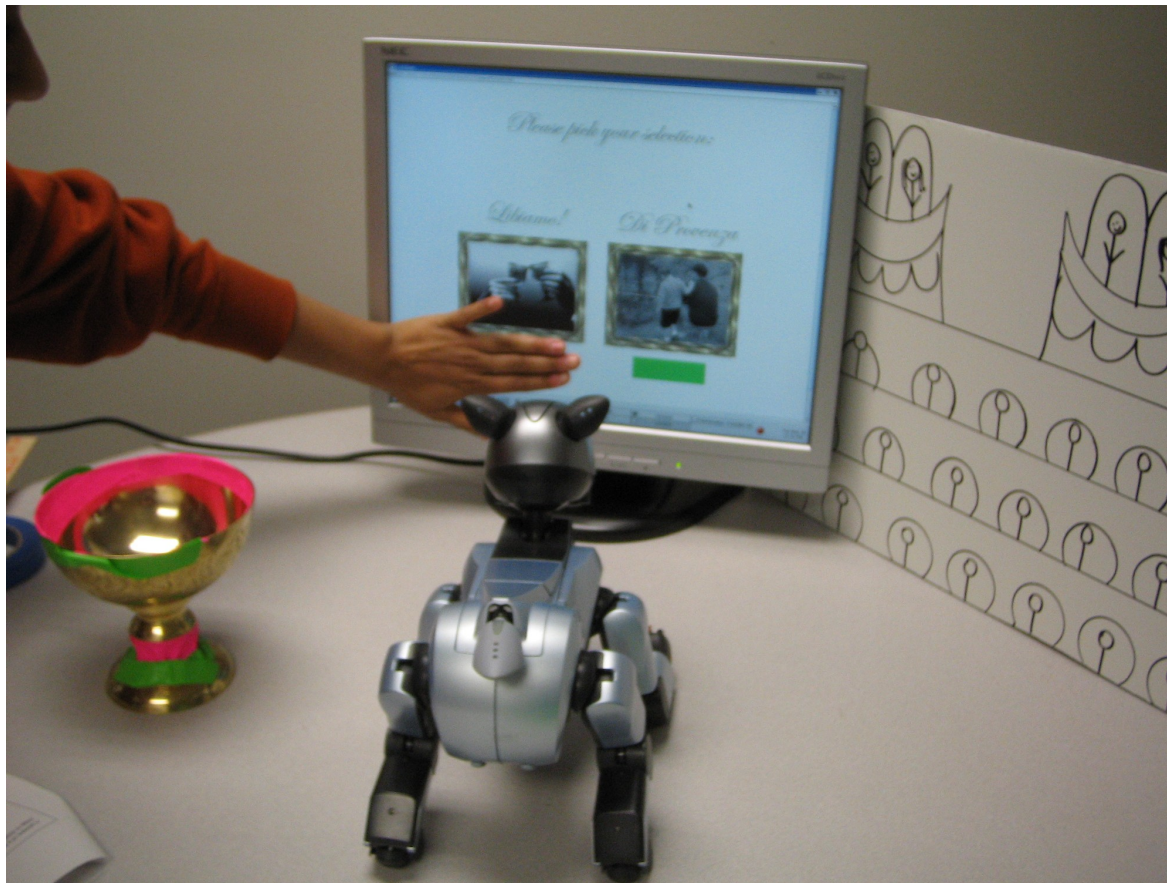


Looking Glass Applications

- 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



Virtual Violetta



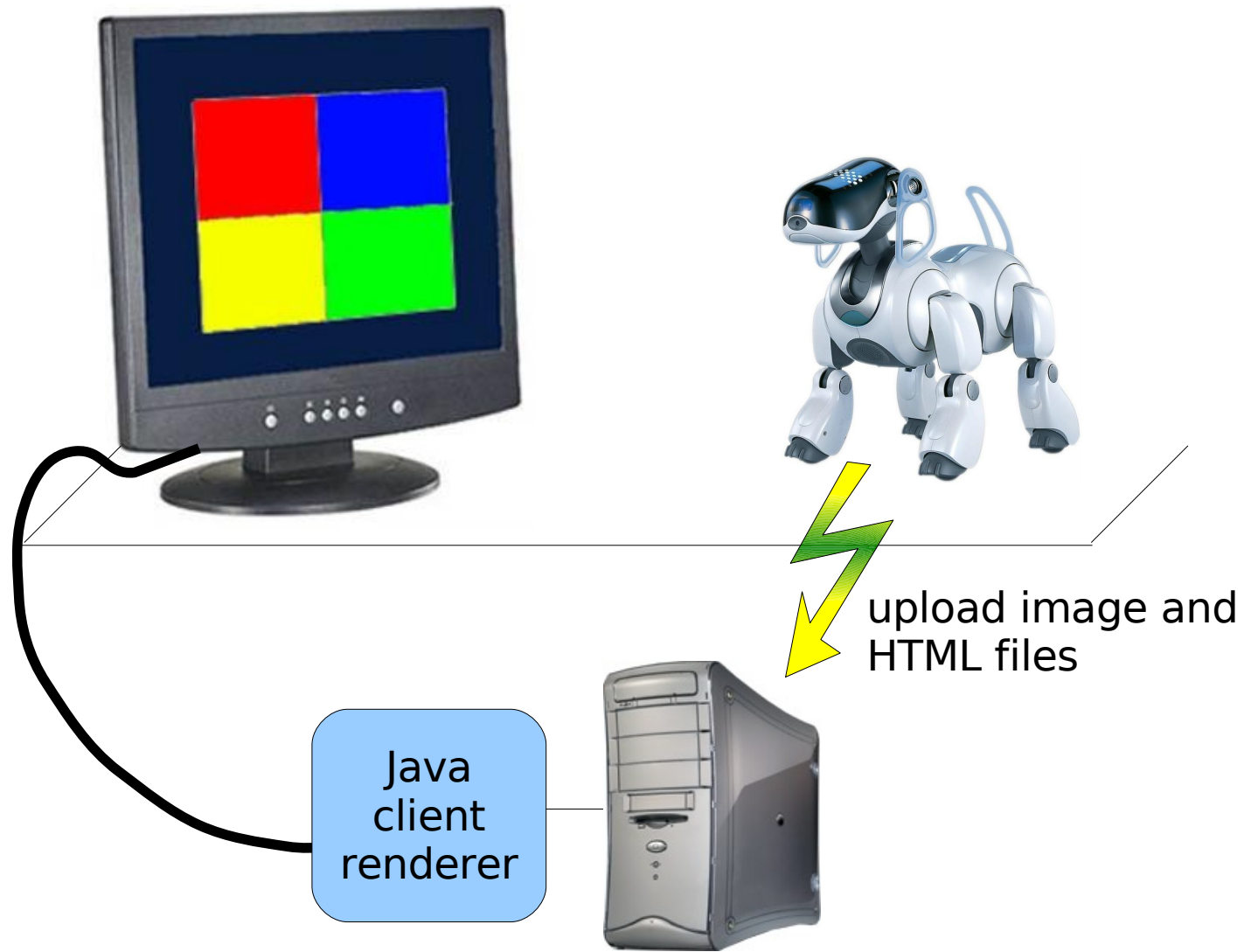
(movie)

A Visual Joke

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



How Looking Glass Works



Looking Glass Example

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

$nodeclass LGdemo : StateNode {

    $nodeclass DisplayMessage : LGNode : doStart {
        displayHtmlText( "<html><body>Hello world!</body></html>" );
    }

    $setupmachine{
        StateNode =B(GreenButOffset)=> DisplayMessage
    }

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)`