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 (rangedfinder); 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.
Facial Expressions: Kismet

- Cynthia Breazeal, ca. 1999-2000

Kismet Social Interactions

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

SpeechNode($, “Take me to your leader!”)

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

Speech in Tekotsu

```cpp
#include "Sound/SoundManager.h"

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

Tekkotsu uses the Mary text-to-speech system:

[http://mary.dfki.de](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

- Java client renderer
- Upload image and HTML files
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)