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:
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.
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
  - 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

Person backs off

Person draws closer

Too close – withdrawal response

Comfortable interaction distance

Too far – calling behavior

Beyond sensor range

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
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
#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)