Principles of Human-Robot Interaction

an introduction to robots in our daily lives

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Human-Robot Interaction

- What is an interaction with a robot?
  - What is a robot?
  - What counts as interaction?
- Robot(ic)s, for our purposes, is where computation meets the physical world
  - Sensing: seeing, hearing, range-finding...
  - Actuation: moving, manipulating objects
- Physical interactions with humans
  - Speaking, hearing, gaze contact, holding hands...

Competitions and Areas

- Search & Rescue
  - Useful near-term
- Hors d’oeuvres, anyone?
  - Involves crowd navigation, direct social interaction
- Assistive Robotics
  - Social, physical, and cognitive support
  - Vulnerable populations
- Space and Extreme Condition Robotics
  - Extreme operating conditions
  - Partial, delayed, or no communication

Robocup Search and Rescue

HAL exoskeleton: medicine, construction, disaster response

Assistive Robotics

DLR Institute – arm controlled by electrical brain signals

http://www.dlr.de/robotics/html/home/robo/index.html
Types of Interaction

- Non-interactive work
  - Still doing tasks for humans
- Teleoperating
- Supervising
  - Correct errors, give low-level instructions
- Providing goals
  - From “Pick up the block” to “Cook dinner”
- Non-supervisory interactions
  - With people
  - In environments (e.g., cleaning)

Types of Interaction

- Engineering:
  - Building, maintaining, (re)programming
- Teleoperating
- Supervising
  - Correct errors, give low-level instructions
- Providing goals
  - From “Pick up the block” to “Cook dinner”
- Non-supervisory interactions
  - With people
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System Design

- How autonomous should this robot(s) be?
- What kind of group is the robot in?
  - Other robots? Humans?
  - How is it structured? Who’s in charge?
- Information management
  - Who knows what? Is it transferred?
- How adaptive or predefined is the task?
- What is the task or task domain?

Autonomy

- How autonomous should this robot(s) be?
  - For what kind of interaction?
  - What is the target problem(s)?
  - Are their human collaborators?
- Partial; full; social; correctable; haptic; feedback; …
- What kind of autonomy?
  - Goal-based
  - Behavior-based
  - Probabilistic

Many human-robot interactions can also be human-human, robot-robot, or a more complex mix. This is why I often say agent.

Information Exchange

- Who knows what? Who needs to know what?
- When information transferred:
  - When exactly?
  - From whom to whom?
  - How slow? How costly?
- How information is transferred:
  - Using what media?
  - In what format? (Scripted, one-way, free?)
- Do you need a cognitive model of the agents?

Information Exchange (II)

- The medium
  - Seeing
  - Hearing
  - Touch

In practice, these are incredibly high-level simplifications of all of artificial intelligence – but useful!
Group Makeup

- Humans and robots
- 1-1, many-many, 1-many, many-1, 1-0, 0-many, ...
- Related to autonomy task
- Who has authority? Who has responsibility?
- When does the human not have pure authority?
- Timing? Task-based?
- What is optimal?

Adaptation

- What can be learned?
  - Task domain; task actions
  - Changes over time
  - Communication style and kind
  - Authority and communication flow
- What can change?
  - The task? The authority? Agent capabilities?
  - Over what span of time?
  - In response to what information?
- What agent(s) should do the learning?

Practical Discussion

- Search & Rescue
- Hors d’oeuvres, anyone!
- Assistive Robotics
  - Transfer
  - Social
  - Wheelchair
- Space/Extreme Conditions
- Surgical
- Autonomy
- Group Structure
- Information exchange
- Adaptation and Learning