Human-Robot Collaboration: Bids and Bytes

Malte Jung
Stanford University
Dept. of Management Science & Engr
mjang@stanford.edu

Jin Joo Lee
Massachusetts Inst. of Technology
Media Laboratory
jinjoo@mit.edu

Nick dePalma
Massachusetts Inst. of Technology
Media Laboratory
ndepalma@mit.edu

Pamela J. Hinds
Stanford University
Dept. of Management Science & Engr
phinds@stanford.edu

Sonia Chernova
Worcester Polytechnic Institute
Department of Computer Science
soniac@cs.wpi.edu

Cynthia Breazeal
Massachusetts Inst. of Technology
Media Laboratory
breazeal@mit.edu

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a Tale of Two Studies

Mars Escape

Urban Madness

Challenges and insights on human-robot teamwork interactions
the Mars Escape study

- Crowd sourced 700 human-”robot” interactions through an online game to learn how people coordinated as a team to complete task
- Search & retrieve 5 hidden items
- Modeled task-oriented behaviors
- Evaluated using physical robot at the Boston Museum of Science

Virtual HRI → Physical HRI

Social-Emotional Rating Scale

Interaction Spectrum

- Positive
- Neutral
- Negative

**Specific Affect Coding System (SPAFF)**
**Rapid Couples Interaction Scoring System (RCISS)**


Bids Analysis

- **Bid:** an attempt to interact
- Coding system for everyday couples interactions
- Bid responses (pos/neg, low/high energy)
- Quality of response powerful indicator of the affective quality of interaction

Research Questions

How do subtle socio-emotional interaction behaviors affect performance in complex human-robot teamwork?

Does a human-robot team in which the robots respond to bids positively perform better on a search and retrieval task?
USAR Task : arena

Scenario Abstraction
A large building has collapsed and the human-robot team needs to search & retrieve specific items

Goal
Retrieve as many items in 10 minutes

Task Design
A task that relies heavily on robots to facilitate interaction
USAR Task: danger zones

**HIGH DANGER ZONE**
Searchable by aerial robot
-> **No** Humans

**MEDIUM DANGER ZONE**
Searchable by ground robots
-> Humans enter this space **ONLY** when safe

**LOW DANGER ZONE**
Searchable by ground robots and human
USAR Task: game components

**Items**
Need to flip to see inside

**Communication Button**
To measure cognitive load

**Projector**
Displays time and items to find
Local & Remote Robot Team

Ground Robot
(Nexi)

Aerial Robot

Ground Robot
(Maddox)
Technology

- **Navigation** (CARMEN + Hokuyo)
- **Mobile Manipulation** (Visual Servoing with Kinect)
- **Speech Recognition** (CMU Sphinx)
- **Speech Synthesis** (Cereproc)
- **Interaction and Dialog Finite State Machine**
- **Coverage Algorithm** (Random search)
- **Human localization** (Vicon)
- **Distributed Controllers** (no inter robot communication minus navigational avoidance)
Challenges and Insights

• Task design for maximum collaboration (danger zones)
• Adjustable autonomy for overrides (high level interfaces)
• Setting a USAR situation (urgency/stress)
• High variance in human-robot interactions
  1. Micro management
  2. Social collaborative (robot as social agent)
  3. Limited collaborative (rarely interacted)

May affect team performance!
Conversation Starters

• What measures and metrics should we use to evaluate team performance beyond “Time of Task” and “Items collected”?

• Can robots be used to influence team dynamics in order to achieve higher overall team performance?

• How do respond more intelligently to bids?