AUTONOMOUS SOCIAL ROBOTS IN THE REAL WORLD: CURRENT CHALLENGES AND FUTURE DIRECTIONS

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EECS
20% OF THE POPULATION > 65 YEARS
857,000 NEW IMMIGRANTS OVER THE NEXT FIVE YEARS
collaborative work
SOCIAL ROBOTS
CURRENT CHALLENGES IN
SOCIAL ROBOTICS

Limited **socially perceptive** capabilities

**Adaptation** to the user and context

**Repetitive** and **limited** behavior
Limited **socially perceptive** capabilities

Lack **Adaptation** to the user and context

**Repetitive** and **limited** behavior

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**Long-term Human-Robot Interaction in the Wild**

- Robust Perception Systems
- User Modeling and Adaptation
- Repeated Social Interactions
DOES GROUP SIZE AFFECT ROBOT PERCEPTION?

Leo is new at school and doesn’t know anyone. Another student, Marlow, called Leo's hat stupid. What should Berry do to help Leo feel included?
group size impacts the way people behave
DISENGAGEMENT CLASSIFICATION

DS_I
N=6899

DS_G
N=5797
• Higher performance when models are tested using data collected in the same type of interaction
• A model trained with group data ($M_G$) generalizes better to individual participants ($DS_I$)
REAL TIME DISENGAGEMENT DETECTION & REPAIR IN SMALL GROUPS

Features
- Voice Activity
- Smiling
- Body Posture
- Look at Robots
- Look Up/Down
- Robots talking
DOES GROUP SIZE AFFECT ROBOT PERCEPTION?

- Classification of social phenomenon is affected by number of people in the environment
- Robots need to account for the different types of social contexts that they will encounter in the real world
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HOW CAN A ROBOT SELECT THE MOST EFFECTIVE SUPPORTIVE STRATEGIES TO THE USER?

SOCIAL SUPPORT TAXONOMY

- Information Support
  - Suggest Move
  - Scaffold
  - Allow take back

- Tangible Assistance
  - Play bad move
  - Start over exercise
  - Tell joke

- Esteem Support
  - Compliment
  - Validation
  - Relief of blame
  - Reassurance

- Emotional Support
  - Relationship
  - Sympathy
  - Understanding
  - Encouragement
\[ \text{Reward} = P(\text{Valence})_t - P(\text{Valence})_{t-1} \]
EXPLORATION VS. EXPLOITATION

- **Exploration**
  - (trying strategies not used before)

- **Exploitation**
  - (using the seemingly best strategy so far)
EVALUATION

Procedure

• N = 16 (9 females, 7 males), ages 8 to 9 (M = 8.5)
• 5 interaction sessions

Measures

• Social Presence
• Perception of the robot
• Adaptation over time

40 hours of interaction
100 adaptation cycles
ADAPTATION TO SUPPORTIVE BEHAVIORS - RESULTS

• Adaptive system converged to each child’s preferred supportive strategies

• Higher correlation for extroverted children
ENTRAINMENT

Interaction is more than just exchanging messages explicitly, we tend to adapt to the other interlocutor in a conversation.
DOES PROSODIC ENTRAINMENT IMPROVE CHILD-ROBOT INTERACTION?

MOLE MADNESS

- Side-scroller where a mole captures food, avoids dangers and returns home

- Requires coordinated use of the keywords “go” and “jump”

- Can be played by two children or by a child and a robot

- Engagement lower in robot child [Chaspari, 2015]
EVALUATION PROCEDURE

- 40 Children (ages 4-10, 50% girls)
- Within-subjects with two conditions (SN, NS)
- Versions:
  - Synchronous: selection from the 50NN
  - Non-synchronous: from all except the 50NN
HOW DOES PROSODIC ENTRAINMENT IMPACT HRI?

• Children adapt their prosody to the robot
• Strong positive effects on users’ engagement
• First impressions of synchronous behavior is important
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THE CONTENT AUTHORING PROBLEM
TYPICALLY, DIALOG SYSTEMS...

Domain experts to manually define structure, goals and transition rules

- Costly and difficult to scale
- Prune to introducing personal bias

Statistical techniques

- Only possible when prior corpora are available

A social robot that self-authors its own dialog for social chat
CROWDSOURCING

**DIALOG FOR**

**REPEATED INTERACTIONS**


AUTOMATIC DIALOG AUTHORING

Dialog Authoring

Dialog Editing

Nonverbal Authoring

Back for another try?

Ready to try again?

Good to see you again

You're back!

You're a lover of late night conversations, aren't you?
QUIZMASTER CASE STUDY

Martin is running a booth at the company picnic where employees can try to answer a trivia question…

num_players_around = one | multiple

num_interactions = zero | one | multiple

last_few_answers = right | wrong

question_difficulty = easy | hard

answer = right | wrong
What if we use a similar approach for social dialogue, i.e., to anticipate what the user can say?
KEVIN

• Repeated social chat with fellow office workers

• No “task” except longer conversation

• Speech in/out
SYSTEM ARCHITECTURE

Semi-situated

Fully-situated
Kevin is a friendly person who enjoys his job in an office downtown...

day of week = Monday | Wednesday | Friday

time of day = early morning | afternoon

familiarity = never met | known each other for a while
DIALOG SELECTION AND BORROWING

INITIAL GRAPH

1. Currently at A:
   User says B:
   Nothing similar
   Kevin fails:

2. Currently at A:
   User says C:
   Kevin says E:

3. Currently at A:
   User says D:
   F similar to D
   Kevin borrows child from F (and says either G or H):

4. Currently at A:
   User says H:
   H exists as child of F
   Kevin borrows H and I (and says I):

5. Currently at A:
   User says G or other (O):
   G exists but has no children
   O does not exist
   Kevin fails:
RESULTS FROM KEVIN DEPLOYMENT

12 days, 22 adults, 486 conversations
568 initial AMT to 2167 lines of dialog
Dialog graph grew from 632 to 4292 nodes
CROWDSOURCING DIALOG FOR REPEATED INTERACTIONS

• Generalization of dialog context via semantic similarity (allow the agent to continue conversation in the moment)

• Real-world deployment showed that while not perfect, the proposed method is a good solution when large corpora are not available to use purely statistical approaches
MAIN TAKEAWAYS

• Social Robotics is a multidisciplinary field

• Robots still struggle with things we (humans) can do effortlessly, but progress is happening fast

• Promising application domains: assistive living & health-care, collaborative manufacturing, education, ...
RECENT PROJECTS (KTH)

• Gathering Collective Intelligence through Crowdsourcing for Social Robotics

• Using Social Robots to Personalize Intercultural Role-Playing Activities for Children

• Robust Non-Verbal Expression in Virtual Agents and Humanoid Robots: New Methods for Augmenting Stylized Gestures with Sound
Acknowledgements