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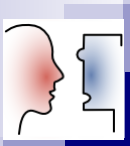

Hands-Off Therapist Robot Behavior Adaptation to User-Personality and Profile for Rehabilitation Therapy

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1. Background

Socially Interactive Robotics (SIR)

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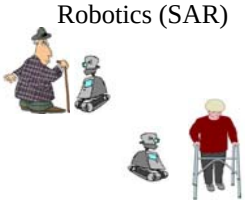
Socially Assistive Robotics (SAR)



- HRI for *socially assistive robotics* applications is a new, growing, and increasingly popular research area
- SAR is a multidisciplinary field at the frontier of many other fields including robotics, medicine, psychology, social sciences, neuroscience, and cognitive sciences
- SAR = providing assistance to human users mainly through social interaction, not physical contact

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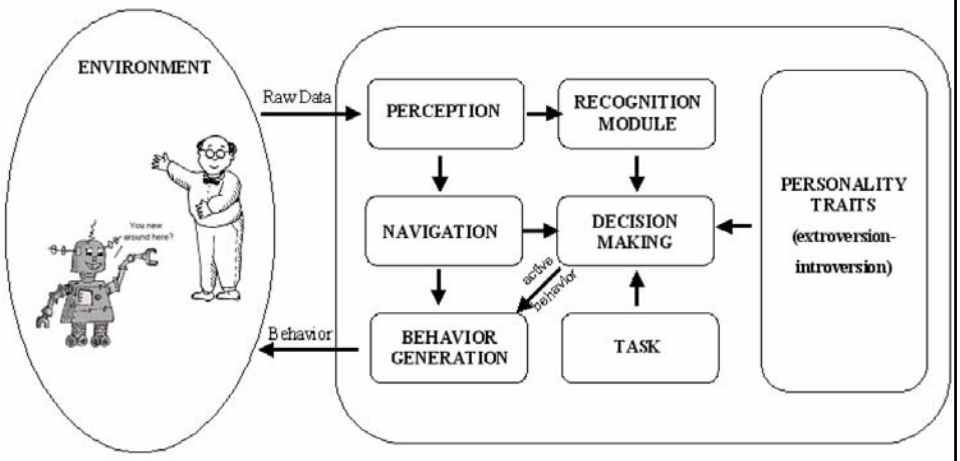
1. Motivation

- Have a customized therapy protocol
- Research Question:
  - How should the behavior and encouragement of the therapist robot be modeled and adapted as a function of the user's personality, preferences, and profile so as to improve his/her task performance?

[Eriksson et al. 2005]

2. Interaction Design



HRI Information Processing Using the Personality Model of the User

[Tapus et al. 2006]

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3 . Robot Behavior Adaptation to User's Personality and Preferences

- The robot behavior adaptation system optimizes the 3 main parameters :
  - interaction distance/proxemics
  - speed and amount of movement
  - verbal and para-verbal cues

  to adapt to the user's personality and preferences and improve his/her task performance
- The system monitors the user's task performance and the time spent between exercises, and changes the robot's behavior in order to maximize the user's level of progress

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3. Robot Behavior Adaptation to User's Personality and Preferences

- We formulated the problem as *policy gradient reinforcement learning* (PGRL) and developed a learning algorithm
- Summary of the PGRL algorithm:
  - parameterization of the behavior
  - approximation of the gradient of the reward function in the parameter space
  - moving towards a local optimum

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5. Test-bed and Subject Pool

- Test-bed:

- Subject Pool:
  - 11 participants (6 male, 5 female)
  - 19-37 years old
  - 73% from robotics or technology-related departments (e.g., computer science, electrical engineering)

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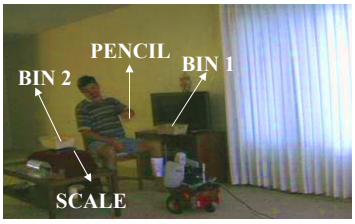
5. Experimental Design

- Duration: 15 minutes
- Task: moving pencils from one bin to another using non-dominant (weaker) limb
- Two Experiments:
  - Experiment 1: Robot Behavior Adaptation to User Personality-Based Therapy Style
  - Experiment 2: Robot Behavior Adaptation to User Preferences
- Learning Algorithm: activated only when the participant was performing below the set threshold



4. Experimental Design – Experiment 1

- Experiment 1: Robot Behavior Adaptation to User Personality-Based Therapy Style
  - Choice of therapy styles as a function of the user personality

Parameter	Extroverted			
Therapy Style	Id=1	Id=2	Id=3	Id=4
	Coach-like	Very Challenging	Stimulating	Encouragement-based
	Introverted			
	Id=1	Id=2	Id=3	Id=4
	Supportive	Educative	Comforting	Nurturing

  - Choice of interaction distances and robot movement speed as a function of the user personality

Parameter	Extroverted			Introverted		
Interaction Distance/ Proxemics (m)	Id=1	Id=2	Id=3	Id=1	Id=2	Id=3
	0.7	1.2	1.7	1.2	1.7	2.2
Speed (m/s)	0.1	0.2	0.3	0.1	0.15	0.2

4. Experimental Design – Experiment 2

- Experiment 2: Robot Behavior Adaptation to User Preferences
  - People are more influenced by certain voices and accents than others
  - Choice of therapist robot's personality as expressed through English accent and voice gender as a function of the user preferences

Parameter	Id=1	Id=2	Id=3	Id=4
Therapist Robot's Personality as Expressed through English Accent and Voice Gender	Female with accent	Male with accent	Male without accent	Female without accent

5. Evaluation Methods

- Pre-study:
  - Eysenck Personality Inventory (EPI) Questionnaire
- Post-study:
  - Likert 7-point scale questionnaire:
    - The questions were designed to evaluate participants impressions about the robot's therapy style and personality (e.g., "Did the robot succeed to adapt to your preferences?")

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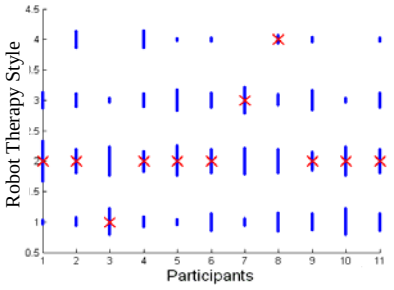
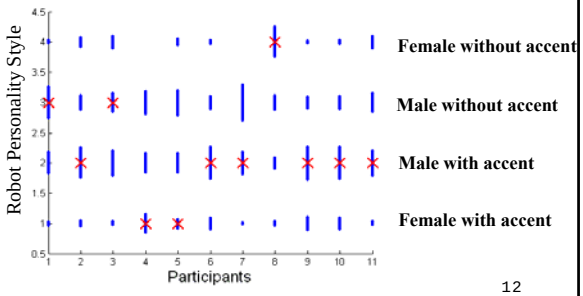
5. Experimental Results

- Experiment 1



Therapy Style

- Experiment 2



Personality Style

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5. Experimental Results

- A direct match between the values learned by the robot and the values given in the questionnaires by the participants was found
- The robot adapted to both user's personality and user's preferences

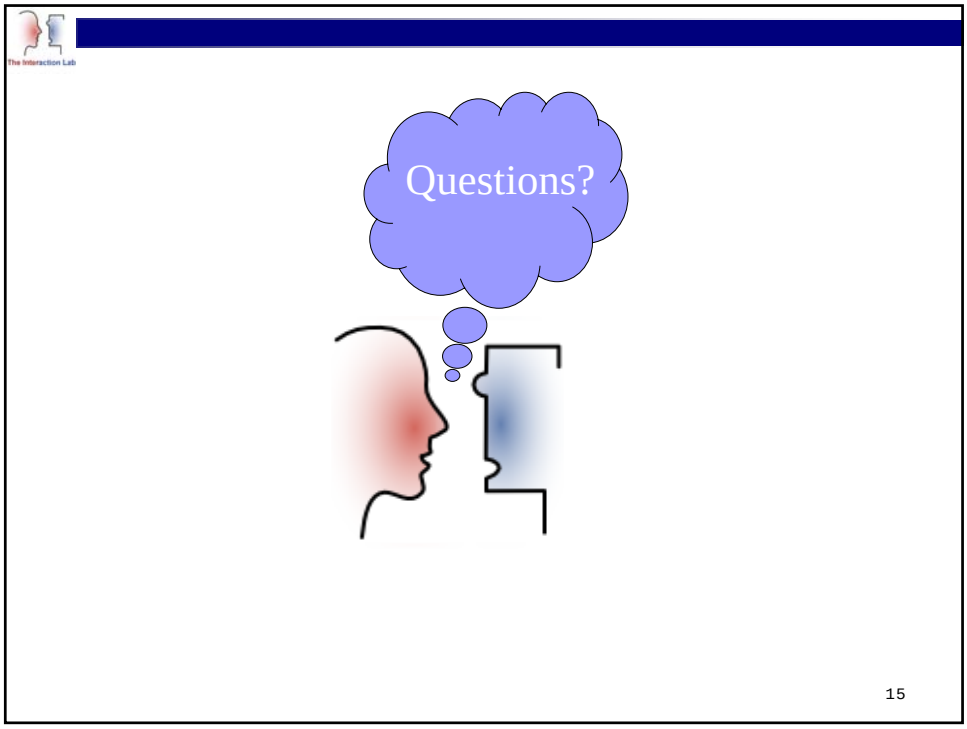
Exp1: Adaptation to User Therapy Style

Exp2: Adaptation to User Preferences

6. Conclusions and Future Work

- A behavior adaptation system using a reinforcement learning algorithm was presented
- The adaptation system takes advantage of the user's personality and the number of exercises performed
- The robot adapts to deliver customized post-stroke rehabilitation therapy

- Future work:
  - Validate the methodology with stroke-patients
  - Focus on physiological data to determine stress and frustration


Questions?
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