Trends in Robot Assisted Therapy and Robot Enhanced Therapy

Machine Learning in Robot Assisted Therapy  Summer Semester 2018
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Overview

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Introduction

Robot Assisted Therapy and Robot Enhanced Therapy in Autism

Initial distinction made by the DREAM project\(^1\)

**SAR: Socially Assistive Robotics**
**RAT: Robot Assisted Therapy**
  Controlled by a human agent

**RET: Robot Enhanced Therapy (Next Generation of RAT)**
  Semi/Fully automated robots
  Able to infer psychological disposition and assess behaviour
  Tailored to individual needs
  Diagnostic tool

\(^1\)https://www.dream2020.eu/
Introduction

Why RAT and RET in Autism?

• Robots can provide human cues while maintaining object-like simplicity
• Robots can be controlled so that only relevant information is presented
• Lighten the burden of human therapists
• Reducing the costs of standard cognitive therapies
• More rational beliefs and lower intensity level of emotional responses have been reported in RAT

(Boucenna et al., 2014)
Introduction

What are the current needs of Autistic people?

Mc Call, 2017: UK falling to meet the needs of people with Autism (Report from the National Autism Project)

- **Lack of strategic research**: £32 billions invested each year with little impact
- **High unemployment rates**: ‘only 16% of adults diagnosed with autism in England are in full-time employment, and two-thirds are not working at all’. Main reason is attributed to lack of support from society and social and communication difficulties
- **Lack of consideration towards health needs**. Examples are controlling weight and maintaining healthy diets.
- **Address the high variability inside the autistic spectrum**. ‘When you’ve met one autistic person, you’ve met one autistic person’.

(Mc Call, 2017)
Methodology of Research

We used statistical approach to review the current state of research. Types of therapies based on 2791 documents with the keyword of robot assisted/enhanced therapy. These are general main categories that are performed by the assistance of a robot:

- BCI (Brain Computer Interface) Assisted Robotic Therapy
- Robot Assisted Rehabilitation Therapy
- Post Stroke Robotic Assisted Therapy
- Social Robot Assisted Therapy
Methodology of Research

Robot Assisted/Enhanced Therapy in Autism (Based on the research papers*)

- Categorized under social assisted therapy
- 143 papers out of 2791 papers in RAT/RET therapies (about 5 percent)
- Relatively new trend in the field of RET/RAT therapies
- Most of the research in this area was done in the field of CS

* June 2018-Source Scopus with the keywords of “Robot AND (Assisted OR Enhanced) And Therapy” with the refined keywords of “ASD OR Autism OR Autistic” in Titles, Keywords and Abstract
Methodology of Research

Understanding research patterns:
General steps that are performed in RET/RAT projects

- Physical Robot Design
  - Size
  - Anthropomorphism
  - Range of Movement
  - Body Parts

- Human-Robot Interaction Design
  - Joint Attention
  - Turn Taking
  - Imitation

- Evaluations Of Robots In Therapy-like Settings
  - Currently not performed in sense of medical standards in fields of CS/Mathematics
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Targeted fields in Autism by RAT and RET

**Diagnosis**
Collecting data for interaction and automate behaviour evaluation systems (e.g. eye tracking).

**Social interactions and reactions**
Self-initiated interactions: encourage the child to engage the therapy proactively
Turn-taking activities: get children used to wait for a response after a performed action
Imitation: recognize ‘social others’, help children realize their actions are related and have an impact on their environment
Joint attention: ability to consciously focus on the same object with other person. Robots improve that automatically focusing their gaze towards children.

**Emotional wellbeing**
Emotion recognition: robots simplify the complexity of a human face

(Dickstein-Fischer & Fischer, 2014; Ricks & Colton, 2010)
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Mapping robots to ASD Objectives

(Huijnen, Lexis, Jansens, & de Witte, 2016)
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Review of robots used in RAT and RET

Nao  Robota  Probo  Keepon  Cat robot  I-sobot  Tito  GIPY

HOAP 3  KASPAR  Robot arm  Pleo  Labo 1  ifbot  CHARLIE  PABI

(Huijnen, Lexis, Jansens, & de Witte, 2016)
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Distribution of projects by country
# Trends in Robot Assisted Therapy and Robot Enhanced Therapy

## Commercial availability and budget

<table>
<thead>
<tr>
<th>Commercially available</th>
<th>Price</th>
<th>Commercially unavailable (research)</th>
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</thead>
<tbody>
<tr>
<td>NAO</td>
<td>N.A.</td>
<td>Robota</td>
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<tr>
<td>Keepon</td>
<td>170$</td>
<td>Cat robot</td>
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<td>I-sobot</td>
<td>600$</td>
<td>Probo</td>
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<td>Hoap 3</td>
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<td>KASPAR</td>
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<td>GIPY</td>
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<td>Pleo</td>
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<td>Robot arm</td>
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Our vision

1. Needs of joint research in Medical and Computer Science research groups
2. Towards more autonomous robots (‘supervised autonomy’)
3. Orientation towards self-care and independent living
4. Low-cost robots that can easily be used at home
Our vision

Needs of joint research in Medical and Computer Science

- Computer Science is the most active field of science to investigate RAT/RET in ASD
- Question: Why in the field of medicine has not performed numerous investigations about?
- Our interpretation:
  - This field is still under development and we have a distance until we get to a reliable product.
  - CS research approach: Careful quantifications and calculation with limited group of samples
  - Medical research approach: Large group of samples based on observation
Our vision

Towards more autonomous robots

At short term, we strongly suggest following the guidelines of the DREAM project in any future attempt to construct a social robot for autism.

Wizard of Oz technique is not a good option in the long run.

Supervised autonomy: the psychologist, therapist or teacher gives the robot a particular task and the robot autonomously works in that task under the supervision of the user.

Esteban et al., 2017 proposes an architecture with three subsystems:

1. Sensing and interpretation
2. Child behaviour classification
3. Social cognitive controller

At long term, we propose a shared supervision between parents and therapists. It will reduce the costs and could be easily done at home after a required training of the parents.
Our vision

Orientation towards self-care and independent living

Mc Call, 2017 stated that one of the main problems of adults with autism in England is carrying an independent living. So far none of the robots used in RAT and RET has addressed this problem.

We believe that increasing the level of autonomy during the childhood will positively impact in the adulthood. For that reason we encourage the targeting of objectives such as personal hygiene, potty training, healthy eating and drinking, (un)dressing, etc. This objectives could be reached through imitation and rewarding (eg. imitation of daily life activities such as brushing their teeths).

Nevertheless, this doesn’t mean decreasing the focus in social interactions and reactions, which has been reported to be one of the major needs in ASD.
Our vision

Low-cost robots that can easily be used at home

Little commercial development has been developed so far, with prices that are sometimes not affordable for average household incomes.

We propose future development towards low-cost portable devices for home-based autism therapies. As an example we show Probolino (Cao et al., 2015) which faces the challenges of dimension, cost, and autonomy.

Source of the photos: Cao et al., 2015
Conclusions

Current approaches in Robot Assisted Therapy and Robot Enhanced Therapy focus mainly in the development of social interactions and reactions.

According to the current needs of autistic people, social interactions and reactions should be reinforced and self-care and independent living should start be targeted by RAT and RET.

Future approaches should be framed into Robot Enhanced Therapy, with focus in a ‘supervised autonomy’.

Current commercial approaches are often expensive and cumbersome to transport. There is a need of low-cost, portable, prototypes that can be easily used at home.
Bibliography


