Development of Robot-enhanced Therapy for Children with Autism Spectrum Disorders

Project No. 611391

DREAM

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Agreement Type: Collaborative Project
Agreement Number: 611391

D9.3 Intermediate progress report

Due Date: **30/09/2017**

Start date of project: **01/04/2014** Duration: **54 months**

Organisation name of lead contractor for this deliverable: HIS (Högskolan i Skövde)

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Project co-funded by the European Commission within the Seventh Framework Programme		
Dissemination Level		
PU	Public	**PU**
PP	Restricted to other programme participants (including the Commission Service)	
RE	Restricted to a group specified by the consortium (including the Commission Service)	
CO	Confidential, only for members of the consortium (including the Commission Service)	

Background

This report is a pro-forma deliverable that serves no actual purpose because it is superseded by the periodic report at M36, i.e. all information contained here will also be contained in the periodic report at M36 in more detailed and updated form. It might be worth noting that deliverables D9.1-9.4 were only added to Annex 1 because the PO at the time was considering 6-months reviews. These were, however, never implemented, hence these deliverables serve no actual purpose.

The intermediate reports were originally intended to "complement the contractual full annual reports and will be significantly briefer (5-10 pages)" (Annex 1, WP9); therefore this report follows the same structure as the annual reports, but contains less information.

Publishable summary

Project Objectives
DREAM is a 4½ -year European project with seven partners focusing on robot-enhanced therapy for children with Autism Spectrum Disorder (ASD). The aim is to facilitate the use of social robots as tools in interventions with human psychotherapists to develop social interaction skills – in particular imitation, joint attention, and turn taking – in children with ASD, with the final objective of achieving better real-life (human-human) social interaction.

For over 40 years, researchers have explored how to clinically help children with ASD. Recently, researchers have found that, for children with ASD, imitation and joint attention acquisition improves in settings in which technological tools are involved. Taking into account that ASD patients tend to learn more from the interaction with technology than from the interaction with the human beings, robots might have the potential to be used in ASD therapies as intermediaries between human models and ASD patients. There are three ways for this to be accomplished: the robo-therapist, the robo-assistant, and the robo-mediator approaches.[1]

DREAM constitutes an extension of the robo-mediator approach (often referred to has robot-assisted therapy or RAT) in which the robot is a necessary component of the therapy, forming a third element in the therapy intervention alongside the child and the therapist, but the robot has some autonomy in conducting the intervention. The robot's behaviour is still supervised by the therapist and, consequently, it exhibits a form of autonomy referred to as *supervised* or *shared* autonomy. We refer to this next-generation RAT as *robot-enhanced therapy* or RET. To achieve a significant level of autonomy, while following the intervention script, the robot must be able to (a) gather sensory data about children, (b) infer their psychological disposition and assess their behaviour, and (c) adjust its actions accordingly when mediating the therapy intervention. Consequently, the robot software has three main sub-systems, one for sensing and interpretation of perceptual data, one for analysis of child behaviour, and a third for controlling the behaviour of the robot.

The need to ensure that the DREAM system can achieve widespread deployment in clinical settings requires the use of relatively low-cost robots. Specifically, we use the NAO humanoid robot manufactured by Aldebaran/Softbank Robotics. Since these robots have limited sensory capabilities, we make use of five auxiliary cameras – with high-resolution colour sensors and medium-resolution 3-D sensors – and external microphones. These are mounted on a custom-designed sensorized "intervention table" at which the child and the psychotherapist sit during the psychotherapy sessions.

[1] †In the robo-therapist approach, the robot acts by itself as the therapist and completely replaces the human agent. In the robo-assistant approach, the robot acts as a facilitator of the therapy intervention but is not necessary for successful treatment and could be replaced by another agent, e.g., an animal. In the robo-mediator approach, the robot is used as a means for delivering the treatment because it enables faster and better gains from the therapeutic intervention as compared to the classical condition, in which there is only direct interaction between therapist and patient.

Project objectives for the period

The main goals for the third year of the project (P3) are the following:

- To adjust the intervention protocol developed for single-subject experiments to the design of a randomized clinical trial (WP1)
- To adjust the variables measured during the clinical trial in order to better fit with the supervised-autonomy version of the system (WP1)
- To compare manual annotations of the behaviours displayed during therapy sessions with the automatically generated results (WP2)
- To investigate the efficacy of RET in improving imitation, joint-attention and turn-taking skills in children with ASD relative to a standard therapist-assisted intervention (WP2)
- To carry out integration and quality assurance processes, and to coordinate the research activities in work packages that feed into the systems integration (WP3)
- To develop a computationally robust platform for multi-sensory information fusion and interpretation in real-life therapy interventions (WP4)
- To evaluate individual packages of the sensing and interpretation and ensure them meet all the requirements from a fully-operational robot-enhanced therapy system (WP4)
- To produce and evaluate algorithms for automated mapping of WP4-generated information to clinically relevant behaviour assessment (WP5)
- To further improve the software for robot control (WP6)
- To produce a final document exploring the ethics of child-robot interaction for children with autism spectrum disorders (WP7)
- To make significant progress on short- and long-term exploitation (WP8)

Work package goals during P3

Work Package 1: Clinical Framework

Goals
1. To adjust the intervention protocol that has been developed for single-subject experiments to the design of a randomized clinical trial (RCT)
2. To adjust the variables, which are being measured during the clinical trial in order to better fit with the supervised-autonomy version of the system.

Work Package 2: Robot Enhanced Therapy (RET)

Goals
1. To compare manual annotations of the behaviors displayed during therapy sessions with the automatically generated results.
2. To investigate the efficacy of RET in improving imitation, joint-attention and turn-taking skills in children with ASD relative to a standard therapist-assisted intervention.

Work Package 3: Systems Engineering

Goals
1. Design a system architecture that will facilitate the integration of the DREAM software.
2. Establish procedures for software integration and quality assurance.
3. Carry out integration and quality assurance process.
4. Coordinate the research activities in work packages that feed into the systems integration.

Work Package 4: Sensing and Interpretation

Goals
1. Develop a computationally robust platform for multi-sensory information fusion and interpretation of the real-life therapy interventions.
2. ~~2.~~ Evaluate individual packages of the sensing and interpretation and ensure they meet all the requirements from a fully-operational RET system.

Work Package 5: Child Behaviour Analysis

Goals
Production of algorithms for mapping.

Work Package 6: Robot Behaviour

Goals
Continue the development of the software for robot control by improving T6.3 and T6.4 deliverables.

Work Package 7: Ethics of Child-Robot Interaction

Goals
Produce a final document exploring the ethics of child-robot interaction for children with autism spectrum disorders, deliverable D7.2 (version D7.2.2).

Work Package 8: Dissemination & Exploitation

Goals

1. Task 8.1 (Dissemination): Continue to disseminate DREAM project results via publications, website, etc.
2. Task 8.2-8.6 (Exploitation): Make significant progress on short- and long-term exploitation

Deliverables and milestones tables at M30

TABLE 1. DELIVERABLES							
Del. no.	**Deliverable name (from Annex 1)**	**WP no.**	**Nature**	**Delivery date from Annex I (proj month)**	**Actual / Forecast delivery date**	**Planned effort (from Annex I)**	**Comments**
D5.2	Behaviour assessment model	5	R	M30	M34	30	The deliverable is delayed by a few months due to the timing of project meetings.
D9.3	Intermediate progress report	9	R	M30	M30	2	This report. A pro-forma deliverable that serves no actual purpose because it is superseded by the periodic report at M36. D9.1-9.4 are in Annex 1 only because the PO at the time was considering 6-months reviews, which however were never implemented

TABLE 2. MILESTONES						
Milestone no.	**Milestone name**	**Means of verification (from Annex I)**	**Delivery date from Annex I**	**Achieved Yes/No**	**Actual / Forecast achievement date**	**Comments**
MS3	Core functionality in child behavior assessment	D3.1, D3.2, D5.2	M30	Yes	M30	Milestone objectives are encapsulated in the requirements articulated in the deliverables.

Project management

Following the reporting template/instructions, this section is intended to briefly summarise the main consortium management and dissemination activities during the reporting period (P3).

5.1 Management activities

Consortium management tasks:
The main consortium management activities in WP9 are the organization of consortium meetings (cf. below) and the organization/collection of deliverables (cf. Table 1).

Problems which have occurred and how they were solved or envisaged solutions:
In response to P2 review recommendation 3, four new tasks dealing with short- and long-term exploitation, T8.3-T8.6, were formulated, and four additional deliverables were specified, D8.2-D8.5, for which partner ALD/SBR is responsible.

List of project meetings, dates and venues:
The main project meetings in P3 – in which all (or practically all) of the partners participated – have been the following (cf. WP3 text for more details on developers/integration meetings):

- general progress meeting (and 2nd review), Brussels/VUB, May 2016
- integration meeting, Skövde/HIS, 6-7 June 2016

It should be noted that DREAM partners of course also regularly meet and interact at international conferences and other events. Furthermore, several partners regularly interact in Skype meetings, e.g. PLYM and VUB in the context of WP6.

Project planning and status:
The project is progressing according to the (revised) plan, apart from the deviations noted above.

5.2 Dissemination and use of knowledge

Publications

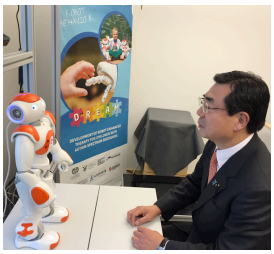
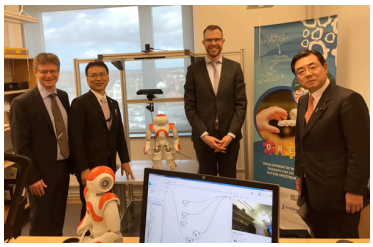
A list of publications is maintained at http://www.dream2020.eu/publications/. A summary will be included in the periodic report at M36.

Events, demonstrations, and talks include the following examples:

HIS:

- talks (Ziemke)
    - scientific
        - invited keynote on "Using Social Robots in Psychotherapy for Kids with Autism : the DREAM Project" at workshop on "Contemporary Technologies for Mental Health, Montpellier, France, 29-30 Sept. 2016

        - invited talk on ”Intentions, Intentionality, and the Illusion of Agency” at the conference ”Robotics in the 21st Century”, Volpriehausen, Germany, 24-28 September 2016
        - invited talk on “The Embodied Mind – Sum, ergo cogito?” at the workshop “Embodiment at Play: Embodied Perspectives in Psychology, Philosophy and Neuroscience”, Univ. Bergamo, Italy, 23 Sept. 2016
    - popular-scientific
        - invited talk on social dimensions of human-robot interaction at KVIT 2016 “Quality of Life” conference (cognitive science student conference), Linköping (Apr. 2016)
- other presentations:
    - presentation of DREAM to representatives of the regional parliament of Kanagawa, Japan, in collaboration with a local school for autistic children (Apr. 2016) (Billing, Hemeren)

UBB:

- XI Autism-Europe International Congress, 16-18 September 2016, Edinburgh, Scotland
    - *Long-term robot-enhanced intervention: social engagement, emotional and behavioral reactions of children with ASD in an imitation task.* Authors: Cristina Costescu, Bram Vanderborght, Silviu Matu, Aurora Szentagotai, Anca Dobrean, Daniel David

VUB:

- Dissemination events (examples):
    - Robocup Junior (30.4.2016), Brussels, Stand and presentation during robotcontest for 500 participating children (excluding parents and visitors).
    - Wetenschapsexpo (29-30.4.2016), Brussels, stand and presentation during price award.
    - Guest lecture Erasmus Hogeschool: 'Idea and Innovation Management' (25.4.2016): innovatie in robotica
    - Lift Up Robotica (De Lift Education, Diest, 2.4.2016) World Autism Awareness Day, Nao coding workshop for children with autism
    -

PLYM:

- Demonstrations at UK Robotics week 2016
- Newspaper article, “The Robot Revolution in Caregiving”, The Atlantic: http://www.theatlantic.com/technology/archive/2016/04/the-robot-revolution-in-caregiving/479535/

DMU:

- Interview on BBC Click about Robot Ethics, May 2016 (Richardson)
- Interview about DREAM in Polish psychology magazine Charaktery, April 2016 (Coeckelbergh)

ALD:

- Presentations in which DREAM was mentioned (with at least a few slides)
    - SMART School on Computational Social and Behavioral Sciences, Sept. 2016, ISIR, UPMC, Paris, *France*
    - 8th International Conference on ICT Innovations 2016, Sept. 2016, Ohrid, *Macedonia*
    - IEEE Smart World Congress 2016, July 2016, Toulouse, *France*
    - IEEE International Conference on Robotics and Automation (ICRA), Industry Forum, May 2016, Stockholm, *Sweden*
    - TATA Communications, Moonwalk - Robotics in Service Industry talk series, April 2016