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DE-ENIGMA

Playfully Empowering Autistic Children

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THE PROJECT

The DE-ENIGMA project, funded by **Horizon 2020** (the European Union's Framework Programme for Research and Innovation), aims to **create and evaluate the effectiveness of robot-based technology, developed to support autistic children in their learning**. The main goal is to realise **robot-assisted therapy solutions specifically for children on the autism spectrum**. Leading to effective therapies more tailor-made for individual children than previously available.

The technology will allow for **interaction between children with autism and robots** that is:

- **context-sensitive** (caters for the specific need of the child in the local culture);
- **child-sensitive** (automatic understanding of children's facial, gestural, vocal and verbal cues);
- **real-world-sensitive** (robust and naturalistic).

DE-ENIGMA answers a number of long-standing questions in research on autism which may speed up the adoption of technologies in education and health by:

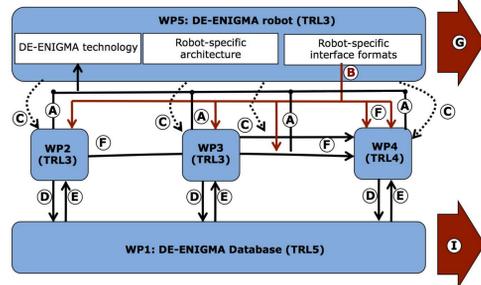
- **testing** whether autistic children's ability to learn socio-emotional (facial, bodily, vocal) skills within a direct-instruction programme is better during a robot-led than a therapist-led interaction, when performed in unconstrained recording conditions and when using all three modalities (face, body, voice);
- **conducting** a gold-standard randomized controlled trial to test the efficacy of a direct-instruction versus an implicit learning approach within a robot-led interaction;
- **examining** for the first time the effects of culture by conducting fine-grained analyses on autistic children's recognition and expression of emotion expressions (via face, body, voice) in Western/ Northern European (UK) and Eastern/ Southern European (Serbian) contexts and by examining whether culture moderates autistic children's ability to learn socio-emotional skills during robot-led versus therapist-led interactions.

The **consortium** is a partnership made up for various entities: **university research departments in the field of computer science and psychology, non-governmental organisations focusing on autism and a company working in the field of robotics**. The project will **run until August 2019**. DE-ENIGMA ensures through its commercial partner (IDM) that the knowledge and know-how accruing from the DE-ENIGMA endeavors is transferred to the number of **potential public-private interested parties**.

TECHNOLOGY & METHODOLOGY

DE-ENIGMA achieves target goals through five work packages (WPs):

Fig. 1: Pert Chart (Interrelations between DE-ENIGMA components/WPs)



DE-ENIGMA components/WPs:

- WP1:** database- collection, annotation and release (TRL 5)
- WP2:** perception- low- and mid-level audio-visual feature extractor (TRL 3)
- WP3:** reasoning- affect, stress and interest level estimator, and rapport detector (TRL 3)
- WP4:** action - robot-child interaction (TRL 4)
- WP5:** robot integration and evaluation (TRL 3)

*TRL = Technology Readiness Level
NOTE: TRL given as is on the start of the project (month M0)

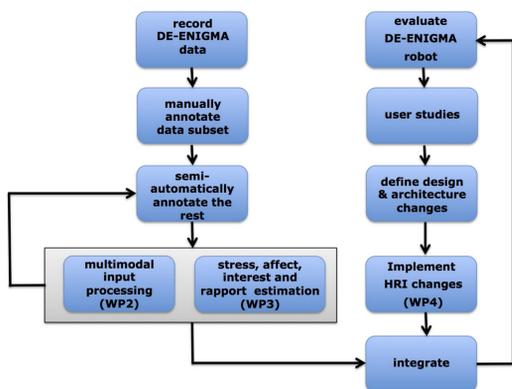
Interrelations between DE-ENIGMA components/WPs:

- (A)** provides tools to be integrated into the DE-ENIGMA applications
- (B)** defines data formats to produce/expect as output/input
- (C)** Provides optimization of the tools (i.e. DE-ENIGMA components)
- (D)** provides semi-automatic annotation of the DE-ENIGMA data
- (E)** provides training data / template examples for machine learning methods
- (F)** Data flow between the components (simplified)
- (G)** provides tools for behaviour analysis of children with ASC for research within and beyond the project
- (I)** provides annotated data of target behaviours to the research community

The key to DE-ENIGMA approach in development of target technology -> **incremental iterative work plan:**

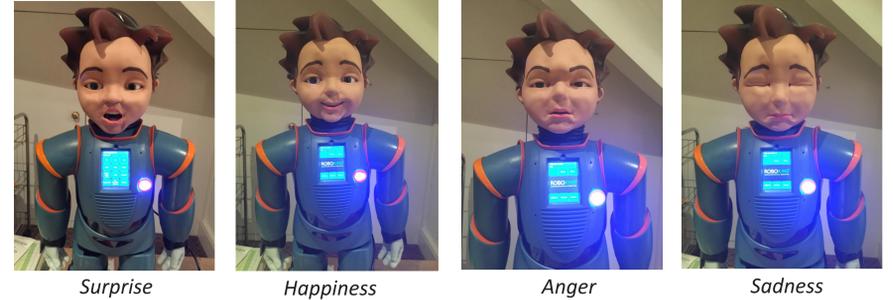
- technology and system are repeatedly evaluated and refined;
- feedback from children and the therapists involved in the study on potential failure points is received early enough;
- incompatibilities in design of components are prevented from going undetected until it is too late.

Fig. 2: Incremental, iterative work plan of the DE-ENIGMA project



STUDY DESIGN

- **Recording of audio and 2D and 3D Kinect-based dynamic facial and bodily behaviour** of 130+ children with autism of English and Serbian cultural background (approx. 65 subjects per culture).
- Children (5-12 years old) will be involved in **therapist-based teaching (no robot) and robot-based teaching** (using Wizard of Oz setting).
- Teaching perception, expression, understanding, and social imagination related to **4 affective states**: surprise (high arousal), happiness (positive valence), anger (negative valence, high arousal), and sadness (negative valence, low arousal).
- **Direct-instruction strategies** (i.e. directly teaching emotional displays) during the following six phases (10-15 minutes long).



EXPERIMENTAL SETTING ON SITE IN SERBIA

Recording rooms and Equipment: Robot room (Testing room 1):

- 4 microphones
- One analog high-performance space diversity wireless receiver (AKG SR45).
- One analog high-performance wireless body-pack transmitter (AKG PT45).
- One audio interface (M-Audio M-track Quad Interface).
- 6 webcams (5 webcams + 1 on the chest of the robot).
- 1 Microsoft Kinect One
- 1 keypad
- 1 desktop and 1 laptop

Recording rooms and Equipment: Robot room (Testing room 2):

- Audio configuration identical to the one adopted for the robot room.
- 5 webcams
- 1 Microsoft Kinect One
- 1 desktop and 1 laptop



DE-ENIGMA Database Recording so far:

- 6 weeks of recordings in Serbia/Belgrade;
- 42 participants (21 boys, 5 girls), 5-12 years old (23 in robot sessions, 19 in therapist sessions);
- 14/12 children randomly assigned to robot-/therapist-led sessions;
- **Pre-testing:** background and parent questionnaire, Vinneland adaptive behavior scale;
- **Post-testing:** SRS, SDQ and CARS2-QPC scale (mid-to-moderate vs severe autism).

NEXT STEPS

- Processing of the collected audio-visual data (feature extraction and model design)
- Database recording in UK/London
- Integration of the developed models with Zeno
- Evaluation and dissemination of the developed DE-ENIGMA technology

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