ERF 2017 – WORKSHOP SUMMARY

Title: Empathic Human-Robot Interaction: A Joint Industry-Academia Outlook for the Future

Organisers:

This workshop was organised by the members of the Topic Group for Natural Interaction with Social Robots (NISR). The four main organisers were:

(1) Prof. Kerstin Dautenhahn, University of Hertfordshire, UK
(2) Teena Hassan, Fraunhofer IIS, Germany
(3) Prof. Ana Paiva, Universidade de Lisboa, Portugal
(4) Dr. Katrin Lohan, Heriot-Watt University, Scotland

Date and time: 24 March 2017, 08:30 to 10:00

Number of attendees: About 50

Outline of the workshop:

The workshop began with the opening words from Prof. Kerstin Dautenhahn, the lead organiser of the workshop. She gave an outline of the objectives of the workshop, the expected outcomes and the activities planned.

Afterwards, six speakers gave short presentations reflecting their perspectives and outlook on the topic of the workshop. Prof. Ana Paiva introduced the speakers. The presentations were followed by a brief question-answer session of about 15 minutes, also moderated by Prof. Ana Paiva.

Following this, Prof. Kerstin Dautenhahn moderated a general discussion for about 25 minutes. These discussions were conducted along three subtopics. Since the allotted room was not conducive to hold three parallel group discussions, the three subtopics were presented sequentially. Finally, Prof. Dautenhahn concluded the workshop and thanked the participants for the rich and lively discussion.

Objectives:

The goal of the workshop was to bring together experts from the industry and academia to discuss the achievements and highlight the challenges involved in empathic human-robot interaction, as well as to jointly define future research directions to address the challenges and key open issues.

More specifically, the expected outcomes from the workshop were:

- Identification of future research directions related to empathic human-robot interaction.
- Identification of examples of how industry can benefit from and deploy empathic machines and robots in the next few years.

Speakers:

(1) Dr. Alessandra Sciutti; Cognitive Robotics and Interaction Lab at the Robotics, Brain and Cognitive Sciences Department, Italian Institute of Technology, Italy
Topic: Actions as a means of empathic communication

(2) Prof. Andrea Bonarini; AI & Robotics Lab at the Department of Electronics, Information, and Bioengineering, Politecnico di Milano, Italy
Topic: Achieving empathic relationships with low cost robots: A need to get market leading positions

(3) Prof. Agnieszka Wykowska; Social Cognition in Human-Robot Interaction research line, Italian Institute of Technology, Italy
Topic: Social attunement in social cognitive neuroscience and human-robot interaction

(4) Dr. Clement Moulin-Frier; Synthetic, Perceptive, Emotive and Cognitive Systems laboratory (SPECS), Universitat Pompeu Fabra, Spain
Topic: DAC-h3A Proactive robot cognitive architecture to acquire and express knowledge about the world and the self

(5) Dr. Costanza Navarretta; Centre for Language Technology at the Department of Nordic Research, University of Copenhagen, Denmark
Topic: Mirroring facial expressions, emotions and empathy

(6) Prof. Erwin Prassler; Professor of Autonomous Systems, Bonn-Rhein-Sieg University of Applied Sciences, Germany; CEO of Locomotec GmbH and runfun GmbH, Germany
Topic: Robotics and empathy- the uncanny valley

Key questions:

The following key questions were intended to be addressed in the presentations and the discussions that followed:

1. What have the academia and industry achieved so far, what questions have we addressed so far?
2. What are the typical use-cases that have been researched so far?
3. What contextual and behavioural aspects can robots already reliably perceive, and how?
4. What are the computational models of empathy? How to integrate empathy in a robot's response?
5. What can we learn from the psychological studies on empathy and (human-human) interaction?
6. What are the challenges we face in existing research?

Summary of the presentations:

The six speakers presented their positions as food for thought for the discussions that followed.

- Dr. Alessandra Sciutti spoke about the power of actions as a means of empathic communication to improve the efficiency of human-robot interaction. While performing an action, humans send implicit signals to communicate their intent, which enables the other agent to be prepared and collaborate efficiently to achieve the joint goals. These implicit signals form the basis of empathy and mutual understanding. Some examples of implicit signals are gaze, head and hand movements, body posture, sounds, etc. The ability to read these implicit signals and send appropriate implicit signals is an important component of empathic human-robot interaction. These capabilities are essential for robots to collaborate efficiently, fluently and safely with humans to achieve joint goals.

- Prof. Andrea Bonarini spoke about the research issues involved in achieving empathic relationships with low-cost robots such as robotic toys, which constitute a multi-million dollar market. He noted that the robotic toys of tomorrow should have the ability to initiate interactions with the user, and to react to the implicit signals in a believable way. For price compatibility, it is essential to develop new, inexpensive sensors, actuators and computational methods for detecting and expressing emotional states. Artificial vision and natural language understanding would raise the computational, reliability, cost and privacy concerns. Research is also needed to identify which implicit signals are most relevant and well perceived. Effective performance evaluation methods are also needed to prevent huge commercial loss due to inappropriate interactive behaviour.

- Prof. Agnieszka Wykowska spoke about empathy being an element of social attunement in human-human interactions. As robots do not possess the physiological processes that enable it to be empathic, the solution is to detect the socio-emotional signals conveyed by humans and to make the robots imitate the empathic behavioural responses that would be displayed by humans. She recommended the use of cognitive neuroscience methods and well-controlled experiments to identify the signals and responses that are the key markers of empathy in human-human interactions. She also highlighted that humans perceive empathy in a robot's actions, when they are not aware of what cues the robot uses to trigger its actions.

- Dr. Clement Moulin-Frier spoke about the relevance of building an integrated cognitive architecture for social robots and human-robot interaction. Human-robot interaction is a complex process that involves a large number of software modules performing different

cognitive functionalities such as perception, planning, etc., and interacting with each other in real-time. Integrating all these modules is very challenging from the software engineering and cognitive modelling points of view. A cognitive architecture helps to integrate these modules and deal with the complexity in a better way. He presented the DAC-h3 architecture that was developed as part of the WYSIWYD EU Project, and described how it helps a robot to acquire and express knowledge about the world and itself.

- Dr. Costanza Navarretta presented her research that investigated how mirroring theory could explain the empathic facial expressions that occurred during first-time encounters between two humans. The mirrored facial expressions of emotions as well as co-occurring facial expressions of complementary emotions were both related to empathy. For example, when one person smiled to convey amusement, the other person smiled too. When one person showed hesitancy, the other person showed support. Based on the collected data, it was possible to train classifiers that could predict the facial expression of one person, based on that of the other. These data-driven cognitive models learned from human-human interaction could be applied to the domain of human-robot interaction to enable robots to convey empathy.

- Prof. Erwin Prassler recommended the building of robots that serve humans but do not pretend to be humans. He was sceptical about robots that look like humans, communicate like humans and behave like humans. Instead, he recommended building of robots that look, behave, decide, move and manipulate in a human-friendly way. He narrated several examples of interaction between robots and persons with dementia during the trials conducted at a care facility in Germany. The trials showed that movements were crucial for attracting attention to the robot and for generating interest to interact with it. However, a human-looking robot was either perceived as a puppet or as a remotely operated toy. To conclude, he recommended keeping the uncanny valley as wide as possible.

The presentations of all six speakers can be found at the homepage of the Topic Group for Natural Interaction with Social Robots http://homepages.herts.ac.uk/~comqkd/TG-NaturalInteractionWithSocialRobots.html

Subtopics for the general discussion:

1. Empathy: Nature versus Technology

    a. What is the added value of empathy in robots?
    b. Who should empathise: the robot or the person?
    c. When do we need empathy with robots?
2. Key aspects to be included in AI models of empathy
3. Applications/use cases where the robotics industry can benefit from empathic robots in the next five years.

Highlights from the question-answer and general discussion sessions:

- The spectrum of methods that have been employed to realise empathic human-robot interaction is very wide. There are low-level processes such as mimicking, and high-level processes involving complex cognitive models. There are also differences in the embodiment and other aspects. Do we need complex robots for realising empathic processes? Complex systems help in detailed investigation of interaction with humans to identify what the most relevant aspects of empathic interaction are.
- An interesting discussion about the difference between human-friendly and human-like robots took place. It was noted that while human-like shape might not be critical for empathic human-robot interaction, certain human-like behaviours could play an important role.
- Robotic interventions with autistic children are done with humanoid robots.
- Contextual and behavioural aspects that robots can already perceive: gaze, movements of eyes, head, hand and body, gestures, facial expressions, speech, etc.
- The way a robot moves also reflects empathy.
- There are two types of empathy: automatic empathy and cognitive empathy. Sometimes, humans show empathy not because they feel it, but because it is the correct behaviour.
- We need to understand when to show empathy and in which contexts. Empathy is not needed in a washing machine, but it is essential in teaching applications.
- Why is empathy necessary for robots? Empathy improves the efficiency of interaction between robots and humans. Empathy is necessary to build relationships between robots and users.
- Pre-programmed behaviours can be annoying and inefficient. For example, people may actively refuse to listen to a car that repeatedly says that you are tired and should stop.
- What does empathy mean for other classes of robots, such as exoskeletons and service robots ? Do the differences in embodiment matter? If so, to what extend ? An example : An exoskeleton that does not start walking when the user sneezes could reflect empathy.
- Human-robot interaction studies involve short-term experiments, usually carried out in laboratory settings. Exploring long-term interaction between humans and robots is a challenge and is still an open problem. The role of empathy would be crucial in long-term interaction between robots and humans.

- Achieving results of statistical significance is extremely difficult in human-robot interaction studies, due to the overhead involved in planning and execution. In particular, several ethical, legal and social aspects become crucial in this context.
- Empathic interaction could take away fear from people and help to make humans feel more comfortable with robots and machines. However, for the service robotics industry, the primary concern for the moment would be on how to avoid causing physical harm to the user. Empathy would become a priority only later on.
- Realising human-robot interactions that can positively improve the mood of the user would be of particular interest to the social robotics industry in the coming years.

Key conclusions and recommendations:

- It is recommended to investigate what empathy means for different types of robots, such as exoskeletons, social robots, service robots, and robotic prosthetics and orthotics, and how they can express empathy in their respective application contexts.
- The use of complex systems with more capabilities is recommended to investigate the different aspects of empathic behaviour and to quantitatively evaluate its impact. After the different aspects of empathic interaction have been studied, the most relevant aspects could be selected and realised on simple, low-cost systems for commercialisation.
- Empathic interaction should be a dynamic process that evolves with the aim of building a relationship with the user over time. Pre-programmed, repetitive behaviours are not perceived as empathic by the user, especially when the behavioural hints used to trigger the robot's actions are known to the user.
- Before engineering empathy, it is necessary to understand the basic evolutionary mechanisms of empathy. It is also recommended to investigate the role of automatic empathy and cognitive empathy in human-robot interaction.
- Applications and use cases that would benefit from empathic human-robot interaction in the immediate future include toys, cars, robots in care facilities, and virtual agents for customer service.