Module 2 TRM Cultural Knowledge, Learning Unit 2.2 Capabilities and the potential 'role' of SARs

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THEORETICAL COMPONENT

Principles and Values

This topic will provide some practical examples of what Socially Assistive Robots can do in the health and social care scenario by highlighting some SAR capabilities and the innovation they can bring to the field. Different SARs can obviously do different things depending on the purpose for which they have been built: some are humanoid, others look like animals; some can talk with people with different accents, others can express themselves through gestures or facial expressions; some are equipped with a tablet to show videos or webpages, others have cameras and may be used to understand if an emergency occurred requiring the intervention of medical staff.

Regardless of the type of robot used, it turns out that some things may be simple for humans (e.g., pick up an object from the floor) but highly complex for a robot: we simply cannot expect a robot to do such things given the current technology. However, these limitations may not be evident to people: people's expectations are often forged by robots that they have seen in the media, in literature, movies, or comics. Therefore, as a professional using SARs for health and social care, you must open your mind to understand what is truly achievable by current technology and communicate it in the right way to your patients what robots can and cannot do. To this end, this learning unit will provide you with the skill to distinguish between the capabilities of "imaginary" robots and "true" robots available today or in the near future, to make you more aware of what we can and cannot expect from Socially Assistive Robots in the health and social care domain.

The principles and values that guide this tool include:

- Communication,
- Innovation,
- Open-mindedness,
- Professionalism,
- Truth.

Aims

This tool aims to make participants aware of the actual capabilities of Socially Assistive Robots. In addition, the tool will clarify the difference between "imaginary" robots depicted in books, movies, and comics (which may forge people's expectations) and "true" robots that are available on the market today or will be available in the near future.

Learning outcomes

At the end of this training, the participants

- will be able to distinguish between what SARs can do today and what they cannot do, given the current technology
- will be aware of SARs functionalities that can play a crucial role in health- and social care
- will be aware of the major problems that still need to be solved to make SARs capable of a full autonomous behaviour

- will be able to recognize the practical solutions that robotic scientists implement to simplify such problems.

Relevant definitions and terms

Perception. Perception, in Artificial Intelligence and Robotics, is a process that provides robots with the capability to sense the environment, interpret and understand what they have sensed, and reason about it. The essential elements of a robotic perception system are: sensors (e.g., cameras for video or microphones for audio); algorithms for sensor data acquisition and processing (e.g., to increase the luminosity in a dark image or to remove environmental noise from recorded audio); algorithms for data merging and interpretation (e.g., to detect objects in a picture or to understand the meaning of a sentence starting from the recorded audio). The last phase is possibly done through machine learning algorithms capable of merging different data to produce knowledge about the environment.

Sensors. Sensors are physical devices capable of measuring and recording a physical quantity as it evolves with time. Some examples of commonly used sensors in robotics are: cameras (to capture images or videos); RGB-D or stereo cameras (to acquire 3D information about the surrounding environment); microphones (to capture audio); ultrasound sensors (to measure the distance from the closest obstacles); laser rangefinders (to measure the distance from obstacles with a higher resolution, usually to build a map of the environment); touch sensors (to detect collisions or allow people to physically interact with robots); encoders (to measure the movements of robotic parts).

Autonomous behaviour. Robots are considered autonomous if they are able to perceive the environment, reason about it, make decisions, and then move in complete autonomy without following a script or being teleoperated by someone. Researchers in AI and Robotics usually aim to build fully autonomous robots that may interact with people without the need of an operator: only fully autonomous SARs can assist people as companions during their everyday life. However, building fully autonomous robots is highly complex since autonomous perception, reasoning, and action execution are complex. Nowadays, no robot is capable of "understanding" the surrounding environment as humans are, and very few robots have the required skill and strength to interact with such an environment. For this reason, most of the robots that you can see on the media are not autonomous but teleoperated.

Actuator. An actuator is a component of the robot responsible for controlling a robot part and making it move, typically converting energy into a mechanical force that helps the robot achieve mechanical movements. An electrical motor is a very common type of actuator in robotics, which can be used to control robotic arms, hands, or wheels – if the robot is wheeled. Actuators usually require a significant amount of energy to move mechanical parts, and for this reason, all robots have limited energetic autonomy and need to be periodically recharged. For the same reason, many SARs have wheels, even if their upper body may have a humanoid shape in order to better communicate with people using gestures: wheels are more energetically efficient than wheels (and, obviously, biped locomotion may incur a higher risk of falling).

What the research says

Research focusing on robots' capabilities tends to be technology-oriented. Therefore some parts of the following scientific works may be hard to read for a student without a background in robotics or computer science. However, all these works contain some elements that the reader can appreciate, and therefore we warmly welcome you to look at them.

- ***Zachiotis, G.A., Andrikopoulos, G., Gornez, R., Nakamura, K., Nikolakopoulos, G. A Survey on the Application Trends of Home Service Robotics (2018) 2018 IEEE International Conference on Robotics and Biomimetics, ROBIO 2018.*** The article presents a survey on the possible applications of social and service robots in different scenarios, including education, entertainment, rehabilitation, social interaction, household keeping, gaming, and security. The article provides an exhaustive list of the most popular robots, their physical appearance, and capabilities, highlighting their key enabling features that justify their inclusion in each application area. The article provides a good starting point to understand what "real" robots look like and what they can do. Available here.

- ***Leite, I., Martinho, C., Paiva, A., Social Robots for Long-Term Interaction: A Survey, (2013) International Journal of Social Robotics, 5 (2), pp. 291-308.*** The article addresses the problem of Human-Robot Interaction over long periods by reviewing the current research on long-term interaction between users and social robots. To this aim, the article considers the most popular robots, either commercially available or used as research platforms, and highlights how their main features and characteristics may impact keeping the user's interest high for a long period. Robots for health care, education, interaction with people in public spaces, and assistance at home are discussed by focusing on their interaction capabilities, appearance, and possibilities for adaptation. Available here.
- **Kruse, T., Pandey, A.K., Alami, R., Kirsch, A. Human-aware robot navigation: A survey (2013) Robotics and Autonomous Systems, 61 (12), pp. 1726-1743.** The article addresses the problem of robotic navigation in human-populated spaces, where "navigation" is defined as the capability to move between different places safely by avoiding all possible obstacles on the robot's path. In the last years, the article observes that human-robot interaction has addressed many different capabilities required by social robots in terms of perception, reasoning, and learning. However, for navigation, the presence of humans requires novel approaches that take into account constraints in terms of human comfort and social rules. Then the article provides a survey of existing approaches to human-aware navigation. The article is partly technical in its nature, but a significant part of it may also be appreciated by a non-technical reader. Available here.
- **Yan, H., Ang Jr., M.H., Poo, A.N. A Survey on Perception Methods for Human-Robot Interaction in Social Robots (2014) International Journal of Social Robotics, 6 (1), pp. 85-119.** The article starts from the consideration that autonomous perception is one of the most important capabilities in human-robot interaction (HRI). It then reviews several widely used perception methods that can play a key role in the development of social robots. To this end, the article mentions several commercially available robots or used as research platforms, together with their main characteristics in terms of sensors used, perception methods, capabilities, and main scenarios where they have been adopted. The article is very technical in its nature: however, we suggest exploring at least the first part of the article, where a very interesting survey of the most used sensors and sensing techniques is proposed. Available here.

What do national legislation and international/European treaties and conventions say on the topic?

- **ISO 13482:2014, Robots and robotic devices — Safety requirements for personal care robots.** International standards exist to guarantee compliance of robots with safety requirements, which are covered by ISO13482:2014 Robots and robotic devices – Safety Requirements for personal care robots. Overall, the standard specifies requirements and guidelines for the inherently safe design, protective measures, and information for the use of personal care robots. While the standards generally define requirements and guidelines for mobile servant robots, physical assistant robots, and person carrier robots, specific safety requirements for social robots include hazards related to charging batteries, robot motion, contact with moving components, robot stopping functions. Available here.
- **Expert Group on Liability and New Technologies, Liability for Artificial Intelligence and other emerging technologies, 2019.** In November 2019, the European Commission published a very important document, "Liability for Artificial Intelligence and other emerging technologies." The report addresses the problems raised by autonomous, intelligent behaviour when damage occurs and victims seek compensation. Specifically, the report discusses how the capability of robots to autonomously perceive the environment and take decisions accordingly can make the existing regulations inadequate or obsolete. Only regulation to determine the so-called "strict liability" is harmonized at the EU level: strict liability covers all cases in which damages are caused by a defective

product, which turns out to be inappropriate in the case of intelligent systems and robots in particular. For example, a SAR may not be defective when it exits from the factory, but it may learn and adapt its behaviour as it acquires new information during usage. To which extent will the producer (or a third-party operator that uses the robot) be liable, in this case? The report discusses this and other aspects that should be taken into account to allow AI and robotic technologies to become part of our lives, suggesting the use of obligatory insurance schemes for AI programs and robots and other possible solutions. Available here.

PRACTICAL COMPONENT

Learning Activities

Activity 1: Explore robots in action and spot their strength and weaknesses

- Watch some videos on YouTube showing robots interacting with people and with the environment:
    - robots that converse with people by executing the commands people give them (available here, 8.59 minutes, feel free to watch only the first two minutes only);
    - robots that search for specific objects and interact with them in different ways (available here, 5.05 minutes, feel free to watch only the first two minutes only);
    - robots that move between different places in the environment (available here, 1.31 minutes).
- Some tasks can be easily performed by robots, some other tasks turn out to be quite complex. While watching videos, you will have to find the "tricks" that researchers have implemented to make things easier for robots. Maybe some objects have been painted of uniform color to be more easily detected… Perhaps the person is only using a pre-defined set of sentences to interact with the robot they learned in advance… Maybe the scenario in which the robot operates has been oversimplified to make things work well… If yes, how? You will have to watch the videos and take notes by answering 3 questions for every video:
    - Is the robot really able to perform this task in complete autonomy?
    - Is the environment simplified to make operations simpler, and how?
    - Is the interaction simplified to make things work, and how?
- Discuss your answers with other participants on the social platform for collaborative learning.
- Resources needed: YouTube video 1, video 2, video 3; social platform for collaborative learning.
- Duration of activity: about 20 minutes.

Activity 2: Control the IENE robot and understand more about its capabilities

- The second activity will require you to interact with a virtual robot that we developed using one of the most famous tools to design conversational agents, i.e., DialogFlow (available here).
- You will have to interact with the robot and ask it to perform a sequence of tasks such as: moving from one place to another, picking up objects and moving them from one place to another, setting up an alarm to remind the person about a visit to the doctor, understanding where the person is and what is doing, and in general helping the person in different ways. Different activities will require different capabilities in terms of perception, reasoning, and action: however, it turns out that this robot, as most robots in commerce, does not have all the required capabilities to perform such tasks! Therefore, when you ask the robot to perform tasks, in some cases, the robot will execute the command; in other cases, it will refuse to perform a task it has not the capability to perform; in some other cases, it will fail! Through trial and error, you will learn the difference between "imaginary" robots that populate books and movies and "real" robots that may assist people now or in the near future. See detailed instructions below.
- Share your experience with other participants on the social platform for collaborative learning.
- Resources needed: DialogFlow chatbot; social platform for collaborative learning

- Duration of activity: 20 minutes.

Instructions for interaction

You are talking with the IENE robot! In order to interact with me, you need to digit your sentence in the virtual smartphone on the left and press return. I will reply as fast as I can! Don't forget to ask me the things suggested in your Learning Unit!

As a suggestion, you may ask me

- wash dishes, clean the floor, wash your clothes;
- bring you some water, your medicine, your clothes or shoes;
- make the way to a room in your house;
- prepare pizza, fish, pasta, or different kind of meat and vegetables;
- help you stand up from your sofa, armchair, bed, chair, or toilet;
- help you make a phone call with a friend of yours or one of your relatives;
- turn on the lights in a room of your house or your smart TV.

ASSESSMENT COMPONENT

Assessment Activities

Activity 1: Now, soon, or in the far future.

- You will be presented with a list of tasks that Socially Assistive Robots are expected to perform in a social and health care scenario.
- Using the same online tool for card sorting you already used in LU 1.2, you will have to categorize these tasks in three classes: 1) Now - robots can successfully perform the task today; 2) Soon - robots may be able to perform these tasks in the near future; 3) In the far future - only "imaginary" robots in books or movies can perform the task (of course, we can never know what will happen in the far future!). Then check the solution below.
- Resources needed: kardSort, an online tool for card sorting.
- Duration of the activity: 5 minutes.

Now, soon, or in the far future

- Take decisions according to Asimov's Laws of robotics
- Go to the kitchen and take a medicine for a person
- Moving from one place to another in the environment
- Converse with people understanding basic commands
- Converse with people in a natural way as like as humans do
- Operate smart devices in the environment
- Feel emotions
- Grasping and manipulating generic objects in a messy domestic environment
- Helping people to raise from bed
- Do things that they were not programmed to do
- Reminding a person to take a pill
- Understand their own position in the environment using sensor data

- Monitoring dangerous situations

Activity 2: Making the robot's life easier

- Please, think about the videos you have watched and the chatbot you have played with. Then play the quiz at the following address. You will be asked to consider a list of tasks that "real" robots are not likely to perform today or in the near future. For every task, we will propose a set of "tricks" that researchers can adopt to make that task feasible, such as colouring objects to make it easier for robots to detect them. You need to identify the "trick" that works better with that task.
- Resources needed: TryInteract, a website for online quizzes.
- Duration of the activity: 3 minutes.

Tricks and cheats

- Navigate from one place of the house to another. Tricks:
  - Stick QR code to walls;
  - Add more sensors to the robot;
  - Use neural networks to recognize places.
- Take and manipulate objects. Tricks:
  - Paint objects with uniform color;
  - Add more fingers to the robot hand;
  - Use neural networks for object recognition.
- Chitchat with people about general topics. Tricks:
  - Always pretend to understand what the person says, by giving general answers like that: "I see", "Good to know", etc;
  - Instruct people to use only predefined commands;
  - Explain to the robot the meaning of what people are saying, as you would do with a child.
- Interact with the environment (turning on/off lights, open/close windows, etc.)
  - Let the robot communicate with smart device for home automation;
  - Teach the robot how to do these things through demonstration;
  - Add a robotic arm equipped with a hand to press switches and turn handles.

EVALUATION COMPONENT

Participants to evaluation

The online evaluation questionnaire of each Learning unit are completed by the MOOC participants (students and student/facilitators) on Survey Monkey

What to evaluate

The criteria for the Learning Unit's evaluation are: coverage of the identified learning needs, innovation and quality of the content and training materials, intuitive and friendly presentation , relevance of learning activities and efficiency for achieving established learning outputs.

Please, complete this online evaluation of the learning unit by clicking on this link:

https://www.surveymonkey.com/r/LJFDZHF