PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Giovanni Ercolano

XXXIII Cycle

Training and Research Activities Report – First Year

Tutor: Silvia Rossi

1. Information

   I, the undersigned, Giovanni Ercolano, Ph.D. student in Information Technology and Electrical Engineering (ITEE) of the XXXIII cycle, have a Masters Degree with honors in Computer Science at the University of Naples Federico II. My master thesis is titled “Recognition of Activity of Daily Living for assistive robotics”. My tutor is prof. Silvia Rossi, assistant professor and Scientific co-chief of the PRISCA lab at the University of Naples Federico II. She is currently Coordinator and Principal Investigator of the National Project UPA4SAR “User Profiling and Adaptation for Socially Assistive Robotics”.

2. Study and Training activities

   During the first year I followed the following courses, seminars and external courses:

   Courses:

   - Tecnologie Digitali e Scienze Umane, Lecturer: prof. Guglielmo Tamburrini
   - Compilers and code optimization, Lecturers: dott. Edoardo Fusella, prof. Alessandro Cilardo
   - Sistema Multiagente, Lecturer: prof. Silvia Rossi
   - Ingegneria del Software – Tecniche Avanzate, Lecturer: prof. Sergio Di Martino
   - Quantum Computing and Artificial Intelligence, Lecturer: prof. Giovanni Acampora
   - Cognitive Robotics & Artificial Intelligence: prof. Maria Carla Staffa

   Seminars:

   - Logic-Based Languages and Systems for Big Data Applications, Lecturer: Carlo Zaniolo, Organizer: Antonio Picariello
   - The age of human-robot collaboration, Lecturer: Oussama Khatib, Organizer: Bruno Siciliano
   - Lecture on “Tailoring waves at the extreme with metamaterials”, Lecturer: prof. Nader Engheta, Organizer: prof. Amedeo Capozzoli
   - Lecture on “near-zero-index photonics”, Lecturer: prof. Nader Engheta, Organizer: prof. Amedeo Capozzoli
   - Malattie professionali da campi elettromagnetici tra scienza e giustizia, Lecturer: dott. Alessandro Polichetti, Organizer: prof. Rita Massa
   - Uso del cellular e tumori cerebrali le evidenze epidemiologiche, Lecturer: dott. Susanna Lagorio, Organizer: prof. Rita Massa
   - “Weak” methods in computational electromagnetics, Lecturer: prof. Salvatore Alfonzetti, Organizer: prof. Raffaele Martone
   - Types and levels of computational explanations in AI: a dual process proposal, Lecturer: dott. Antonio Lieto, Organizer: prof. Guglielmo Tamburrini
   - Parallel and distributed computing with MATLAB, Lecturer: eng. Stefano Marrone, Organizer: prof. Alessandra D’Alessio
   - Filtraggio dell’Azimuth Ambiguity in immagini SAR, Lecturer: eng. Gerardo di Martino, Organizer: prof. Antonio Iodice

   External courses:

   - 2nd International Summer School on Deep Learning - DeepLearn 2018, held in Genoa, Italy, from July 23 to July 27 2018

3. Research activity

My research activity during the first year is addressed to the PRIN 2015 research project UPA4SAR "User Profiling and Adaptation for Socially Assistive Robotics". This project is aimed at assisting with mobile robots in the fields of health and social care, in particular, for assisting elderly people affected by dementia who can be in danger during normal daily activities. For example, the elderly people may forget to take medication, or that they have already completed a certain activity, or may be in a negative state, such as loneliness, anxiety, depression. All this can lead to not caring for one's own person in an adequate manner, having constant need of a caregiver. The robot can be a valuable help for the family and the caregiver, to monitor the activities and health status of the elderly.

The aim is to develop a mobile robotic system capable of considering the profile and needs of the user, adapting its behaviour for better acceptance by the subject. It must therefore regulate its social interaction based on personal factors and the cognitive state of the user. A fundamental feature of the project is the cost-effectiveness with affordable hardware costs without requiring in-house sensors. In addition, we have carried out experiments with different robots, to recognize the best robot in relation to its acceptability and cost.

We have therefore faced a number of challenges in order to achieve this objective. To make the robot acceptable to the subject, we carried out several experiments throughout the year concerning proxemics, navigation, user's pose recognition, activity recognition by camera and smartwatch.

We focus on monitoring the instrumental activities of daily living (iADLs) using a non-invasive reactive system to respect the privacy of the person inside the house. In particular, we experimented this system with the robots Turtlebot 2 and Pepper compared to four different activities (watching tv, ironing, making coffee, talking on the phone) with different poses (sitting, standing, considering also the occlusion and the approach from behind). The approach estimates show that the angle and distance differ on average from those expected. The results showed that such approach can be a useful solution especially when the robot has less reliable sensors, and therefore, even robots like those used in the experiment are comparable despite we have a considerable difference in cost. In fact, the Turtlebot 2 has a low cost compared to Pepper, but Turtlebot 2 has reached the task faster.

For activity recognition and novelty detection of the instrumental Activity of Daily Living (iADL) we proposed a framework composed by two phases: a Learning phase with the Long Short-Term Memory (LSTM), that is a time-series automatic features extractor, and a Modelling phase with the Gaussian Mixture Model (GMM), created for each ADL class to identify novelty class from the extracted features of the LSTM output. The GMM component number is chosen by using BIC and varies for each GMM. The calculation of the log-likelihood weighted on the components indicates if a given element belongs to the class modelled by the GMM. The LSTM is trained on normal ADL, in particular we trained with the UniMiB smartphone-based Human Activity Recognition dataset. The LSTM and GMM are combined to identify novel instances from the Test Set composed by both ADL and Anomaly data. The final results seem promising and the proposed framework will be further evaluated with different datasets providing anomaly-related data.

We also carried out a study on distraction during user monitoring using a mobile robot. The robot must understand when it is the right time to interrupt or not the user, taking into account his personal spaces, and trying to be a non-intrusive system, for better acceptability. The assessment of

distraction in the performance of daily activities was carried out on a sample of seniors. Through video analysis, we have considered the non-verbal cues of the user, to understand the possible disengagement and possible perturbations of the person's behaviour. During the experiments, Pepper did not disturb the elderly people from their activity in the same way. It turned out that human disengagement depends on several factors: the direction and distance of the monitoring, the pose of the person and his/her cognitive involvement.

A Robotic Care System for the Elderly should be accessible and well accepted by end users. To follow this aim we have considered the adaptation of the user in a dynamic environment, abstracting the general functionalities, to then concretize them and adapt them according to the user's profile. Through the collaboration with the CNR - ICAR, we have developed a framework with a multi-level architecture that allows to decouple the actual execution of a service plan (workflow), from its planning and adaptation. As already pointed out, the workflow depends on the cognitive personality, the patient's profile, his preferences and other information that can be dynamically detected during the execution of a plan. The aim is to structure a modular and easily expandable framework, after which you can add, remove or modify the services and then the care plans. We therefore have a Workflow Manager developed by the CNR - ICAR that deals with the daily planning for elderly care, while the other devices such as robots, smartwatches, beacons, or smartphones, constitute the ecosystem that offers the basic personalized services for the care of the patient's health. Finally, the proposed approach follows the RaaS (Robot as a Service) business models, while planning and calculation are based on the cloud to have greater computational power, limiting the costs of the robot. It is expected that in the coming years, domestic care robots will be more widespread thanks to this type of framework proposed.

The future work will primarily involve experimenting with 40 elderly people: 20 with medium form of Alzheimer disease, 10 with mild form of Alzheimer disease, 10 without Alzheimer. During my activity abroad at Sheffield Hallam University, from April 1 to July 1 2018, I'll also make research in therapy with robots for children with cognitive disabilities, in particular, I'll apply my knowledge in the activity recognition and develop robot system based on embedded computer like NVIDIA Jetson TX2, that is optimize for the execution of the deep neural network.

4. Products
    - Publications
        i. Rossi, S., Bove, L., Di Martino, S., & Ercolano, G. (2018, November). A Two-Step Framework for Novelty Detection in Activities of Daily Living. In International Conference on Social Robotics (pp. 329-339). Springer, Cham.
        ii. Rossi, S., Ercolano, G., Raggioli, L., Savino, E., & Ruocco, M. (2018, August). The Disappearing Robot: An Analysis of Disengagement and Distraction During Non-Interactive Tasks. In 2018 27th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN) (pp. 522-527). IEEE.
        iii. Ercolano, G., Raggioli, L., Leone, E., Ruocco, M., Savino, E., & Rossi, S. (2018, August). Seeking and Approaching Users in Domestic Environments: Testing a Reactive Approach on Two Commercial Robots. In 2018 27th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN) (pp. 808-813). IEEE.
        iv. Rossi, Silvia & Ercolano, Giovanni & Raggioli, Luca & Valentino, Marco & Di Napoli, Claudia. (2018). A Framework for Personalized and Adaptive Socially Assistive Robotics. Volume 2215, 2018, Pages 90-95, 19th Workshop "From Objects to Agents", WOA 2018; Palermo; Italy; 28 June 2018 through 29 June 2018;
        v. Rossi, S., Santangelo, G., Ruocco, M., Ercolano, G., Raggioli, L., & Savino, E. (2018, March). Evaluating Distraction and Disengagement for Non-interactive Robot

Tasks: A Pilot Study. In Companion of the 2018 ACM/IEEE International Conference on Human-Robot Interaction (pp. 223-224). ACM.

5. Conferences and Seminars

I attended the following conferences:

- 2018 ACM International Conference on Computing Frontiers (CF'18) held in Ischia, Italy, from May 08 to May 10 2018
- The 10th International Conference on Social Robotics (ICSR 2018) held in Huiquan Dynasty Hotel, Qingdao, China, from November 28 to November 30 2018

I presented the following paper:

- Rossi, S., Bove, L., Di Martino, S., & Ercolano, G. (2018, November). A Two-Step Framework for Novelty Detection in Activities of Daily Living. In International Conference on Social Robotics (pp. 329-339). Springer, Cham.

6. Tutorship

I have assisted in teaching for the course of "Sistemi per il Governo dei Robot" held by Dr. Silvia Rossi:

- 1 hour for the description of the robots of the Prisca lab
- 2 hours for the ROS (Robot Operating System) lesson
- 1 hour for a demonstration and implementation of ROS nodes on Pioneer 3DX robot.

I am currently aiding master graduate candidates for thesis' issues, master students for exams projects concerning laboratory activities, and high school students for RomeCup 2019.

On July 20th 2018, we participated to the "Giffoni Film Festival" where Pepper was part of the jury.

We took part to "Maker Faire 2018" from 12th to 14th October 2018 where we showed demos using Sanbot Elf, Turtlebot 2, NAO, Lego Mindstorms, Microsoft Kinect 2, and Emotion Recognition with RGB camera.

I started tutoring for "Fondamenti di Informatica", "Programmazione" e "Laboratordio di Programmazione".

	Credits year 1							
		1	2	3	4	5	6	
	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary
Modules	18			5,4	6	3		**14**
Seminars	10	0	1,2	1,3	3	1,2	1	**7,7**
Research	40	10	8,8	7	7	8,8	9	**51**
	68	10	10	14	16	10	10	**73**