PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Riccardo Caccavale

XXIX Cycle

Training and Research Activities Report – Second Year

Tutor: Alberto Finzi

1. Informations

Riccardo Caccavale, MS title: Computer Science (Computational Models) – Federico II

XXIX Cycle- ITEE – Università di Napoli Federico II

Tutor: Alberto Finzi

2. Study and Training activities

Courses:

The Entrepreneurial Analysis of Engineering Research Projects – ad hoc ITEE.

Designing and writing scientific manuscripts for publication in english language scholarly journals, and related topics – ad hoc ITEE.

Seminars:

Colloquium on Robotics: Six Kaynote Talks By International Experts

A WiSARD-based multi-term memory framework for online tracking of objects

Model based and pattern GUI testing

Test and diagnosis of integrated circuits

Predictable real-time embodied control system

	Credits year 1								Credits year 2								Credits year 3									
		1	2	3	4	5	6			1	2	3	4	5	6			1	2	3	4	5	6			
	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	**Summary**	**Estimated**	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	**Summary**	**Estimated**	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	**Summary**	**Total**	**Check**
Modules	**18**					3	14	**17**	**15**		3				3	**6**	**7**							**0**	**23**	**30-70**
Seminars	**13**				2,8	2,2		**5**	**4**	1				5,8		**6,8**	**0**							**0**	**12**	**10-30**
Research	**34**	10	10	8	8	7	5	**48**	**45**	9	7	10	10	5	7	**48**	**40**							**0**	**96**	**80-140**
	65	10	10	8	11	12	19	**70**	**64**	10	10	10	10	11	10	**61**	**47**	0	0	0	0	0	0	**0**	**131**	**180**

3. Research activity

Title:

An Architecture for Top-Down Attentional Regulation in Human-Robot cooperative tasks.

Description:

This research activity concerns the design and development of an architecture for robotic cognitive control [Bot01, Pos75], which supports mechanisms of attentional regulation [Norm86] and temporal allocation of attention. In this work, our aim is to endow an autonomous robotic system with executive functions such as cognitive control, working memory and attention [Coh04], improving decision-making processes and behaviour management [Breaz02].

During the research activity a human-robot interaction framework has been designed, starting from the attentional system presented in the first year. The framework is to modulate both reactive and deliberative processes taking into account human interventions. For this purpose, the executive system is endowed with attentional mechanisms that focuses sensory acquisitions/processing and regulates behaviours activations with respect to the human activities, tasks execution, and the environmental context. The overall architecture comprises an interaction module, a task planner, and a supervisory attentional system. The latter is structured in two layers: the attentional executive system (for top-down regulations) and an attentional behaviour-based system (for bottom-up influences). The interaction module [Ros13] allows a human to naturally interact with the robot by combining different modalities. It also exploits a dialogue manager to top-down emphasize behaviours according with the history of the interaction (see [Cac14, Luc13] for details). On the other hand, the task planner can exploit a hierarchical task networks (HTNs) to generate plans where both the human and the robot activities may be involved [Fiore14, Lalle14]. In this framework, a generated plan is exploited as a top-down attentional guidance that drives the robot behaviors towards the task accomplishment. In addition, the attentional regulation mechanism integrates environmental stimuli, interactive behavior, and plan execution while managing behavioral conflicts. In this setting, the bottom-up stimulation emphasizes actions

that are more accessible to the robot, while top-down stimulations exploit task structure, plan sequence and dialogue, to facilitate the activation of task-related and goal-oriented actions.

The proposed framework has been implemented and tested in different case studies considering both simulated and real-world environments [Cac15a, Cac15b, Cac15c]. In the mentioned cases, we show how the proposed attentional executive system can be exploited to execute complex tasks in a flexible manner interacting with humans.

4. References:

[Bot01] M. M. Botvinick, T. S. Braver, D. M. Barch, C. S. Carter, and J. D. Cohen, "Conflict monitoring and cognitive control." Psychological review, vol. 108, no. 3, p. 624, 2001.

[Breaz02] C. Breazeal, Designing Sociable Robots. MIT Press, 2002.

[Cac14] R. Caccavale, E. Leone, L. Lucignano, S. Rossi, M. Staffa, A. Finzi. Attentional regulations in a situated human-robot dialogue. In Proc.of Ro-MAN-2014.

[Cac15a] R. Caccavale, A. Finzi, Plan Execution and Attentional Regulations for Flexible Human-Robot Interaction, in Proc. of System, Man, and Cybernetics, pp. 2453-2458, 2015.

[Cac15b] J. Cacace, R. Caccavale, M. Fiore, R. Alamì, A. Finzi, Attentional Plan Execution for Human-Robot Cooperation, Proc. of the AIRO at AI*IA 2015, pp. 19-28, 2015

[Cac15c] R. Caccavale, A. Finzi, D. Lee, E. Leoni, S. Rossi, M. Saveriano, M. Staffa. Integrating Multimodal Interaction and Kinesthetic Teaching for Flexible Human-Robot Collaboration, Proc. of HFR-2015

[Coh04] J. Cohen, G. Aston-Jones, and M. Gilzenrat, "A systems-level perspective on attention and cognitive control," Cognitive neuroscience of attention, pp. 71-90, 2004.

[Fiore14] M. Fiore, A. Clodic and R. Alami. On Planning and Task achievement Modalities for Human-Robot Collaboration. In Proc. of ISER 2014.

[Lalle14] Raphael Lallement, Lavindra de Silva, and Rachid Alami. HATP: An HTN Planner for Robotics. In 2nd ICAPS Workshop on Planning and Robotics, PlanRob 2014, 2014.

[Luc13] L. Lucignano, F. Cutugno, S. Rossi, and A. Finzi, "A dialogue system for multimodal human-robot interaction," in Proc. of ICMI, 2013, pp. 197–204.

[Pos75] M. I. Posner and C. R. R. Snyder, "Attention and cognitive control," in Information Processing and Cognition, 1975, pp. 55–85.

[Ros13] S. Rossi, E. Leone, M. Fiore, A. Finzi, and F. Cutugno, "An extensible architecture for robust multimodal human-robot communication," in Proc. of IROS-2013, pp. 2208-2213, 2013.

Collaborations:

LAAS-CNRS laboratory, Toulouse (FR). Technology University of Munich, Munich (DE), Airbuss (FR).

5. Products

Publications:

Plan Execution and Attentional Regulations for Flexible Human-Robot Interaction, in proceedings of System Man and Cybernetics 2015 (International conference paper).

Attentional Plan Execution for Human-Robot Cooperation. AI*IA-2015 Italian Workshop on Artificial Intelligence and Robotics (AIRO2015) (reviewed workshop paper at the conference AI*IA-2015, CEUR Workshop Proceedings).

Integrating Multimodal Interaction and Kinesthetic Teaching for Flexible Human-Robot Collaboration, International workshop on Human-Friendly Robotics (HFR2015) (reviewed workshop paper)

Deliverables:

Deliverable 7.5.2 for SAPHARI project (WP7).

Submitted:

“Flexible Task Execution and Attentional Regulations in Human-Robot Interaction”, submitted to IEEE trans. in Cognitive and Developmental Systems

In preparation:

Paper for Ro-Man2016, International Conference on Intelligent Robots and Systems.

6. Conferences and Seminars

Participation to the Workshop AIRO2015 (Ferrara).

Participation to the Final Review Meeting SAPHARI (Augsburg- Oberpfaffenhofen).