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 – Third 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:

Testing Automation – ad hoc ITEE.

Introduction to Artificial and Computational Intelligence – ad hoc Industrial Engineering.

	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						6	**6**	**29**	**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	8	8	8	8	8	3	**43**	**139**	**80-140**
	65	10	10	8	11	12	19	**70**	64	10	10	10	10	11	10	**61**	47	8	8	8	8	8	9	**49**	**180**	**180**

3. Research activity

Title:

An Architecture for Top-Down Attentional Regulation in Robotics Supporting flexible plan execution, human-robot interaction and learning.

Description:

This research activity concerns the design and development of an architecture for robotic cognitive control[Bot01, Pos75] which supports mechanisms of attentional regulation [Norm80] 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, the attentional system presented in the previous years has been extended and applied to different robotic scenarios. The framework is to modulate both reactive and deliberative processes taking into account of human interventions and environmental changes. For this purpose, the system is endowed with attentional mechanisms that focus sensory acquisitions/processing and regulate behaviours activations with respect to the human activities, the tasks execution, and the environment [Cac15a,Cac16a]. The system integrates an interaction module [Ros13,Luc13,Cac14] and a task planner [Fiore14,Lalle14,Cac15b,Cac16b] that top-down regulate task activation and execution.

The attentional framework has been also deployed to design an attentive user interface suitable for monitoring the activities of multiple drones involved in search and rescue missions in the Alps [Cac16c,Cac16d]. The interface is modelled as a supervisory attentional system [Coo00,Coo06] that exploits top-down and bottom-up attentional regulations to filter the information flow toward the operator, by selecting and adapting the communication mode according to the context and the human state. The interface has been assessed in a simulated case study by comparing user performance gathered with or without the attentional filtering.

Moreover, we extended the proposed attentional system with a learning mechanism that allow the interactive refinement of the structured tasks. The framework combines physical human-robot interaction [Sav15] with attentional supervision [Coo00,Coo06] in order to support kinaesthetic teaching, incremental learning and cooperative execution of hierarchically structured tasks [Cac15c,Cac16e]. Specifically, human demonstrations are automatically segmented into basic movements exploiting contextual information. The generated primitives are simultaneously monitored by the attentional system, which relates them to the associated task structure exploiting top-down and bottom-up attentional mechanisms. The proposed approach has been evaluated considering a robotic manipulator operating in a kitchen scenario considering complex, structured and incremental tasks.

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

[Cac15a] Plan Execution and Attentional Regulations for Flexible Human-Robot Interaction, R. Caccavale, A. Finzi, in Proc. of SMC-2015.

[Cac15b] Attentional Plan Execution for Human-Robot Cooperation J. Cacace, R. Caccavale, M. Fiore, R. Alamì, A. Finzi, Proc. of AIRO-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.

[Cac16a]R. Caccavale, A. Finzi, Flexible task execution and attentional regulations in human-robot interaction, IEEE Transactions on Cognitive and Developmental Systems, 2016.

[Cac16b] R. Caccavale, J. Cacace, M. Fiore, R. Alamì, A. Finzi, Attentional supervision of human-robot collaborative plans, Proc. of ROMAN-2016.

[Cac16c] J. Cacace, R. Caccavale, A. Finzi, V. Lippiello, Attentional multimodal interface for multidrone search in the Alps, Proc. of SMC-2016.

[Cac16d] J. Cacace, R. Caccavale, A. Finzi, V. Lippiello, A human-robot interaction framework for search and rescuein the Alps, Proc. of AIRO-2016.

[Cac16e] R. Caccavale, A. Finzi, D. Lee, M. Saveriano, Integrated task learning and kinesthetic teaching for human-robot cooperation, Proc. of AIRO-2016.

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

[Coo00] R. Cooper, T. Shallice, Contention scheduling and the control of routine activities, Cognitive Neuropsychology, 2000

[Coo06] R. Cooper, T. Shallice, Hierarchical schemas and goals in the control of sequential behaviours, Psychological Review, 2006.

[Fiore14] On Planning and Task achievement Modalities for Human-Robot Collaboration. M. Fiore, A. Clodic and R. Alami in 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.

[Norm80] D. Norman, T. Shallice, Attention to action: Willed and automatic control of behaviour, Tech. report, DTIC Document, 1980.

[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, 2013.

[Sav15] M. Saveriano, S. An, D. Lee, Incremental kinaesthetic teaching of end-effector and null-space motion primitives, Proc. of ICRA-2015.

Collaborations:

TUM: Technology University of Munich, Munich (DE).

5. Products

Publications:

Flexible task execution and attentional regulations in human-robot interaction, IEEE Transactions on Cognitive and Developmental Systems, 2016.

Attentional supervision of human-robot collaborative plans, in proceedings of IEEE international symposium on Robot and Human Interactive Communiaction (ROMAN) 2016 (international conference paper).

Attentional multimodal interface for multidrone search in the Alps, in proceedings of System Man and Cybernetics 2016 (international conference paper).

A human-robot interaction framework for search and rescue in the Alps, AI*IA-2016 Italian Workshop on Artificial Intelligence and Robotics (AIRO2016) (reviewed workshop paper at the conference AI*IA-2016, CEUR Workshop Proceedings).

Integrated task learning and kinesthetic teaching for human-robot cooperation, AI*IA-2016 Italian Workshop on Artificial Intelligence and Robotics (AIRO2016) (reviewed workshop paper at the conference AI*IA-2016, CEUR Workshop Proceedings).

Cognitive control and adaptive attentional regulations of robotic task execution, euCognition meeting in Vienna, Austria, 2016.

In preparation:

Paper for Autonomous Robots, Springer Journal.

6. Conferences and Seminars

Participation to the conferenceSMC2016 (Budapest).