ADAPT

IST–2001-37173

Artificial Development Approach to Presence Technologies

Deliverable Item 1.3
Management report
Revision number 2

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Partners Contributed: ALL

Short Description:
Contributors:

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This revision number 2 of the deliverable 1.3 has been produced taking into account the suggestions of the reviewers after the meeting in Venice on May 5-7th, 2003.

Updates:

- Planning for next meeting and improved coordination
- Effort detailed by partner, workpackage and task
- Plan of work for next period [short version]
- Added PowerPoint presentations delivered at the kick-off meeting
- Added list of deliverables
- Added description of activity within Omnipres

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Summary

1 Coordination and collaborative activities

ADAPT started on September 1st, 2002 with a consortium composed of 3 partners. The research activity was initiated with a kick-off meeting that was held in Paris on January 20-21. The meeting was attended by all partners. A copy of the agenda with the list of attendees is enclosed. The kick-off meeting objectives were two: 1) update the mutual knowledge about the scientific activities of the partners; 2) plan in more details the initial steps of the project. The second meeting is scheduled to be held in Venice just before the joint review meeting of the PRESENCE initiative in May 2003.
During the management part of the meeting documents describing the procedures and format for the preparation of the first year report and the cost-statement (both due in September 2003) were presented.
Besides these formal meetings the cooperation during this initial phase of the project went on particularly through e-mails and phone calls. The major issues discussed were related to the preparation of a **theory of intentionality** as in Deliverable 2.1 and to a minor degree to different experimental setups and the planning of the experimental part. Discussions about joint experiments were also very interesting both before and during the discussion at the meeting.
Considering that this is the initial phase of the project, when everybody is preparing for the following experimental part collaboration is proceeding as planned. The first year of the project is mainly devoted to the implementation of the experimental setups and the definitions of the experimental protocols.
Around month 12 we foresee also a more formal definition of how the lines of work (described in the additional document) of the partners will be integrated into a coherent global picture. This includes the plan for the assessment of results and the definition of an overall methodological framework. We see this latter aspect as functionally dependent on the theoretic aspects of the project and consequently it will be defined after the preparation of Deliverable 2.1 and 5.1 (definition of the tentative theory of intentionality).

2 Research activity up to month 6

The research activity is proceeding as planned.

2.1 DIST – University of Genoa

The research activity at DIST has been directed mainly along two directions:

- Design and implementation of a robotic hand with tactile sensing.
- Formulation of a theory of intentionality and the sense of being there.

These activities are described in details in deliverables 2.1 and 5.1. In short, the robotic hand is completed and it's being debugged both mechanically and electrically. The hand is five-fingered, with six controlled degrees of freedom and 16 moveable joints. It is equipped with Hall effect sensors for measuring the position of each moveable joint, motors have digital encodes, and FSR-type sensors are now being interfaced to the hardware of the hand. The combination of Hall sensors and encoders allow to measure simultaneously the position and torque being applied to each joint. In practice, joints are coupled through springs and therefore by measuring the deflection of the springs we can estimate the force applied to each joint. The encoders allow measuring the global positioning of the fingers. FSR sensors are expected to cover the palm and the back of the hand and each segment of the five fingers. They have been tested in isolation; we are now proceeding to the final integration.

The proposed theory of intentionality (described in details in D2.1) is still at the level of a **draft**. The document hence presents a tentative theory with candidate definitions and/or assumptions. The initial idea (at the time of preparing the proposal) was to produce a document with a contribution to the **theory** of presence and with a strong integration of experiments and concepts from all the partners. This process revealed to be longer than expected but we believe to be definitely worth in order to bridge the gap from robotics, engineering, computer science, into psychology and neural sciences.

The tentative theory at the moment of writing makes an explicit assumption on the nature of presence (the feeling of being there). In brief, a conscious being is a system that experiences (feels) something. To build an artificial conscious being we must deal with what is to feel something, the feeling of being there, or presence. As a working hypothesis we propose that experiencing something is a kind of causal relation with that something. What kind of causal relation? We propose a particular kind of ontological counterfactual causal relation (elsewhere called reciprocal causation, mutual causation, or co-causation). This relation is defined "intentional relation" (or "onphene"). An artificial conscious being is a system whose structure is totally built by these intentional relations. Its development is driven by these intentional relations triggered by physical reality. An intentional relation is a process in which the occurrence of an event creates the conditions for the occurrence of an event of the same kind (if I am impressed by a landscape, I will try to repeat that experience). Then the design of an artificial conscious being is based on an architecture capable of letting external events provoke the repetition of events of the same kind. In a developing artificial conscious being, this attitude to repeat events can be named a motivation. An artificial conscious being is a system capable of developing new motivations on the basis of its experience.

The formulation of the theory is now relatively at an early stage. The next step is to work at the definition of a set of experiments in order to validate the assumption, rules, and consequences of the theory within the domain of scientific explanation.

2.2 AI-Lab, Zurich

Given that the primary research focus of the Artificial Intelligence Laboratory (AI Lab), University of Zurich, is the role of embodiment in the understanding via building methodology of artificial systems, the main contributions of the AI Lab will be directed towards investigating the role of embodiment and morphology. It is important to delineate two aspects in this notion of embodiment. The first aspect concerns the physical properties of the system, specifically, how the robotic setup is to be constructed. The second aspect concerns the information-theoretic implications of an embodied system. One of the innovative aspects is based upon the hypothesis that a “sense of presence” results from the complex interplay between morphology, materials and control of the system. Morphology in this context refers to physical characteristics as well as the positioning of sensors and motor components in the robotic setup.

Thus, research activity at the AI Lab will primarily focus upon the following research directions:

- The first research direction concerns the exploitation of different morphologies and material properties in the experimental robotic setup, in order to significantly reduce the complexity of control for particular behavioral tasks.
- The second research direction concerns the design of a humanoid inspired robotic setup, which will allow for more complex experiments in sensory-motor coordination acquired through agent-environment interaction. The design of this robotic setup will be done in collaboration with the Lira-Lab, University of Genoa.
- The third research direction concerns the design and implementation of a system architecture that will control the robotic setup as well as exploit the body morphology.
- The fourth research direction concerns the investigation and study of the information-theoretic implications of embodiment, such as the generation of patterns induced through sensory motor coordination.

Concerning the first point of the research focus, previous research has indicated that morphological and material constraints, which include anatomy, and properties of the muscle-tendon system, induce biases in behavior that are necessary for generating patterns of sensory stimulation relevant for biological organisms. Similar morphological and material properties and constraints apply to embodied cognitive systems. Morphology has proven to be essential in developmental robotics, given its relevance to establishing correct sensory motor coordination. For example, this can be observed in the formation of categories, which can only be formed if the agent has the proper morphology and can apply the proper sensory-motor coordination (Lungarella and Pfeifer, 2001), (Lungarella and Berthouze, 2002a), (Lungarella and Berthouze, 2002b).

Regarding the second point of the research focus, the robotic setup needs to be both a situated and embodied system possessing a physical body equipped with enough sensor and motor capabilities to interact with the environment in significant ways. The robotic setup will be composed of a robot arm with torque and haptic feedback equipped with tactile sensors, and a four-degree of freedom head. The head will use retina-like CMOS cameras for vision and microphones for acoustic perception. Experiments executed using this robotic setup will be psychologically inspired and designed to investigate the role of haptic perception in conjunction with vision and auditory perception, and how they are combined with sensory-motor coordination. Past experiments using a six degree-of-freedom robotic arm have tested the physical as well as the information-theoretic implications concerning the nature and origin of sensory signals, and the way these are processed by an artificial neural system. Preliminary results demonstrated a significant reduction in complexity induced through sensory-motor coordination (Gómez and Lungarella, 2003), (Lungarella et al. 2003).

Concerning the third point of the research focus, the architecture controlling the robotic setup is to maintain two goals. The first is for the system to learn how to exploit environment interaction in order to establish a coherent behavior. In this context, coherent means that, during exploration of an environment the, system learns to derive sensory-motor coordination from multi-modal sensory integration. For example, the system needs to deduce that a falling object has visual and acoustic components, which are part of the same event. The second goal is for the system to develop and refine its own exploration strategies to augment its exploratory repertoire. For example, learning that releasing a grasped object will elicit the "falling object" event. The system will be initialized with the goal of exploring and acquiring new representations. Perceptually the system will be initialized with a set of visual, auditory and haptic primitives as well as a very simple repertoire of motor actions represented as coordinated motor synergies similar to motor reflexes.

In relation to the fourth point of the research focus, we propose to mimic developmental processes via defining morphological changes during the artificial ontogenetic developmental process. Due to the current state of technology we cannot have physically growing robots, therefore we proposed a method to "simulate" development. We will use a high-resolution sensory and high-precision motor system; though will begin by simulating sensor and motor changes in software. Specifically, the first change is to be the simulation of low-resolution sensors, and the second is to be the simulation of a low precision motor system. Over time, the resolution of the visual sensors, and the precision of the motors will be gradually increased in order to investigate the following hypothesis: if the system begins with low resolution vision sensors and a low precision of movement, and gradual increases are made in vision sensor resolution and movement precision, then this will lead to faster learning comparative to a system that is initiated with complex sensor and motor modalities.

References

Gómez, G. and Lungarella, M. (2003). Simulating development in real robots by gradual increase of sensory-motor complexity. In preparation.

Lungarella, M. and Pfeifer, R. (2001). Robots as cognitive tools: Information-theoretic analysis of sensory-motor data. In Proceedings of the 2nd International Conference on Humanoid Robotics, Waseda, Japan.

Lungarella, M. and Berthouze, L. (2002a). Adaptivity through physical immaturity. In Proceedings of the 2nd International Conference on Epigenetics Robotics, pages 79-86.

Lungarella, M. and Berthouze, L. (2002b). Adaptivity via alternate freeing and freezing of degrees of freedom. In Proceedings of the 9th International Conference on Neural Information Processing (ICONIP'02), Singapore.

Lungarella, M., te Boekhorst, R., and Pfeifer, R. (2003). Dimensionality reduction through sensory-motor coordination. Submitted to ICONIP2003 10th International conference on Neural Information Processing, June 26- 29 2003, Istanbul, Turkey.

2.3 CNRS, Paris

Our line of research is guided by the option that experiencing our own agency is the sine qua non condition of what differentiates self and other objects, from which emerges "a sense of being there". By agency, we mean, the ability to alter at will one's perceptual inputs, motorically or attentionally. This implies not only unified sensation that integrates visual, auditory and haptic sensory modalities, but also action-perception and perception-action coupling. We should also keep in mind that, for a developing infant, the primary and decisive embodiment is a social one, not a physical one. Why do neonates prefer human faces, human voices, and human smells? Certainly because humans are more than multisensorial objects, they are dynamically contingent ones. Very young infants detect and expect social contingency, thus telling us that they map their behaviors to their close partners' behaviors. Imitation can be considered as the most perfect example of social contingency, and TV face to face interactions in progress show that 8 week-olds detect being imitated and react via reciprocal imitation. So far, neonatal imitation seems to be selective of human models, which, if fully demonstrated, may promote imitation as a candidate precursor of understanding humans as agents.

Within this framework, the developmental group in Paris is currently involved in experiments devoted to test the development of intermodal transfer and to explore how cross-modal relationships help differentiating self-actions from others' actions via neonatal and early imitations.

Three experiments already started:

1. Concerning intermodal transfer, an experiment is in progress. We are testing the hypothesis of a primitive unity of senses at birth. Previous experiments have provided evidence that intermodal transfer from hand to eyes is present in newborns younger than 3 days. If a primitive unity of senses exists at birth, we should find an intermodal transfer from vision to touch. To test this hypothesis, 50 full-term newborns with an average weight of 3 kg were randomly assigned to two groups of 25. The group 1 has a tactile habituation phase in which the newborns are given an object in their right hand. The test concerns the visual modality. The group 2 is tested from vision to touch. The experiment involves two phases: a visual habituation phase in which the newborns are presented with a big red moving object (a prism and a cylinder) and a test tactile phase in which two smaller shapes are given to the right hand in alternation : the familiar visual shape and a novel shape. We expect that newborns will hold the novel shape longer than the shape which has been previously seen. The group 1 has already been tested. On an additional population, haptic strategies will be explored, via the use of finger sensors for pressure as an index of specific exploratory procedure about shape, texture or size relevant to visual identification of the objects. Palm, finger enclosures and digit movements will be the dependent variables.
2. A three-step counterbalanced procedure with newborns, 2-month-olds and 6-month-olds, compares their behavior in front of a robotic mouth protruding its tongue, a human mouth protruding its tongue, and a human face protruding her tongue. The robotic mouth is programmed so as to follows speed and rhythm used by the human model. The aim of the study is to test whether early perception-action coupling

imitation is a selective process that requires biological modeling or whether it is an elective process likely to occur in front of animated though non biological stimuli.

3. Two month-olds and their mothers and 6-month-olds and a stranger interact via teleprompters. The mother and the stranger are either contingent or non-contingent depending on technical manipulations of their records. An additional test will be to delay vocal signals or visual signals separately, so as to explore separate or joint contribution of vision and audition in primary social exchanges.

3 Planned research activity

A complete plan (proposal) of the experiments has been included as additional document. This provides a better view of the experimental activity within Adapt although it clearly doesn't provide the complete picture yet. In our view this overall picture cannot be defined unless the theoretical formulation of the project has reached a more stable and definite form. This is expected to happen by month 12 or 13 with the consolidation of the Deliverable 2.1 and 5.1 which constitute a considerable (though theoretical) effort of the project.

The next step is to meet again before month 12 in order to both refine the final form of Deliverable 2.1 and 5.1 and to link the theory to the planned experiments.

This next meeting should move the project to the next stage of experimentation. A further step is foreseen to improve the evaluation and assessment of experimental results with respect to the theory. This is important to try to actually validate the theory through a multidisciplinary convergence of methods and results. This will be discussed at the next project meeting.

4 Deliverables

The following table lists all the deliverables due at month 6. We included also D2.1 because we believe it to be a major contribution of the project to the initiative although the document is still at an early stage. D1.1 has been completed and the web-page of the project has been published at http://www.lira.dist.unige.it/adapt. The web-page is meant to be continuously "work in progress", there's a password protected section we use as repository for common documents, deliverables, data. The completion of Deliverable 1.2 (Dissemination and use plan) is expected to be delayed because we concentrated our efforts more on the technical and scientific aspects of the project.

Number	Title	Type	Due month	Expected
D1.1	Project presentation	Docs + web site	3	N.A.
D1.2	Dissemination and use plan (DELAYED)	Document	6	12
D1.3	Management report	Document	6	6 (rev1) 12 (rev2)
D2.1	A tentative theory of intentionality and the sense of being there (DRAFT VERSION)	Document	7	12-13
D5.1	System's architecture specifications and design (PROPOSAL, DRAFT	Document	6	12-14

	VERSION)			
Additional document	Plan of experiments	Document	-	N.A.

5 Effort and cost

As it often happens the start of the activities is limited by how fast it is possible to recruit young researchers and post-docs. This is happening also in Adapt where some partners are comparatively late in recruiting. We expect this to be corrected before the end of the first year. No major deviation from the original expenses is foreseen even if more details can be given as the project approaches the end of the first year.

5.1 Effort for the reporting period

One person-month corresponds to N hours:

Participants Code	One person-month corresponds to N hours
C1 - DIST	141
P2 - UNIZH	179
P3- CNRS	135
P4 –UPMC	

Work-Package ID	Title	Reporting period
WP1	**Project management**	1.10.2002 – 31.03.2003

Participants Code	Spent (person-months)	Planned (person-months) Total	Start date / End date Month 1 / Month 36
C1 – DIST	0.5	3	
P2 – UNIZH [1]	0.2	1 (1)	
P3/P4 –CNRS/ UPMC	0.2	1.2	

Work-Package ID	Title	Reporting period
WP 2	**Theory of intentionality and the sense of being-there**	1.10.2002 – 31.03.2003

Participants Code	Spent (person-months)	Planned (person-months) Total	Start date / End date Month 1 / Month 36
C1 – DIST	2	12	
P2 – UNIZH [1]	1.5	10 (5)	
P3/P4 –CNRS/ UPMC	0.5	4	

Work-Package ID	Title	Reporting period
WP 3	**Embodiment and body morphology**	1.10.2002 – 31.03.2003

Participants Code	Spent (person-months)	Planned (person-months) Total	Start date / End date Month 1 / Month 30
C1 – DIST	2	12	
P2 – UNIZH [1]	4.0	24 (10) [1]	
P3/P4 –CNRS/ UPMC	1	12	

Work-Package ID	Title	Reporting period
WP 4	**Development of Coherent Representations**	1.10.2002 – 31.03.2003

Participants Code	Spent (person-months)	Planned (person-months) Total	Start date / End date Month 1 / Month 31
C1 – DIST	2.5	14	
P2 – UNIZH [1]	4.0	25 (10)	
P3/P4 –CNRS/ UPMC	3	26	

Work-Package ID	Title	Reporting period
WP5	**System's architecture**	1.10.2002 – 31.03.2003

Participants Code	Spent (person-months)	Planned (person-months) Total	Start date / End date Month 1 / Month 33
C1 – DIST	1.5	12	
P2 – UNIZH [1]	1.5	12 (3)	
P3/P4 –CNRS/ UPMC	0	4	

Title	Reporting period
Cumulative effort	1.10.2002 – 31.03.2003

Participants Code	SPENT HOURS	Spent (person - months)	Planned hours 1st year	Planned hours (TOTAL)	Planned person-months (TOTAL)
C1 – DIST	**1248**	**8.5**	**2496**	**7488**	**53**
P2 – UNIZH	**2004**	**11.2**	**4296**	**12888**	**72 (29)**
P3/P4 CNRS- UPMC	**635**	**4.7**	**3388**	**6372**	**47.2**
Total					**172.2**

1 The number between brackets report the persons/month spent by permanent staff at UNIZH and not charged to the project.

6 Publications

There are no publications within the reporting period.

7 Activity within Omnipres

The only activity within Omnipres to month six is the participation to the board of director meeting held at Goldsmith College on January 2003. One person from Adapt is also in the organizing committee of the Presence 2003 conference to be held in Aalborg next October. We expect to contribute to the proposed handbook on presence research. We are posting once a month a very short report on the status of advancement of the project to Omnipres as planned.

8 Agenda of kick-off meeting

ADAPT
Kick-off meeting

Paris January 20th-21st, 2003
Venue: Hospital Pitié-Salpêtrière – Batiment de la Force, door at the left, ground floor

Program

January 20: Past and Present
14:30 Adapt Introduction and News: Giorgio Metta
LIRA-Lab: Giulio Sandini, Sajit Rao
UPMC/CNRS: Jacqueline Nadel, Arlette Streri
University of Zurich: Martin Krafft

January 21: Future
9:00 LIRA-Lab: Giorgio Metta, Riccardo Manzotti
UPMC/CNRS: Jacqueline Nadel, Arlette Streri
University of Zurich: Rolf Pfeifer
Discussion
13:00 End of meeting

Attendees:

LIRA-Lab: Giorgio Metta, Lorenzo Natale, Sajit Rao, Giulio Sandini, Riccardo Manzotti, Carlos Beltran
UPMC/CNRS: Jacqueline Nadel, Arlette Streri, Marie Maurer, Pierre Canet, Coralie Sam
University of Zurich: Rolf Pfeifer, Martin Krafft

9 Presentations at the meeting

The presentations given at the kick-off meeting are in the web server at:
http://www.liralab.it/adapt