Cooperation

ICT Theme

Call identifier: FP7-ICT-2009-4

Large-scale integrating projects (IP)

PROJECT MARS

Development of a Prototype Multiagent System for a Collaborative and Cooperative System of Heterogeneous Robots in non structured environments

Date of submission: 01 April 2009

Development of a Prototype Multiagent System for a Collaborative and Cooperative System of Heterogeneous Robots in non structured environments

Proposal Acronym: ***Project MARS***

Type of funding scheme: Large collaborative project

Work programme topics addressed:

- ***FP7-ICT-2009-4***:
- **Coordinator**: Scientific coordination: Abdelkader El Kamel, LAGIS – Université des Sciences et Technologies de Lille - Ecole Centrale Lille - Lille (F)
- Administrative and financial management: University of Sciences and Technologies - Lille 1 (F)

List of participants:

Part No.	Participant Organisation Name	Participant Organisation Short Name	Country
1	Université des Sciences et Technologies de Lille	USTL	France
2	Ecole Centrale de Lille	ECL	France
3	Universidad Tecnológica Metropolitana	UTEM	Chile
4	Pontificia Universidad Católica de Valparaíso	PUCV	Chile
5	Universidad de Santiago de Chile	USACH	Chile
6	Universidad Nacional Autónoma de México	UNAM	México
7	Universita Degli Studi di Parma		
8	Universidad de Granada	UPR	Italia
9	Valahia University of Targoviste	UGR	SPAIN
10	University Politechnique Bucarest	UVT	Romania
11	Wittman and Partners	UPB	Romania
12	Computer Technology Institute	**WPCS**	Romania
13	Robotec Robot Company	CTI	Greece
14		RBT	Chile

1. SCIENTIFIC AND/OR TECHNICAL QUALITY, RELEVANT TO THE TOPICS ADDRESSED BY THE CALL (20 pages)

To develop of a Colony of Robots, that is to say, a Prototype of Robotic Multi-Agent System for a Collaborative and Cooperative Community of Heterogeneous Robots. The Community of Robotic Agents allows the coexistence and interaction of heterogeneous robots, and its behavior as a whole group of robots, for the accomplishment of collaborative and cooperative works in a non structured environment

1.1 Concepts and objectives

1.1.1. General objectives

The objective of the project MARS is to improve the position of the EU in academic research by generating and organizing knowledge on Intelligent Agents and Mobil Robotics, developing applications, in a Social Community, and to conceive and to implement a collective of robots working together in cooperative and collaborative way and to exploit this architecture for **strengthening the competitiveness of EU industries.**

The project MARS is guided in the high-priority area of the Systems Cognitive, of Interaction and of Robotics, according to the high-priority line ICT-2007.2.1 (ICT-2007.2.2), for that which the project involves to 7 countries (Chile, Mexico, Spain, Italy, France, Romania, Greece), **to develop, to implement and to put into operation a prototype of a system of Agents Robotics for the realization of collaborative and cooperative works in a not structured environment.**

One of the environments world where it operated will be in exploration activities and environmental supervision in areas of high ecological sensibility and that they are declared as environmental reservation of the Humanity and of Chile in particular as being, the reservations of Fresh water of the Humanity located in the Glacial ones, the Campos of Ice and the Antarctica. Others environments will be in a business world as a support of Logistics in ports.

The main objective is to develop of a Prototype of System of Agents Robotics and multi-agent for a Collaborative Community and Cooperative of Heterogeneous Robots that allows the coexistence and heterogeneous robot's interaction in a community behavior among the group of robots for the realization of collaborative and cooperative works in a not structured work space.

Progress in this area requires a **multidisciplinary consortium** of specialists from the European Community and specialist from Latin America, to present a research project and to develop and implement it in the frame of the CORDIS FP-7 Projects. The consortium will present a project in the FP-7 Call, in the frame of the Challenge 2: - Cognitive Systems, Interaction and Robotics, in the objective specified in **ICT-2009.2.1**: Cognitive Systems Interactions Robotics.

The specified Area and Topics will be: To design, to develop, to implement and to operate a Community of Robotics Agents for a cooperative and collaborative work that it allows acting with multivariable parameters in no structured environments for specific works.

1.1.2. **Specific objectives.**

The general objective of the project MARS is to improve the position of the EU in academic research by generating and organizing knowledge on Intelligent Agents and Mobil Robotics, developing applications, in a Social Community, and to conceive and to implement a collective of robots working together in cooperative and collaborative way and to exploit this architecture for **strengthening the competitiveness of EU industries.**

The **specific objectives** of the project MARS are:

1. To generate a theoretical model that describes, integrates and implements the theory of Intelligent Agents to Actuators and Sensors used in Robotic applications to obtain the Robotic Agents with Internal Connected Interfaces and system of Sensors with Cognitive Agents.

2. To design and to implement an Architecture for Community of Mobile Robots generating a methodology to transform Autonomous Robots in Robotic Agents able to cohabit in a robotic community .

3. To generate an applied theoretical model of ontology for the definition of the different parameters that have social pattern of a community of Heterogeneous Robotic Agents.

4. To propose a model of a Communication System among robots and agents that use special ontology and semantics. This model has to allow the robots to exchange knowledge and to generate a

conversation among Agents, by means of the language based on theory of the speech and Protocols of Semantic Languages ACL

5. To present a model of architecture for a community of Robotic Agents, this will be formed by different agents, each one with a specific mission and assignment inside the structure of the Multi-agent robotics system.

6. To use the different implemented agents, to form the multi agent system, to implement a prototype of robots community, able to carry out a collaborative and cooperative work.

7. To validate and to prove the functioning of the Prototype System of Community of Agents Robotics, to carry out a work in a collaborative and cooperative way, in a no structured environment for the solution on a defined problem.

8. To Apply and to Control the Work in an Community, to Analyze the work environment and the capacity of operation of a Robotic and Human Agents Community

9. To create a Centre of Colony with persons who manage the colony.

10. To create a Nest of the Colony that receives orders and assigns tasks to working robots.

1.1.3. **Concept description**

In robotic systems, the tasks that have to be done increase in complexity, in such away that it is needed a robotics community to achieve the objectives. This community has to have different kind of robots, in hardware and tools. That is to say, the community will be heterogeneous.

This heterogeneity adds a new difficulty to the collective robotics: the aptitude to coordinate individuals with multiple qualities of an intelligent way, considering, in addition, on having faced a certain tasks, each of them fulfils a specific function with which the rest must be able to coexist, obtaining satisfactory results by means of the union of their qualities, and of the work as a whole

The development of this research based on the proposition of a model for Robotic Agents RSMA (Robotics System Multi Agent), capable of controlling a heterogeneous community of robots in order that these cooperate and collaborate among them to come to the aim that somebody has proposed.

Using theory of Intelligent Agents applied to a community of robots for Cooperative and Collaborative work, it is proposed that the community work should be realized on the basis of agreements among their members, as what the SMA (Systems of Multi Agents) integrated to every robot must have the capacity of taking decisions and to have solution of problems, integrating the variables and offers generated for the community, then to come to a general solution, which will be considered to be the best of a group, delivered by the members of the community.

It is sought, therefore, to create a SMA capable of provoking cooperation and collaboration generating intelligence, flexibility and autonomy, besides eliminating the concepts of subordination to arrive to results obtained from actions realized as consequence of decisions agreed by consensus.

As the tasks that must be realized by a robot become more complex, more robots are necessary to be used to achieve the aims. This community of robots, the colony, must have different types of robots, with different hardware architectures and tooling capacities, and they will be employed in a cooperative and collaborative form to reach the objectives. Thus, the robots form a heterogeneous colony of robots.

The utilization of the heterogeneous robots in a community involves a necessary coordination among them in an intelligent way, to fulfill a specific task and to work successfully. Each robot must have a determined function depending on the common aim and to be in the service of the community, using its qualities and its skills. This means that the robots must be utilized in a collective and cooperative organization, as the ants or other insects have.
The communication between the robots must be given in an egalitarian way, this it refers a communication among the members of the community has not intermediaries, and each of them must have the capacity of direct connection with its partners, without establishing first the communication with the agency.
The idea is to develop a Colony of robots as a Prototype of Robotic Multi-Agent System for a Collaborative and Cooperative Community of Heterogeneous Robots, implementing, programming and to put into operation a prototype of a Community of Robotic Agents. This Community allows the coexistence and interaction of heterogeneous robots, and its behavior as a whole group of robots, for the

accomplishment of collaborative and cooperative works in a non structured environment. The colony of robots will have a Centre of Colony, a Nest of the Colony, Colony Leader, Agency Leader, and different types of Working Robots.

In the development of the proposed research, we will use a model of Robotics Multi-agent System RMAS capable of controlling a community of heterogeneous robots in order to make these robots to cooperate and to collaborate among them so as to achieve the purposed aim.

A colony will have the following components and actors: A Centre of Colony, A Nest of the Colony, Colony Leader, Agency Leader, and different types of Working Robots.
Centre of Colony is a place controlled by human beings. It is located far from the working zone of the colony. Persons determine the work that the Colony must realize, what initial and final times are, in what place the work is necessary to be done and when the Colony must report its work. The orders of work are sent to the Nest of the Colony in a remote way.
Nest of the Colony is where the Colony is placed, and it is composed of several heterogeneous autonomous robots; it has Colony Leaders and several Agency Leaders who assign the tasks.
Colony Leader is a robot that has to communicate with the Centre of Colony. This Leader receives the work orders from Centre of Colony; it sends reports of the realized work, problems occurred in the work or in the colony; it decomposes orders into tasks and assigns a task to the different Agency Leaders. It receives the state of works and reports it to the Agency Leaders.
Agency Leader is a robot that communicates with the Colony Leader and with Working Robots or Robot Agents. It receives orders, from the Colony Leader, regarding the task that it is necessary to be realized, determines the needs of Working Robots to accomplish the tasks and sends orders of positioning and carry out working at the working place. It can build a global map of the working place from individual maps, make planning of the works and discompose tasks.
Working Robots are a group of heterogeneous mobile robots that receive orders from the Agency Leader, to move to a workplace and to carry out a given task. The Working Robots communicate between themselves to make decisions by sharing information with the others robots from the team; to determine the best path to arrive to the workplace; to warn if they need help to do a task; to report the work realized, to report when faults occur or the system has little energy, to build its local map; to do tasks in cooperative or collaborative way, etc.
Some of these robots could be specialized. Some of them may have computer vision systems; others - manipulation devices; others can be derricks systems, transport robots, robots repairers, etc.

The objective of the project will improve the position of the EU in academic research by generating and organizing knowledge on Intelligent Agents and Mobil Robotics, developing applications, in a Social Community, and to conceive and to implement a collective of robots working together in cooperative and collaborative way and to exploit this architecture for **strengthening the competitiveness of EU industries.**
Progress in this area requires a **multidisciplinary consortium** of specialists from the European Community and specialist from Latin America, to present a research project and to develop and implement it in the frame of the CORDIS FP-7 Projects.
The consortium will present a project in the FP-7 Call, in the frame of the Challenge 2: - Cognitive Systems, Interaction and Robotics, in the objective specified in **ICT-2009.2.1**: Cognitive Systems Interactions Robotics.
The specified Area and Topics will be: To design, to develop, to implement and to operate a Community of Robotics Agents for a cooperative and collaborative work that it allows acting with multivariable parameters in no structured environments for specific works. The general concept of the project is summarized in figure 1.

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	List of participants and WP inclusion from UTEM			
	Name	**WP**	**Responsability**	**Functions**
3- UTEM	Homero Latorre	2	Local Director	Workpakage Lider
	Fransisco Cofre	4-5	Survey and designrules ultivariables for desicion in robotics agents comunity	Implement a Model for rules decision for a social community of Agents Robotics in a collaborative and cooperative Works for Agents Robots in a Real work Space
	Marta Rojas	3--10	Prototype for Agents Robotics Plataforms system using intelligent agent metodologies	Develop a methodology for transforms and assembled Robotics Mobil Vehicular and Robotics Agents control , for obtained a Agents Robots Mobil Platform
	Mauro Castillo	4-7	Develop and Implemented a Model of a Ontology Agentes Robots comunity works	Implement a Ontology decision maps for a community works in Agents Robotics
	Hector Pincheira	3- 7	Prototype for Agents Robotics Plataforms system using intelligent agent metodologies	Develop a methodology for transforms and assembled Robotics Mobil Vehicular and Robotics Agents control , for obtained a Agents Robots Mobil Platform
	Victor Escobar	5-7	Design of the Collaborative Software Architecture for Robotics Agents	Design and implementation of decision rules for agents and robots in a cooperative and collaborative models
	Ivan Camousseigth	3-7	Prototype for Agents Robotics Plataforms system using intelligent agent metodologies	Develop a methodology for transforms and assembled Robotics Mobil Vehicular and Robotics Agents control , for obtained a Agents Robots Mobil Platform
	Luis Gutierrez	7	Design and implement the Collaborative t Colaborative environmental Works	Design and implementation of collaborative and cooperation agents robotics working in environmental specific space and work
	Alvaro Miranda	7	Design of the Collaborative Transport Comunity for Colaborative Works	Implement a Transport Model for collaborative and cooperative Works for Agents Robots community in a Real work Space
	Angel Fernandez	3-7	Theory and Implementation of a Comunity Cooperative and Colaborative Agents Robots	Design and implementation of Collaborative and cooperation models
	Name (1) Thesis enginners	7	Develop and Implement a Robotics Agents Network	Implement a comunications networki community of collaborative and cooperative Agents Robots Systems
	Name (2) Thesis enginners	7	Inteligents , and conceptual comunications protocol for a Comunity of Agents Robotics	Implement communication networking usable in a community of agents Robotics
	Name (3) Thesis enginners	7	Prototype for Agents Robotics Plataforms system using intelligent agent metodologies	Develop a methodology for transforms and assembled Robotics Mobil Vehicular and Robotics Agents control , for obtained a Agents Robots Mobil Platform
	Name (4) Thesis enginners	7	Programing ontologies, rules and interfases for conecting agents robots comunicatios to a mobil devices	Generation of the programming code of the agents robbots further testing, simulation, and improvement, based on the programming framework defined in the Work Package 7.
	Name (5) Thesis enginners	7	Programing and Operating a networks server for a agents robotics comunity	Programming and Operating a server Agency for a makefeasible a connectiosn to all agents robots comunity based on the programming framework defined in the Work Package 6.
	Name (6) Thesis enginners	7	Implement a Agents Robots Web Portal for Human Comunity acces to Agentes Robots Comunity	Generation of the programming code of the agents robots web portal comunicatiosn and improvement, based on the X-Opennet agents Plataforms defined in the Work Package 8.