L3M SPL Team Description

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Abstract. This paper presents the French-Spanish-Turkish joint team composition and describes the achievements and research objectives for its participation in the 2011 RoboCup Standard Platform League.

1 Team composition

The 2011 team is a joint team between the French team, the Spanish team named *Los Hidalgos* and new Turkish members. The team name L3M is the acronym of the French novel title *Les Trois Mousquetaires* (The Three Musketeers) by Alexandre Dumas.

Institutes and people involved in the L3M team are:

- Université de Versailles (UVSQ),
  Laboratoire d'Ingénierie des Systèmes de Versailles (LISV),
  Science and Technology Engineering School (ISTY),
  Vincent Hugel (faculty staff),
  Pierre Blazevic (faculty staff),
  Patrick Bonnin (faculty staff),
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- Universidad Politécnica de Valencia (UPV),
  Instituto Universitario de Automática e Informática Industrial (AI2),
  Juan Francisco Blanes Noguera (faculty staff),
  Manuel Muñoz Alcobendas (student staff),
  Pau Muñoz Benavent (student staff),
  Ruben Perez Bachiller (student staff),
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– Université Paris 8 (UP8),
Laboratoire d'Informatique Avancée de Saint-Denis (LIASD),
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Loïc Thimon (student staff).
– Universidad de Murcia (UMU),
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Grupo de Investigación de Ingeniería Aplicada (GIIA),
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2 Achievements

The French and the Spanish teams have gained experience in RoboCup since their first participation a few years ago in the standard AIBO league and now in the NAO SPL league. In 2009, the L3M team participates in the SPL league for the first time. In March 2010, the Spanish team *Los Hidalgos* won the RomeCup tournament in the NAO league and the French team accessed the semi finales. In March 2011, *Los Hidalgos* went to the finales. The French team also participated in the German Open.
In the RoboCup 2011 in Singapore, the L3M team did an honest job [1]. The team won 2 games 2-0, tied once 1-1, and lost 3 games with scores of 0-2, 0-2 and 0-5. These participations lead to significant improvements in the vision procedure and behavior design.

3 Research interests

3.1 High priority research objectives

L3M team has defined two high priority research objectives that will be developed for RoboCup 2011 to enhance reactive skills of humanoid robots.

1. The first objective aims at designing efficient collaborative behaviors between soccer robot players inside a team.
2. The second research objective focuses on designing a robust closed locomotion for biped robots.

1st high priority research objective: collective behaviors During the past year, we have implemented a communication module that supports a simple message passing protocol [1]. It allows us to transmit current state and desired state to other players. Therefore, a decisional collective process can be activated to define next actions. It has been applied to simple collective situations and is integrated manually beside our hierarchical finite state automaton [2]. It remains interesting to address a distributed team play decision process to achieve complex actions.

Through the last SPL challenges results, we noticed that some teams do not use any collective behaviors. This is probably due to time needed in such implementation. Through three 2010 technical reports (B-Human [3], rUNSWift [4] and Nao Devils Dortmund [5]), we can see that it is possible to establish primal data sharing system that allows collective playing. Such primal data sharing can contain only self position and ball position, as rUNSWift mentioned, or additionally state and desired state as we did. Goalie is not included in the collective process. For two other teams (B-Human and Nao Devils Dortmund), the collective behavior is more than primal and seems to be useful to score against non collective behaviors. B-Human defines it over a role selector and a tactical selector. The role selector allows players to switch between five roles (undefined, striker, supporter, defender and keeper) that is mainly defined by the number of players on the field. The tactical selector allows to switch between normal, offensive and defensive tactics depending on the goal ratio. Local information is shared to optimize each player behavior. The collective decision process is then well mastered. Nao Devils Dortmund considers that XABSL has several disadvantages: the growing number of symbols to use and combine, the lack of a learning trend and the problem of decision making with instantaneous views in a constrained continuous timed process. To solve the first two ones, they use an action selection mechanism based on an artificial immune network that provides high level aspects of the game. To solve the last disadvantage, they integrate future coordinates of each player in the global decision process.

In the more classical literature, common single agents approaches exist to deal with decision process and can be easily declined to multi-agents cooperation. Potential fields, cellular automata and digital pheromone are one of those. On the one hand, as shared potential fields improve multi-robot coordination [6], we think that it can be applied first to set up an efficient collective looking for ball, and second to enhance efficiency more generally in many collective situations that could be complex.

On the other hand, extensions of XABSL have been recently proposed to specify collective behaviors [7]. Such concurrent hierarchical finite state machines are difficult to set for many players, where each single agent behavior has to contain options for each possible set of multiple agents. We think that a more graphical issue is possible to express collective behaviors over a message passing architecture. As robots can temporary lose connection with others, we think that a more consensual process is needed to maintain a coherent collective issue. We think that such architecture could allow us to anticipate future situations and to finalize such collective actions without final acknowledgments or with rendez-vous situations.

This research in collaborative behaviors is conducted by UP8 and UPV.

2nd high priority research objective: robust closed loop biped locomotion The main objective regarding locomotion consists of designing stable walking gaits for the NAO biped. The robot must be capable of achieving omnidirectional walk through the scheduling of high level movement commands. Currently NAO is capable of walking and turning using open-loop algorithms. As a consequence the robot that can be subject to disturbances can fall down very often. Closed loop algorithms based on the feedback from the inertial sensor and feet force sensors must be implemented to enhance stability.

The French part UVSQ and the Spanish part UMU are already closely cooperating in the design of a new locomotion. The first step consists of implementing a robust open-loop algorithm using a preview controller as did Aldebaran-robotics company [11]. The second step deals with the estimation of the robot's center of mass that can be used for closed-loop control feedback. For measurements and control, we currently use the Matlab software interface for NaoQi kindly provided by the Austrian team [10]. This interface is very useful since it permits to control the robot's joints remotely, get feedback from all kinds of sensors, and use the libraries of matlab for control algorithms and signal processing. The FSR sensors located in the feet can give a qualitative feedback of the portions of foot in contact with the ground. Qualitative information from foot sensors will be used to select the foot that is the most flat on the ground in the double support phase. The inertial sensor can be used quantitatively for control feedback. The third step will aim at designing a closed-loop locomotion algorithm based on center of mass estimation and preview controller. Here it is necessary to carry out benchmarks to check the real added value of the new locomotion algorithm with respect to other existing algorithms.
In order to improve the robots's capabilities to resist strong external disturbances due to stumbling or collisions with other robots, the motion module will also be modified to incorporate reflex motion. Reflex motion will be superimposed to walking gaits commands to anticipate loss of balance and falls. FSR sensors can be used here to anticipate loss of foot contact with ground.

3.2 Other research objectives

Other research objectives concern:

- the setup of execution support tools and developments,
- vision algorithms enhancements dedicated to color learning and detection of white and green border lines,
- absolute self-localization procedures. Up to now the L3M team was using relative positioning with respect to goal poles. But this is not enough when robots are too far away from goals or when goals are obstructed by other robots on the field.

Execution support tools and developments. Program execution environment is very important to deal with real time control robots. At the same time having system tools to trace programs and check execution parameters (priority, memory consumption, CPU using each thread) are very useful to detect bottlenecks and potential problems. In this line a new linux distribution to support Naoqi execution has been started. It is a linux embedded distribution for Nao, as an alternative for the official NaOS from Aldebaran. It is based on Linux Gentoo distribution (Base System Release 1.12.14) and has been developed from scratch, maintaining the stack kernel and some adaptive small changes in the initram from Aldebaran.

It is boot from an ExtLinux into a small initrd with a more complete busybox compilation, adding support – among others – for netcat, which is used as a debugging tool and has been the base of the development till the kernel and some remote access was available. In addition, a static compilation of Flite TTS is used to track the booting process.

The partition layout has been designed in help with unionFS, to keep the integrity by mounting the system partition in read-only and applying all the changes in a secondary one. This prevent file system from corruptions due to non correct robot switch-off.

The package management system in Gentoo – Portage (version 2.1.9.42) – has been adapted to avoid synchronize useless build recipes. Some other improvements have also been made at the runlevels and at the toolchain flags used to build up the distribution.

The second important layer in the run-time support is the threads model. The most of our modules contains at least a main thread where its cohesion can be kept. In order to make this process the most easy and transparent as possible, a superclass called MWthread has been deployed. This class can manage up to 3 different types of thread, which are: periodic, aperiodic and callbacks. All of them can be located in the system as Real-Time threads using standard POSIX calls. This allows the complete monitoring of them using the tools described before.

All the threads are indexed in single instanced class called ThreadsLibrary, where we can manage the life cycle of each one or all as a group. This is very useful in the destruction process of our library and allows the use of a loader which provides a small terminal and interpreter where following Naoqi modules can be managed without miss the Naoqi running. Using the loader we obtain a fast way to reload our code in a quicker way without need to wait mainly for the DCM initialization.

Vision: enhancement with color learning and robust white lines detection. The actual vision processing is based on a `yuv422` color space analysis. The image interpretation is done by subsampling a `yuv422` image to obtain a processing time of 40ms. Our vision process includes a vertical segmentation in a similar way to other teams like [3] that wisely uses such segmentation. Our progressive subsampling steps have been studied in depth and quantified in our

last report [1]. For this year, we plan to enhance ball detection and study color learning to enable off-line and on-line enhancements like [8]. Such enhancements are also possible with simple shape segmentations [9].
Algorithms for detecting lines have been embedded and tested on the NAOS. The processing time varies between three and six times the video rate. However the identification and selection process of lines remains to be implemented and validated. This procedure is very tricky since false positives must be avoided. In a first step, white lines detection will only be used for local situations, when the goalkeeper needs to position itself with to its goal area, and when the first attacker that is supposed to kick-off must position itself with respect to the central circle.

Absolute localization. The global localization system can deal with goal frames of the soccer field with the help of white and green border lines. The objective consists of self-localization of the robot on the field. Instead of using white lines, it can be helpful to use green field borders of the soccer field to have a rough estimation of the robot's position of the field. The idea behind that is to transform some elements detected in the image issued from the camera into a top view image and to run correlation algorithms to match the green patch viewed by the robot in the transformed top view with the green soccer field. The navigation module can then use global positioning thanks to probabilistic methods, but also local positioning with respect to detected edges using adapted Kalman filtering.

Figure 1 depicts the collaborations between L3M team members.

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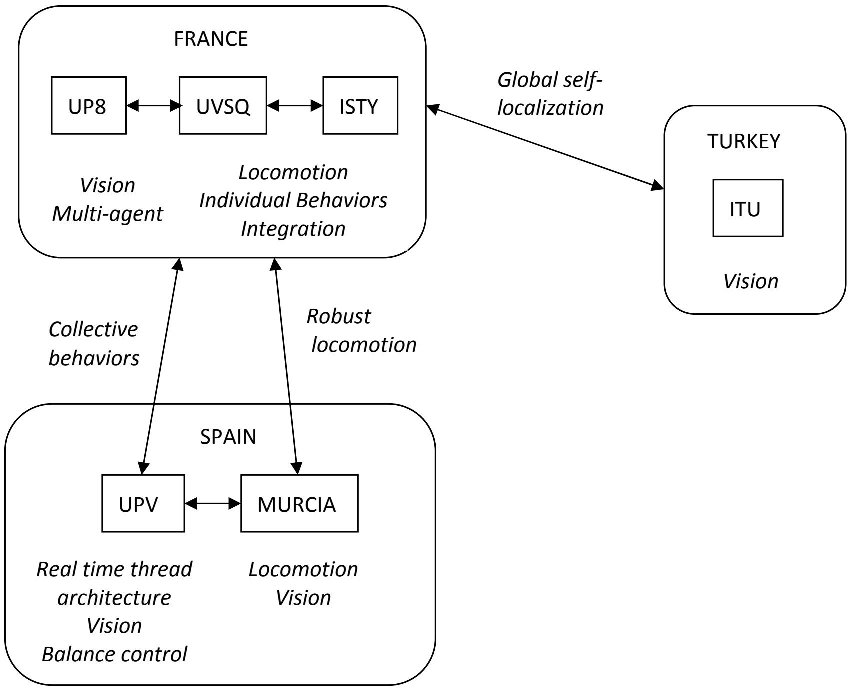

Fig. 1. L3M organization

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