# L3M-SIM Team Description

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**Abstract.** This paper presents the French team composition and research objectives for its second participation in the 2012 RoboCup 3D Simulation Soccer League.

## 1 Team composition

The team name comes from *Les Trois Mousquetaires* in reference to the novel by Alexandre Dumas. The members mainly comes from the standard platform league, where the French team is named L3M. As a part of the L3M team has decided to experiment the 3D Simulation Soccer League, we chose the name of L3M-SIM.

Institutes and people involved in the L3M-SIM team are:

- Université Paris 8,
  Laboratoire d'Informatique Avancée de Saint-Denis (LIASD),
  *Nicolas Jouandeau (faculty staff)*,
  *Zhi Yan (faculty staff)*,
  *Loic Thimon (staff member)*,
  *Thomas Da Costa (student member)*
- Université de Versailles,
  Laboratoire d'Ingénierie des Systèmes de Versailles (LISV),
  Science and Technology Engineering School (ISTY),
  *Vincent Hugel (faculty staff)*.

## 2 Research objectives

### 2.1 Collective behaviors

Collective behavior is one of the most important problems in robotic soccer competition. In this section, we present a prototype for cooperation between robots, which borrowed ideas from our recent works [1, 2]. The proposed method is a lightweight and robust decentralized method by using trade rules for coordinating different robot behaviors (trade-based approach). The core of the idea is to simulate the relationship between buyers and sellers in a business system, to achieve dynamic task allocation by using a mechanism of unsolicited bid.

While solving a single problem with cooperative actions of multiple agents, waiting situations can arise from dependencies between task and from space occupancy. Considering only cooperative agents, there are also predictable situations like congestion and undesirable situations that results from errors and uncertainty (false localization, delayed moves, falls, and all undesired moves). In the present soccer game, such bad situations can append more frequently due to adversarial team play. To solve this problem, we sample iteratively the field to make a map that allow players to be assigned to targets. This approach divide the players into two parts : buyers that purchase services with money and sellers that collect money and provide services. Then the whole coordinate action is defined as a set of disjoint tasks as follows: $Trade =< R, M, T, P, C >$ where R represents the players. M represents the whole mission to be completed, which consists of several tasks, M = m0 , m1 , . . . , mn . T represents the time needed. P signifies the task allocation plan. C signifies the set of cost to complete the whole mission, C = c0 , c1 , . . . , cn . In fact, to each player, the process contains three steps: role allocation, task allocation and task execution where each player is autonomously responsible of its moves according to its perceptions. Because RoboCup 3D Soccer team is a homogeneous system, agents may need to differentiate into different roles at design time or dynamically at run time. Thus we first decomposed the roles of robot into three types include striker, midfielder and defender. which can be identified by computing the distance from the ball, then we use the trade-based approach to assign the roles to each individual robot reasonably.

### 2.2 Locomotion

Walking functions for the simulation league were designed from scratch. The open-loop walking algorithm used is based on the LIP-3D pendulum (Linear Inverted Pendulum) [7, 8]. This technique considers that the robot can be modeled with an inverted pendulum with the mass concentrated on the top. The center of mass (COM) remains at constant height zc. The generation of the COM trajectory is derived from the following equations (longitudinal and lateral directions):

$$d^2/dt(x) = g/zc.x$$

$$d^2/dt(y) = g/zc.y$$

The trajectory of the center of mass is composed of walking primitives. It is generated with hyperbolic cosine and sine time functions. Each walking primitive takes into account the left or right foot as support foot. Walking primitives must be connected to enable successive steps. Figure 1 presents the successive footprints in a forward motion of $0.6[m]$ and the trajectory of the center of mass (COM). Thanks to the COM trajectory each foot trajectory can be calculated. The inverse geometric model of the leg is then used to get the angles to send

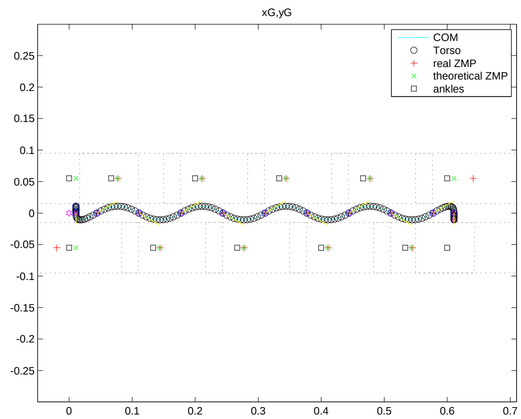


**Fig. 1.** Footprints with center of mass trajectory, theoretical and real zero moment points in forward motion of $0.6[m]$. Model of linear inverted pendulum.

to the joints. This inverse geometric model is also useful to build predefined movements, like knee flexion/extension, hip swaying and kicks.

The walking primitives enable to make steps forward, sideways and to combine forward and sideways steps to walk diagonally. The algorithm also enables to make rotations about a point located on the longitudinal axis of the robot. However it is not possible to rotate about a point located ahead of the robot on the longitudinal axis. This is due to the limited range of the coupled hip joints of the NAO model. The algorithm for rotation was designed separately from the algorithm used for translation walk. This was necessary to avoid numerical drift when the number of rotation steps is largely increased. Figure 2 presents the successive footprints in a rotation motion on the spot of $60[deg]$ and the trajectory of the center of mass (COM).

The parameters for tuning the walk are the following:

- $z_C$: height of the COM,
- $t_{step}$: time required to execute one step,
- $h_{lift}$: height of leg lift-off,
- offset of COM with respect to torso center. Here we assume that the COM is fixed with respect to torso.
- flexion ratio, this is useful to set how much the knees are flexed. This parameter is linked to $z_C$.
- maximal forward step. This parameter is linked to ratio flexion.
- maximal sideways step. This parameter is linked to ratio flexion.

Current developments aim to make the walk fully reentrant to enable the interruption of the current walk by a new walk request, without waiting for the current walk to terminate. It will also be possible to combine all three movements, namely forward, sideways and rotation moves.

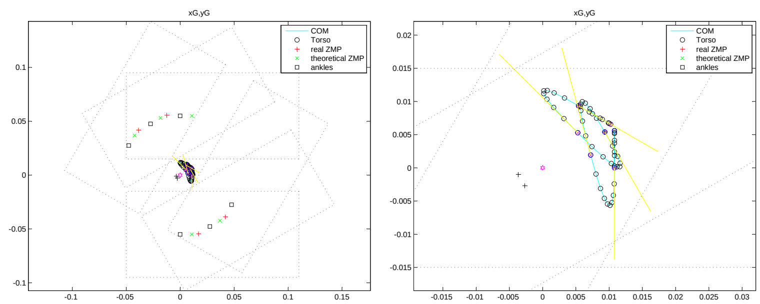


**Fig. 2.** Footprints with center of mass trajectory, theoretical and real zero moment points in rotation motion of 60[*deg*] about the middle of ankle joint centers. Model of linear inverted pendulum. The right view is a zoom of the COM trajectory from left view.

Next developments will aim at making the walk more robust to disturbances. Disturbances can come from the nature of the ground which may be slightly irregular, from the joints that become too hot and therefore weaker, and from collisions with another robot or a fixed obstacle.

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