# Identifying obstacles in the RoboCup Middle Size League

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## Abstract

*When building a representation of the environment for a robot in a multi-agent application, such as the case of robotic soccer, sensor and information fusion of several elements of the environment is an important task. One of the aspects that should be considered is the treatment of obstacles. This paper gives an insight of the general steps necessary for a good obstacle representation in the robot world model.*

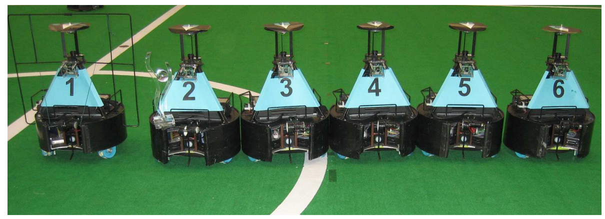



**Figure 1. Picture of the CAMBADA team robots.**

## 1 Introduction

Nowadays, one of the most popular research domains in the area of multi robot systems is the robotic soccer, particularly the RoboCup project[1].

Among RoboCup leagues, the Middle Size League (MSL) [2] is one of the most challenging, using real non-humanoid robot teams to play with an ordinary soccer ball.

CAMBADA, *Cooperative Autonomous Mobile roBots with Advanced Distributed Architecture*, is the Middle Size League robotic soccer team from the University of Aveiro (Fig. 1). It is coordinated by the IEETA[2] ATRI[3] group and involves people working on several areas for building the mechanical structure of the robot, its hardware architecture and controllers and the software development in areas such as image analysis and processing, sensor and information fusion, reasoning and control.

Obstacle identification on a soccer team has the advantage of providing coordination capabilities, for example, allowing team mates to know when a given obstacle is a team mate and eventually "order" him to move away or provide cover. It is also important to ensure a global idea of the field occupancy by sharing the knowledge of obstacles among team mates. With a good cover of field obstacles, passlines and dribbling corridors can be estimated more easily allowing improvements on team strategy and coordination.

[1]http://www.robocup.org/

[2]Instituto de Engenharia Electrónica e Telemática de Aveiro - Aveiro's Institute of Electronic and Telematic Engineering

[3]Actividade Transversal em Robótica Inteligente - Transverse Activity on Intelligent Robotics

## 2 Visual detection

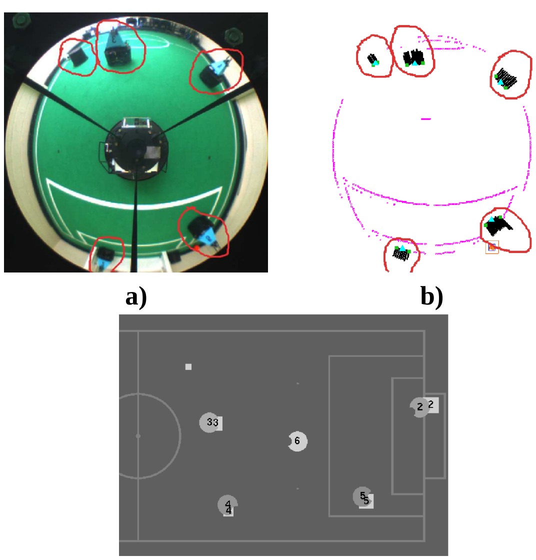
According to RoboCup rules, the robots are mainly black. Since during the game robots play autonomously, all obstacles in the field are the robots themselves (occasionally the referee, which is recommended to have black/dark pants). The vision algorithm takes advantage of this fact and detects the obstacles by evaluating blobs of black color inside the field of play [3]. Through the mapping of image positions to real metric positions [1], obstacles are identified by their center (triangle on the image captures) (Fig. 2 b)) and left and right limits (squares on the image captures) (Fig. 2 b)). This is done by creating, from the center of the image (the center of the robot), radial sensors around the robot, each one representing a line with a given angle, which are then analyzed for the search of black regions. These are called *scanlines* [4].

Since the vision system is a non-SVP hyperbolic catadioptric system [1], sizes of objects on the image vary with the distance to the robot. Due to an inverse distance map calculation, by exploring a back-propagation ray-tracing approach and the mathematical properties of the mirror surface, the relation of distances in the image and the real world is estimated and the image blobs size can be mapped into approximated real metric sizes. These estimated metric positions include the obstacles left and right limits and their centers.

## 3 Obstacle identification

With the objective of refining the information of the obstacles, and have more meaningful and human readable information, a matching is attempted, in order to try to identify obstacles as team mates or opponents.

To identify which of the obstacles are team mates and which are opponent robots, a fusion between the own visual information of the obstacles and the shared team mates positions is performed. The agent keeps information about each obstacle it is detecting, eventually with a numeric identification, correspondent to the team mate if it succeeded on its matching. In Fig. 2 c), each robot represents itself and robot 6 (the lighter gray) draws all the 5 obstacles evaluated (represented by squares with the same gray scale as itself). All the obstacles correspondent to team mates were correctly identified (marked by its corresponding number over the obstacle square) and the opponent is also represented with no number.



**a)** **b)** **c)**

**Figure 2. Illustration of obstacles detection and identification. In a): image acquired from the robot camera; In b): the same image after processing; In c): image of the control station.**

## 4 Obstacle sharing

Obstacle sharing allows the team robots to have a more global perception of the field occupancy, allowing them to estimate, for instance, passing and dribbling corridors more effectively.

However, one has to keep in mind that, mainly due to illumination conditions and eventual reflexive materials, some of the detected obstacles may not be exactly robots, but dark shadowy areas. If that is the case, the simple sharing of obstacles would propagate any false obstacle among the team. Thus the algorithm for sharing the obstacles makes a fusion of the several team mates information.

After building the worldstate using only information from its own sensors, the agent checks obstacle information shared by team mates. Their obstacles are matched with the own ones. Each robot keeps the information of obstacles that it does not see by itself. However, it only accepts an obstacle if it is confirmed by at least two team mates. Fig. 3 depicts a situation where robot 2 considers the existence of an obstacle in the center of the field by shared information. It only accepted the obstacle because it was confirmed by both robots 5 and 6.

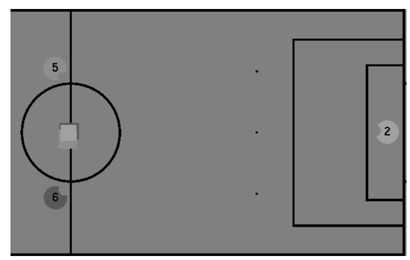



**Figure 3. Image of the control station.**

## References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