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World modeling on an MSL robotic soccer team

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ABSTRACT

When a team of robots is built with the objective of playing soccer, the coordination and control algorithms must reason, decide and actuate based on the current conditions of the robot and its surroundings. This is where sensor and information fusion techniques appear, providing the means to build an accurate model of the world around the robot, based on its own limited sensor information and the also limited information obtained through communication with the team mates. One of the most important elements of the world model is the robot self-localization, as to be able to decide what to do in an effective way, it must know its position in the field of play. In this paper, the team localization algorithm is presented focusing on the integration of visual and compass information. An important element in a soccer game, perhaps the most important, is the ball. To improve the estimations of the ball position and velocity, two different techniques have been developed. A study of the visual sensor noise is presented and, according to this analysis, the resulting noise variation is used to define the parameters of a Kalman filter for ball position estimation. Moreover, linear regression is used for velocity estimation purposes, both for the ball and the robot. This implementation of linear regression has an adaptive buffer size so that, on hard deviations from the path (detected using the Kalman filter), the regression converges faster. A team cooperation method based on sharing the ball position is presented. Other important data during the soccer game is obstacle data. This is an important challenge for cooperation purposes, allowing the improvement of team strategy with ball covering, dribble corridor estimation, pass lines, among other strategic possibilities. Thus, detecting the obstacles is ceasing to be enough and identifying which obstacles are team mates and opponents is becoming a need. An approach for this identification is presented, considering the visual information, the known characteristics of the team robots and shared localization among team members. The described work was implemented on the CAMBADA team and allowed it to achieve particularly good performances in the last two years, with a 1st and a 3rd place in the world championship RoboCup 2008 and RoboCup 2009 editions, respectively, as well as distinctively achieve 1st place in 2008 and 2009 editions of the Portuguese Robotics Open.

1. Introduction

Nowadays, there are several research domains in the area of multi robot systems. One of the most popular is robotic soccer. RoboCup[1] is an international joint project to promote artificial intelligence, robotics and related fields. Most of the RoboCup leagues have soccer as platform for developing technology, either at software or hardware levels, with single or multiple agents, cooperative or competitive [1].

Among RoboCup leagues, the Middle Size League (MSL) is one of the most challenging. In this league, each team is composed of up to five robots with maximum size of 50 × 50 cm base, 80 cm height and a maximum weight of 40 kg, playing in a field of 18 × 12 m. The rules of the game are similar to the official FIFA rules, with required changes to adapt for the playing robots [2].

Each robot is autonomous and has its own sensorial means. They can communicate with each other, and with an external computer acting as a coach, through a wireless network. This coach computer cannot have any sensor, it only knows what is reported by the playing robots. The agents should be able to evaluate the state of the world and make decisions suitable to fulfill the cooperative team objective.

CAMBADA, *Cooperative Autonomous Mobile roBots with Advanced Distributed Architecture*, is the Middle Size League Robotic Soccer team from the University of Aveiro. The project started in 2003, coordinated by the IEETA[2] ATRI[3] group and involves people working

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[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.

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