French RoboCup Legged league Team Description paper

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Abstract. This paper presents the French RoboCup team of the Legged League and the developments being currently made to participate in the 2003 edition of RoboCup.

1 Introduction

This document is decomposed into 3 parts. The first part describes the research interests of the team, namely legged locomotion, perception systems and inter-robot communication. The second part gives some points on how to address the RoboCup challenge. The third part is dedicated to the team developments and its involvement in RoboCup activities, public demos and publications.

2 Research interests

2.1 Legged locomotion

The team of articulated locomotion systems is working on legged locomotion since 1995. The current research interest focuses on gait transitions between crawl and trot. The USNW team achieved excellent results by tuning a kind of trot. Crawl gaits have also been implemented by other teams with more or less success. If trot is well suited to walk fast, the crawl gait can be suited to precise positioning. However transitions between gaits are not very well managed. The research purpose of the French team is to design new algorithms with generalized parameters that can incorporate smooth transitions between all kinds of gaits, from crawl to trot, even faster gaits. The locomotion should also be made omnidirectional to improve the robot's maneuverability. Another research axis in locomotion includes algorithms that can deal with irregular ground crossing.

2.2 Perception systems

The main problem encountered in visual perception concerns the lighting conditions variations. A visual system can be considered reliable when it is insensitive enough to variations in luminosity. Presently the vision is based on segmentation in the YUV space. Other color spaces can be explored to see if colors can be better separated. This is to avoid confusion between colors. In addition, the object outline detection can be used at the same time with color detection to improve the reliability.

2.3 Inter-robot communication

Since last year, wireless communication can be used to design multi-agent systems where robots can interact with each other in order to achieve a common task. If the robots can localize themselves inside the environment, they can exchange some useful data about what they see and the situation they have inferred from the objects detected in the scene. Before we can incorporate some artificial intelligence onboard, the robots must be able to master some lower level skills such as gait adaptation to the terrain, visual recognition and localization. Communication among robots can help them make an overall cartography of the environment together.

3 Addressing the RoboCup challenge

1st challenge: time-limited goal shooting challenge with a black-and-white ball

For this challenge, the French team will use the vision algorithms developed for the challenge of last year that consisted in recognizing different shapes with black-and-white texture like 'T', 'L', etc. However these algorithms should be adapted to detecting the ball. The computing power available should be used for ball edge detection or some ball density calculation.

2nd challenge: localisation without colored landmarks, using only the boundaries and field markings.

The first step to deal with this challenge is to implement 2D to 3D transformation to get information of angles and distances from the 2D image into a 3D world reference frame. For this purpose, the 3D geometric or kinematic model of the head must be used. In some cases, it can be possible to get the position and orientation of the robot with one image only. This assumes that the robot has been able to detect the field boundary and the angle of the boundary in the image, and that it has been able to recognize a field marking like the central or the penalty line (or another texture in the boundary if any).

The second step consists of updating the different parameters of a statistic method like the Monte Carlo's using virtual robots in order to converge towards the position and orientation with enough accuracy.

In the third step the scanning movement of the head and the body displacements should be optimised in order to better refresh the computation and to accelerate localization convergence thanks to new visual data.

3rd challenge: avoidance challenge where a robot is required to navigate from one end of the field to the other, without touching other, stationary robots placed randomly on the field.

This year collision avoidance must absolutely be incorporated for the soccer games. This challenge should help better design related algorithms. The technique that seems to bring fair results consists of detecting blobs inside the green carpet. This technique was implemented with success by the CMU team in 2002. The French team is planning to use the same kind of technique.

4 Team developments and involvement

4.1 Special effort on integration

Last year the French team spent a lot of time in designing debug interfaces with wireless connection, and did not have time to validate all the onboard modules together. This year the integration part will get priority over the other parts. In order to make testing and validation easier, special TCP/IP servers have been incorporated into the robot code that serves to play soccer. At every stage of development 2 people are in charge of checking the onboard programs and testing the behavior of the robot.

4.2 Special developments for onboard implementation

– New algorithms are being developed for addressing the following issues:

  - Regarding the localization challenge without landmark, a complete new code has to be rewritten.
  - To improve the visual perception system, the algorithm will search for white color below the two colors of the landmark. This should enhance the reliability of landmark detection. For obstacle detection, everything that is not detected as the orange ball within the green color of the carpet will be marked as an obstacle. However, only obstacles detected that are considered to be too close will be used for the collision avoidance algorithm. In addition, detection algorithms are being improved to reduce the computing power needed for the vision module.
  - local behaviors are also under study. The team will pay special attention to the shoot reflex that was not so precise last year. Other local behaviors are being designed that involve inter-robot communication. Local behaviors that are based on the cooperation between robots and that could be implemented with reasonable success are listed below:
    - one robot heading for the ball and other attackers playing the role as a flanker to assist the possessor of the ball.

    * Robots covering the field by adjusting their respective placement on the field according to the context.
    * The goalkeeper robot calling its defenders to come to its rescue if it sees the ball approaching dangerously.
    * Two robots attacking the opponent goalkeeper penalty area without being in the way of each other.

- Development of a special network module:

  With the wireless interface at disposal the French team already developed a kind of netgateway module that can handle up to 6 TCP connections. This means that 4 robots at max. can communicate with each other. Robots can connect with each other at boot time, whatever the order of boot, and even if one of them has to be switched off and restarted. The netgateway module can be easily replaced with the TcpGateway provided by SONY without changing the code of the other modules.

4.3 Special developments for the remote operator

This work consisted of defining complete interfaces for debugging onboard locomotion, vision, and localization wirelessly. They can be run using cygwin/Xfree/Qt environment. These interfaces have been presented in the 2002 technical RoboCup report, and are still operational.

- The vision stream interface permits to display images in three resolution, low, medium and high. Color detection table (CDT) images can also be displayed, either the medium CDT image that comes from the robot's hardware , or the high resolution CTD image reconstructed by software. Stream or static modes can selected. In stream mode, the robot sends images successively. The remote operator can also display bounding boxes of the objects detected in the scene: ball, landmarks and goals.
- The tunetrot interface allows to remotely control the velocity of the robot using a 3 DDL joystick. It is also possible to use position control. The interface serves to tune the trot parameters and to control head movements. In addition it is possible to switch between control mode or autonomous soccer modes, trigger special reflexes such as shoot.
- The localization stream interface will be used to display successive robot's positions and orientation computed by the robot itself from the data acquired using the objects detected. This interface will be very useful for the localization challenge.

4.4 Practice

The French team participates at the German Open since 2001, takes part to public demos with the Sony quadrupeds in public school or places for special events like Internet or Science festivals. These participations are a good way to test the developments made on the robots for RoboCup.

4.5 Papers and educational activities

The French team has written several papers related to RoboCup. The most recent ones (2001-2003) are the following:

References

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Other activities include the writing of a French book on OPEN-R SDK and AIBO programming, and Applied Robotics courses that use AIBO as a robotic platform.