ISocRob 2001 Team Description

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Abstract. *This paper describes the ISocRob team current status, new features planned to be demonstrated in RoboCup 2001, and the project long term scientific goals, as of March 2001. An evolution of the team prior software architecture, full demonstration of multi-sensor navigation during games, a new goalkeeper and field robots endowed with dribble capability are new features that will be briefly described.*

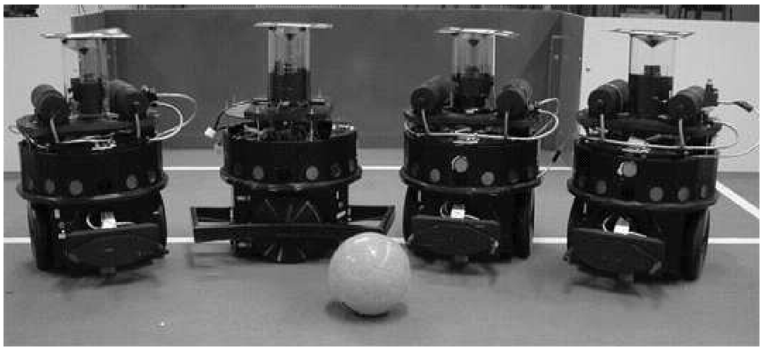

Fig. 1. ISocRob team robots. The goalkeeper is the second from the left.

1 Introduction

The ISocRob team, shown in Fig. 1, has been participating in RoboCup events since 1998. This participation is part of the team scientific project **SocRob** (*Soccer Robots* or *Society of Robots*), under which several graduation and post-graduation students have been developing their Final Year Projects, M.Sc. and Ph.D. theses. The project involves the Intelligent Control and Artificial Intelligence groups of the Lisbon location of the Institute for Systems and Robotics

(ISR/IST), and aims at developing a formal framework for teams of cooperating robots, demonstrable in real world scenarios. The current research topics within the project include Multi-Agent Systems, Multi-Sensor Navigation and Object Location, Reinforcement Learning and Stochastic Games. Recently, most of the researchers involved in the project joined other researchers at ISR/IST in a long-term project on Robotic Rescue (http://www.isr.ist.utl.pt/labs/rescue/).

Current research work covers the development of appropriate software and functional architectures for multi-robot teams, an approach to relations between teammates (e.g., passes, one robot advances and another covers its position left free) based on reinforcement learning applied to stochastic games and the application of Monte Carlo and sensor fusion methods to self-localization, cooperative ball and cooperative localization of opponent robots from omnidirectional images. The implementation work for Seattle 2001 Middle-Size League concerns a considerable update of the current software architecture, as well as behavior fine tuning and introduction of features not demonstrated before in games by the team, such as dribbling and multi-sensor navigation, including the vision-based self-localization method that granted us the *Engineering Challenge Award* in RoboCup 2000 Workshop [3].

2 ISocRob Current Status

The ISocRob robots are based on Nomadic SuperScout II robots, each of them a two-wheel differential drive robot equipped with sixteen sonar sensors radially distributed around the robot, one Pentium 233MHz based motherboard (PCM-5862), 64MB of RAM, 8GB of hard drive, one PCI and one PC104 bus connectors, one m68k based daughterboard with three-axis motor controller, sonar and bumper interface, and battery level meters, as well as two 12V batteries of 18Ah capacity. After RoboCup 99 (the team has only participated in EuRoboCup, during the year 2000), one Ultrak KC7500CP color 1/3" CCD PAL camera with an Ultrak KL0412DS lens (4mm, F1.2), in the robot front, an omnidirectional vision assembly consisting of one MicroVideo MVC26C color CCD camera under an 11cm diameter mirror, designed to obtain an image representing the orthographic projection of the points at the floor level (apart from an affine transform), a pneumatic kicking device, based on Festo components, plus two 0.85l bottles for pressurized air storage (70mm diameter by 220mm length), one Lucent WaveLAN/IEEE Turbo 11Mbps (Silver) wireless Ethernet modem connected through a PC104/PCMCIA bridge and one Bt848 based (Zoltrix TV-max) frame grabber board, with S-VHS and Composite video inputs were added to the robot platforms.

The total weight of each robot is about 30Kg for the goal-keeper and 35Kg for the remaining ones, which complies with the RoboCup middle size league rules limit of 80Kg, and its height is about 64cm which is below the rule limit of 80cm. According to the rules, there are two geometric restrictions imposed to the convex hull of the robot projection onto the floor plane, with all actuators extended to their maximum reach: the area must not exceed 2025cm^2, and any single cut must be no longer than 63cm. The field robot dimensions, shown in Fig. 2-left, are $R \simeq 207$mm, $W \simeq 240$mm, and $L \simeq 190$mm. Therefore, after some straightforward calculations [4], the area and maximum cut of the field robot convex hulls are found to be $\simeq 1992\text{cm}^2 < 2025\text{cm}^2$ and $\simeq 62.2\text{cm} < 63\text{cm}$, respectively. The goal-keeper robot dimensions (Fig. 2-right) are $R \simeq 207$mm, $a \simeq 220$mm, $b \simeq 510$mm, $c \simeq 604$mm, and $\delta \simeq 47$mm. Therefore, similar calculations lead an area of $\simeq 2018\text{cm}^2 < 2025\text{cm}^2$ and a convex hull of $\simeq 60.4\text{cm} < 63\text{cm}$.

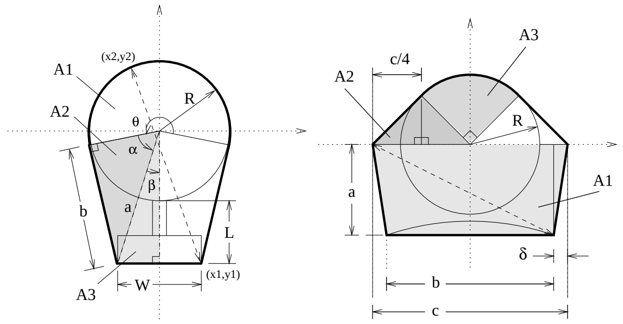

Fig. 2. Diagram showing dimensions used for the convex hull footprint calculation: the central circle denotes the SuperScout platform body while the structure attached below denotes the kicking device fully extended (field robot). Left: field robot; right: goal-keeper robot.

The current software architecture consists of two main layers: the **H**ardware **A**bstraction **L**ayer HAL) and the micro-agents. The HAL encapsulates the interface to the operating system multi-thread mechanisms and to the robot hardware, such as motor control, odometry, sonars, bumpers, and battery status, BTTV frame grabber driver (including an API that allows full-rate vision processing through a dual-buffering technique), multicast network communication, pneumatic kicker hardware, the X Window System and the Blackboard — the communication medium among the architecture components (intra-robot) as well as between physically distinct robots (inter-robot). The micro-agents layer includes concurrent processes that interface the Blackboard with the sensors, the actuators, the communications and the state machine representing a *role.*

3 New Features Planned for RoboCup 2001

The most significant problem we have experienced in past competitions, that hinders our efforts to demonstrate some of our scientific advances, has been the lack of a robust, fast calibrating and reliable color segmentation. Therefore, in parallel with the development of other new features, our top priority is currently to attain a color segmentation procedure which is friendly (i.e., through a graphical interface already finished where the result of the adjustments is immediately visible), automatic (e.g., using a *k-means* clustering [2] or a decision-tree-based [1] algorithm) and as robust and reliable as possible (we are considering replacing the current MicroVideo MVC26C cameras, and/or migrating to the YUV or RGB color spaces, instead of the current HSV space). The catadioptric system calibration device is also being re-worked. A new version of the software architecture will be used in RoboCup 2001 and is being currently finalized. It will significantly upgrade the current one, mainly by direct connections between perception and actuation micro-agents, instead of the current solution, under which connections are established through the state machine micro-agent. Furthermore, software primitives will be efficiently shared among different robot roles (e.g., Attacker, Defender). We also plan an increased usage of the architecture data sharing among teammates capabilities, currently used only to share the ball position estimates of the team robots and avoid both going at a ball simultaneously [4].

Besides several individual behavior tuning procedures, we also wish to demonstrate the following new behaviors:

- **dribble** - currently, our robots can avoid other robots at a relatively high speed (0.6 m/s) using their sonars, but only when they do not have the ball. An algorithm based on geometric and kinematic considerations to dribble field robots while keeping the ball and head towards the opponent goal is under test, with good initial results.
- **new goalkeeper** - ISocRob new goalkeeper, partially demonstrated in EuRoboCup 2000, moves parallel to the goal line, as most current robots in the middle-size league. One of its relevant characteristics is that its state machine switches between two operation modes: following the ball if it is moving away or parallel to the goal, intercepting it when it is moving towards the goal, both based on the up camera/catadioptric system. Currently, we are working on providing the goalkeeper robot with local navigation capabilities that include self-localizing near the goal.

References

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