UChile Robotics Team
Team Description Paper
RoboCup 2013 - Standard Platform League

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Abstract. The UChile Robotics Team is an effort of the Department of Electrical Engineering of the Universidad de Chile. The team participates in the RoboCup Standard Platform League since 2008. This year our focus is on improving our software architecture by doing it flexible, open source and more efficient. This mainly includes: the use of the ROS framework, the integration of XABSL to develop our behaviors; the addition of an extra vision thread for processing images from the both NAO's cameras in parallel; the use of OpenSurf and OpenCV in our software.

1 Introduction

The UChile robotics team is an effort of the Department of Electrical Engineering of the Universidad de Chile in order to foster research in mobile robotics. The team is involved in RoboCup competitions since 2003 in different leagues: Four-legged 2003-2007, @Home in 2007-2013, Humanoid in 2007-2010, and Standard Platform League (SPL) in 2008-2013. UChiles team members have served RoboCup organization in many ways (e.g. TC member of the @Home league, Exec Member of the @Home league, and co-chair of the RoboCup 2010 Symposium). Among the most important scientific achievements of the group are obtaining three RoboCup awards: RoboCup 2004 Engineering Challenge Award, RoboCup 2007 @Home Innovation Award, and RoboCup 2008 @Home Innovation Award. UChile's team members have published a total of 25 papers in RoboCup Symposia, in addition to many RoboCup related articles in international journals and conferences.

This year our focus is on improving our software architecture by doing it flexible, open source and more efficient. This mainly includes: the use of the ROS framework [16] to improve process communication and synchronization; the integration of the Extensible Agent Behavior Specification Language (XABSL) [7] as language and tool to develop our behaviors; the addition of an extra vision thread for processing images from the both NAO's cameras in parallel;

the inclusion of OpenSurf and OpenCV in our software; the use of the B-Human motion and walking engine module.

This report is organized as follows: Section 2 describes the current state of our core and software library, improvements regarding the last year, and some planned activities. Section 3 describes some of our past relevant work and scientific publications. Finally, some conclusions are drawn in section 4.

2 Development for 2013

2.1 Core with ROS

We decided to use ROS (Robot Operating System) [16] as the core of our software architecture. We have assumed the challenge to explore this framework in order to share our experience too. Recently we have uploaded to the ROS community a detailed tutorial to build, install and run ROS natively onto the Atom CPU of the NAO V4 [14]. In addition, a paper which describes the integration of the B-Human motion engine as a ROS node, and the communication of two NAO robots running a ROS-based control software is in press [5].

We consider that in the future it will be interesting and important for the SPL league, to work over a standard software platform in order to show and share our develops in an easier way. This could accelerate progress and increase the level of the league.

We are currently using the installation of ROS for the NAO referenced in our tutorial [14]. We have carried out this migration to ROS in a progressive way. First its package and project management tools were used just for making and compiling. Then, two independent ROS nodes (processes) were created, one for motion and the other one for cognition (Perception, World Modeling (WM) and Decision Making (DM)). Currently we are using three parallel processes (dotted line blocks in figure 1), orange for driving NaoQi-DCM, blue for motion, and red that contains three modules: perception, WM and DM. All our inter process communication is carried out by using shared memory or shared pointers (ROS-boost supported). Each node publishing or subscribing to several topics, communicates different messages according to their types. One of the advantages of using ROS is that ROS-Core manages all the communications between nodes.

Planned activities: We plan to test ROS nodelets [17] which allows very fast communications because it avoids any copy transport between algorithms in the same process.

2.2 Motion

According with B-Human license, at May 16th, 2012 in the SPL mailing list, we announced that we went to use the B-Human motion module [12]. B-Human motion code has been encapsulated and integrated into our code. Besides to understand and make compatible our functions and messages with the B-Human

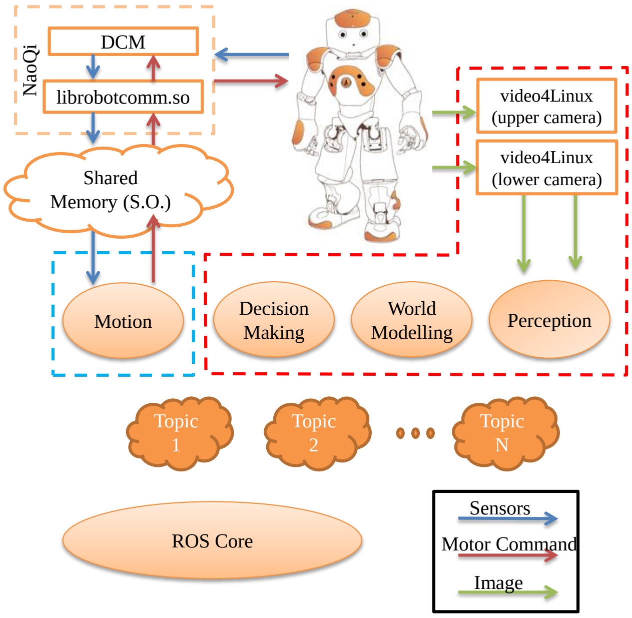

Fig. 1. Block Scheme of Our New Core with ROS

representations needed for using the motion module, it was necessary to implement a shared memory block, for inter-communicating the motion process with NaoQi DCM in a faster way. The source code of the B-Human motion ROS package is shared [5].

2.3 Decision making

In order to make our decision making module easy-to-build, flexible and scalable, this year we are using the Extensible Agent Behavior Specification Language (XABSL) [7] as language and tool to describe our behaviors based on hierarchical finite state machines. Currently we have developed the following behaviors:

- Visual ball tracking and pursue.
- Initial positioning.
- Obstacle avoidance.
- Goalie.
- Player striker with several kind of kicks according its position on the field and the game situation.
- Player support.
- Basic cooperative behaviors sharing ball and teammates information.

Some of these behaviors can be seen in our qualification video [15].

2.4 Vision

Since the newest Nao (H25 V4) has two cameras with independent drivers, we have integrated video for linux (V4L) [6] as video camera driver.

An extra vision thread has been added for processing images from the secondary camera in parallel to the main one. This secondary thread is called when it is required, instead of switching the cameras.

We have achieved to run OpenSurf and OpenCV in the NAO robot successfully, with these software libraries it is possible to extract local descriptors in orther to identify detected goals (own or opponent). In addition, we are computing local color histograms around the goal, these are used like additional information for the goal identification process.

2.5 World Modeling

Last year we was using EKF to perform the self-localization task. Motivated by ambiguity in the goal detection, this year we are using a particle filter again. About the goal identification, currently it is carried out by using local histogram dynamic models, taken from predefined regions in the surroundings of the goal in addition to the self-locator module (see section 3.1).

Planned activities: We plan to use the extracted local Surf [9] descriptors and add them into the global map and self-locator for improving disambiguity of the goals.

3 Past Relevant Work and Scientific Publications

UChile's team members have published a total of 25 papers in RoboCup Symposia (see Table 1), 18 of them directly related with robotic soccer, in addition to many papers in international journals and conferences.

Table 1. Presented papers in the Robocup Symposia by year

RoboCup Articles	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Oral	1	2	1	1	2	3	2	2	-	-
Poster	1	1	1	-	3	2	-	-	2	1

UChile team is on restructuring. Because of that, only some modules of the previous control architecture and software library are being used. A briefly description of these modules is presented below:

3.1 Perception

Vision System: UChile's vision system includes an automatic on-line color segmentation technique that makes extensive use of the spatial relationships between color classes in the color space [2]. Using class-relative color spaces the system is able to remap color classes from the already trained ones. For achieving that, the system uses feedback information from the detected objects using the remapped (or partially trained) classes. The system is able to generate a complete color look-up table from scratch, and to adapt itself quickly to severe lighting condition changes. In addition, the vision system incorporates a spatiotemporal context integration module that increases the robustness of the vision system [10, 11]. The module computes the coherence between a given detection (object candidate) with other simultaneous detections, objects detected in the past, and the physical context. A Bayesian model integrates all these information sources.

Goal Identification: Since 2012 both goals are of them are the same color, and the robot is not be able to identify them by their color anymore. To overcome this issue we have developed a goal-identification system that is based in the visual clues that can be obtained from the surroundings of the goal. The system divides the surroundings of the goal in several regions and computes a color histogram for each one. The system is trained before each game starts and it is able to be adapt to changes during the game. A first version was tested in the 2012 RoboCup.

Efficient Color Segmentation: We have developed a procedure for dramatically diminishing the time consumption in the color segmentation process. This procedure is based in sub-sampling the pixels to be segmented allowing to have a non-uniform segmentation resolution along the image. The method uses a priori knowledge of the structure of the image in order to determine a resolution function over the image, and implements a multi-resolution version of the run-length encoding algorithm.

World Modeling UChile has improved classical self-localization approaches by estimating, independently and in addition to the robot's pose, the pose of the static and mobile objects of interest [1]. This allows for using, in addition to fixed landmarks, dynamic landmarks such as temporally local objects (mobile objects) and spatially local objects (view-dependent objects or textures). Moreover, the estimation of the pose of objects of interest allows the robot to carry out certain tasks, even when having high uncertainty in its own pose estimation. This is especially valuable when performing attention-demanding tasks, like tracking a ball. Another nice feature of the proposed system is that the robot is able to correct its odometry even when it is totally lost.

Ground Truth: In order to quantitatively evaluate state-estimation methods, the availability of ground-truth data is essential since it provides a target that the result of the state-estimation methods should approximate. Most of the reported ground-truth systems require a complex assembly which limit their applicability and make their set-up long and complicated. Furthermore, they often require a long calibration procedure. Additionally, they do not present measures of their accuracy. We have developed a portable laser-based ground-truth system [8]. The system can be easily ported from one environment to other and requires almost no calibration.

3.2 Decision Making

Active Vision: We have developed a task oriented approach [4, 3, 13] to the active vision problem and applied it to our SPL team. The system tries to reduce the most relevant components of the uncertainty in the world model, for the task the robot is currently performing. It is task oriented in the sense that it explicitly considers a task specific value function. When compared with information-based approaches, experimental results show that our task-oriented approach surpasses them in the tested application.

4 Conclusions

This team description paper described the main developments of our team for the 2013 RoboCup standar platform league competition. Important changes and additions have been implemented for this year like: the use of the ROS framework, the integration of XABSL to develop behaviors, the simultaneous processing of images from the two NAO's cameras, the inclusion of OpenSurf and OpenCV in our software, the use of the B-Human motion engine module. Some of our playing skills have been shown in the qualification video and some others will be presented on Robocup 2013 in Eindhoven, Holland.

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