The Northern Bites 2010 Standard Platform League Team

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Abstract

This document serves as the team description paper for the Northern Bites entry into the RoboCup 2010 Standard Platform League World Championship competition in Singapore.

1 Introduction

The Northern Bites is Bowdoin College's Standard Platform League RoboCup team. As a small, liberal arts, undergraduate college, Bowdoin is not the typical entry in international robotics competitions. The team is a late entry into what was formerly the Four-Legged League, but has performed strongly since its inception. The Northern Bites won two games at the U.S. Open 2006, finished tenth at RoboCup 2006, and in 2007 took home first place in Atlanta. In 2008, the last year of the Aibo competition the Northern Bites placed in third. Last year the team took second place in the new Standard Platform League in Austria.

The Northern Bites is a unique team. It hails from a small college (less than 1600 students) with an even smaller Computer Science department (averaging about 8 majors a year) with no graduate programs. All team members are undergraduates. These students are not necessarily majoring in Computer Science; most do their work as an extracurricular activity without credit and while balancing a full course load. Our initial goal during our first two years of competition was to make RoboCup a positive educational experience as our team became functional. Because our primary goal was educational we used little code from other teams. This has served us well as we have not become bogged down with trying to understand other people's code or debug code we have not written. In recent years we have increasingly shown a research focus.

At the end of the Aibo league our publications focussed mainly on behaviors and multi-agent coordination. In moving to a two-legged platform we were forced to temporarily shift our focus to motion. Now that we have a stable walk engine we are turning once more towards the behavioral side of robotics.

This paper highlights some of the work currently going on in the Northern Bites as well as the features of the team that have made us successful.

2 Code Structure

Like most Standard Platform Teams we divide our code up into several major sections: Vision, Localization, Motion, Comm, and Behavior. The low level systems are written almost exclusively in C++, while the Behavior system is written in Python.

2.1 Two Legged Motion

One of our major achievements in 2009 was the development of a stable walk engine [1, 2] based on the "zero moment point" approach. While our walk was not the fastest at RoboCup in 2009, topping out around 15 cm/s, it was probably the most stable. Disregarding collisions with opponents we fell only once during the tournament while walking.

Our motion system is highly flexible and can generate walks that differ in speed, step height and many other characteristics. Tuning these gaits by hand is somewhat of a black art, requiring patience and a little luck. This year we are focussing on writing an optimization system to allow us to quickly create stable, environment specific gaits. We use a particle swarm optimizer to search the many-dimensional gait space, selecting the fast, stable walks. This will eventually allow us to fix certain parameters and then machine-learn highly specific gaits (e.g. a goalie-only squatting walk). Also, we are working on extending the motion system to generate gaits on-the-fly based on in-game conditions.

2.2 Cognitive Vision Processing

Vision is considerably simpler on the Nao versus the Aibo. This is due in part to the superior cameras on the Nao which are not prone to problems of chromatic distortion and the like that plagued the Aibo, but also comes from a simplification of the environment. For example, the field no longer has beacons that must be recognized.

2009 was largely a year devoted to transitioning from the Aibos to the Naos. This meant a reorganization and simplification of our vision system. As a part of this effort we built library of several thousand labelled images taken from various competition venues. These images were labelled according to the field objects they contained (goal posts, robots, etc.). The labelled images can now be used as a fast way of testing changes to our system. We can easily run batch jobs on the labelled images and compare scores against previous versions of our system. This ability has dramatically speeded up our vision development and made it considerably more robust.

With the completion of this work in late 2009 our focus on vision shifted to making our system a platform for cognitive research. Projects are currently under way that explore how humans use perception to build spatial representations and how those representations can be used in reasoning. The goal in RoboCup is to extract "spatial prototypes" that will improve our team's situational awareness and make more accurate predictions of what will happen next possible.

2.3 Localization

One drawback of the simplified field now used by the Standard Platform League is the lack of field landmarks such as beacons. To compensate we have worked on beefing up our use of lines and corners as key parts of our localization system. Unlike most Standard Platform Teams we do not use a Particle Filter for localization, instead in the past we have used an Extended Kalman Filter (EKF) and this year we are experimenting with an Unscented Kalman Filter.

2.4 Behavior

In past years our behavior development has been haphazard and last minute. While the results have been good it has often made our code impenetrable. Our work on behavior this year has focused on easing entry into programming for our team while simultaneously advancing the capabilities of our behaviors. Toward this end, we have introduced a greater level of object orientation and modularity to the behavior code by adding new abstract classes for field locations and c++ objects created by our vision system. These additions significantly ease understanding and use of operations related to them.

As an example benefit, this work has allowed us to develop a new feature in the code controlling the robots head. It is now possible for us to give the robot a position in field coordinates for the robot to look at, and the robot will do so using his current estimate of his position to judge what angles are necessary. Work in using this in behaviors is ongoing, but very promising for enhancing localization. Work utilizing the new object classes is is in progress to refine how we walk to a given destination. This code had previously

been inappropriately implemented in the centralized behavior controller, obfuscating the main purpose of that code and impeding development in navigation. Redeveloping that code in the appropriate module is allowing for more appropriate levels of abstraction in the behavior controller, and more intelligent navigation to a destination.

3 Future Work

It is impossible to play good soccer without having good low-level systems. Thus, the first two years of Nao competition have largely been devoted to build high quality low-level systems. In 2009 our major focus was on the motion system. In 2010 it has been upgrading localization and vision. Once these are in place we can truly begin to focus on behavior and team coordination. This will pick up where we left off with the Aibos in 2008 [3, 4]

4 References

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