UT Austin Villa 2019 Team Report

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1 Introduction

UT Austin Villa is a team led by Professor Peter Stone. We hail from the Learning Agents Research Group in the Department of Computer Science at The University of Texas at Austin.

We've participated in the Standard Platform League since 2003. Since the league switched to using NAO robots exclusively in 2008, the team has consistently finished in the top eight teams and often finishes in the top four teams. Years to note include 2009 when we finished fourth, 2010 when we finished third, 2012 when we finished first, 2013 when we finished third, 2015 when we finished fourth, 2016 when we finished second and 2017 when we finished fourth.

The technical details of our past Nao and four-legged teams are available in our series of technical reports [11–14, 7, 8, 1, 3], as well as in the inaugural book in the MorganClaypool Synthesis Lecture Series on Artificial Intelligence and Machine Learning [10]. This book presents a roadmap for getting started on *any* vision-based and/or legged-based robot, using the Aibo as a case study. Additionally, the technical details of our 2012 Standard Platform Championship team can be found in our champions paper that was published in the RoboCup-2012: Robot Soccer World Cup XVI book [2].

We're consistently one of the smallest teams to participate in the RoboCup Standard Platform League. Almost all of the students working on our team are PhD students for whom RoboCup is not a part of their thesis. As such, one of the challenges each season is determining which projects we will focus on given our limited resources. Our resources for the 2019 season were particularly limited due to most members not being able to dedicate significant time to working within the codebase. Further, an extra challenge this year was to get our code working on the Nao v6 robots. As such, our efforts for 2019 were limited, with a large focus on understanding the v6 robots, adapting our code to work on them, and make sure that mixed teams of v5 and v6 robots worked well. This report details the projects that occupied most of our time for the 2019 season.

2 Adapting Codebase for Nao v6

Last year one of the major undertakings for our team was to begin working on the new Nao v6, and adapt our code base to the new robots. An important aspect of this move was the necessity to refactor our entire build process. We transitioned from using QiBuild to CMake, which allowed us to deviate more from the old Aldebaraan build system. Overall, this update makes the build pipeline cleaner, since we were already using CMake for part of it before. In additon, many of the libraries on the robot were upgraded with the new version, so many parts of our code needed to be upgraded to reflect the changes. Most of these dependency changes were easy to identify, since they appeared as compile time erros.

Another aspect of moving to the new Nao robots with its new firmware was the use of the new LoLA interface to read sensor data and to communicate motor commands. We adapted the HTWK LoLAConnector [9] to our codebase and modified interactions with NaoQi to instead use the LoLAConnector. These changes were particularly complex because the old NaoQi Motion module included motion interpolation code that we relied on. Since we were no longer using NaoQi, we had to write our own interpolation code that worked similar to to the NaoQi method. We found that NaoQi did not use a linear interpolation scheme, since our motions did not work when we tried implementing linear interpolation. Thus, we had to estimate the smoothing parameters NaoQi used.

Finally, another required change to our interface with the firmware was in the technique to listen to the microphones, used to detect the whistle during the game. Specifically, the move to the `alsa` interface that is standard for linux systems.

3 Adapting to new Camera Module

The Nao v6 has a new camera module (`OV5640`) with new settings and behaviors. A major effort this year has been to adapt our previous vision system to work with this new camera. A part of this movement was moving away from `video4linux`.

With better resolution we also found that our algorithms were more sensitive to small differences in the camera mounting. To account for these differences, we had to use an adjustment in each robot's forward and backward models used to calculate angles to objects and hence distances.

These adjustments were calibrated individually for each robot using a custom tool, as shown.

4 Learning a Faster Walk

One area of ongoing research on our team considers learning the parameters of our walk engine in simulation and then transferring the learned parameters to the physical NAO[4, 5]. Our team uses the UNSW walk engine[6], which has a number of parameters such as the hip height and maximum forward step as well as a number of hard-coded constant values. We consider all these values as parameters that can be optimized with the goal of finding a faster forward walk. We have introduced a framework called grounded simulation learning (GSL) and an algorithm within this framework called grounded action transformation (GAT). With this methodology we improved the speed of the UNSW walk by 40% for the task of stable, forward walking starting from a standing position with all learning taking place in simulation. To the best of our knowledge, this is the fastest stable walk implemented on a NAO.

In previous seasons, our main tasks were creating this framework and getting it working. Recently, we integrated the faster walk into the existing behavior architecture. One of the challenges here was to accomplish the switch between the regular walk and the fast walk, since the sudden change in speed could destabilize the robot. We managed to overcome this challenge by a gradual interpolation between current values and target values.

We also began to apply this Sim2Real technique to learning other skills like a better kick also getting up off the ground faster. We have made some progress in this direction, but the skills learned were not stable enough to apply to our robots yet. For the 2020 season, one of the aims is to integrate other skills learned via this methodology onto the Nao.

Finally, we have started working on refinements and improvements in the GAT technique. It is an active thread of research in our team with further work under review.

5 Corner Kicks

Corner kicks were added to SPL games for the 2019 season, so a critical part of playing at RoboCup 2019 was to successfully handle corner kick situations. Our strategy when we were awarded a corner kick was to continue acting as if it was a normal play. Our strategy to defend our goal when the opposing team was awarded a corner kick was to form a “wall” in front of the ball. This meant calculating robots closest to the ball, and moving them into position on a circle of a certain tunable radius around the ball, at a tunable angle away from each other.

One challenge that we faced was making sure that this strategy did not change the position of a robot currently in an advantageous position on the field. We addressed this by creating two tunable parameters, which controlled the maximum number of robots that would approach the ball, and the the minimum distance a robot must be from the ball so that it would approach it. We also had to make sure that the robot would not enter the restricted area around the ball when the opposing team had the corner kick. To counter this, we made the size of the circle tunable, and changed our approach code to avoid the restricted area.

6 Conclusion

Despite being one of the smallest teams in the Standard Platform League, we’ve consistently performed well due to our solid code base and experienced team members. In 2019, our team was smaller than usual, with 7 members actively participating, with 2 of these being completely new members. During the 2020 season, we expect to focus on getting our core vision and motion modules adapted to the V6 robots. Beyond this functionality, we hope to improve vision under natural lighting, implementing passing and throw-in bahaviors, improving role switching and free kick behaviors and integrating learned behaviors besides walking. Under our goals for improved vision, we aim to implement more robust learned models to take over a larger part of the vision pipeline, taking advantage of the higher processing provided to us by the new processing unit in the v6.

7 References

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