Open Challenge Abstract

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In 2011, the UT Austin Villa team won the 3D simulation league competition, due in large part to a fast and robust humanoid walk on an approximate model of the Nao robot in the ODE-based RoboCup 3D simulator [3]. Using the CMA-ES evolutionary learning algorithm [2] for parameter optimization and using the Condor system to perform large-scale distributed computing, the team was able to run thousands of simulated trials to find parameter values that transformed a relatively slow walk into the most effective simulated walk for the Nao in the simulation environment. The walk engine and the intial (seed) walk were ported from the real Nao robots based on the work of Graf et al. [1], making this the first time, to our knowledge, that control code on a real robot was used to improved control in a simulator, rather than vice versa.

In simulation there is little cost to running and testing an instance of parameter values, and these tests can be run in much less time. In addition, by utilizing Condor, it was possible to run up to 150 robust tests simultaneously and have them complete in less than twenty minutes. Due to the success in simulation, it is tempting to utilize the same infrastructure to improve the walk of the real robot.

However simulators are never perfectly accurate representations of reality. Therefore the parameters learned in simulation rarely work "out of the box" on a real robot. In the 3D simulation league, this issue did not arise because the simulator was the ultimate task environment. But due to discrepancies between the simulator and the real world (not least of which was the fact that the simulator assumes infinite torque, resulting in instantaneous joint movements to desired positions), transfering optimized parameters to the real robot was initially ineffective.

This demonstration will demonstrate the Masters thesis research of Alon Farchy, who devised a way to compensate for these deficiencies in simulation and enable the use of the simulator to find parameter values that improve the walk speed of the Nao. Specifically, by using supervised learning to model the actual joint movements on the real robot, we were able to update the simulator with realistic torque limits and re-optimize with these limits in effect. The optimized parameters in the adjusted simulator led to a 30% increase in walk speed on the real robot compared to the base-level walk behavior.

1. REFERENCES

[1] C. Graf, A. Härtl, T. Röfer, and T. Laue. A robust closed-loop gait for the standard platform league humanoid. In C. Zhou, E. Pagello, E. Menegatti, S. Behnke, and T. Röfer, editors, *Proceedings of the Fourth Workshop on Humanoid Soccer Robots in conjunction with the 2009 IEEE-RAS International Conference on Humanoid Robots*, pages 30 – 37, Paris, France, 2009.

[2] N. Hansen. *The CMA Evolution Strategy: A Tutorial*, January 2009.

[3] P. MacAlpine, S. Barrett, D. Urieli, V. Vu, and P. Stone. Design and optimization of an omnidirectional humanoid walk: A winning approach at the RoboCup 2011 3D simulation competition. In *Proceedings of the Twenty-Sixth AAAI Conference on Artificial Intelligence (AAAI-12)*, July 2012.