Design of a Dynamic Omni-Directional Kick Engine for NAO Bipedal Robots in RoboCup

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This project aims to design a reliable omni-directional kick engine for the NAO bipedal robot, with dynamic optimization of motion parameters, based on data-driven nonlinear optimal control. The new kick engine will be integrated into the current control and behavior framework of the NomadZ RoboCup Team at ETH Zürich (**https://robocup.ethz.ch**).

Keywords
Robotics, Nonlinear Control, Data-Driven Control

Labels
Semester Thesis (SA), Master Thesis (MA), Theory (IfA), Computation (IfA)

Project Description

The design and implementation of a dynamic kick engine that is both fast and effective is required for competitive humanoid robot soccer competitions like RoboCup. Using a NAO bipedal robot as a testbed, we will develop a dynamic kick engine that can generate an optimized kick trajectory with an arbitrary direction, while also guarantee closed-loop stability.

In overall, this project includes the following parts:

- In depth understanding of the different modules in the current codebase of the team.

- Literature review of state-of-art approaches on walk/kick engines design and dynamic optimization of motion primitives.

- Design of a novel kick engine with successful results on an appropriate robot simulator.

- Integration of the proposed kick engine on the codebase of the team, as well as implementation on the real NAO bipedal robots.

Prerequisites

We are looking for an outstanding Master Student with a strong expertise in Robotics (e.g. Kinematics, Dynamics, Motion Planning), and Control Theory (e.g. Optimal Control, Model Predictive Control). Furthermore, a solid knowledge of programming in Matlab and C++ is required. Finally, solid experience in developing data-driven control algorithms (e.g. Reinforcement Learning Control) is desirable.

This project investigates a challenging yet important problem, and promising results will be published. Moreover, this project can be continued by the student in very interesting directions, involving further development on the robots as well as active participation in the team and future robot tournaments.

Applications

Interested students should send an email to Alexandros Tanzanakis (**atanzana@ethz.ch**) with an updated CV and transcript of records (both BSc and MSc).

References

[1] P. Pena, J. Masterjohn, and U. Visser, "An Omni-directional Kick Engine for Humanoid Robots with Parameter Optimization", in *Proceedings of the Robocup International Symposium*, 2017.

[2] A. Rezaeipanah, P. Amiri, and S. Jafari, "Performing the Kick During Walking for RoboCup 3D Soccer Simulation League Using Reinforcement Learning Algorithm", in *Springer International Journal of Social Robotics*, 2020.