Modification of Foot Placement for Balancing using a Preview Controller Based Humanoid Walking Algorithm

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Abstract. Lunges are an important utility to regain balance under strong perturbed biped walking motions. This paper presents a method to calculate the modifications of predefined foot placements with the objective to minimize deviations of the Zero Moment Point from a reference. The modification can be distributed over different points in time to execute smaller lunges, and an arbitrary point in time can be chosen. The calculation is in closed-form, and is embedded into a well-evaluated preview controller with observer based on the 3D Linear Inverted Pendulum Mode (3D-LIPM).

Keywords: 3D-LIPM, ZMP, observer, humanoid robot, reactive stepping, walking algorithm

1 Introduction

Research in the area of biped robots has become increasingly important over the last years. Especially in environments that contain obstacles and barriers such as stairs, or small objects lying on the ground, biped robots are advantageous in comparison to wheeled robots. Bipedal locomotion in such surroundings is naturally susceptible to disturbances that may occur when the robot collides with those objects. As a precedent step, biped robots must be capable to regain balance even on flat grounds to prevent from damage.

1.1 Related work

A widely used criterion to determine the stability of a humanoid robot is the Zero Moment Point (ZMP). It was invented by Miomir Vukobratović [1] based on the term support polygon which is the convex hull of all contact points of the feet with the ground. If the ZMP is inside the support polygon, the ground does not exert torques around the roll and pitch axes of the feet, and thus the robot can be considered as stable.