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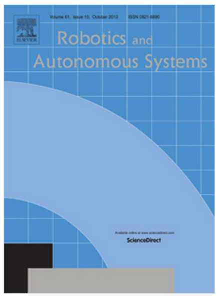

Balance recovery through model predictive control based on capture point dynamics for biped walking robot

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Balance recovery through model predictive control based on capture point dynamics for biped walking robot

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Abstract

This study proposes an online walking-pattern generation algorithm with footstep adjustment. The algorithm enables a biped walking robot to effectively recover balance following external disturbance. The external disturbance is measured as a capture-point error, and a desired zero-moment point (ZMP) is determined to compensate for the capture-point error through a capture-point control method. To follow the desired ZMP, the optimal ZMP and the position of the foot to be changed are determined through model predictive control (MPC). In the MPC, quadratic programming is implemented considering a cost function that minimizes the ZMP error, the constraints that the ZMP maintains within the support polygon, and the constraints on the varying foot positions. The proposed algorithm helps a humanoid robot (DRC-HUBO+) to regain balance following disturbance, i.e., from strong pushing or stepping on unexpected obstacles.

Keywords

Humanoid robot, biped walking, walking pattern, model predictive control, footstep adjustment, capture point

1. Introduction

For humanoid robots to coexist with human beings and provide various services and perform tasks that are difficult for humans, they must be capable of moving stably, even on unexpected surfaces, and under the influence of different types of disturbance. To achieve this capability, a stable walking motion having both dynamic and kinematic feasibility must be continuously generated based on the current state of the robot.