論文の内容の要旨

論文題目

Quadrature of Energy Cost Minimization Problems for Generation, Planning, and Stabilization of Humanoid Walking Patterns

(ヒューマノイド歩行パターンの生成、計画、安定化のためのエネルギーコスト最小化問題の求積法)

氏名　サンタクルス　　カルロス　フェリペ

This dissertation studies the generation of walking motions for humanoid robots. Although not few works have been proposed in the area, the problem of generating arbitrary walking motions through a computationally fast and efficient framework is going to be discussed. The problem is analyzed through simplified models of the humanoid dynamics and state transfer theory. The conditions on which the generated motions are consistent with the physical constraints of the system are going to be analyzed.

From a theoretical point of view, the problem can be tackled by formulating it as an optimal problem taking into account the general dynamics and constraints related to the motion tasks and physical consistency. This is a highly nonlinear problem which cannot be solved online so it is not a realistic solution for humanoid robots operating in constantly changing environments.

In this dissertation, the main analytical tools to be considered in the design of the biped walking control framework are: the reachability and stability properties of the linear realization of the humanoid dynamics and an optimal formulation based on minimal energy control theory. As a case study of retargeting motions of humanoid robots in

different gravity conditions, the main concept to be utilized in this work is the time scaling transformation of the dynamics of free floating base systems.

The major outcomes of the dissertation are 1) a method to generate walking trajectories based on an optimal formulation with analytical solution 2) a framework to integrate the proposed pattern generator with a motion adaptation and footstep replanning technique to handle disturbances during walking motion 3) a method to generate and analyze the motion feasibility of humanoid robots under different gravity conditions.