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التوثيق الالكتروني والميكروفيلم

Ain Shams University

Faculty of Engineering

Mechatronics Department

Dynamic walking control of humanoid lower limb

A Thesis submitted in partial fulfillment of the requirements of the degree of Master of Science in Mechanical Engineering (Mechatronics Engineering)

By

Samer Ahmed Mohamed Ahmed

Bachelor of Science in Mechanical Engineering

(Mechatronics Engineering)

Faculty of Engineering, Ain Shams University, 2018

Supervised by

Prof. Farid Abdel Aziz Tolba

Associate Prof. Mohamed Ibrahim Mohamed Hassan Awad

Dr. Shady Ahmed Maged Ahmed Mohamed

Cairo - (2021)

Ain Shams University-Faculty of Engineering

Mechatronics Department

Dynamic walking control of humanoid lower limb

By

Eng. Samer Ahmed Mohamed Ahmed

B.Sc. in Mechanical Engineering (Mechatronics)

Faculty of Engineering – Ain Shams University

EXAMINERS COMMITTEE

Prof. Saber Mahmoud Abdrabbo	……………….
Prof. Sherif Ali Hammad	……………….
Associate Prof. Mohammed Ibrahim Awad	……………….
Dr. Shady Ahmed Maged	……………….

Date:

Statement

This thesis is submitted as a partial fulfilment of Master of Science in Mechanical Engineering (Mechatronics Engineering), Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Student Name

Samer Ahmed Mohamed Ahmed

Signature

……………………………………………..

Researcher Data

Name	: Samer Ahmed Mohamed Ahmed
Date of birth	: 15/9/1994
Place of birth	: Cairo, Egypt
Last academic degree	: B.Sc.
Field of specialization	: Mechatronics
University issued the degree	: Ain Shams University
Date of issued degree	: 28/08/2018
Current job	: Teaching Assistant

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List of Publications

- Mohamed, Samer A., Mohammed I. Awad, and Shady A. Maged. "Online Gait Generation For NAO Humanoid Robot Using Model Predictive Control." *2020 International Conference on Innovative Trends in Communication and Computer Engineering (ITCE)*. IEEE, 2020 (Aswan, Egypt).

Abstract

Humanoid robots will have many applications in the industrial sector in near future. Based on this motivation, the thesis presents a complete study on humanoid robot kinematics and dynamics. The thesis also discusses some basic methods for walking pattern generation and elaborates on some modifications to enhance the basic walking pattern generation methods in terms of stability and power consumption optimization. The thesis then proceeds to introduce some stabilization techniques using ZMP feedback and upper body posture correction. The suggested algorithms were validated using MATLAB [104] simulations for NAO robot. The presented methods produced satisfactory results in terms of stability, as the RMSE for ZMP x-coordinates (x-axis being parallel to walking direction), ZMP y-coordinates, upper body roll angle deviation and upper body pitch angle deviation were found to be 0.0028 m, 0.0139 m, 0.0028 rad and 0.0014 rad respectively. Also, the presented work contributed significantly to humanoid walking power consumption optimization as the average locomotion cost of transport was reduced from 0.2367 to 0.11993.

Keywords: bipedal; model-predictive control; humanoid; cart-table model; cost of transport; linear inverted pendulum model; Zero moment point; bio-inspired robotics; trajectories; center of mass.

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