

OPTIMUM STABLE GAIT PLANNING FOR AN 8 LINK BIPED ROBOT USING SIMULATED ANNEALING

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Abstract

Biped or humanoid robots should have a higher level of autonomy to achieve different tasks in service and manufacturing sectors. Biped locomotion is a complex dynamical task because of the intermittent interaction with its environment and the ground through its feet. Most of the previous gait planning efforts were made by complex and time consuming algorithms with maximum one limb in the upper body for controlling the gaits. This work presents the kinematic and dynamic modelling and simulation of 8 link biped robot walking with two limbs in the upper body. Optimum cycloidal gait trajectory is simulated and compared between the static and dynamic walking cases. Easy and comparatively less time consuming simulated annealing algorithm is used for the optimization. Zero Moment Point criteria is used for the stability analysis.

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Key Words: Gait Planning, Sagittal Plane, Zero Moment Point, Simulated Annealing, Degrees of Freedom

1. INTRODUCTION

One of the main objectives of humanoid robotics is to create autonomous systems for imitating humans at a wide variety of dynamic, complex and novel environments. Experts from various fields of science, engineering and linguistics have tried to combine their efforts to create a robot as human-like as possible. Although this field has witnessed tremendous progress in recent years, realistic, periodic and rhythmic gait generation is not yet achieved due to the limitations in kinematics, dynamics and control techniques.

Biped robot walking consists of two stages, namely single support phase in which one foot is in contact and double support phase in which both feet are in contact with the ground. In a complete walking cycle, stability has to be analysed in both the above phases during static and dynamic conditions. Position of Center of Gravity (COG) and Zero Moment Point (ZMP) are two important criteria for analyzing the static and dynamic stability of legged robots. Qiang Huang et al. [1] interpreted ZMP, as that point on the ground about which the sum of all moments of the active forces is equal to zero. This concept adopts Vukobratovic et al.'s [2] claim that the ZMP has been vaguely related to the ground surface, regardless of referring to the support foot polygon of the legged robot. Researchers have been working on gait planning and executing gaits for humanoid or biped robots based on genetic algorithms (GA), artificial neural networks (ANN) and fuzzy logic control (FLC) and other conventional algorithms [3-12] considering stability mostly only in the sagittal plane. Goswami Dip et al. [3] optimized the walking gaits using genetic algorithm (GA) by considering the Zero Moment Point (ZMP) and walking speed. The optimal walking gaits are also experimentally realized on the biped robot also. Maitray Shrivastava et al. [4] used a trajectory generation method using GA for a 8 degrees of freedom (DOF) robot that can walk on flat terrain and

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