Motion Generate and Control of Quasi-Passsive-Dynamic-Walking based on the concept of Delayed Feedback Control

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1. Introduction

Recently, Passive-Dynamic-Walking[1] has been noticed in the research of a biped walking robot. Then we consider providing the new control method of Quasi-Passive-Dynamic-Walking in which the actuators are used just only when the walking begins or disturbances come in. In this paper, refering our previous results[2],we also focus on the concept of DFC and the entrainment phenomenon of PDW.

2. Model of the Waking Robot

A model of the biped robot which we consider is shown in Fig.1. And, using the state of robot just before k-*th* collision, we introduce a vector p as $p(k) = (\beta_k, \dot{\theta}^-_{p,k}, \dot{\theta}^-_{w,k})^T$ and define this p as **Impact point**.

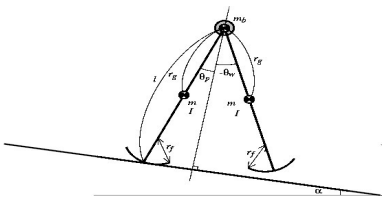

Figure 1: Compass model of Walking robot

3. Propose Control Method

Then, we propose the following control method:

$$\begin{aligned} \tau_k &= K_f(\delta_k)[K_v(\dot{\theta}_{k-1} - \dot{\theta}_k) + \\ &\qquad K_p(\theta_{k-1} - \theta_k)], \qquad (1) \\ \delta_k &= ||p(k) - p(k-1)||_\phi. \end{aligned}$$

where θ_k is k-*th* step's $\theta = (\theta_p, \theta_w)^T$ and $K_f(\cdot)$ is a weight function[2].

As the feature of this control method (1), the following can be given. At first, it dose tracking control with r_{k-1} which is the (k-1)-*th* trajectory of robot, and as a result, the reference trajectory is updated in each steps. This is equivalent to doing *continuous*-DFC. Furthermore, it evaluates the stability of walking by using the impact point $p(k)$ and $p(k-1)$.

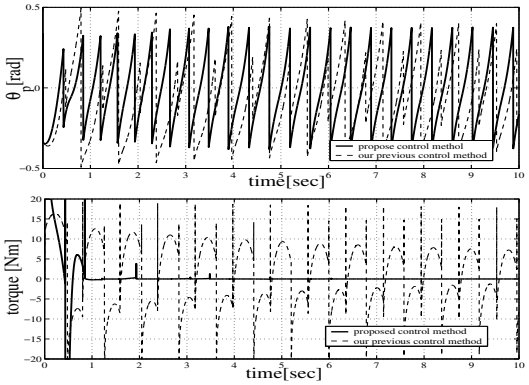

Figure 2: Simulation results

4. Computer simulation

Simulation results in which the proposed control method (1) is used are shown in Fig. 2. Simulation results in which one of our previous control method[2] is used are also shown. And the manner of updating the reference trajectory is shown in Fig. 3. From these figures, it seems that the proposed control method works better than our previous control method.

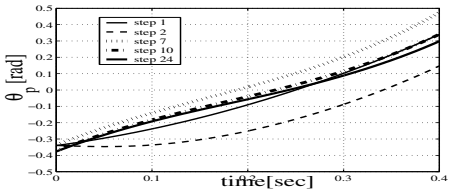

Figure 3: Reference trajectory of $\dot{\theta}_p$

References

[1] T.McGeer: "Passive Dynamic Walking", *Int.J.of Rob.Res.*, Vol.9, No.2, 1990.

[2] K.Osuka,Y.Saruta: "Gait Control of Legged Robot Quartet III via Passive Walking", *Proc. of the 8 th Symposium on Control Technology8th*, pp.355-360,2000 (in Japanese)