The Influence of Friction on Gait and Energy Efficiency of the Walking Robot Based on Rhythmic Control

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1. Introduction

An increasing number of studies have implemented neural oscillators to control movements of real robots. In many of the conventional methods, when the robot loses its balance during its walk due to a slip, instead of sensing the slip itself, the problem is dealt with by controlling the position and the dynamic condition of the entire robot. By detecting the slip and conducting appropriate compensative motions, unnecessary movements can be avoided, the energy efficiency is increased. As a result of such increase in energy efficiency, motion in environments with changing surface conditions can be made much easier. Considering the walking in an environment with varying friction, it is also desirable to employ a gait appropriate to such variations. In this study, the effect of a gait on the energy efficiency in an environment with varying frictions is investigated through a simulation. A correlation is presented between the energy efficiency and the walking cycle with different friction coefficients.

2. Generation of A Gait Pattern

A gait generation method that combines rhythm generators and reflexes is used[1].

3. Simulation

The effects of the friction condition on the gait and the energy efficiency will be examined by a walking simulation in the environment with varying friction coefficients. A 3-D dynamics simulation environment that we developed is used for the simulation environment, and the values of a real robot TITAN-VIII used for the robot model. For the surface condition, a flat plane and the friction coefficients (μ=0.4, 0.6, 1.0) that the general conditions of slippery, normal and sticky are chosen. Figure 1 shows the relation between the walking velocity and the energy efficiency due to the varying friction coefficients. The effect of friction can be seen that the energy efficiency tends to decline at a low velocity, a friction coefficient of μ=0.6 is most efficient after the velocity exceeded V=0.2.

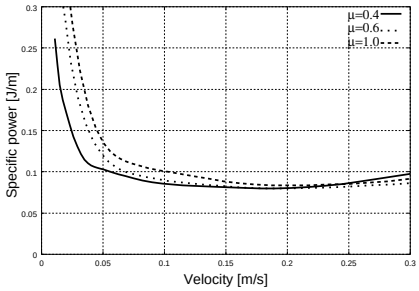

Figure 1: The relation between velocity and specific power.

4. Conclusions

In this study, we focused on the slip which occurs during the walking motion. We examined the effect that the friction condition has on the gait and the energy efficiency, namely:

- The energy efficiency increases as the velocity increases regardless the friction condition.
- When the walking velocity is low, the energy efficiency increases as the friction decreases. When the walking velocity increases, the middle friction condition is the most efficient.
- There is a difference in the form of the effective gait in an environment with varying frictions.

The obtained results suggest that an effective walking can be attained by changing the walking pattern in accordance with the friction condition and the walking velocity. The change of the friction can hypothetically be replaced by the walking on a slope, thus we think that this study may discover an appropriate walking pattern on a slope.

References

[1] Takemura, H., Matsumoto, Y., Ogasawara, T., 2001, "Dynamic walking of an autonomous quadruped robot based on rhythm generation", *Proc. CLAWAR2001*, pp.727-734.