Controlling Walking Velocity of a Pneumatic Actuated Biped by Changing Hip Passivity

[1]Takahi Takuma and [1,2]Koh Hosoda
[1]Osaka University,
[2]HANDAI FRC; email: takuma@er.ams.eng.osaka-u.ac.jp

INTRODUCTION

The behavior of the passive walker [1] is governed by its dynamics, and therefore, walking velocity cannot be controlled. On the other hand, a hip joint of a human is driven by an antagonistic pair of muscles, and its passivity seems to contribute to his/her behavior. In this paper, we propose to control walking velocity of a pneumatic actuated biped by changing hip passivity. We can control hip passivity by regulating duration to open the air valve. We conducted walking experiments to reveal the relation between the duration and the walking velocity.

BEHAVIOR OBSERVATION

Figure 1 shows the biped named "Que-kaku". It has three joints: hip and knees. The joints are driven by the antagonistic pairs of the pneumatic muscles: flexor and extensor muscles. We utilize the McKibben actuator as the pneumatic muscle. The McKibben actuator has a characteristic that it has elasticity, which has positive correlation with the pressure.

The right side of the figure 1 shows the schematic construction of the joint driven by the muscles. We utilize the air valve unit that can not only supply and expel the air but also close both valves. We operate the duration to supply and expel valves, and, after supplying or expelling the air, we close both valves to let the muscle have the elasticity and then to let the joint have the compliance.

In this paper, we measure the walking velocity to observe the robot's behavior with various types of the passivity. We change the duration Se(k) to expel the air from the muscle that drives the hip joint. By changing the duration, we operate the passivity of the hip joint.

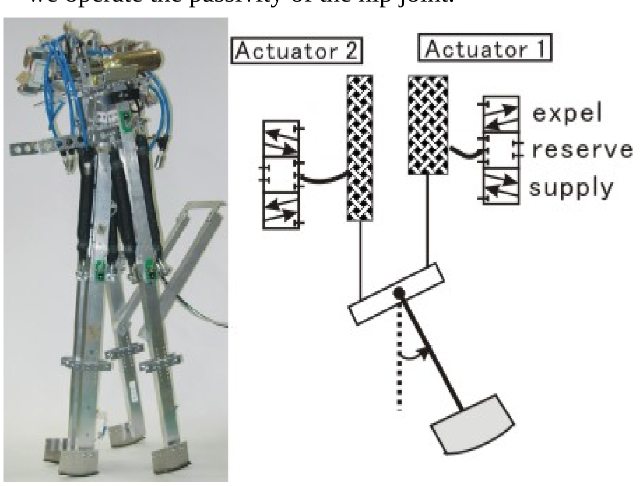

Figure 1: The biped driven by the pneumatic muscles "Que-kaku" (left) and the schematic construction of the joint driven by the antagonistic pair of muscles (right).

RESULTS

In the experiment, we let the robot with various types of the passive joint, and we measure the walking velocity by utilizing a 3D motion capture system. Figure 2 shows the relation between the walking velocity and expel duration of the hip muscle Se(k). Shown in the figure, the walking velocity is higher when Se(k) is smaller and the velocity becomes longer when Se(k) under 200 [ms] is larger. This result leads us that we can control the robot's behavior by changing the joint passivity.

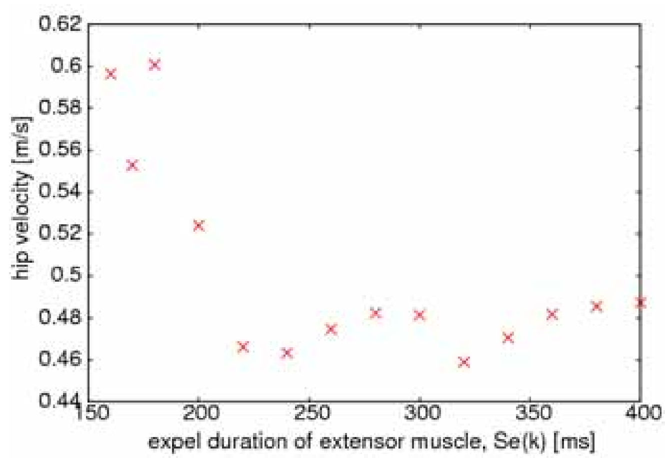

Figure 2: Relation between the walking velocity and the expel duration to hip extensor muscle.

CONCLUSION

In this paper, we observed the behavior of the passive walker with different passivity. We operate the duration to open expel air valve of the hip muscle in order to operate the hip joint passivity. In the experiment, we measured the walking velocity, and the result showed that the passive walker changes its behavior by the hip passivity. We then show the possibility that the behavior can be controlled by designing the passivity.

REFERENCE

1. T. McGeer. *Passive dynamic walking*, International Journal of Robotics Research, Vol.9, No.2, pp.62-82, 1990