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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Robots in recent years play an important role in human society, such as improving human work efficiency and substituting dangerous tasks for humans. In particular, a legged mobile robot has been actively researched since it can adapt to human environment easily because of its behavioral similarity to human's movement, and it has many advantages in mobility like it can move on rough terrain or change direction in narrow space.

Legged robots have been actively studied in terms of both mechanical and control aspects. A leg-type mobile robot consists of a relatively heavy upper body and a lower body to support the upper body, and the movement of a legged robot requires a high thrust to generate a force in the direction of travel while supporting the upper body with the legs, which causes a high ground reaction force. In addition, the leg-shaped robot loses kinetic energy due to the impact force of a high bandwidth at the moment when the foot touches the ground while moving. To overcome these phenomena, the mechanically devised methods such as attaching a series elastic element in the actuator or adding an inertial element in the joint of robot have been proposed. However, only a few studies for the control techniques that cover these mechanical improvements have been studied because of its complexity of dynamics, so realizing the mobility of the robot with these mechanical structures has been challengeable problem in the study of biped robots.

In the aspect of the control scheme, control methods for a legged mobile robot to realize movements have been actively researched for a few decades, and the feedback-controlled method is the most universally used to control for the robot, which contains generating the appropriate template gait and calculating the control input based on stabilizing the whole states in periodic movement for the target system. There are several variations of this control method, including the use of template models from simple system behavior and the use of trajectory optimization methods obtained by approximating the robot's dynamics to simple equations.

When applying this method, it is often better to modify each of the target systems to obtain better results. For instance, as a template model often used in movement control of a biped robot, the behavior of a simple system consisting of one spring and one point mass called the Spring Loaded Inverted Pendulum (SLIP) model is widely used. This system is useful for simulating the movement of a robot, but there is a limit to expressing the dynamics of the swing leg or to applying directly to control for the robot model because of its simplicity. However, using a model that has been modified to suit each target system can provide better performance and easier control than conventional methods.

Another advantage of the method using a simple model is that the robustness of the gait can be improved by giving an appropriate reference model. Robustness of the gait is an important problem in control of a biped robot because the stability of periodic walking is easily lost in the walking of a biped robot against disturbances such as steps and rough terrains. In conventional research, limit cycle walking robots have the same low robustness problem and it was relaxed by implementing the reference with the virtual model of a simple system. This result has been contributed to the potential for improved robustness by using a simple model as the controller reference, and the improvement of robustness by modifying this method could be expected.

From the aspect of a structural idea, robots with the series elastic actuator (SEA) have been proposed. This mechanism is composed of a motor and a link and there exist elasticity elements between them. In the robotic researches, these mechanisms were adopted because of the adaptability for the unknown environment or the energy storage for the robot's hopping. In addition, by absorbing the impact force with the elastic element, the possibility of damage to the motor due to impact can be reduced. From these advantages, the SEA robots are expected to realize high-energy efficiency running gaits and the high-durability against impact forces.

The purpose of this study is to improve the mobility performance of a mechanically devised biped robot

with a control method using simple template model dynamics. In this thesis, we present the following four contents that contribute to the purpose of this research. First, we present a new template model for biped walking robot which is modified version of the conventional SLIP model. Second, we present the new template model for 4-link walking robot to improve the robustness of walking. Third, we present a control method to use the template running gait for mechanically devised bipedal robot. Finally, we present an effectiveness verification of mechanically devised robot when the control scheme is based on the using a simple template model.