

論文 / 著書情報
Article / Book Information

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| 題目(和文) | |
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| Category(English) | Doctoral Thesis |
| 種別(和文) | 論文要旨 |
| Type(English) | Summary |

(博士課程)
Doctoral Program

論文要旨

THESIS SUMMARY

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| 系・コース： Department of, Graduate major in | システム制御 系 コース | 申請学位 (専攻分野)： Academic Degree Requested | 博士 Doctor of Engineering |
| 学生氏名： Student's Name | PELIT Mustafa Melih | 審査員主査： Chief Examiner | 山北 昌毅 |

要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

This thesis studies bipedal robot locomotion with an emphasis on improving efficiency, robustness, and adaptability. As technology intertwines more closely with human life, the need for robots capable of seamless mobility across various environments becomes increasingly evident. Inspired by living organisms, this study delves into the fundamental concept of bipedal movement, focusing on a 5-link biped model constrained to the sagittal plane. The contributions of this thesis are aimed to improve the foundation of bipedal robotics while catering to real-world demands and applications. The effectiveness of the proposed methods are shown through simulation studies.

Central to the thesis is the notion of a versatile walking template model named SLIP-SL (Spring Loaded Inverted Pendulum model with Swing Legs). This model introduces swing leg dynamics to the existing SLIP model, thus facilitating concurrent trajectory generation for the center of mass and swing foot. This integration of swing leg dynamics optimally generates the study's trajectory optimization efforts for effective bipedal walking control. The culmination of these efforts results in a feasible bipedal gait trajectory that can be used to achieve stable and efficient bipedal locomotion through our proposed controller. To make this template model robust, the Variable Stiffness SLIP-SL (VSLIP-SL) model is proposed. The primary challenge addressed here is the intrinsic instability of the SLIP model, which is overcome by integrating variable stiffness springs and a nonlinear controller. By proposing a controller for the high degree of freedom walking robot model based on the VSLIP-SL model, the study bridges the gap between model-level improvements and the implementation on a 5-link bipedal robot.

Also, mechanical improvements/additions to the bipedal walking system are explored in this thesis. Effects of augmenting bipedal robots with biarticular muscles and an active wobbling mass are investigated. We show through simulation studies that addition of passive biarticular springs can increase walking efficiency, walking speed and decrease the minimum torque requirements by tuning the springs properly via our proposed method. We also show that the use of a wobbling mass that is analogous to the arm swing motion can increase walking speeds and if we use them in combination with biarticular springs, the effect is further improved.

Another critical challenge faced by bipedal robots lies in adapting to varying terrains without the luxury of advanced perception or sensing mechanisms. In response, the study proposes a terrain-blind walking controller that employs phase variable manipulation and optimized trajectories to navigate rough terrains. This controller simultaneously reduces computational burdens and minimizes errors stemming from perception inaccuracies. We further improve the robot's walking performance by introducing biarticular springs and tuning them for robustness. Furthermore, the study delves into the efficacy of variable stiffness biarticular springs, showcasing their ability to enhance robustness against external disturbances. This novel approach broadens the arsenal of tools available for engineering robust bipedal robots capable of withstanding unexpected perturbations.

In essence, this thesis underscores the potential of bipedal robots to contribute significantly to human endeavors. By fine-tuning efficiency, robustness, and adaptability, these robots could play a pivotal role in tasks that are dull, dangerous, or difficult. The multidimensional exploration across various chapters underscores the complexity and potential of bipedal locomotion in the realm of robotics. As technology continues its rapid evolution, we hope that this thesis will also help in the pursuit of unlocking the full capabilities of bipedal robots to augment and enhance human lives across the world.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note: Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1 copy of 800 Words (English).

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