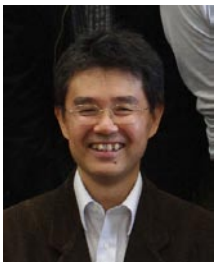
【Grant-in-Aid for Scientific Research(S)】
Integrated Science and Innovative Science (Comprehensive fields)



Title of Project : Understanding Human's Adaptive Bipedal Walking by Using a Cadaver Feet/ Artificial Muscular-Skeleton Hybrid Robot

Koh Hosoda
(Osaka University, Graduate School of Information Science and Technology, Professor)

Research Area : Informatics, Intelligent Robotics
Keyword : Intelligent Robot

【Purpose and Background of the Research】

Habitual bipedal walking is one of most fundamental features of humans over other animals, and understanding its adaptability is very important for study on human intelligence. It is supposed that soft feet and complicated structure of foot bones largely contribute to the adaptability. However, it is very difficult to observe the dynamic behavior of the foot even though its anatomical structure is, to some extent, known. In this study,
(1) we construct a cadaver feet/ artificial muscular-skeleton hybrid robot, and observe its precise dynamic behavior by using X-ray, force sensors, pressure sensors, and high-speed cameras, (2) we build a precise dynamic simulator based on the anatomical data of the foot and validate it by comparing with the hybrid robot, (3) we realize an adaptive biped walking robot by understanding the mechanism.

【Research Methods】

We will focus on the following three points:

(1) we construct a cadaver feet/ artificial muscular-skeleton hybrid robot, and observe its precise dynamic behavior by using X-ray, force sensors, pressure sensors, and high-speed cameras. During walking, some of the ligaments are pulled by artificial pneumatic muscles. We conduct lesion experiments by getting rid of ligaments, too.
(2) we build a precise dynamic simulator based on the anatomical data of the foot and validate it by comparing with the hybrid robot
(3) By understanding the underlying mechanism, we realize an adaptive biped robot whose adaptability is superior to the existing humanoid robots

【Expected Research Achievements and Scientific Significance】

Anatomical structure of a human foot is well investigated. There are many reports on the observable features from outside, e.g., contact situation of the sole during walking. Recently, to verify the dynamics of the foot, there are a few studies to push the cadaver foot against the floor, and observe the dynamic process. However, in these experiments, they observe behavior of an isolated foot pushed against the floor, which may be different from the one in the context of real walking. They try to reproduce the same loading condition, but is very difficult to be realized.
In this study, the cadaver foot is driven by anthropomorphic muscular-skeleton robot, and it is observed by X-ray, force sensors, pressure sensors, and high-speed cameras. We can expect to observe precise micro motion of the bones in the foot as well as macro information such as force, pressure, and gross motion of the foot. We expect that we can investigate fundamental mechanism of the foot-leg system. The knowledge obtained from this study will contribute to clarify the foundation of the mechanism of the foot for adaptive bipedal walking. It also contributes to the plastic surgery aiming at treatment of broken foot/ leg, and to the sports science to develop new shoes that can absorb impact against the floor.

【Publications Relevant to the Project】

Koh Hosoda, Takashi Takuma, Atsushi Nakamoto, and Shinji Hayashi, "Biped robot design powered by antagonistic pneumatic actuators for multi-modal locomotion", Robotics and Autonomous Systems, Vol.56, No.1, pp.46-53, January 2008.

【Term of Project】 FY2011-2015

【Budget Allocation】 166,100 Thousand Yen

【Homepage Address and Other Contact Information】

TBA. Currently, http://www-hi.ist.osaka-u.ac.jp