

**【Grant-in-Aid for Scientific Research(S)】**  
**Science and Engineering (Engineering)**



**Title of Project : Innovation of Unified Platform of Medicine and Engineering by Haptic Technology**

**Kouhei Ohnishi**  
 (Keio University, Department of Science and Engineering,  
 Professor)

**Research Area :** Engineering, Electrical and Electronic Engineering, Power Engineering, Power Conversion, Electric Equipment

**Keyword :** Haptics, Motion Control, Human Support

**【Purpose and Background of the Research】**

The progress of aging society is going to introduce a paradigm shift; human is now more likely to value “Quality of Life” more than “Quantity of Products.” Due to shifting, progress of the society cannot be sustained without artificial realization of labor and human effort. To achieve such tasks in automation, soft touching based on haptics sense is crucial. In usual robotics, consideration of “ideal force source” and “generalized transformation expressing motion function” is missing; therefore generated motion is “hard” all the time. However, this research achieves artificial realization of physical support on the basis of “principle of duality in motion.” Physical support is accomplished by constructed system HEM<sup>2</sup> (Haptic End-effector for Medicine & Manufacturing). HEM<sup>2</sup> is not only a system that can perform “soft” motion, but also a key for haptic technology on the collaboration between medicine and engineering.

**【Research Methods】**

The innovation introduced in this research is on the basis of “the principle of duality in motion” and mathematical analysis between action and function of the motion. The research is decomposed into four research plans. [A. “Expression” of Physical Function] The plan applies “the principal of duality in motion” for physical coordinate that expresses multi-function of humans. [B. “Generation” of Physical Function] The plan analyses physical function data in the form of matrix to realize various actions. [C. “Realization” of Human Action by Integrating Multi-Function] The plan introduces a method to efficiently index and database physical function for spatiotemporal integration. [D. Prototyping the Physical Human Support System] In research plan D, research plan A through C are verified in a step by step manner in the series of developments and experiments. Finally, prototype of 22 degree of freedom, 44 axes, physical human support system, “HEM<sup>2</sup>” is developed and effectiveness of the research is demonstrated.

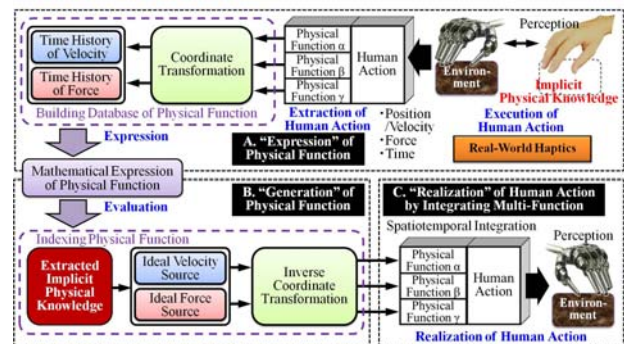


Figure 1 Research Methods and Outline

**【Expected Research Achievements and Scientific Significance】**

This research discovers the relation of human action and physical function, by drastic advance of “the principle of duality in motion”. The novelty of this research in academics is outstanding, because it treats physical functions in a form of mathematics by integration of “control energy sources” and “function topology”. As a result, technology based on the research indicates a high potential for the renovation of the industry and the society. The applicants are convinced that this new project can give technology innovation and more benefits back to the society, on the basis of the highly-integrated platform bridging between medical fields and engineering field.

**【Publications Relevant to the Project】**

- S. Sakaino, T. Sato, and K. Ohnishi: "A Novel Motion Equation for General Task Description and Analysis of Mobile-Hapto," IEEE Trans. Ind. Electron., vol. 60 no. 7 , pp. 2673-2680, 2013.
- A. Sabanovic, K. Ohnishi: "Motion Control Systems," John Wiley, 2011.02.

**【Term of Project】** FY2013-2017

**【Budget Allocation】** 154, 100 Thousand Yen

**【Homepage Address and Other Contact Information】**

<http://www-oml.sum.sd.keio.ac.jp/>