

**[Grant - in - Aid for Scientific Research on Innovative Areas(Research in a proposed research area)]**  
**Interdisciplinary Area**



**Title of Project : Science of Soft Robot:interdisciplinary integration of mechatronics, material science, and bio-computing**

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**[Purpose of the Research Project]**

In this area, we focus on “softness” peculiar to organisms as the platform of life phenomena. In various fields, academic studies that refer to softness occur individually. The international trend of science and technology “from hard to soft” is the background toward science and technology that is close to human and living things. A science that organically bundles biology, information science, material science, and mechanical/electronic engineering is an unexplored area, and integration is desired. Introduction of softness brings an essential change accompanying the construction of a new academic area and we believe that a vast knowledge will be opened.

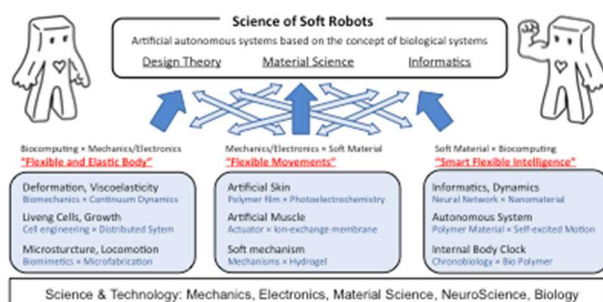
In this project, we propose “artificial autonomous systems based on the concept of biological systems” with the features of living organisms and define them as “soft robots” anew. The soft body of a living thing, its form, structure, mechanism, and information processing are fundamentally different from artificial things we can build at the present day. We call this frontier the new academic area “Science of Soft Robots.” The aim of this area is to integrate new academic challenges in each field and to create an active academic trend toward science of soft robots.

**[Content of the Research Project]**

The new academic area “Science of Soft Robots” not only imitates and reproduces organisms but also learns from living things, but also to learn from biological systems and to make artificial systems beyond living things. The framework consists of “soft robot design theory”, “soft robot material science”, and “soft robot informatics”.

Soft Robot Design Theory aims to blend mechatronics and biomechanics. It aims to allow flexible and elastic body. Also included is a biohybrid device incorporating living cells. Soft Robot Material Science creates flexible movements by smart material that has never been used on machines. We focus on soft mechanisms, electronics with extreme softness/elasticity, artificial muscle comparable to biological muscle using polymer material. Soft Robot Informatics aims to design smart and flexible intelligence in which software and hardware are inseparably combined. By utilizing the soft material dynamics as an information processing device, we aim to break through the limits of conventional information processing. In

addition, by introducing a chemical reaction system on a soft body, we obtain spontaneous periodic motion and chemical body clock.



**[Expected Research Achievements and Scientific Significance]**

Through collaboration among interdisciplinary researchers who have never before met, the following academic outcomes are expected. First of all, it is possible to reveal principles of skillful soft mechanisms found in the animals and realization by artificial systems. From the viewpoint of material science, we can provide new actuators, flexible sensors, and soft energy source utilizing a functional polymer material and an electrochemical phenomenon. As a contribution to robotics, it is possible to provide a theoretical framework of continuum dynamics that handles nonlinearity and large deformation of soft materials. It is also expected to have soft mechanics using a functional hydrogel. For information processing technology, we will show that soft behavior of complex body can be used as a computational resource different from semiconductor chip.

As a social return of academic outcomes, various applications utilizing safety due to softness, biocompatibility are conceivable. Soft robots that can coexist with humans are expected to develop into safe and intellectual physical exercise support in an aging society, realization of safe mobility, monitoring robots without discomfort.

**[Key Words]**

Soft Robot, Soft Actuator, Soft Mechanism, Flexible Sensor, Biohybrid, Biocomputing

**[Term of Project]** FY2018-2022

**[Budget Allocation]** 1,194,200 Thousand Yen

**[Homepage Address and Other Contact Information]**

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