●Development Stage

(Fiscal Year 2006-2008)

Koriyama Area

Enhancement and Application of Haptic Technology with Collaboration of Medical Science and Engineering

Fukushima Prefecture Industrial Promotion Center
1-12 Machiikedai, Koriyama City, Fukushima 963-0215 JAPAN
TEL: +81-24-959-1951

Life Sciences
IT
Environment
Nanotech Materials
Others

Framework for Project Promotion

Project Director·····Kuniaki Fukui (President, Nippon Zenyaku Kogyo Co., Ltd.)

Chief Scientist·····Isao Saito (Professor, Department of Mechanical Engineering, College of Engineering, Nihon University)

Science and Technology Coordinator···Takashi Hashimoto
Ryuichi Iritani
Hirofumi Tateyama

Core Research Organizations

College of Engineering Nihon University, Fukushima Medical University, Fukushima University

Major Participating Research Organizations

Industry···P&M Co. Ltd., ASTER INDUSTRIES CO. LTD.,
ATOM PRECISION TOOLS CO., Nidec Copal Corporation, and others

Academia···College of Engineering Nihon University, Fukushima Medical University, Fukushima University, and others

Government···Fukushima Technology Centre,
Fukushima Agricultural Technology Centre - Livestock Research Centre, and others

Aims of Project

Nihon University (located in Koriyama City) in Fukushima Prefecture, has developed haptic technology, which is a Japan-original cutting-edge technology. In order to create the next-generation medical industry in Japan, it is essential to foster an up-to-date medical equipment industry with the haptic technology as its core. Therefore, to prompt the wide-spread use of this technology in state-of-the-art medical equipment, such as telemedicine devices and surgical robots, as well as in a clinical setting, research and development in the industry-academia-government collaborative City Area Program (Basic Stage) in Koriyama has been conducted, aiming at a wide range of use in the field of clinical treatment. The research and development of haptic technology has led to the development of new medical equipment and progress towards the next-generation medical and welfare equipment that is non- or minimally invasive for patients. Many other types of medical equipment have been tentatively fabricated with this technology.

In the City Area Program (Development Stage), the research and development of medical and welfare equipment based on the haptic technology is being conducted, and making use of the industry-academia-government network that has been built up, as well as the "Utsukushima next-generation medical industry accumulation project," it is aimed to accelerate the formation of a medical and welfare equipment industry cluster in the Koriyama area.

Contents of Project

This research is aimed at the realization of next-generation medical equipment through the use of the new haptic technology that can be fused with state-of-the-art equipment such as telemedicine devices and life support robots.

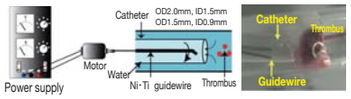
1. Integration of haptic (sense of touch) device, and its advanced functionalization and application to medical equipment
   1-1 Development of high-performance ultrasound probe with haptic function and its application to the clinical field
   The application of haptic technology in next-generation ultrasonic medical equipment that can detect the hardness of cirrhosis or hard lumps on the basis of touch, just like the hands, and produce an image is attempted.
   1-2 Development and research of a noncontact tonometer by the phase shift method
   A new tonometer is developed for diagnosis without direct contact between the object and the measuring probe (augen), unlike the conventional contact probes, by using supersonic waves that are transmitted through air.

2. Development of bio-quality evaluation system of ovum and culture tissue by haptic measurement
   2-1 Development of bio-quality evaluation system of ovum by haptic measurement
   A system for evaluating the bio-quality of the ovum on the basis of its biomechanics properties is completed through the use of haptic technologies to (1) improve the reliability of the Micro-Tactile Sensor (MTS) probe, (2) develop a chamber for cultured cell measurement, (3) improve the functions of the MTS integrated with a monitoring technique of the respiration rate of oxygen, and (4) conduct clinical evaluation.
   2-2 Tactile mapping
   A system for evaluating the bio-quality by measuring the bio-mechanics property at the culture tissue level is completed by (1) increasing the MTS probe speed, (2) developing a probe scanning system, (3) developing a culture tissue chamber for measurement, and (4) conducting clinical evaluation.

3. Development of next-generation gentle and soft robotic hand-arm system with haptic function and its application to medical support systems
   A robotic hand-arm system with the minimum possible weight will be realized through an optimal structural design and systematic joint mechanisms using lightweight and direct-acting actuators made of a composite functional material, all of which were achieved through a close relationship among experts in different fields, such as those of materials, sensors and systems.
   The ultimate aim is to improve the usability of next-generation hand-arm systems of robots that are intended to exist alongside humans, by integrating the results of psychological analysis and evaluation by experts and the advanced sensor device or lightweight and flexible enclosure realized through the research.

Main Results

1. Integration of haptic (sense of touch) device, and its advanced functionalization and application to medical equipment
   1-1 Development of high-performance ultrasound probe with haptic function and its application to clinical field
   On the basis of the phase shift principle, an ultrasonic haptic probe, an optical tumor detection system, a catheter for haptic imaging of blood vessels, a functional catheter for the treatment of blood-brain tumor, a haptic probe for an arthroscope, a phase shift blood flow and pressure monitoring system, and a phase shift pulse oximeter were developed. Clinical studies of these devices are in progress.



Functional catheter
for the treatment of blood-brain tumor

   1-2 Development and research of a noncontact tonometer by the phase shift method
   A novel phase shift circuit was developed that allows a system to oscillate with an extremely high frequency, and it was demonstrated that the measuring device with the novel phase shift circuit exhibited a highly stable performance. Clinical studies of this circuit are in progress.

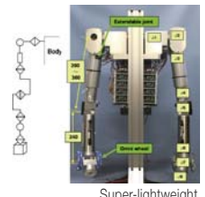
Prototype of
handy-type tonometer

2. Development of bio-quality evaluation system of ovum and culture tissue by haptic measurement
   2-1 Development of bio-quality evaluation system of ovum by haptic measurement
   The method of optimizing the sensitivity and an effective fabrication process of a Micro Tactile Sensor (MTS) were established. As a consequence, a tenfold more stable MTS was developed.

Micro Tactile Sensor

   2-2 Tactile mapping
   The origin of error and instability of the Micro Tactile Sensor (MTS) during high-speed mapping was investigated. As a consequence, the stability of the MTS was increased 5.3-fold.

3. Development of next-generation gentle and soft robotic hand-arm system with haptic function and its application to medical support systems
   A high-precision compact finger-type 3D-cam and an ultralight structure material were successfully developed and are now being used in the fabrication of a five-fingered robot hand.

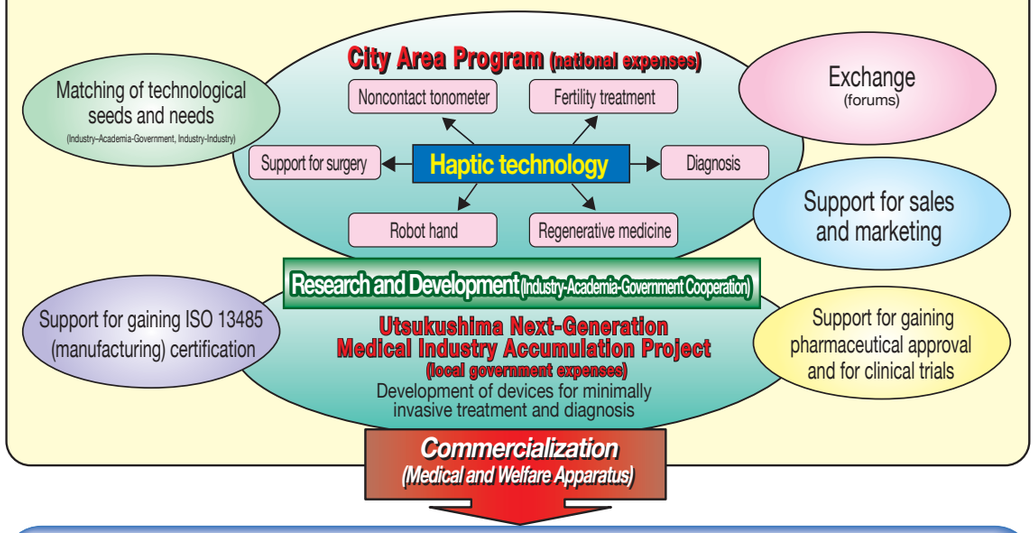


Super-lightweight
eight-degrees-of-freedom manipulators

Support for Next-Generation Surgery and Development of Medical Diagnostic Apparatus Using Haptic Technology

(Basic Stage, 2002 – 2004)

Enhancing and Applying Haptic Technology with Collaboration of Medical Science and Engineering
(Development Stage, 2006 - 2008)



Formation of Medical and Welfare Apparatus Industry Cluster