●Development Stage

(Fiscal Year 2007–2009)

Southern Area of Lake Biwa

Development of an On-site Diagnosis and Treatment System for Reducing the Physical Load on Patients - Development of a Manufacturing Cluster in Cooperation with Clinicians and Engineers

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Life Sciences
IT
Environment
Nanotech Materials
Others

Framework for Project Promotion

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(Professor, Faculty of Science and Engineering, Ritsumeikan University)
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(Professor & Chairman of Surgery, The Shiga University of Medical Science)
Satoshi Konishi
(Professor, Faculty of Science and Engineering, Ritsumeikan University)
Science and Technology Coordinators…Yoshihiro Nishinaga
Masao Hirano

Core Research Organizations

The Shiga University of Medical Science, Ritsumeikan University, Industrial Research Center of Shiga Prefecture

Major Participating Research Organizations

Industry…I.S.T Corporation, NIPRO CORPORATION, FUJIFILM Corporation, Technes Co., Ltd., YAMASHINASEIKI CO.,LTD.

Academia…The Shiga University of Medical Science, Ritsumeikan University, Ryukoku University

Government…Industrial Research Center of Shiga Prefecture

Aims of Project

In Japan, the incidence of adult diseases and cancer has been increasing rapidly because of aging of the long-living population. Therefore, an important theme in medical practice is improvements in diagnosis and treatment to reduce the physical load during operations and improve postoperative QOL.

In this project, we are developing an On-site Diagnosis and Treatment System (hereafter ODTS) to accomplish treatment promptly within the operating room. The research focuses on operations performed to remove cancerous tumor. ODTS is applicable to treatments such as “Specification of malignant tumor locations,” “Grading of the malignancy,” and “Removal of malignant tumors located beyond the reach of conventional endoscopes.”

We aim to (i) distribute the developed system to regional hospitals after testing at Shiga Medical University Hospital, (ii) establish a local medical service, and (iii) form a manufacturing cluster to cooperate in the fields of medicine and engineering.

Contents of Project

1. Research and Development of Technologies Required for a Robot for Endoscopic Surgery

Micro-robotic technologies developed in the Basic Stage are expected to realize an advanced endoscope with improved performance and less physical invasion. Various core technologies for this endoscopic surgery robot have been developed and verified in animal or phantom models. These technologies will contribute to the practical application of therapeutic instruments and inspection equipment.

2. Research and Development of Micro-Biopsy and Micro-Biochemical Tests

Micro-biopsy and micro-biochemical tests are expected to realize rapid on-site diagnosis during surgery and to reduce the physical load on patients. We developed the technologies required to integrate the process of clinical sample collection and biochemical testing into a single small package, which was subsequently verified in animal tests. We also investigated technologies for the acquisition of new diagnosis data and predictions of drug effects to assure accurate diagnosis.

3. Research and Development of Diagnosis and Treatment Technologies Using Nanoparticles

Gold nanoparticles usually show strong red-wavelength absorption due to the surface Prazmon phenomenon, and near-infrared (NIR) light is transmitted inside the human body. Therefore, NIR radiation has the potential to be applied in diagnosis and treatment at the cell level using light-bio interactions between luminescence and heating. In this research project, we developed gold nanoparticles with absorption in the NIR region, and nanoparticles with antibody agents introduced for a target cancer. We studied visualization technologies for tumor location and patches of malignant cells, as well as applications of nanoparticles in diagnosis medicine.

Main Results

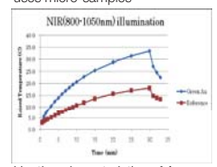
1. In the development of robotic technologies for endoscopic surgery, many technologies have been developed for an advanced endoscopic robot (e.g., washing, holding, cutting, stopping bleeding, and sensing), and a prototype endoscope has been achieved with the function of carefully lifting up the organ wall. We have prepared the technologies necessary for a next-generation endoscopic robot to enable accurate diagnosis and ease of operation.

Lifting operation of a retractor set at the endoscope tip

2. The R&D project, focusing on micro-biopsy and micro-biochemical tests, developed the following fundamental technologies: 1) new blood-sampling technology, 2) micro-fluidic technologies for separation and pipetting, 3) new biochemical testing technology, and 4) a new method of acquiring diagnosis information. These technologies promise further progress in the development of an on-site diagnosis system.

Prototype of in-vivo analyzer that uses micro-samples

3. In the R&D of nanoparticles, chemically modified “green” gold nano-particles were synthesized with a specific NIR absorption spectrum. The nanoparticles absorb NIR light and are easily identified from haemoglobin. This new particle is expected to be applied in the visualization of cancer cells and in thermotherapy.



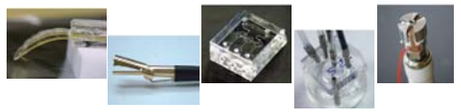
Heating characteristics of Au nanoparticles excited by NIRlight

Development of an On-site Diagnosis and Treatment System to Reduce the Physical Load on Patients

Development of an in vivo micro-robot for diagnosis and treatment
(Basic Stage, Fiscal Year 2004–2006)

Technology “seeds”

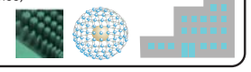
Micro-robotic technology



Fusion

Area Potential of Academia and Industries

- ○Micro/nanoscience and system integration (Ritsumeikan University)
- ○Low-invasive operation under MRI (Magnetic Resonance Imaging) (Shiga University of Medical Science)
- ○Biomedical Engineering
- ○Synthesis of nanoparticles



Practical application

On-site diagnosis and treatment system