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Feature

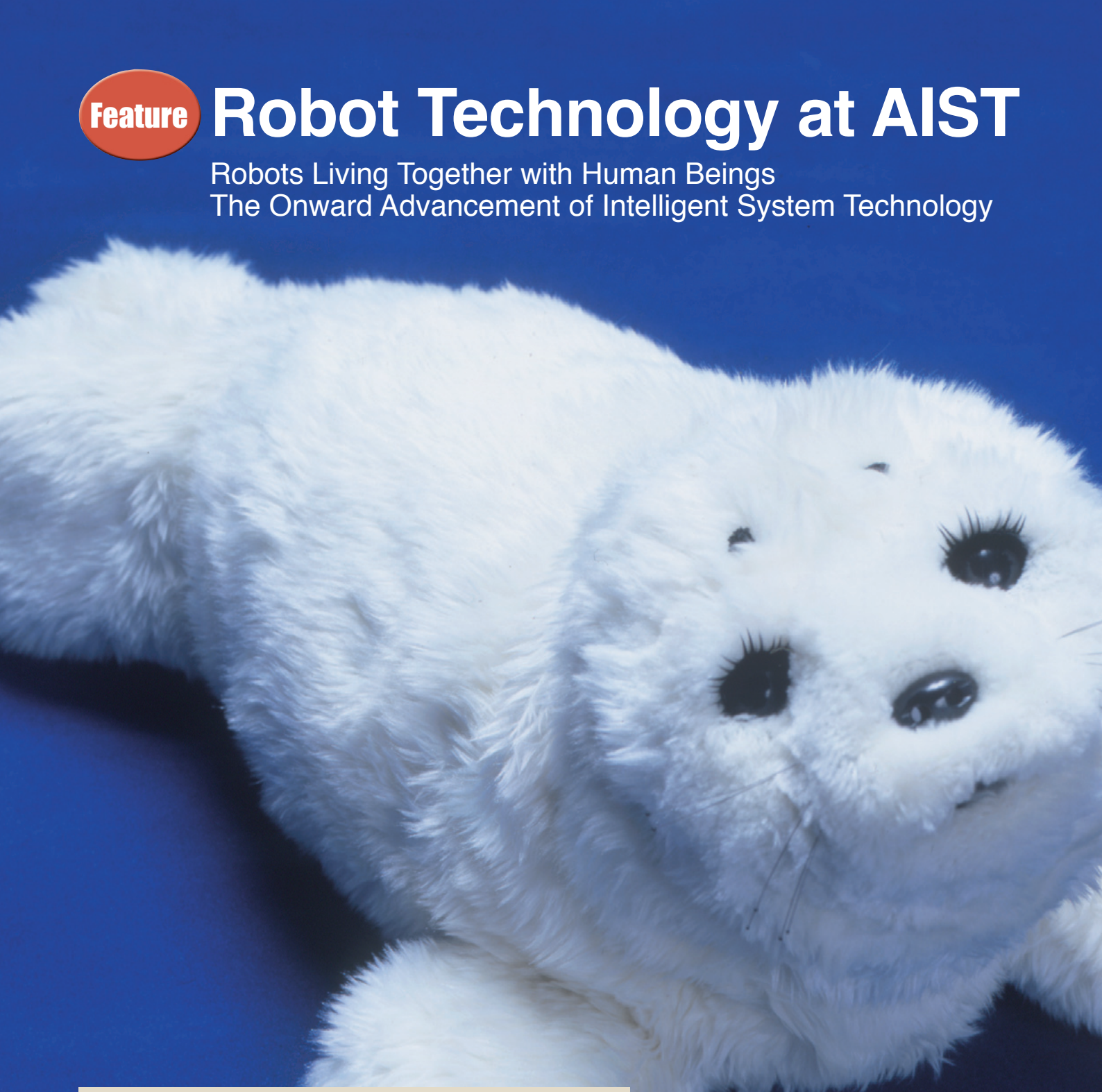
Robot Technology at AIST

National Institute of Advanced Industrial Science and Technology

Feature

Robot Technology at AIST

Robots Living Together with Human Beings
The Onward Advancement of Intelligent System Technology



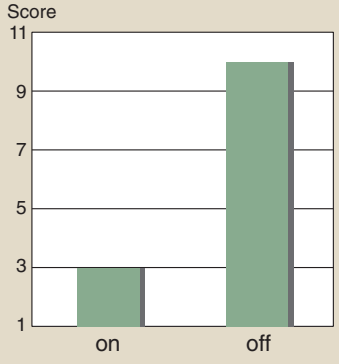


Fig.1 Comparison of average face scale scores when the power of the robot is "ON" and "Off"

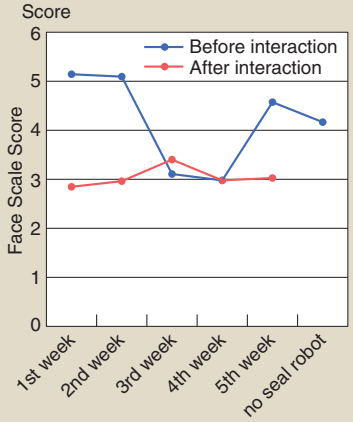


Fig.2 Average face scale scores of the elderly

Fig. 1 shows the comparison of the pediatric patients' mood at a children's ward who hold the robot with the mains switch both on and off. Fig.2 represents the results of a series of interaction tests between the elderly people and Paro. The tests were conducted one time per day, 3 days a week, for the period of 5 weeks at an adult day-care centre. Face Scale is a measurement tool to assess the mood using a scale of one to twenty from a smiley face to sad face.

7th generation Paro, weighing 2.7kg

Therapeutic Robot

Prime Minister Mr. Koizumi holding Paro (Photo: Cabinet Public Information Office)

World's Most Therapeutic Robot

"Mental Commit Robot" Nickname: "Paro"

Since ancient times, animals have always played a role in man's life. Although the merits of animal therapy are positively recognized in the areas of medical care and welfare, there are difficulties to introduce this form of therapy at hospitals and nursing homes for fear of the associated problems such as allergy, zoonotic infections, biting, scratching etc. Additionally, it is also difficult for those who live alone to take care of pets. It is often forbidden to raise animals in housing complexes. Under such circumstances, Paro was developed in order to meet the demands for a robot pet which can coexist with humans.

This white-haired "Paro" is modeled after a baby harp seal. Seals are not so common in daily life and thus the robot would not draw upon too much of a comparison with real life seals. Paro is the world's first "Mental Commit Robot" and gives pleasure and comfort to humans through interaction.

Since 2000, Paro has been a great success in a series of demonstration experiments concerning robot therapy which have been implemented at the pediatric ward of Tsukuba University Hospital, adult day-care centers and nursing care facilities. Moreover, with the aim of improving robot-assisted therapy, further improvements have been made to Paro, leading to the completion of the 7th generation Paro.

Paro has received widespread acclaim not only in Japan but also in Britain, Norway, Italy, UAE, Korea, Australia and the U.S., among others. The exhibit of "Paro and Robot Therapy" has started at the National Museum of Science and Technology in Sweden in May 2003 and is attracting increasing attention. The exhibit will continue for the next three years.

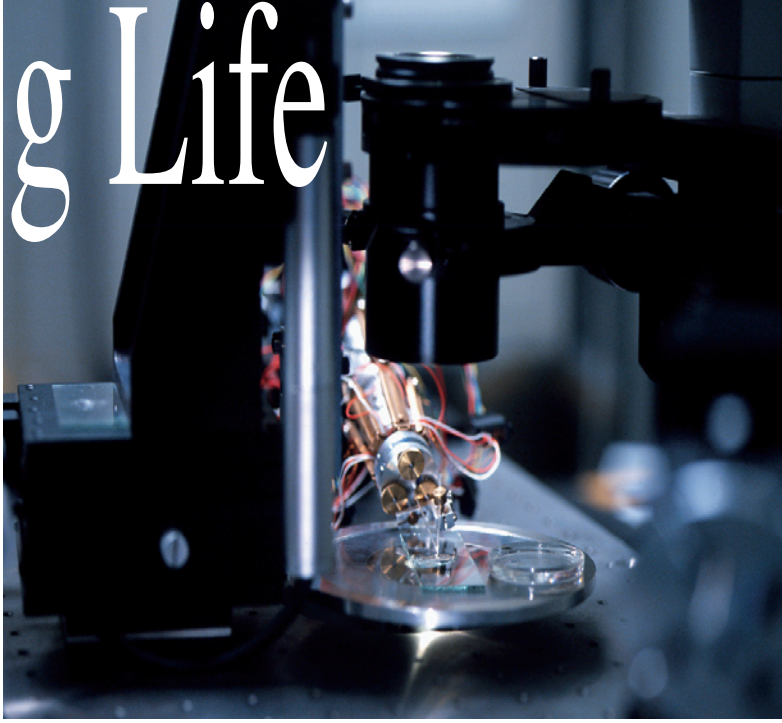
Paro at the Science Museum in London, UK

Paro surrounded by children at a pediatric ward

Researcher's Message

We are striving for an early practical application of the Mental Commit Robot "Paro" in order to provide comfort and relaxation and also improve people's quality of life.

Supporting Life

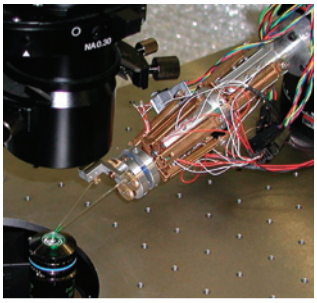


Deft Fingers for Micro Manipulation

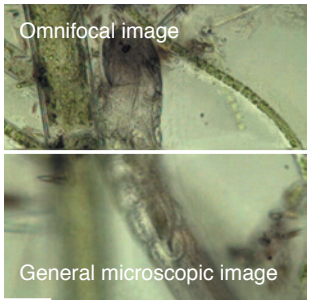
Robot working in microenvironment

In areas including engineering, medical care and biology, microscopic operation is required for manipulation of micro objects that is beyond the limits of human ability. The micro-manipulator was developed by combining the technologies of observation and manipulation within a microscopic environment.

The omnifocal camera capable of focusing on any point in an image and a micro hand system that was developed by emulating the movement of chopsticks realized an operation with precision of "submicron order". The system contributes to the research in the fields of most advanced technologies, including engineering, medical care, biology, etc. The merits of the technology are expected to be most exploited in gene manipulation of cells in the field of biotechnology especially for gene function identification. It is also useful in the medical field.



Micro hand



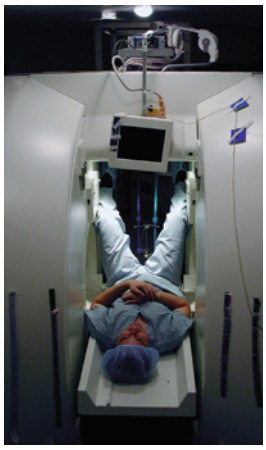
Microbe observation
(×50 Magnification)
Cooperated by
PHOTRON LIMITED

Safe, Precise and Minimal Intervention in Surgery

World's first MR-compatible surgical robot

Surgical robot, one of the dreams of the 21st century, has been developed, aiming at the realization of minimally invasive surgery. The robot is to access the target under the image guidance for safe, accurate and minimal intervention.

Since 1998, AIST has been developing an image-guidance system comprising of the MR-compatible robots and endoscopes and so on, in cooperation with Harvard Medical School in the U.S., Tokyo Women's Medical University and other institutions.



Open MRI
MRI has been used for diagnosis. This is an open MRI system which provides visual support to surgeons.

Robot Assistant for Open MRI
This robot incorporates a nonmagnetic mechanism of five-degree-of-freedom and is used with axisymmetric surgical devices such as a needle and a laser pointers. The main body of the system is installed overhead so that it does not interfere with the surgeons.

Researcher's Message

We do not consider robotic sugery as the ultimate goal but as a step to decrease medical accidents. In order to resolve conflicts between technology and medical practice, we maintain a close coordination between the researchers of the both fields from the early stages of the projects.

Handy Hands for Housework

Robot with interchangeable hands

What if we have a robot that assists our everyday duties...A robot with interchangeable hands was developed to approach the realization of this dream. The AIST's unique invention enables the robot to replace the hands by itself and maneuver a variety of objects.

The hands can be attached and removed mechanically according to the movement of the robot arms.

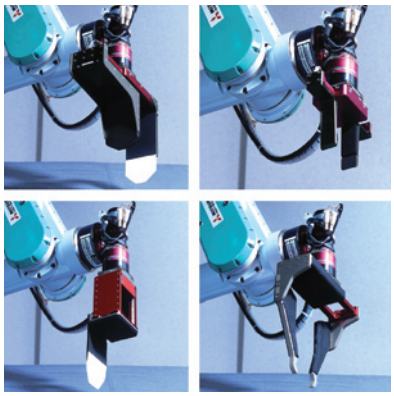
Unlike conventional industrial tool changers, the robot does not require a drive source specially for mounting and fixing of the hands. This resulted in downsizing as well as weight reduction of the system.

A four-fingered hand, one of the interchangeable hands, is called “WitchHand” and is able to grasp a variety of objects securely by adapting the fingers to the shape of the target object by means of a single axis driving motor.

*(*WitchHand® is a registered trademark of AIST.)*

The figure illustrates a future robot with interchangeable hands.

Life Support



Researcher’s Message

We are proceeding with full-scale research projects including the development of hardware other than interchangeable hands as well as sophisticated task teaching technology, aiming at the creation of a robot which can be used as a tool. We will strive for the realization of the system which is beneficial for many people at the earliest possible date.

Vision System for 3-D Perception and Recognition

"VVV" acts for human vision

As human behavior is mostly based on three-dimensional visual information, VVV is developed for an advanced computer vision system that observes 3-D objects stereoscopically to be used for many purposes in many fields.

The principal functions of VVV are range sensing, shape description, object recognition and motion tracking. VVV implements these functions in real time consistently and accurately for any shape of objects in various situations.

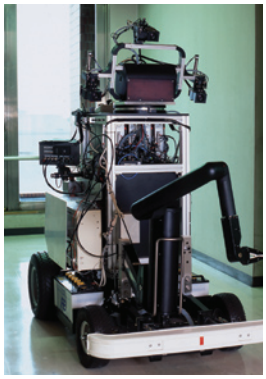
There are many needs for such 3-D vision systems, including: manufacturing, transportation, construction, medical services, welfare, security, disaster prevention, etc. VVV is expected to be commonly used to automate a variety of works and the operation of machines which require human vision.

Flexible Manipulation System without Programming

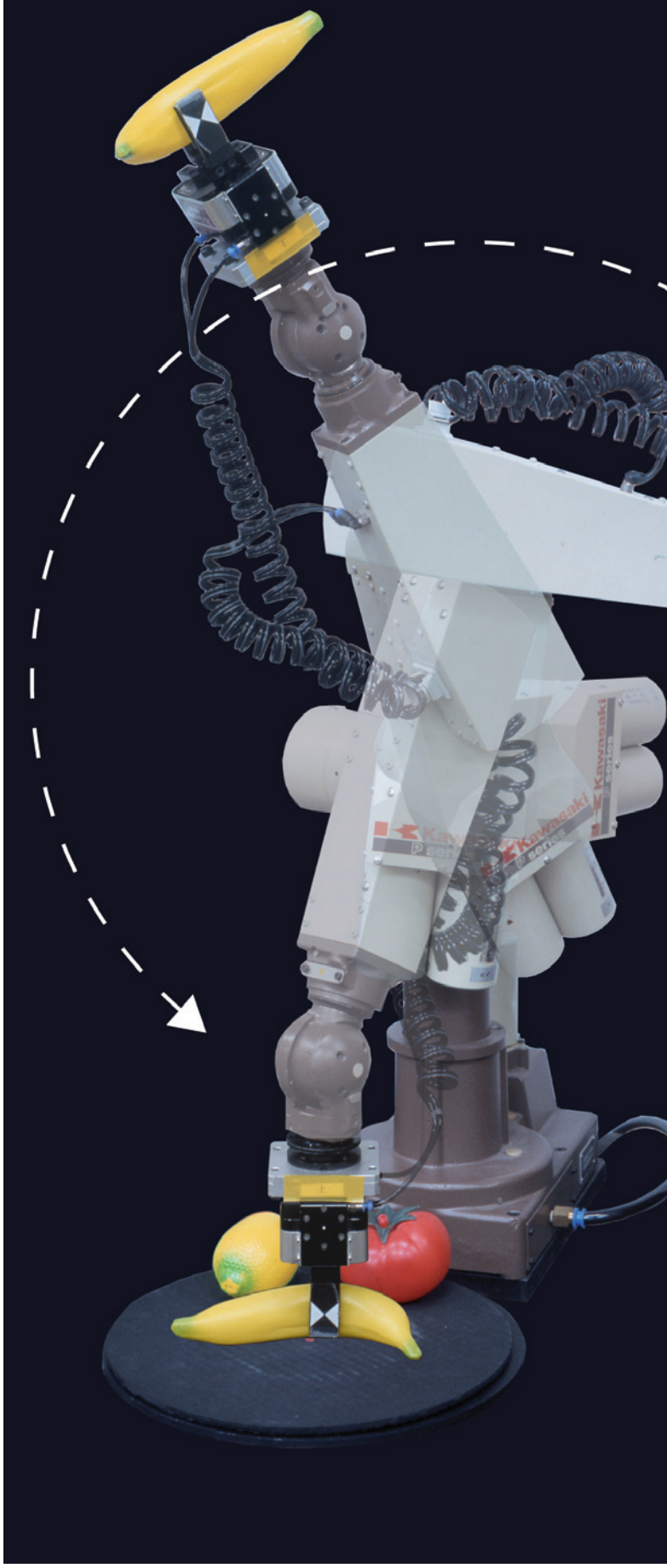
The green lines represent the geometrical model of the target object and indicate that the spatial position and attitude have been recognized by the system.

The manipulator, cooperating with the VVV system that recognizes a banana among various fruits, picks it up and places it on a plate. This technology is applied in the development of automatic assembling systems, for example, to classify castings randomly placed on a moving conveyer belt and to insert parts into the holes of a component even in unstable conditions.

Autonomous Vehicle

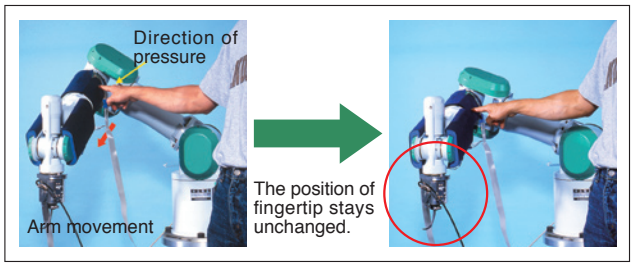


A battery-driven cart that carries an active trinocular stereo camera system as a 3-D visual sensor can autonomously go to the goal avoiding obstacles on the way with a simple map of the distances between the intersections.



Robot Arm with Tactile Sensor throughout Body

It is extremely important for a robot to have a tactile sense in order to ensure safe operation in an environment with humans. To meet this requirement, a robot which has a tactile sense throughout the body has been developed. This robot will sense being touched by a human and avoids further contact so that it can continue to operate safely. The new tactile sensor is easy to load on a robot arm and conveys various information such as positions and degree of pressure at multiple contact points over a large area. The arm is covered with soft materials, taking into account the safety of the contact with humans. Currently it is planned to improve the response speed of the control system as well as incorporation with other sensors such as a visual sensor. The arm with a tactile sensor is expected to open a path to safer co-existence between robots and humans.

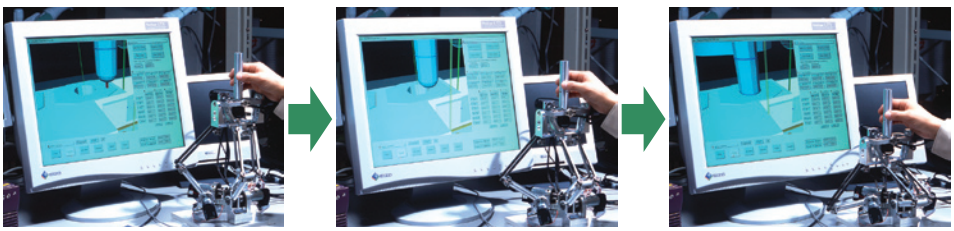


The robot avoids further contact and continues to work.

Haptic Interface Carries All Kinds of Force and Motion Information

The six-degree-of-freedom haptic interface invites the users to experience various force and motion in remote places or in the virtual world as if they have entered there. The system enables interactions with remote places and/or virtual reality by taking advantage of its wide range of motion (translation movement: a ball with a diameter of approximately 150 mm; orientation movement : Approx. ±70 degree from each axis) and excellent movement properties.

The haptic interface was originally developed by Prof. Uchiyama of Tohoku University and Prof. Tsumaki of Hirosaki University. Further improvement was pursued in cooperation with AIST focusing on stiffness analysis of the mechanism, for the development of a haptic interface with high and well-ballanced rigidity.

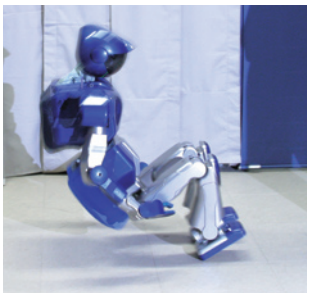


Humanoid

HRP-1S drives a backhoe wearing a waterproof protective gear in artificial rainfall.

Ultimate Robot
Humanoid Robot

A humanoid robot that coexists and has the ability to work with human beings is required to walk with two legs and have a body of similar shape and size to that of human beings. This is because every artificial object surrounding us is made based on the premise that the users are human beings.


HRP-2P under falling motion controll

AIST has been pursuing the possibilities of a humanoid robot and successfully developed a robot capable of working on highly advanced tasks with human workers and moving flexibly on a rough terrain by means of a remote control through a communication network.

Humanoid Robot HRP-1S

We succeeded in the experiment of operating a forklift and a backhoe by a humanoid robot by using a remote control.

The robot will work in extreme conditions at disaster relief sites, construction sites and so on (Joint research project with Kawasaki Heavy Industries, Ltd. and Tokyu Construction Co., Ltd.).

Using a remote control from a safe distance, various tasks can be carried out safely and smoothly.

HRP-2, a Fruit of HRP-2P

HRP-2 was developed with an aim to create a robot that can walk on a rough terrain, get up after falling and work with human beings.

The robot is 154cm tall and weighs 58 kg. It has a body similar to human's by eliminating a backpack for electronics installation. The power of the arms are increased, enabling them to carry out versatile tasks.

When carrying a panel, the force and torque applied to the panel are regarded as a command to determine the direction of the movement of the robot.

Furthermore, the movements of robot arms are controlled so that the positions of the panel where the robot holds can be kept stable (Joint research project with Yasukawa Electric Corporation, Kawada Industries, Inc. and Shimizu Corporation).

Towards Practical Application

Kawada Industries, Inc., one of our research partners has started to supply HRP-2 to the research institutions since March 2003.

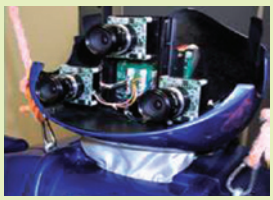
The control software of HRP-2 that was originally developed by AIST has been put into practical use and marketed by General Robotix Inc., a venture corporation authorized by AIST.

Researcher's Message

We plan to develop a waterproof and dust-proof humanoid robot and more advanced software for complex task in a real world to create a humanoid robot industry.

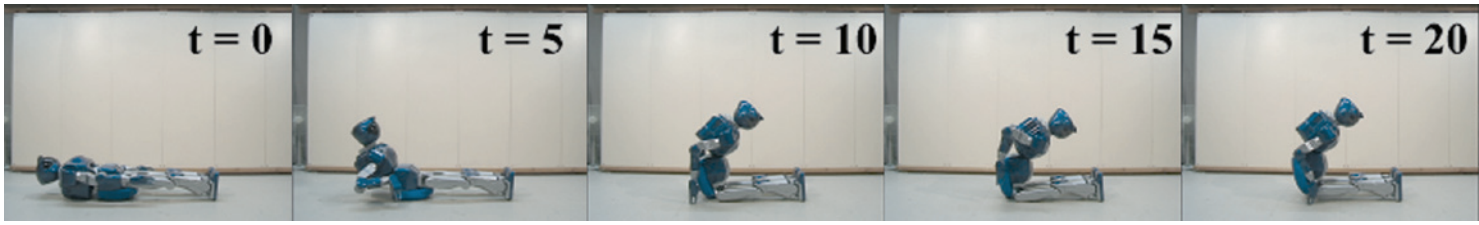
Humanoid Robot Eye

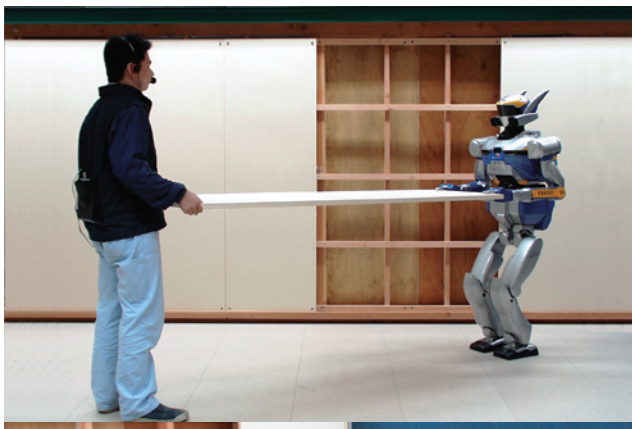
A stereo camera system composed of three cameras is incorporated as a stereoscopic visual sensor enabling the robot to measure and recognize the three dimensional shape of objects, such as panels. This system has the ability to control pan and tilt the head so that it can shift focusing points. It also controls shutter speed of the cameras in order to respond to changes of light conditions.


Head of HRP-2P

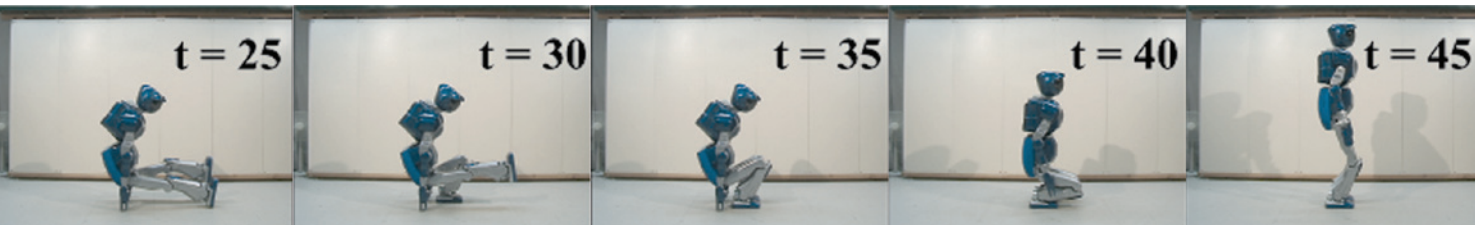

Head of HRP-2

Getting up motion from face-up position (t=second)

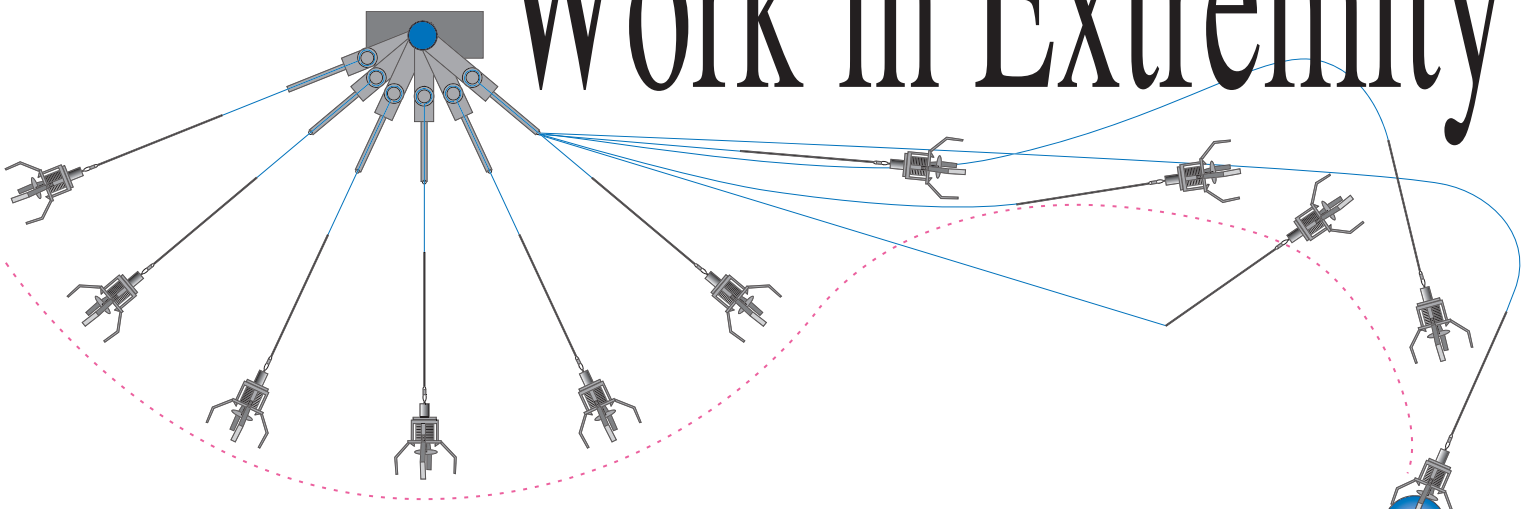




● HRP-2 understands a spoken command, "Pick up the panel" and lifts the panel with a human partner.
● The robot is able to control the swinging movement of the panel by coordinating the movement of the arms and legs. It can place the panel against the wall.
● The newly invented features include abilities of walking on rough terrain, falling down without being severely damaged and getting up from a tipped over position. These qualities are indispensable for carrying out tasks at unstable sites.



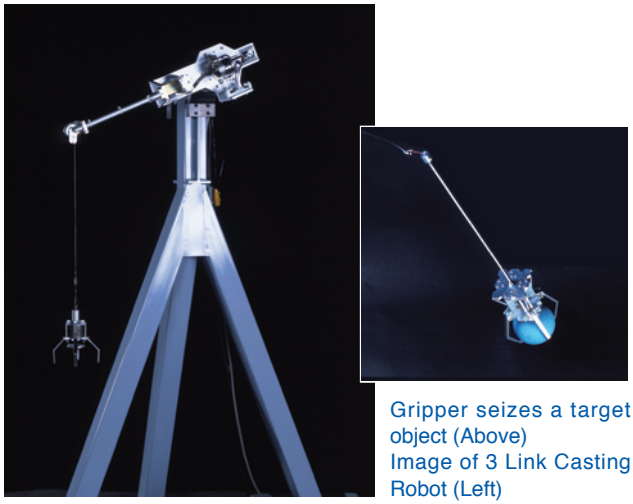
Work in Extremity



Never Off Target
Casting Robot

The casting robot was developed, inspired by “fishing”. Flexible materials similar to ropes or fishing line are incorporated into the mechanism in this invention. This robot has the ability to handle distant objects by "out-in" movement of its light-weight and flexible arms. It can also cast a "hand" to grip objects (gripper) to a target position with accuracy and controls the flying movement of the gripper to collect the target objects by changing the tension of the rope through the use of a braking system.

The casting robot ensures an extensive working area and it features a high moving speed and reduced energy consumption. On account of these advantages, it is expected to take an active role in field works which may be dangerous for humans such as civil engineering and construction projects, disaster relief, recovery efforts etc.



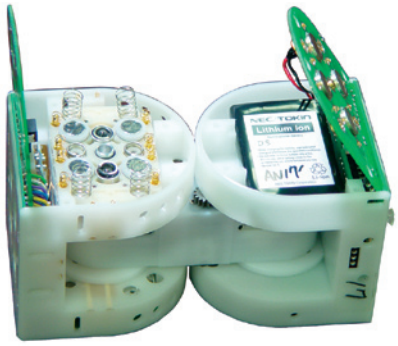
Gripper seizes a target object (Above)
Image of 3 Link Casting Robot (Left)

Free to Go, Free to Transform
Modular Robot: M-TRAN

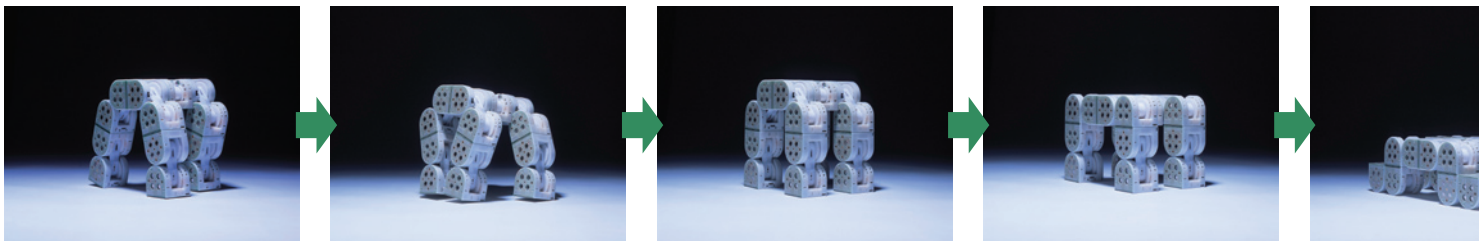
M-TRAN is a robot composed of several identical components called a module. A module works as a joint powered by an electric motor that is capable of controlling the connection with adjacent modules and communicating with other modules to determine the next move. The combination of the modules enable a robot to transform itself into another shape. The robot goes through a narrow ditch in a shape of a snake, walks and crawls on a flat terrain in a different form. It climbs over an obstacle which it runs into. Even if some of the modules fail to operate, it has a remarkable ability to maintain the integrity of overall functions by disposing of the broken modules and reconfiguring the entire system.

Various improvements were made to reduce the size and weight of the robot and to realize its battery operation. M-TRAN II is an important step forward towards the practical application in extreme conditions including in rescue operation, planetary exploration and so on.

(also see p.17 under)



M-TRAN II Module



Robotics at AIST for the Creation of Systems to Cater to Versatile Needs

Robotics research at AIST, boasting a thirty-year history, has contributed largely to the development of robotics and related industries by playing a major role in the promotion of national projects of research and development which aim at strengthening the foundations of the robot industry in Japan. The projects include the creation of robots working in extreme conditions, humanoids, etc.

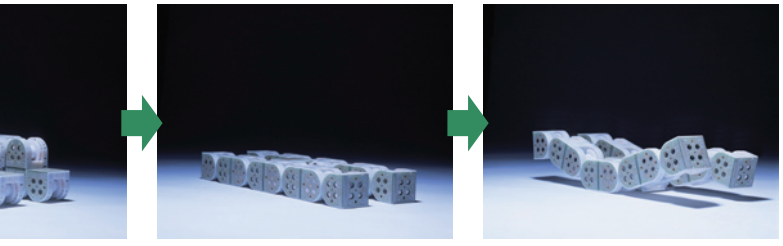
AIST researchers engage in research and development of the robots with various abilities under the motto of "Creation: Drawing a picture on an empty canvas according to the people's desire". There are a variety of robots, including those which function to replace people under various situation. There are robots with highly sophisticated abilities comparable to human specialists. The robots profiled in this feature article represent the achievements of our efforts to offer robots with smart intelligence that serve a useful purpose in society.

There are demands for robotics as resolution to a number of issues of the 21st century, such as an ageing population, environmental concerns, creation of new industries, etc. AIST must explore a scenario to expand the industry, fulfilling these expectations.

Although it is commonly recognized that Japan's robotic industry has international competitiveness, it is also true that the market size is limited as the technology application is focused on the manufacturing industry.

Enormous efforts will be called for in order to respond to the versatile needs of the users through the creation of products which will serve as a core of a new industry. AIST will assess the needs which can be met by the implementation of various technological seeds of AIST from the broader range of social demands. It is also demanded to propose and advocate the new concept of a robot that is feasible and meets social needs, based on the technological seeds AIST can offer.

AIST is striving for the further advancement of robotics research projects including the robots introduced in this article and development of robotics industry, that, we believe, will lead to the resolution of the key issues of our society in the 21st century.



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Haptic Interface Carries All Kinds of Force and Motion Information
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Free to Go, Free to Transform Modular Robot : M-TRAN
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AIST RESEARCH HOT LINE

UPDATES FROM THE CUTTING EDGE

(Apr. — Jun. 2003)

The abstracts of the recent research information appeared on the Vol.3 No.4-No.6 of "AIST Today" are introduced and classified by research area. For inquiry about the full article, please contact the author directly.

Life Science & Technology

A Novel Method for RNA Sequence Data Analysis

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AIST Today Vol. 3, No. 4 (2003) 11

We proposed a novel method to deliver kernels for RNA sequence data using stochastic context free grammar (SCFG)[1]. Our previous work was to deliver kernels for general biological sequences using hidden Markov model (HMM)[2]. RNA sequences can not be dealt with HMM because they involve remote base interactions which consequently form stem-loop structures. The stem-loop structure thermally stabilizes secondary structures of RNA, which is essential in terms of evolutionary conservation. SCFG is more powerful stochastic language model than HMM which allows dealing with the stem-loop structures (Fig1). We call our novel kernel *Marginalized Kernel over SCFG*. The kernel shows good performances in several demonstrations. Fig2 shows a result of kernel PCA for three-class human tRNAs.

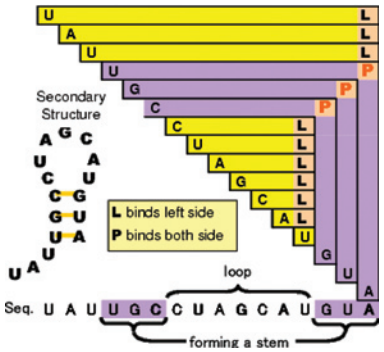

Fig.1 Binding structural information labels to an RNA sequence

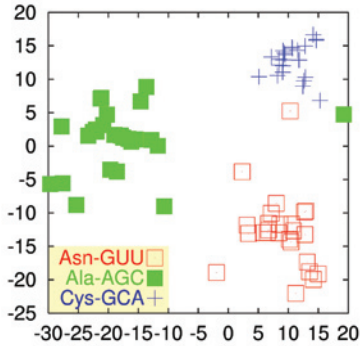

Fig.2 Kernel PCA for three-class human transfer RNA

A Functional SNP in BDNF Gene Impairs Human Memory

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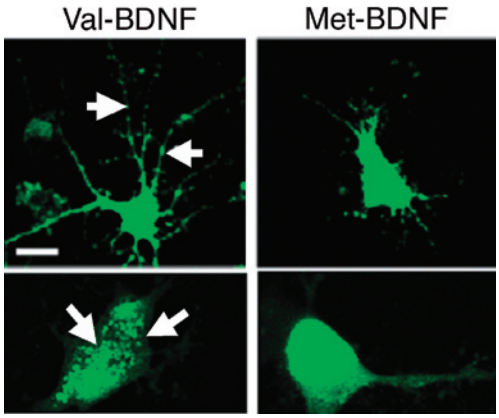
e-mail: m-kojima@aist.go.jp
AIST Today Vol. 3, No. 4 (2003) 12

To clarify whether the genetic interference of BDNF secretion leads to deficits in hippocampal functions, the study was focused on single nucleotide polymorphism (SNP) in the human BDNF gene. We found that one frequent SNP located at nucleotide 194 (G/A) producing an amino acid substitution (valine to methionine) at codon 66 (val66met) caused deficits in the intracellular distribution and extracellular secretion of BDNF as well as corresponding alternations of human hippocampal functions in vivo. These results provide new insights in the relationship between BDNF secretion and human memory.



Visualization of Distributions and Movement of SNP in Living Neurons with Green Fluorescence Protein (GFP)

Context-Dependent Relation Process in Episodic Memory: An fMRI Measurement

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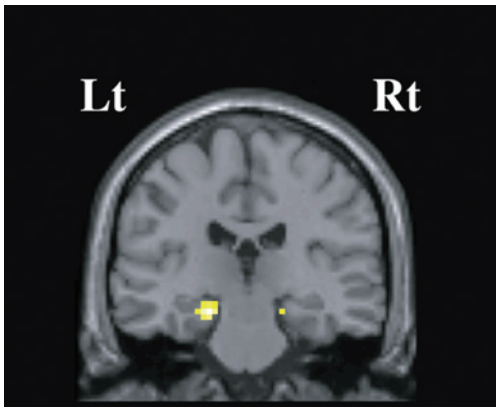
AIST Today Vol. 3, No. 4 (2003) 13

We used functional magnetic resonance imaging (fMRI) to investigate neural activities during the retrieval of relations within an organized episode. Healthy, normal participants memorized 50 four-scene comic strips before fMRI scanning. In the retrieval phase with fMRI scanning, participants were engaged in two tasks: story recall (SR) from previously learned comic strips, and picture recognition (PRe) of previously learned scenes from comic strips. The SR task, compared to PRe task, differentially activated the bilateral parahippocampal gyrus (Figure). The results suggest that the activity of the medial temporal lobe structures may be strongly associated with episodic memory retrieval requiring context-dependent relational processing.



Bilateral parahippocampal activations in SR vs. PRe

Hierarchical Odor Coding in Receptors

- Biological system may be designed to extract common or unique information of objects -

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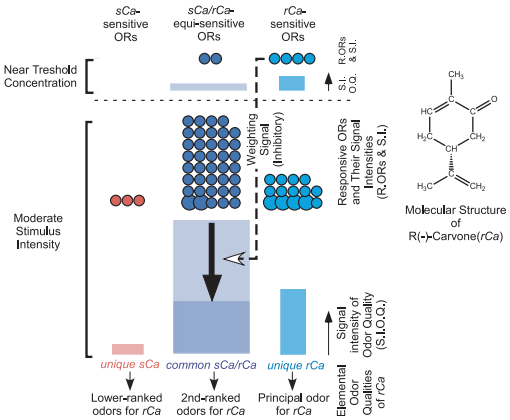
AIST Today Vol. 3, No. 5 (2003) 18

The basic question is what mechanism enables us to discriminate different odors. We suppose that the brain genetically functions to find common information and unique information between different objects, based on an informational factorization at receptors. Here, we describe a sensitivity-dependent hierarchical odor coding in receptors. The most-sensitive receptors encode the principal odor qualities, and the less-sensitive receptors encode supplementary odor qualities of the odorant. The receptors preferably sensitive to either S(+)-carvone (sCa) or R(-)-carvone (rCa) could represent the unique odor qualities of caraway or spearmint, respectively; those equally sensitive to both enantiomers could represent the fresh herbal quality common to both. In the hierarchical receptor codes, multiple subordinate odor qualities encoded by common receptors or less-sensitive receptors are reduced in an overall odor identity representation by signal weighting governed by the most-sensitive receptors. (OR: Odorant receptor.)



Schematic diagram of receptor-sensitivity-dependent hierarchical odor coding

Development of a Novel Profile-Profile Comparison System, FORTE1

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AIST Today Vol. 3, No. 5 (2003) 19

We have developed a novel profile-profile comparison technique to increase the sensitivity of fold recognition and improve alignment accuracy. The FORTE1 program has distinct features of measuring similarity between two profiles as compared with other published methods which exploit alignment information. The FORTE1 program utilizes the sequence profiles of both a target and templates to predict the structure of target sequence. With the Magi cluster (http://www.cbrc.jp/magi/), we performed PSI-BLAST iterations maximally 20 times to prepare the profiles of both target and templates with the NCBI non-redundant database. FORTE1 is available at http://www.cbrc.jp/forte1/.

The submission form of FORTE1

Implicit Estimation of Sound Arrival Time

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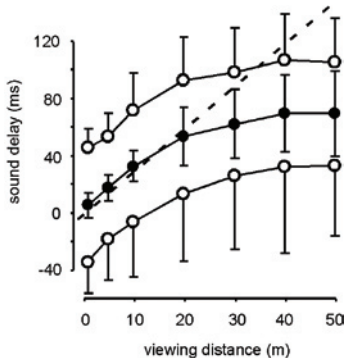
AIST Today Vol. 3, No. 5 (2003) 4-6

A sound is often produced by visible movements of objects in natural environment. Complementary inputs from vision and audition are coordinated to perceive real-world objects and events. Although auditory inputs are received much later than visual inputs, the delay is seldom noticed. Here, we show that audio and visual inputs are coordinated not because the brain has a wide temporal window for auditory integration but because the brain is actively changing the temporal location of the window depending on the distance from the visible sound source. A sound burst via headphones and a light flash were presented with different stimulus onset asynchrony. At greater distances from observers to the light, they could withstand a longer sound delay while still maintaining the impression of a common source object. These results indicate that real-world constraints, such as sound travels much slower than light, are implemented by audio-visual integration processes.



PSEs (filled circles) were plotted against viewing distance. 25% (lower open circles) and 75% level (upper open circles) of light first response were also plotted to indicate the threshold for detecting asynchrony. A dashed line represents sound arrival time in the real world.

The World's First Precise Human Model for ESS Training

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AIST Today Vol. 3, No. 6 (2003) 14-17

While minimally invasive endoscopic sinus surgery (ESS) is a benefit for the patient, it requires the surgeon a higher level of surgical skills due to its complex structure and its location adjacent to vital organs. This new human paranasal sinus model is based on the CT images and built using rapid prototyping techniques with originally developed materials and structures. This provides tactile perceptions similar to the human body and enables the surgeon to practice surgical techniques that are nearly equivalent to those acquired with cadavers, which are decreasing. This model should contribute to an increase in ESS with improved safety.

TOP LEFT: The whole view of a precise model of the human sinus (primary test piece). It has been named "SurgReady" (TM)
RIGHT: Opening the natural ostuim of the maxillary sinus (ABOVE). After making an incision with a scalpel (BELOW), the interior of the maxillary sinus is observed through the exposed natural opening.
BOTTOM: Ethmoidectomy. (LEFT) The right ethmoidal sinus is approached from the front using forceps. (MIDDLE) The posterior part is being exposed.

Titanium Dioxide is Crafted into Photonic Nanostructures (Photonic Crystal Structures)

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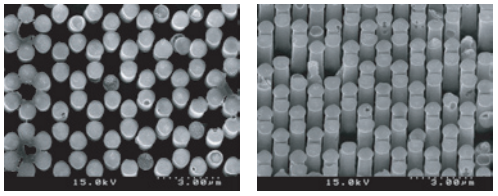
AIST Today Vol. 3, No.4 (2003) 8-10

The Photonics Research Institute of the National Institute of Advanced Industrial Science and Technology (AIST) developed a novel production technology for forming photonic nanostructures (photonic crystal structures) from titanium dioxide. The technology employs X-ray lithography methods based on synchrotron orbital radiation to deeply and precisely form a submicron-order polymeric mask. Then, liquid-phase deposition is used to faithfully deposit a tightly packed layer of titanium oxide onto the template. Finally, the template is selectively removed to obtain a photonic nanostructure. Energy conservation should result if the technology indeed leads to photonic crystals with better light transmittance, lower loss in connections with optical fiber, and less intensive temperature regulation requirements.



Scanning electron microscope observation of photonic crystal of titanium dioxide. The template was creased on PMMA films by deep x-ray lithography. Then, the template was molded by titanium dioxide with the liquid phase deposition. A pillar of 640nm diameter with 2micron height.

New VOF Based Stabilized Finite Element Method for ill-Conditioned Two-Phase Flow

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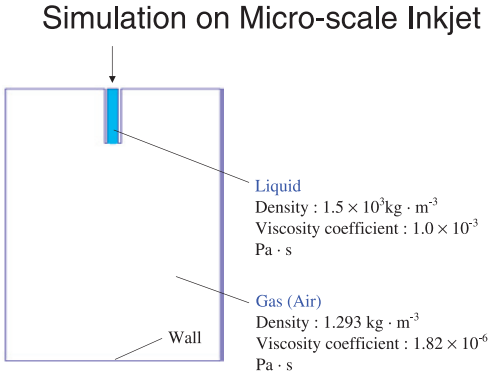
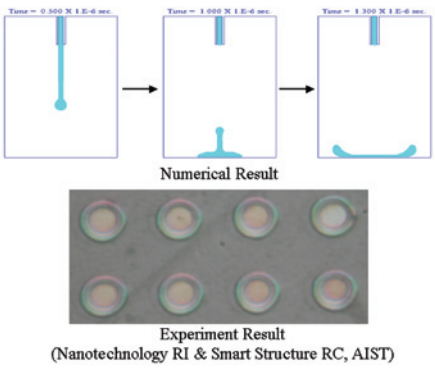
AIST Today Vol. 3, No. 6 (2003) 25

We developed a new VOF (Volume of Fluid) based FEM (Finite Element Method) for two-phase flow, which is generally valid for severe phenomena in industry. The new proposed VOF-FEM provides physically acceptable numerical results on two-phase flows at steel converter and micro-ink jet, for example, which are ill-conditioned problems.





Designing and Building of Quantum Chemistry Grid

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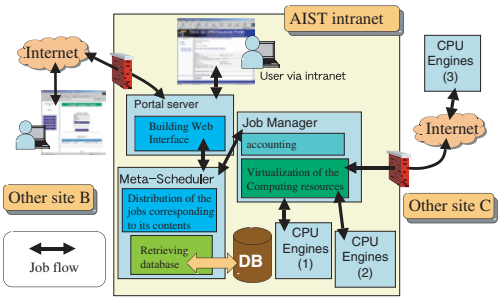
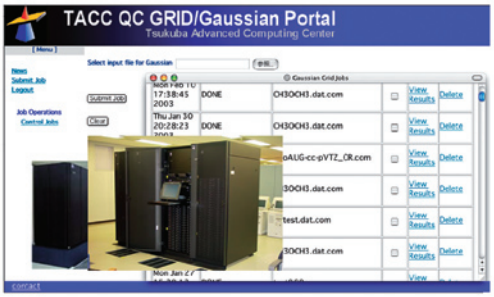
AIST Today Vol. 3, No.5 (2003) 20

We developed "Quantum Chemistry Grid/Gaussian Portal" to utilize efficient resource usage without special knowledge of computer. The system realizes a problem solution environment of computational chemical research.
The design concepts are :
(1) Preservation of specialist's know-how in a database for a resource selection with analysis of the input-parameter.
(2) Preservation of reliable results in a database avoiding the same job execution by different users.
(3) Management of users and accounting information about the calculation resources.
(4) Easy access via Web interfaces.

Gaussian Portal is the first implementation of application service portal for Quantum Chemistry Grid. Gaussian is widely used in computational chemical research.



Overview of Quantum Chemistry Grid



Computing resource of Gaussian portal and Web interface. The Gaussian portal has been employed with Tsukuba Advanced Computing Center, AIST since 2002

Development of Self-Reconfigurable Modular Robotic System M-TRAN II

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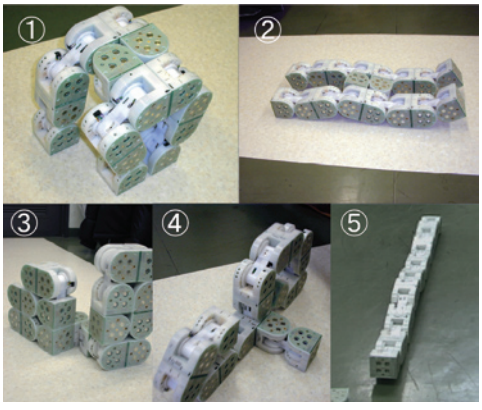
AIST Today Vol. 3, No. 6 (2003) 24

A Distributed System Design Research Group of Intelligent Systems Institute, AIST developed a self-reconfigurable modular robotic system called M-TRAN II, which were fully upgraded in its performance compared to the first generation. Each M-TRAN II module has two degrees of freedom and six connection surfaces with permanent magnets. Robotic configurations made by several modules such as a snake-type crawling robot and a quadrupedal walking robot can move independently by using internal batteries and microprocessors. They can also transform themselves into other configurations according to a control command by a remote controller using RF wireless system. This robot is expected to be applied to such areas as rescue missions or space exploration.



Experiment on a series of locomotion and transformation

An Integrated Computer Simulation Program for Plasma and Gas Processes

- The simulation program facilitates cost reductions in the development of plasma process technologies -

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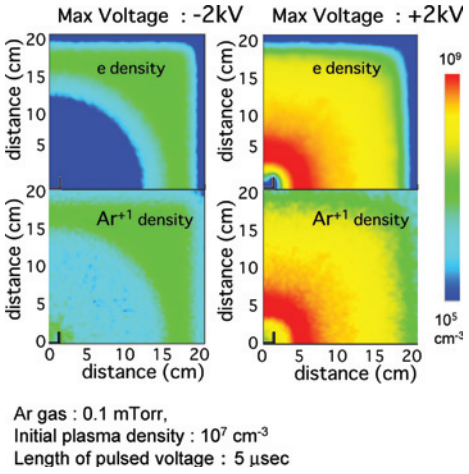
AIST Today Vol. 3, No.4 (2003) 14

Materials processing technologies using plasma have progressed rapidly in recent years. In collaboration with PEGASUS software incorporated, an integrated computer program for the analysis of plasma processes and rarefied gases has been developed by combining the dynamic-SASAMAL code, which was developed in AIST for analyzing the interactive behavior of energetic ions with a solid surface. The program enables computer analysis of the interactions between the vacuum chamber inner wall or a workpiece surface and the plasma, in terms of gas flow, plasma behavior, sputter etching, and other factors. The program can be used for process analysis in a wide range of equipment, including that used in plasma enhanced chemical vapor deposition, etching, plasma display panels, magnetron sputtering, ion injection devices, and various vacuum equipment.

Spatial distribution of plasma density generated when a positive pulsed voltage (maximum voltage: 2 kV, pulse length: 5 μs) was applied to the workpiece (H shape in cross section; 4cm × 4cm). The results show that a high-density region of plasma was generated around the workpiece.



Example of simulation :
Comparison of plasma generation by a positive and a negative pulsed voltage which is applied to the target.
It is clearly shown that a plasma is not generated by a negative pulsed voltage but a intense plasma is generated by a positive pulsed voltage.

Detection of Genes with Tissue-Specific Expression Patterns using AIC

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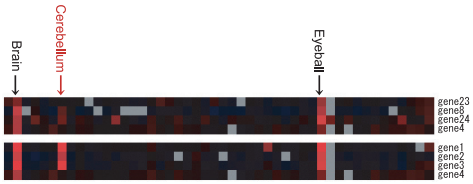
AIST Today Vol. 3, No. 6 (2003) 28

We applied a method based on Akaike's Information Criterion (AIC) to detect tissue-specific genes whose expression profile is considerably different in target tissue(s) than in others[1]. Such observations are detected as outliers and the method we used was originally developed to detect outlier(s). Our analysis showed that it is specifically applicable to the extraction of specific expression patterns from arbitrarily selected tissues under the condition of co-existing similar tissues because of those detected as outliers. This method is currently employed in other analyses[3] and appears to be readily utilizable in various fields of expression analysis.



Detection of genes specifically up-regulated in brain and eyeball.
The AIC based method (upper) detects 4 genes whose expression profiles meet our expectation. However, among the top 4 genes identified by the conventional pattern-matching method (lower), the detection of 3 is disappointing they manifest up-regulated signatures in the cerebellum, contrary to the expectation that the expression profile be similar to that of objective tissues.

Energy Science & Technology

Development of Efficient Biogas-Powered 6 kW Gas Engine Cogeneration System

The Institute for Energy Utilization, a division of the National Institute of Advanced Industrial Science and Technology, in cooperation with Aisin Seiki Co., Ltd. (Aisin Seiki), has made improvements to the production model of a compact, highly efficient, city gas-powered 6 kW gas engine cogeneration system manufactured by Aisin Seiki. The 6-kW gas engine cogeneration unit was successfully operated using a low-calorific-value model biogas. This system is being viewed as a new means of establishing small-scale biogas-powered plants at livestock farms, sewage sludge treatment plants, and other biogas plants.

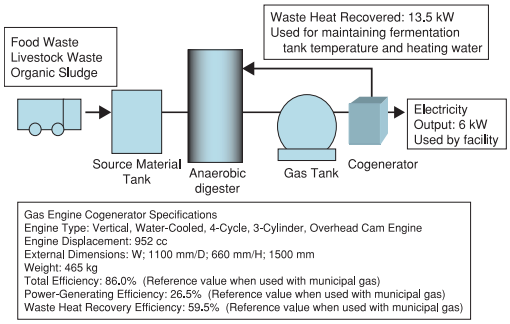


Diagram of efficient biogas-powered 6 kW gas engine cogeneration system

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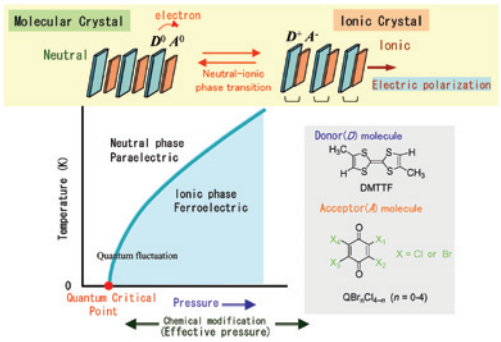
AIST Today Vol. 3, No. 6 (2003) 21

Nanotechnology and Materials Science & Technology

Discovery of Quantum Phase Transition in Organic Crystal

- Transformation of crystal binding at absolute zero temperature -

By reducing the phase transition temperature to close to absolute zero, we have achieved quantum fluctuation (tunneling) between two states of different crystal binding—molecular crystals and ionic crystals—in a single organic substance (a charge-transfer complex). The molecular charge (crystal binding) and dielectric polarization simultaneously fluctuate at close to absolute zero temperature and the findings represent a new type of quantum phase transition. We can expect that the accurate control by use of both pressure and chemical modification is a useful method for the further development of new materials with diverse functionality, including non-linear optics and switching using light, electric field, current, etc.



Temperature-pressure phase diagram and scheme of crystal transformation

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AIST Today Vol. 3, No. 4 (2003) 15

Photo-Switched Storage and Release of Guest Molecules by Modified MCM-41

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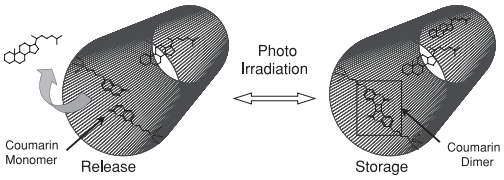
AIST Today Vol. 3, No. 4 (2003)16

Modified MCM-41 is applicable to storage-release cycle of chemicals in the pore void. This photo-switched storage-release system is achieved by grafting coumarin derivative, which is reversibly dimerized to the corresponding dimers by ultraviolet ray irradiation, on its surface near the outlet of pore. By the formation of coumarin dimer around the pore void of MCM-41, various organic compounds are stored even after sufficient solvent washing. After photo cleavage of the coumarin-dimer, stored compounds are released to outside of the pore. This unique storage-release cycle technology provides a novel class of controlled release system and drug delivery system.



Conceptual scheme of photo-switched controlled release system

Ultrasonic Micromanipulation

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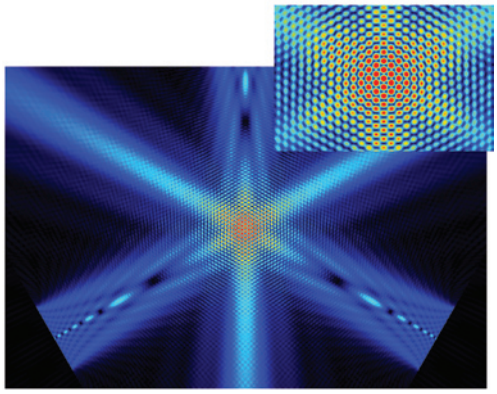
AIST Today Vol. 3, No. 4 (2003) 17

Trapping of particles and control of their positions are studied in water using acoustic radiation pressure in the ultrasonic standing wave field. The transducers are settled to make the beam axes cross with an angle of 120 degrees. When polystyrene particles are poured with a pipette into the sound field, the particles are trapped in the central region. When the phase of one of the transducers is changed, the particles move along the sound beam axis of that transducer. Two-dimensional transportation can be realized by controlling the phases of two transducers out of three. It would be possible to extend this scheme into three-dimensional manipulation by adding one more transducer.



Calculated sound pressure distribution. The right top is an enlarged picture

New Technique for Optical Switching

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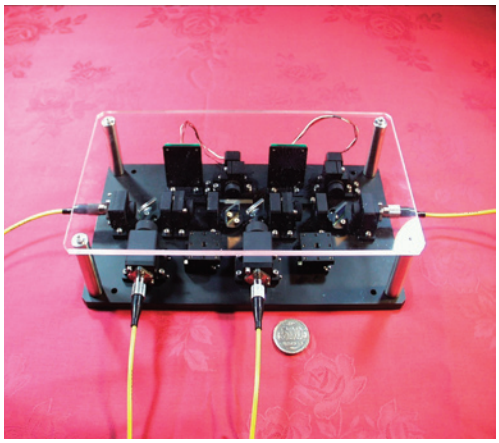
AIST Today Vol. 3, No. 5 (2003) 14

The Photonics Research Institute has been successful, in collaboration with Dainichiseika Color & Chemicals Mfg. Co., Ltd., in developing a device ("optical switch") capable of separating the incident signal light from the optical fibers directly, without conversion to the corresponding electrical signals, under optical control and of outputting these optical signals to other multiple optical fibers. The separation of the signal light under optical control is achievable by utilizing the high-speed thermal lens effect generated in a thin-film element by applying the control light to a stacked layer-type organic thin-film optical element. This system is capable of separating the incident light at micro-second speed. Since, furthermore, light is also used for switching control, this development marks a technical breakthrough toward the realization of an "exclusively photonic optical switch," a technology recognized as essential for the next generation photonic network.



Developed All-optical photo-switch

Development of High Power and Low Loss SiC MOSFETs

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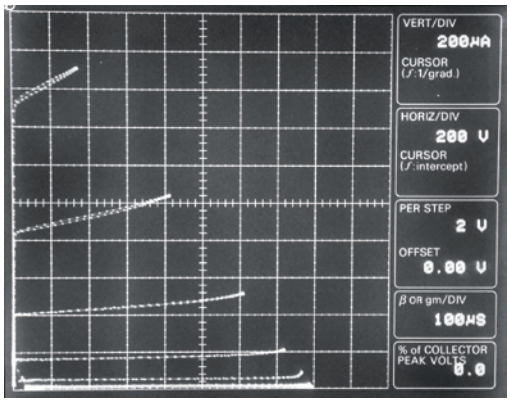
AIST Today Vol. 3, No. 5 (2003)15

SiC(Silicon Carbide) MOSFET has been investigated for ultra-low-loss high power electric device applications. However, the channel mobility (μ_{ch}) of SiC MOSFETs is extremely low, and its improvement has been a critical issue in this field. We have developed a pyrogenic re-oxidation annealing (ROA) for improving the low μ_{ch}, where the amount of water content (ρ_{H2O}) is controlled by adjusting the oxygen/hydrogen gas flow rate. Significant μ_{ch} improvement is attained when the ρ_{H2O} is over ~25%. Using this pyrogenic ROA in conventional SiC vertical MOSFET fabrication process, we succeed in reduction of specific on-resistance to tenth of Si MOSFET theoretical limit.



Typical output characteristics of (0001) 4H-SiC vertical MOSFET

Development for a Rapid and Selective Synthesis of Plastic Raw Materials by Supercritical CO_2 Fixation

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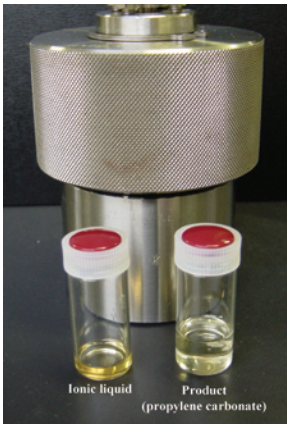
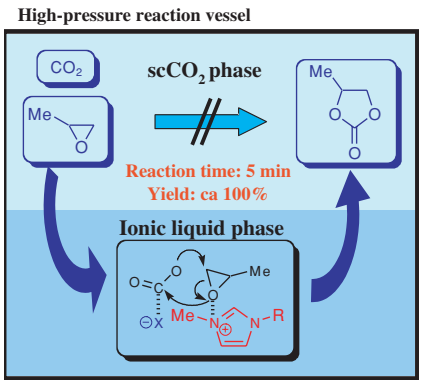
AIST Today Vol. 3, No. 5 (2003) 16

Cyclic carbonate is an important raw material for engineering plastics such as polycarbonate, which can be synthesized from carbon dioxide in the presence of various catalysts. However, the carbonate synthesis using conventional carbon dioxide fixation method is under development and only produces a yield of around 50% at best, even at reaction temperatures of 150 – 200 ºC and with reaction times of 4 – 24 hours. We devised a two-phase system comprising supercritical CO_2 + ionic liquid as a new reaction system for selective and rapid cyclic carbonate synthesis with the potential for practical application, produced 100% yields and 100% selectivity even at a reaction temperature of 100 ºC and reaction time within 5 minutes. This development is expected to significantly accelerate the production methods for more environmentally friendly engineering plastics, and should pave the way for practical application of this technique.





The rapid and selective synthesis of propylene carbonate by CO_2 fixation using $scCO_2$ + ionic liquid two-phase reaction system

Design of Self-Organizing Functional Molecular System

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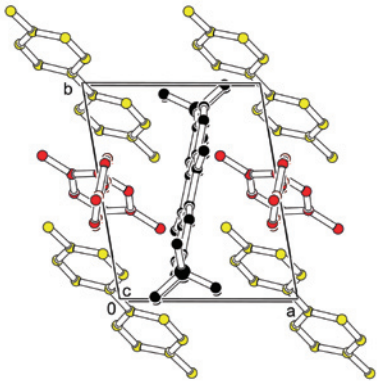
AIST Today Vol. 3, No. 5 (2003) 17

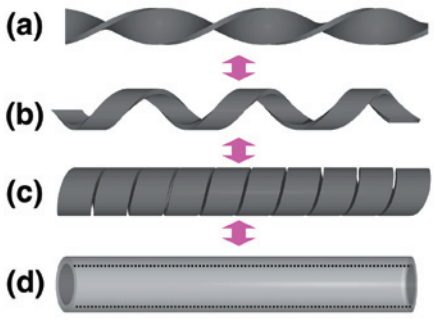
Many scientists focus on constructing functional molecular systems utilizing self-organization of molecules, because the method is economical and works with high (molecular level) accuracy. Here, we report our recent works on the self-organizing molecular systems utilizing electrostatic and donor–acceptor interactions as the driving force for organization. Unique crystal structures containing two kinds of crossed charge-transfer columns are demonstrated by cocrystals consisting of ion pairs of acceptors of methyl viologen anthraquinone disulfonates and a donor, hydroquinone.



Structure of cocrystal of dimethylviologen 2,6-anthraquinonedisulfonate and hydroquinone

Precise Morphology Control of One-Dimensional Nanostructures

Mixed molecular species of cardanyl glucoside derived from renewable resources, which differ in the molecular structure of the hydrophobic chains, proved to produce nanotube structures upon self-assembly in water, while the pure saturated homologue generated a twisted fibrous morphology. In order to study their contribution to the nanotube formation, we fractionated the mixture into four individual components, *i.e.*, triene, diene, monoene, and saturated homologues. The rational control of self-assembled helical morphologies was achieved by binary self-assembling of the saturated and monoene derivatives. This method can generate a diversity of self-assembled high-axial-ratio nanostructures (HARNs), ranging from twisted ribbons to nanotube architectures.



Schematic representation of the typically obtained one-dimensional nanostructures

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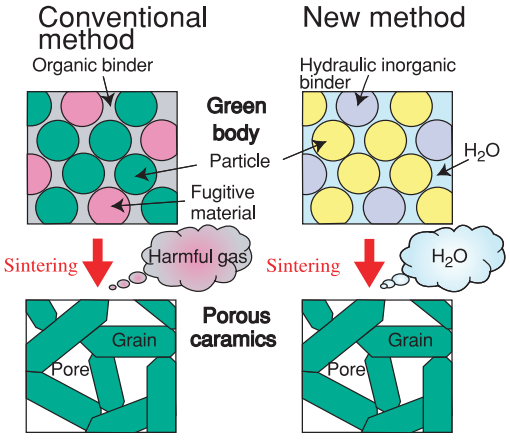
AIST Today Vol. 3, No. 6 (2003) 20

Mechanical Engineering and Manufacturing Technology

R & D of Eco-Friendly Ceramics Processing

A novel fabrication process for ceramics was developed using hydraulic inorganic binder and water. The hydraulic binder and water acted as agents for direct consolidation, and water acted as a fugitive material to create open pores too. The green bodies formed with the hydraulic inorganic binder and water had high compressive strength. The porosity of the sintered ceramics increased with the content of water in the starting mixture: porosities could be adjusted by the addition of water. The results of gas analysis measurements showed the emissions from the novel fabrication process of the porous ceramics to be environmentally safe.



Schematic of the novel fabrication process for ceramics

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AIST Today Vol. 3, No. 6 (2003) 22

Measurement of 2-Micrometers from 200-m Distance using Femtosecond Optical Comb

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AIST Today Vol. 3, No. 4 (2003) 19

Word-record resolution has been achieved in a distance measurement using a femtosecond laser. Number of precise frequency modes of a femtosecond laser (optical comb) gives a series of radio wave frequencies as a result of intermode beat. Distance information is obtained by the phase measurement of the radio wave. Because of the broadband frequency of the femtosecond laser, highly stable beats up to GHz to THz are generated. High frequency is essential for ultrahigh-resolution in distance measurement. By comparison between two-color measurements, automatic compensation of environmental fluctuation in distance measurements is realized. Simple setup is attractive for industrial applications as well as length standard.

Femtosecond-Comb Distance Meter in the optical testing tunnel at AIST. The arrow in the photograph indicates the laser beam.

Towards Commercialization of New Ultrasonic Urination Sensor

- Development of compact sensor based on expansion characteristics of bladder -

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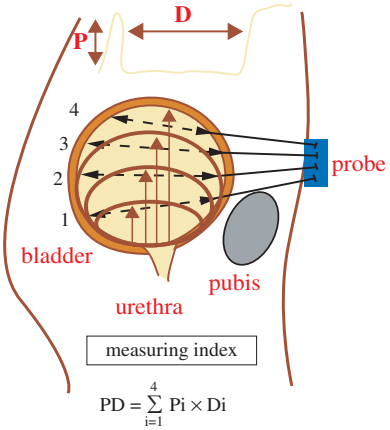
A compact ultrasonic urination sensor has been developed that can measure the amount of urine in bladder with a good accuracy. The main purpose of this apparatus is to prevent urinary incontinence, to improve the quality of life in aged or spinal cord injured people. The principle is based on echoes of ultrasound to measure the volume of bladder and thus detect the amount of urine. Intensive clinical evaluations already demonstrated clearly the feasibility and viability of the urination sensor. Commercialization and extensions to deal with other urination dysfunction are now underway.



Principle of ultrasonic urination sensor and schematic illustration of expansion of bladder

Development of Practical Device for the Automated Manufacture of Hyperpolarized Xenon Gas

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A practical device for the automated manufacture of hyperpolarized xenon gas, which can be used to increase the sensitivity of sophisticated measuring devices (NMR/MRI) has been developed. The device produces a 10,000-fold increase in NMR signal sensitivity. The research should facilitate work on NMR/MRI to shorten measuring times, produce more diverse information, and increase accuracy. The research should also facilitate the development of technologies suitable for industrial applications, including measurement of pore size distribution, analysis of gas dynamics, and nondestructive testing. The research is the result of the AIST's small and medium-sized enterprise support R&D system, which is run by the AIST's Collaboration Department for industry, academia, and government partnerships.

Practical device for the automated manufacture of hyperpolarized xenon gas developed through the AIST research

Calibration Facility of Infrared Ear Thermometers

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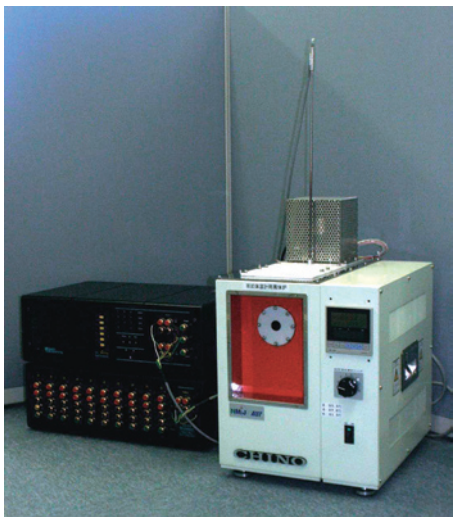
Clinical ear thermometer sensing infrared thermal radiation from an eardrum is capable of measuring temperature in less than a few seconds and has rapidly become widely used. To meet the demand of calibration and conformity assessment in industry, AIST has developed a standard blackbody system traceable to the International Temperature Scale (ITS-90) for the calibration of the clinical ear thermometers. An expanded uncertainty of around 30 mK has been evaluated in the temperature range from 35 ºC to 42 ºC. The AIST has also established a high-quality traceability system for industries.



Standard blackbody for infrared ear thermometers

Remote Calibration of Length Standards using an Optical Fiber

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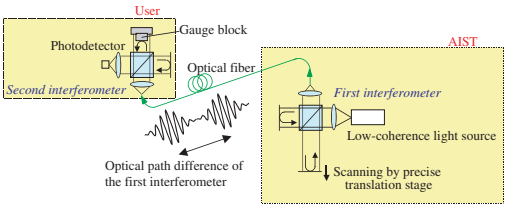
We have developed a method for remote, accurate calibration of practical length standards (*e.g.*, gauge blocks) using a tandem, low-coherence interferometer developed by the AIST and passing light signals down a single-mode optical fiber. A gauge block of 50 mm length has been calibrated through 3 km single-mode optical fiber. The standard deviation of the calibration was 0.1 μm and the result agrees with that of conventional interferometer within the uncertainty of the calibration. To date, the calibration of length standards required artifacts to be sent to the calibration laboratories. Using the developed technology, the artifact can remain in situ at the user's measuring laboratory. We aim to validate the remote calibration process with external organizations in the future.



Example of remote calibration system

New Nondestructive Inspection Technology for C/C Composites

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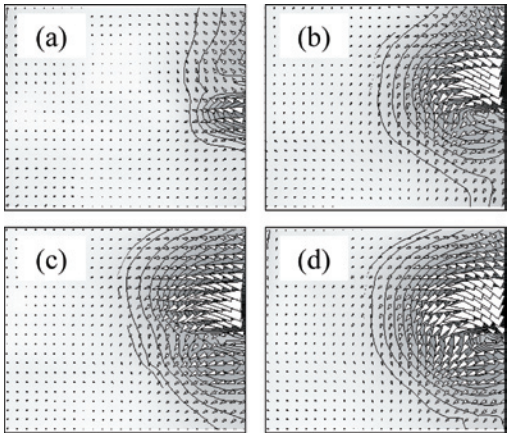
C/C (carbon fiber-reinforced carbon) composites are used in the space shuttle and are of increasing importance as a high-temperature material. However, there is no useful non-destructive method to test C/C composites. We have developed a new non-destructive test technology using a highly sensitive magnetic sensor, SQUID, and a method to visualize the detoured current, by looking at the matter that current flowing around flaws in material changes of direction. The current map (figure 1) shows area and feature of the composite flaws. For practical implementation of this method, a NDI system with small, lightweight and low magnetic noise refrigerator has been developed.



Current maps corresponding to the progress of flaws in C/C sample by tensile test

Crustal Movement Detected by Interval Changes between Poles

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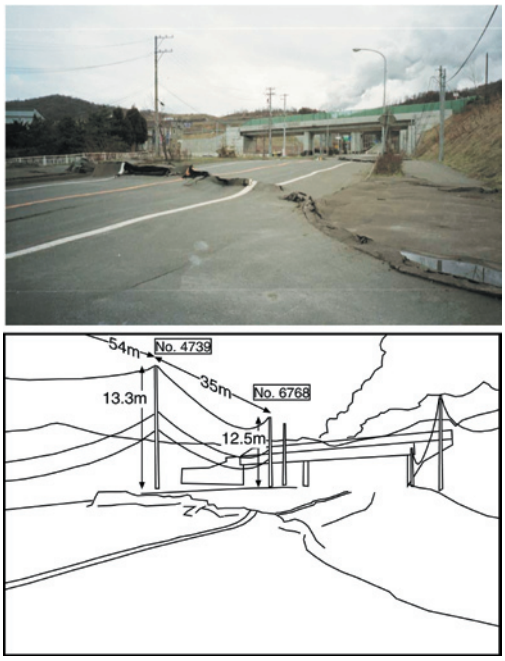
AIST Today Vol. 3, No. 6 (2002) 29

Remarkable crustal movement occurred near the eruption area associated with the 2000 eruption of Usu volcano, Japan. In order to clarify the regional crustal movement, we measured the intervals between the poles of aerial cables two times after the eruption. As a result, we observed significant shortening of the intervals near the eruption point. We also tried to estimate the amplitude of the interval shortening by using the sag of the cables. The sag of 3 - 4 m at the interval of 35 m as shown in the figure corresponds to the interval shortening of 0.7 - 1.2 m.



Crustal deformation near the eruption area

Feature

Annual Plan of the National Institute of Advanced Industrial Science and Technology for FY 2003

Planning Headquarters

Introduction

Two years have passed since the inauguration of the National Institute of Advanced Industrial Science and Technology as an independent administrative institution. The performance of the institute in FY 2001, the first year of new AIST, was subject to the evaluations of the advisory board as well as the Independent Administrative Institution Evaluation Committee. Both the advisory board and the Committee gave a certain level of positive evaluation of the significant reformations implemented in the management of AIST compared to the former organization. These include the active involvement in industry-academia-government collaboration under the framework of "Type-II Basic Research", and the introduction of the evaluation system of research results etc.

Presently, each research unit is making steady progress in their research activities, with the aim of the further development of AIST. New research centers and laboratories have been established and we are confident to produce notable achievements for our endeavors. Furthermore, AIST has embarked on various projects including the improvement of intellectual property management systems, the establishment of Innovation Center for Start-ups, the introduction of venture support systems that facilitate the launch of venture businesses capitalizing on the research achievements of AIST. In the year 2003, AIST will further reforms for staff's self awareness and carry out new research frameworks in accordance with its existing operating policy. AIST will operate in a way such that the visible results of a series of reforms will be produced. AIST will also step up through the efforts to popularize the concept of type-II research and positively encourage full-scale research projects.

Operational assignments for independent administration institutions including AIST are determined by the medium-term goal given by the state minister in charge (Minister of Economy, Trade and Industry for AIST). The first medium-term goal of AIST runs for four years from FY2001-2004. Each organization prepares a medium-term plan to achieve the respective goals. A yearly plan for each year is to be developed before the beginning of the new fiscal year.

This document provides a summary of AIST's annual research plan for FY 2003. For further details, please visit our website.

Main Elements of AIST's Research Plan for 2003

Life Science and Technology

AIST set up two major goals in this field: ① Realization of the Sustainable and ② Realization of Active Aged Society. At the forefront of advanced biotechnologies, AIST will engage in the wide range of research programs including bioinformatics in the post-genomic era for the industrial application of gene information, the development of applied life technologies such as glycotechnology, ageing technology etc. Furthermore, AIST will proceed with cross-disciplinary projects for research and development, including the application of brain science in the development of brain-type computing systems, regenerative medical engineering and researches on nanobio machines. As a core organization of this field, the institute will pursue the researches in the establishment of intellectual infrastructure to meet the social demands in environmental measurement /purification /maintenance and waste disposal research.

In FY2003, Research on protein structure-function relation ship will be continued as part of the Basic Biotechnology Research Program for Health Maintenance and Improvement. AIST will also set up new research projects as follows: Glycoscience project; research and development of profile diagnosis system based on genome-proteome; the development of a protein system chip for protein isolation, the application of IT to protein analyzer; Advanced bio-nanodevice Project etc. Green biotechnology programs as part of the Creative program of recycling manufacturing system with biological feature are to be continued. Further progress will be expected in the researches on regenerative medical engineering, the development of medical and welfare devices in the framework of the Advanced programs for medical appliances for a better and longer life. (See Table 1)

Information Technology

In the field of Information Technology, AIST aims to construct a ubiquitous IT society by exploiting a highly sophisticated IT infrastructure so that anyone will be able to create/distribute/share relevant information without the constraints of time or space. In other words, AIST aims towards the realization of a society in which information networks become prevalent in all areas of peoples' life and are utilized on any scale, from individual to global application through user friendly, secure and reliable interfaces (Network-based society). The main issues include research and development of human interface technology, information security technologies to construct a universally secure information system, advanced computing technologies that enable large volume data processing (See Table 2) .

In FY2003, with a view to the further progress of a high speed/ large volume information life line, AIST will promote the research programs on grid technology, large volume optical data storage technology, and femtosecond technology. The aim is to establish global standards for large scale data communication/processing technologies. Further efforts will be made in the development of basic technologies such as femtosecond light sources and data reception technology which forms

Table1 Main Projects in Life Science and Technology

- **Basic Biotechnology Research Pprogram for Health Maintenance and Improvement**
  - Research Development of Protein Expression and Interaction Analysis Technology
  - Informative Analysis of Biopolymer Stereostructure
  - Analytical Technology for Dynamism of Intracellular Network
  - Glycoscience Project 【New】
  - Research Developments of Profile Diagnosis System based on Genome & Proteome 【New】
  - The Development of Protein Scparation Chips 【New】
  - Development of an Integrated Protein Analysis System by the Bio-IT Fusion Technology 【New】
  - Advanced Bio-nanodevice Project 【New】
  - Cell and Tissue-production Project with Microfabrication Technology 【New】
  - The Project of Nano-bio Chips for Protein Interaction 【New】
- **Creative Program of Recycling Manufacturing System with Biological Feature**
  - The Development of Analysis and Control Technology for Biodegradation-treatment Mechanism
  - Highly Acurate and Sensitive Monitoring Technology Development of Microorganism under an Environment
  - Rational Production Technology Development of Industrial Materials with Plant Energy
  - Bio-fiber Production Technology with Glycocluster
  - Bio-molecules Synthetic Technology with Controlled Glycocluster
- **Advanced Programs for Medical Appliances for a better and Longer Life**
  - Development Program for Physical Function of Replacement and Recovery System
  - Research Development of Tissue Engineering (Cell Engineering) Technology
  - Advanced Support System of Endoscopic and other Minimally Invasive Surgery
  - High Technology Medical Equipment Development Program for Cancer, Heart Disease, etc.
  - Behavior-based Human Environment Creation Technology
  - Unified Support System of Diagnosis and Treatment for Heart Disease
  - Totally Implantable Artificial Heart for Clinical Use
  - Rehabilitation Systems for the Elderly

the basis of ultra high speed optical communication.

In the area of security dependability including secure certification systems for Internet and software, AIST will conduct substantive studies of open source software in desktop environments, as well as researches on software validation and web security. As part of the national strategic planning for the semiconductor industry, the MIRAI Project (45nm) will be implemented with a focus on the development of standard process/material for next generation semiconductors (65nm), strengthening the linkage with the Asuka Project.

In the development of low power consumption devices that support mobile human interface, researches on the technology to eliminate standby power requirements for the realization of on-demand devices will be pursued focusing on spintoronics, that is non-volatile functional device technology.

For the practical application of advanced data processing, interdisciplinary research cooperation will be encouraged in the areas of technology which require high performance communication environments such as bio-informatics and nanosimulation etc.

Environment and Energy

In the field of environment and energy, with the aim of contributing to the establishment of a sustainable recycling-oriented society, AIST will conduct research and development to solve the issues of global warming, environmental pollution, as well as to secure stable energy resources. As a resolution to global warming, the Kyoto Protocol was adopted at the Third Conference of the Parties to the United Nations Framework Convention on Climate Change (COP3) in 1997, thereby it was made mandatory for Japan to cut greenhouse gas by 6% in comparison with the emission level in 1990. This requires a significant improvement in levels of technology. There is a strong demand for the research and development of risk assessment/reduction technologies of chemicals as typified environmental endocrine disrupters. The exhaustion of fossil fuels still remains a critical issue. The crucial challenges in the medium and long term are the reduction of green gas emission and the shift of primary energy from oil to natural gas, ultimately to a regenerative energy source.

With the recognition of a present state of relevant issues, AIST places emphasis on technologies that reduce causative agents of green house effect, technologies to raise the efficiency of and to distribute energy systems, researches on environmentally friendly manufacturing processes in the framework of the technologies to prevent global warming. Concerning environmental pollution, chemical substance risk management and reduction technologies are given due attention. In addition, in regards to the goal of attaining stable energy supplies, researches into cleaner and more diverse energy sources will be pursued. Another priority research area is techniques for the integrated assessment of environmental and energy systems including life cycle assessment (LCA) (See Table 3).

In FY2003, AIST will launch a basic research for the standardization of energy and environmental technologies. This is indispensable for the establishment of the standards that are required to disseminate the technologies in the areas of energy saving and new energy sources. In aiming towards the popularization of distributed energy sources in society, including the introduction of fuel cells and hydrogen energy, further efforts will be made in

Table 2 Main Projects in Information Technology

- **Program for Upgrading the Telecommunications Foundation**
  - Organic Device
  - Memory Device Technology 【New】
  - High-frequency Device Technology 【New】
  - Femtosecond Technology
  - Quasi-stationary Satellite System 【New】
  - Promotion of Open Source Software 【New】
  - Strategic Development of Advanced Software (Bescheduled in future)
- **Program of Next-Generation Semiconductor Device Process Technology**
  - Development of Next-Generation Semiconductor Materials and Process Technology(MIRAI)
  - Lithography with extra-UV Light 【New】
  - Advanced Design Technology for SoC (System on a Chip)
  - Ultra-High-Density Electronics System Integration
- **21st Century Robot Challenge Program**
  - Robot Component Technologies for New Application Fields

the primary research of energy leveling technology of distributed energy systems and research and development towards energy saving technologies for the treatment of environmental pollutants.

With regards to the relationship between the risks associated with industrial activities and social security, social-scientific studies on environmental/energy technologies will be implemented at the Center for Technology and Society. In 2003 AIST will participate in the Ministry of Economy, Trade and Industry's research and development program. Development efforts will focus especially on chemicals risk assessment methods, ultra low loss power device technologies, proton-exchange membrane fuel cell system technologies, superconducting technologies and other areas. For the promotion of LCA methods, AIST will also start research into the regional environment in cooperation with local authorities. Other collaboration projects will be in areas which include methane hydrates, biomass, development and assessment of substitutes of fluorine compounds and diesel exhaust control technologies.

Nanotechnology, Materials and Manufacturing

In this field, through the development of frontier technologies that contribute to dramatic improvements of material and production technologies, AIST will work towards the establishment of a technology basis that will enable the realization of reliable life, concerning to belong to well-being, aging society. These efforts will also underpin the foundations of an advanced information society as well as the sustainable development of a society that coexists in harmony with the environment.

Research efforts will focus especially on the establishment of the foundations of "nanoindustry" by boosting the industrial application of nanotechnology which enables material production/processing at nanoscale (1/1 million mm) level. AIST strives for the practical application of material production technologies, focusing on material production technologies that significantly reduce environmental burden and ensure safety and reliability for human beings. Another important subject will be the establishment of a highly developed manufacturing infrastructure.

In 2003, the Nanotechnology Program will go on the Nanostructure Polymer Project, the Synthetic Nano-Function Materials Project, Advanced Nanocarbon Application Project and Nano Structure Forming for Ceramics Integration Project. On the other hand, under the framework of the Material Industrial Competitiveness Strengthening Program, major projects include the development of materials and process technology for high precision parts, and the research on metallic glass (See Table 4) AIST will also develop simulation and metrology technologies that will support the development of nanotechnology. For the innovation of production technologies that South East Asian countries have been rapidly progressing in, AIST will proceed with research and development of NENS technology together with partner companies. Cutting edge researches will be implemented in areas including nano biodevice, high efficient photocatalist etc. High-tech "Mono-zukuri" Manufacturing Project is another vital task.

Geological Survey and Geoscience, Marine Science and Technology

With a view towards the exploitation and preservation of the nation's land which is required for the sustainable development of a society, resource and energy development and environmental conservation, AIST will carry out geological surveys to collect and provide basic geoscientific data as well as research and studies on marine

Table 3 Main Projects in Environment and Energy

- Program for Innovative Technologies to Mitigate Global Warming
  - Development of Energy-Conserving Innovative Production Process Technologies
    - Development of Next-Generation Chemical Process Technology
    - Technology for Supercritical Fluid Utilization
  - Development of Technologies for Innovative Energy-Use Systems
    - R&D on Advanced High-Temperature Air Combustion Control Technology
    - R&D of Fundamental Technologies for Superconducting AC Power Equipment
    - R&D of Fundamental Technologies of Superconducting Generators
    - R&D for Superconducting Bearing Technology for Flywheel Electric Energy Storage Technology
- Energy and Environment Program for Fixing and Effective Use of Carbon Dioxide
  - Investigation of CO_2 Fixation and Utilization Technology
- Integrated Assessment and Management Program for Chemical Substances
  - Risk Assessment of Chemicals and Development of Risk Assessment Methods
- Program for Solid Polymer Fuel Cells and Hydrogen Energy
  - Development of Solid Polymer Fuel Cell System Technologies

Table 4 Main Projects in Nanotechnology, Materials and Manufacturing

- Nanotechnology Program
  - Nanomaterials and Processing Sub-Program
    - Nanostructure Polymer Project
    - Nanotechnology Glass Project
    - Advanced Nanocarbon Application Project
    - Synthetic Nano-Function Materials Project
    - Nanotechnology Material Metrology Project
  - Nano-Manufacturing and Metrology Sub-Program
    - Nano Structure Forming for Ceramics Integration Project
    - R&D of 3D NanoScale Certified Reference Materials Project
- Material Industrial Competitiveness Strengthening Program
  - Innovative Materials Processing Technologies
    - Integrated Development of Materials and Process Technology for High Precision Parts
    - Processing Technology for Metallic Glasses
  - Other (a related project)
    - Synergy Ceramics Project
- Reduce-Reuse-Recycle (3R) Program
  - 3R Key Technologies
    - Development of Recycling Technologies for Construction Wastes/Glass, Etc
- Advanced Manufacturing Technology
  - Digital Meister Project
- Program for Upgrading the Telecommunications Foundation
  - Development of Technology for High-performance of Wireless Network System
    - R&D on Next-Generation Ferroelectric Memory

geology, environment and resources. Projects in the area of security of the nation's land include researches on geological disasters such as earthquakes and volcanoes. The program of environmental conservation covers a wide range of researches, from environmental issues of local ground/water areas to global environmental concerns. The collected basic information through these activities will be provided in the form of maps and databases. AIST will venture into uncharted areas and explore new fields of technology on the basis of state-of-the-art technologies, increasing coordination with other research areas such as environmental technology and life science. Furthermore, AIST will continuously offer foundational information of geological science including geologic maps. Taking advantage of the potential to conduct comprehensive research programs on geological science, the research efforts will be poured into the elucidation of an elementary process in geological science through the development and utilization of the advanced technologies.

In FY2003, AIST will complete the 1:50,000-scale geological maps of 6 areas and carry out geological surveys in 25 areas. As to the project of 1:20,000-scale geological maps, 3 maps will be completed and the surveys are to be conducted in 6 areas. By use of a digital geological map, AIST will work on the preparation of a geological map with which provides seamless coverage across area boundaries. Other tasks include the preparation of maps related to the earth sciences, such as active structure maps and active fault strip maps, maps for predicting damages from earthquakes and tsunamis, geological maps of volcanoes, and volcanic scientific information maps. The comprehensive data base will be constructed for the collection and provision of geological information. In the research program of active faults, the results of surveys at 5 sites will be publisized for the preparation of a draft of the assessment of major active faults across the country. In the area of volcanic research, AIST will further the surveys at Mt. Unzen, Miyake Island, Mt. Fuji etc. The surveys on deep geological environment will contribute to solve the issues relating to the geological disposal of radio-active waste. As part of this program, researches on 3-dimensional geological models, chemical reactions, rock properties and numerical models will be enhanced for the numerical analysis of transition of radionuclide. The results of these programs will be utilized for the prediction not only of disasters but the process of a long-term change in the geological environment. AIST will proceed with the exploration for, and the assessment and development of coal-seam gas, as well as minerals in the earth's crust or on the deep sea floor, and other energy and mineral resources such as methane hydrate existing undersea or in sea water, and strive for the development of the mining technologies. International joint research programs are organized by the Coordinating Committee for Geoscience Programmes in East and Southeast Asia (CCOP). Partnerships and cooperation with Asian countries will be reinforced in areas including the sharing of geological information through a network. AIST will also cooperate with research organizations and relevant committees throughout the world for the standardization of geological information. As a new initiative, AIST will launch a comprehensive geological research program which will lead to geological risk reduction and environmental preservation in metropolitan areas. The development of survey/assessment/management techniques for land pollution will be conducted in coordination with the field of environmental researches.

In the field of oceanography, the projects include: oceanic geological surveys by geological survey ships for the preparation of oceanographic geological maps and superficial deposits maps; the upgrading of databases on oceanographic geology; and researches into global environmental issues by means of paleomagnetic and geochemical methods. Further efforts will be given to the research projects on the environment in nearshore waters and metal /biomass resources in sea water.

Standards and Measurement Technology

In the field of Standards and Measurement Technology, in order to facilitate the development of Japanese economic activities in the international market, a consistent policy concerning measurement standards and legal metrology has been formulated. Based on this, AIST is working on the establishment of measurement standards, tests and inspections of measuring instruments, research and development as well as providing the relevant instructions. The Metrology Management Division, the Metrology Training Center of the Public Relations Department and the International Metrology Cooperation Office of the International Affairs Department are jointly responsible for these researches and services as the Metrology Institute of Japan.

In 2003, AIST aims to begin the provision of at least 24 physical standards and 33 reference materials, that is to say, the introduction of at least 57 standards in total among the medium-term target of 200 measurement standards. Furthermore, AIST will promote the early provision of reliable measurement standards based upon the standard development plan established by the government. To ensure a sustainable and stable system which can provide measurement standards, and to assure compliance with international standards, AIST also will operate the quality system conforming to ISO/IEC17025 and ISO Guide 34 and intends to complete ASNITE-NMI accreditation in over 21 reference materials as to the proof of compliance with ISO/IEC 17025. In the area of measurement standards and measurement and analysis technologies, AIST will also be using the Nanoscopic Measurement Technological Infrastructure Project to work on research and development for next-generation standards. By means of the measure equipment with calibration intelligence (e-trade project), AIST will attempt to become a world leader in the research for developing a network-based standards provision method. AIST will promote the mutual approval of measurement standards and legal metrology, and will play a role for representing Japan in international activities in this area. Regarding the international cooperation, AIST will be involved in the managing body of the Asia Pacific Metrology Program (APMP) and chair and organize the Asia-Pacific Legal Metrology Forum. AIST has been providing technical cooperation to Thailand.

Other Plans for FY2003

In 2003, AIST will continuously strive to achieve further operational efficiencies for the organizational operations and implement research and support projects to promote the effective utilization of research equipment. In line with the policy of “self-reform”, based on the assessment of each research unit, AIST will seek out improvements within the research systems. By promoting the mobility of research personnel and the effective utilization of human resources, AIST is determined to make a significant development in FY 2003.

A New MOU with the China Geological Survey

March 13th, 2003, at the Geological Museum Lobby

The Geological Survey of Japan (GSJ) of AIST and the China Geological Survey (CGS), Ministry of Land and Resources agreed to conclude a comprehensive Memorandum of Understanding (MOU) in geosciences for the smooth implementation and future development of cooperative research activities. On March 13th, 2003, the MOU was signed at the Geological Museum Lobby of AIST by Ms. Shou Jiahua, the Vice Minister of Land and Resources and the Director General of the China Geological Survey and Dr Hiroyuki Yoshikawa, the President of AIST. As Vice Minister Shou could not come to Japan due to the State Council of the People's Republic of China, Mr. Wang Min, the Deputy Director of the China Geological Survey brought the signed MOU.

The Institute for Geo-Resources and Environment (IGRE) of AIST has started a new cooperative project with CGS since 2002 on the development of prediction model for water resource changes in Asian monsoon regions where artificial alteration of nature is significant. For the project, Dr. Tetsuro Noda, the Director of IGRE and Mr. Wu Xuanmin, the Deputy Director of the Department of Hydrology and Environmental Geology of CGS signed a Project Annex under the comprehensive Memorandum of Understanding.

In September 2001, to reorganize as a national center in geosciences of China, the China Geological Survey merged with several geology related organizations, such as the Chinese Academy of Geological Sciences, China Institute of Geo-Environmental Monitoring, Qingdao Institute of Marine Geology, National Geological Museum of China, and National Geological Library. CGS currently consists of 6,200 research scientists with 28 local offices and related organizations.

AIST/ITRI Joint Symposium

On February 19th and 20th, AIST and ITRI (Industrial Technology Research Institute, Taiwan), jointly held a symposium at the National Museum of Emerging Science and Innovation (MeSci) and AIST Tsukuba.

There were 31 attendees from Taiwan including executive officers of ITRI headed by Dr. Chintay Shih, President, and Dr. Jung-Chiou Hwang, Director General of the Department of Industrial Technology, Ministry of Economic Affairs. The 44 Japanese participants included Dr. Hiroyuki Yoshikawa, President, and other researchers of AIST, as well as senior members of other organizations including the Ministry of Economy, Trade and Industry.

On the first day of the symposium, Dr. Yoshikawa and Dr. Shih delivered opening speeches, followed by introductions of both institutions and presentations explaining the efforts to nurture new ventures by each organization. Subsequently, six researchers from each institute gave lectures on their research subjects in the fields of biotechnology, nanotechnology and IT. Dr. Jiro Hiraishi, AIST Vice President, delivered the closing remarks.

On the second day, a discussion was held on the subject of "Management of Research Institutes" and there was a tour of AIST Tsukuba and AIST Tokyo Waterfront. The participants eagerly exchanged opinions for future tie-ups in research activities. The symposium marked an important step forward for the close collaboration of both institutions.

KOCI Chairman Visits AIST

In May 2003, Dr. Won Hoon Park, the Chairman of the Korea Research Council for Industrial Science and Technology (KOCI), visited AIST.

The Chairman, along with Directors of two Member Institutes, Dr. Doug Young Joo of the Korea Institute

of Industrial Technology and Dr. Choong Sup Kim of the Korea Research Institute of Chemical Technology, had laboratory tours at AIST Kansai, Chubu, Tsukuba and Tokyo Waterfront. At the AIST Tokyo Headquarters, they had a discussion on research cooperation with the President of AIST, Dr. H. Yoshikawa.

KOCI is under the auspices of the Office of the Prime Minister and it supervises seven research institutes called Member Institutes in the industrial technology field.

It evaluates and supervises the seven Member Institutes in Korea and offers counsel to the Cabinet. KOCI and AIST concluded the Memorandum of Understanding on Comprehensive Research Cooperation in February 2002.

Delegation of NCST Visits AIST to Boost Relations

(May 26th, 27th, 30th)

A delegation of NCST (National Center for Natural Science and Technology of Vietnam) visited AIST to foster better understanding and cooperation between NCST and AIST. NCST is affiliated directly to the Vietnamese Government, and is the largest national institution in Vietnam responsible for the research and development. The NCST delegation was headed by Prof. Nguyen Khoa Son (Vice Director General of NCST), and the members were composed of the director of the Department of Planning and Finance, the director of the Department of International Co-operation, and other three delegates from NCST together with a delegate from Government Office of Vietnam. Dr. Kodama (Vice-president), Dr. Katsura (Trustee), and other AIST members had a discussion with them on the framework of collaboration and the high-priority research fields. The NCST delegation also made a study tour around Tsukuba Center and AIST Tokyo Waterfront.

Norwegian Minister of Trade and Industry Visits AIST Tokyo Waterfront

On May 27th, 2003, Mr. Ansgar Gabrielsen, the Norwegian Minister of Trade and Industry, made a tour of AIST Tokyo Waterfront.

The Minister had a discussion with AIST President Dr. Yoshikawa and Trustee Dr. Soga, focusing on AIST's management policy and its achievement after reorganization.

Following the introduction of the Computational Biology Research Center and the Research Center of Macromolecular Technology, Mr. Gabrielsen visited the laboratory of the Digital Human Research Center.

Mr. Gabrielsen came to Japan for the signing ceremony of the Agreement between the Government of Japan and the Government of Norway on Cooperation in Science and Technology. At Japan-Norway Science & Technology Seminar held prior to the ceremony, President Dr. Yoshikawa was awarded "The Royal Order of Merit".

Presentation at Hannover Messe Ends Successfully

Hannover Messe, the world's top international fair where industry and technology meet was held in Hannover, Germany, on April 7th-12th, 2003. The fair has a history of over half a century.

AIST debuted with photocatalytic materials, attracting attention for their environmental friendliness. The event featured 6,200 booths and attracted 200,000 visitors. The event's themes included microtechnology, factory automation, energy, materials, and Research and Development.

The AIST exhibit in the pavilion of Research and Industrial Technology centered on research and ideas linking technology to industry. The booth attracted about 2,000 visitors mainly interested in photocatalytic technology, the AIST organization, and technology transfer from such leading enterprises as Volkswagen, Ferrari, Hoechst, BASF, MERCK, DuPont, Helmholtz Research Centers, Seimens, Fraunhofer Research Institute, and European universities together with buyers from many countries.

The exhibition was a great success, likely due to the large number of samples displayed. Certainly, it indicated the considerable interest in photocatalytic technology in Europe.

This led to many business discussions on possible research cooperation, practical applications, transfer of samples, import and sales contracts, and negotiations for technology transfer, involving major European enterprises, universities, and research institutes.

In the Forum of Industry Trends at another site, AIST presented overviews of its work and photocatalytic technology. The result was a major accomplishment featuring the quality and potential of AIST.

Becoming a regular at such a great fairs should provide AIST researchers with considerable incentive and an exceptional opportunity for presenting their research accomplishments.

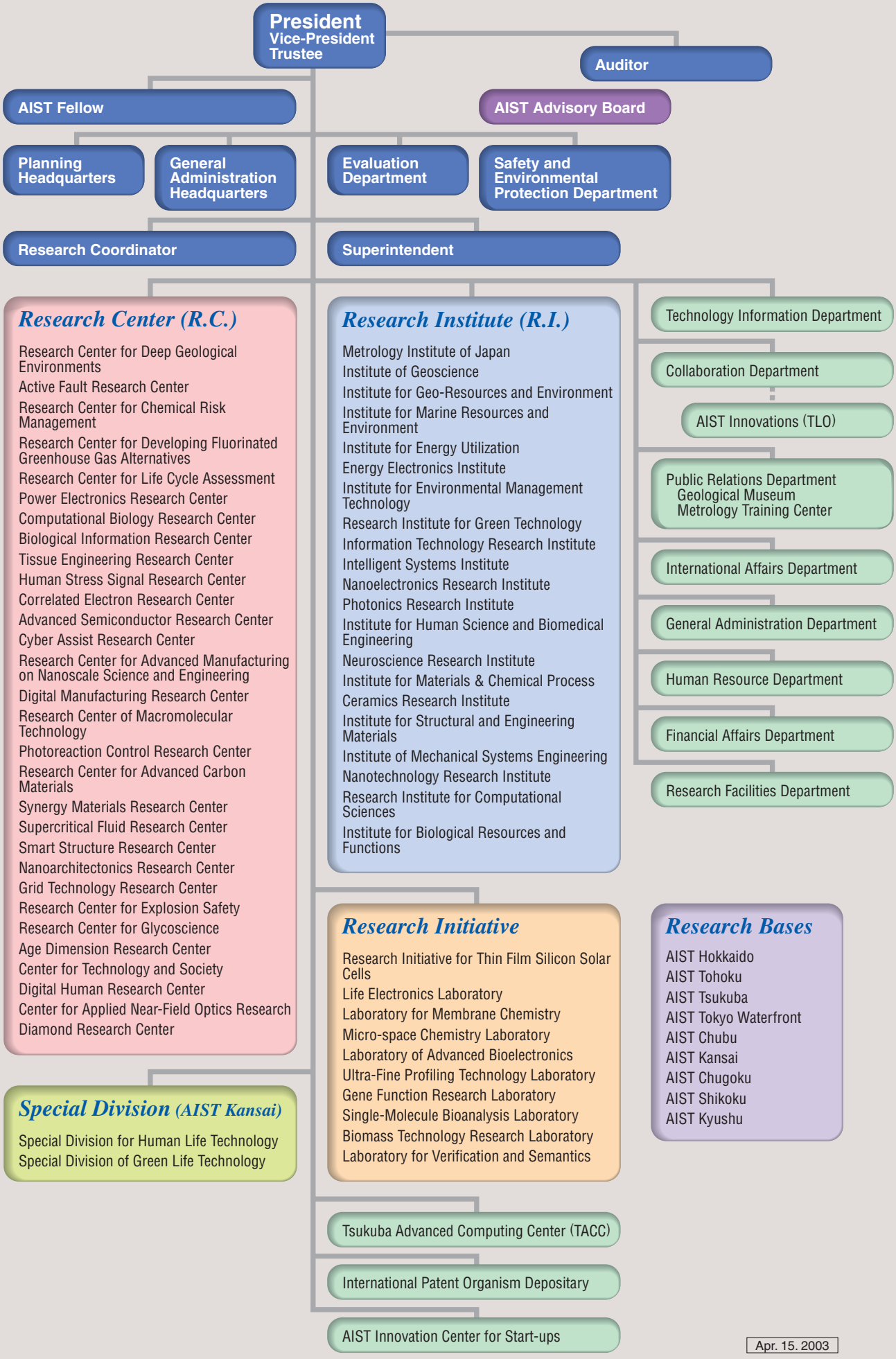
nano tech 2003 + Future

From February 26th to 28th, AIST organized an exhibition, "nano tech 2003 + Future", jointly with the New Energy and Industrial Technology Development Organization and Japan External Trade Organization, both of which are affiliated with the Ministry of Economy, Trade and Industry.

The exhibition was one of the world's biggest events on nanotechnology, which drew international attention as a fundamental technology for the realization of a highly-sophisticated information society in the 21st century. This technology is also indispensable for the sustainable development of society in harmony with the environment. A large number of governmental institutions and companies from 23 countries participated in the exhibition. The program of events included various seminars on the participating countries' strategies, projects and industrial trends, panel discussions on the issues of current research and development projects and future prospects, lectures by Nobel prize scientists, symposiums, introductions of research projects, innovative technologies, products etc.

Taking this opportunity for publicizing the research results and promoting the practical application of the technology, AIST held an exhibition covering 38 subjects and 19 presentations. During the international meeting, AIST hosted a technical symposium on the subject of nano length standards as well as a panel discussion focusing on the efforts in Asian countries. A study tour at AIST Tsukuba was also organized for the participants from Asia.

AIST Organization Chart



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