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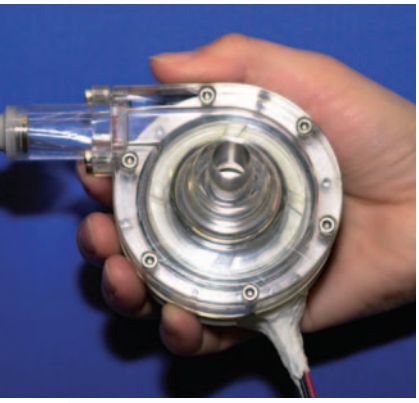

AIST Today

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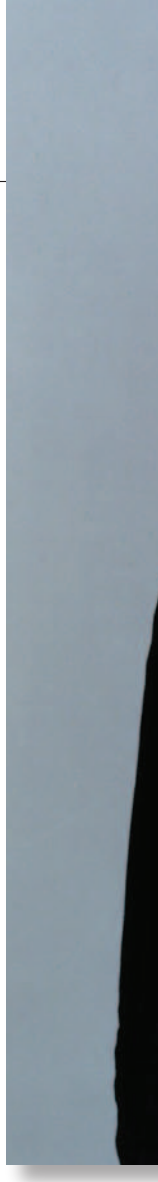
AIST NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

Hiroyuki YOSHIKAWA, President

The Year to Review Our First Phase



It has been three years now since the inauguration of the National Institute of Advanced Industrial Science and Technology (AIST). During that time, we strove to carry out our mission as a research institute within the framework of multiple research units, each involved in "Full Research" centered on "Type-II Basic Research." The very fact that an organization encompassing thousands of researchers in disparate fields has been able to function on the basis of a shared "philosophy," as I would term it, is an accomplishment worthy of special mention. In the process, many people have worked hard to meet unprecedented challenges. Although the issues varied considerably from person to person, I would venture a guess that everyone at the institute faced such challenges and strove, through his or her own efforts, to meet them. While it is impossible to cover all these efforts here, I would like to mention a few and discuss what we can learn from them and how to proceed henceforth.

1 Type-I Basic Research Workshops

For exactly one year, from January 2003 to January 2004, AIST held 24 workshops. The topic for the first series was "Type-II Basic Research," while the second series was devoted to "The Products of Full Research."

Type-II Basic Research is the central work of AIST, which conducts research mainly with public funding. Research geared to industrial technology is important because most of the problems facing contemporary society, most notably the problem of sustainable development, can only be solved through technology, and because industry has a particularly large role to play in dealing with these issues. Furthermore, any objective assessment of the situation today will tell us that industry must change. Indeed, the changes that will be required of industry are widely regarded as comparable in magnitude to those of the Industrial Revolution some 200 years ago, and with that in mind are sometimes referred to collectively as an "industrial transformation." For this reason, today research related to industrial technology has to be research of a very basic sort, going far beyond the modification of existing technologies. We must use the results of scientific research, which is advancing at great speed today, as the raw material from which we will create new industrial technology. Unfortunately, most scientific research does not yield findings that can be put to use directly as industrial technology. To bridge the gap, we need to apply different methods from those used for "scientific research" in the narrow sense. This is a type of basic research that was not publicly acknowledged as such for many years, and it is this that we have termed Type-II Basic Research. Through our workshops, we advanced researchers' understanding of this type of research. Many low-profile research projects were unearthed and discovered to be Type-II Basic Research, as a result of which their importance became clear. Since this process involved a significant shift in the status of the research and the methods used, the directors and researchers in the units involved were doubtless put to a good deal of trouble. But this signifies an important step forward for AIST as it works to meet society's expectations.

The "Products of Full Research" workshops discussed the fact that once the findings of Full Research are released, they can no longer be assessed simply from the researcher's perspective but take on the subjective value assigned to them by society; for this reason, we have termed them "products." This means that we can no longer limit the execution and evaluation of our research to a closed community of researchers but must open it up to

society as a whole. The workshops helped clarify the duties of people who conduct research supported by public funding in terms of the contract formed between society and the research community. This perspective helped participants to see that there exists in each of the diverse fields of research within AIST things that could be called products, and it facilitated a kind of dialogue between these disciplines that would not be possible where research approached in the narrow, conventional sense.

Through these discussions on Type-II Basic Research and its products, we were able to expand the potential for dialogue among disparate research fields, shed light on the form research should take within AIST, and at the same time reassess the relationship between research and society. But where should we go from here?

Since our discussions of Full Research have centered on Type-II Basic Research and its products, the natural next step is to focus on Type-I Basic Research. Some will argue that Type-I Basic Research as we have defined it is nothing more than basic scientific research in the conventional sense, a style of research that has a long tradition and has conferred on humanity a vast, systematic body of knowledge, and that as such, special reexamination within the context of AIST is neither necessary nor possible. I would counter that a consideration of Type-I Basic Research within the context of Full Research, as an extension of our examination of Type-II Basic Research and its products, is not the same thing as a consideration of basic scientific research in the conventional sense. To put it simply, we need to reexamine Type-I Basic Research from the vantage point of the product, backward through the lens of Type-II Basic Research. When we do so, we realize that what may at first appear as nothing more than conventional scientific research is actually distinguished from such research by what motivates it. The direction of one's thinking with respect to the conduct of research is naturally influenced by our consciousness of a potential product, that is, something of value to society. This is what clearly distinguishes Type-I Basic Research from conventional scientific research.

Generally speaking, basic scientific research is internally motivated by the researcher's own curiosity. Conventional wisdom has it that when the researcher is influenced by outside circumstances, the research is no longer "pure," and it is unlikely to lead to truly creative and original work. There is no doubt that creativity is likely to be stifled if the researcher is forced to adopt certain thought processes. But this is not the case when external factors merely influence the impetus behind the research. In this case, the outside influence is manifested simply as a change in some aspect of the researcher's curiosity; it does not affect the independence and freedom of the researcher's thought processes. This sort of influence is inevitably felt to some degree in all basic research. In today's society, basic research is invariably carried out within the framework of a particular existing academic discipline. Within this framework, the factors motivating research are distinct to each field, which means that a researcher's curiosity is based on considerations that pertain only to his or her own field.

Seen in these terms, the Type-I Basic Research carried out in the various research units of AIST is basic scientific research fueled by a curiosity that is motivated by factors relating to the goals of each unit. If the goals of the unit are creative and original, then the Type-I Basic Research carried out there has the potential to be far more creative than basic research carried out within the framework of traditional disciplines. And assuming that a new brand of knowledge will be needed for the coming industrial transformation, the role of Type-I Basic Research within Full Research is bound to be an important one.

What does such Type-I Basic Research look like? How does it vary from one area to another? This question raises an issue we have not yet examined: the effect different motivations for Full Research have on the thought processes of the researchers involved in Type-I Basic Research. It seems to me that this would be an appropriate theme for our third series of workshops.

2 Area Strategies

The overarching goal of AIST is to raise the technological level of Japanese industry. Advances in technology can improve the competitiveness of industry. At the same time, they promise to contribute to the achievement of one of the key tasks facing humankind, the challenge of sustainable development, which is also a necessary condition for the realization of a stable world order. Keeping these larger goals in mind, on what should we focus our research? This was the focus of our discussions on "area strategies." These took the form of consideration of proposals by the research coordinators, as well as frequent discussions among the unit heads at their meetings.

Even if the overarching goal of the institute is clear, the question remains—What should its researchers research? The role of area strategies is to lead us closer to answers to this question. In other words, area strategies support the overarching goal of the institute as a whole and provide researchers with objectives specific to each area. The substance of these strategies is doubtless something that must be carefully constructed while simultaneously focusing on the goals of the institute and considering the desires and abilities of the researchers currently attached to it. Nor can this be done mechanically or automatically.

Rather, these strategies must be a synthesis of the dreams of the individual researchers and an understanding of goals of the institute, crafted with the help of inspiration and intuition. We dubbed these creations dogmas.

A good example is the "Materials Reconstruction" initiative, the result of two years of tremendous effort by Trustee Naohiro Soga. This is something that the researchers created themselves with the aim of achieving "Full Research," working on the premises that (1) the basis for making a discrete field of the science of materials has been undermined by the emergence of nanoscience, (2) it has become clear that materials have a wide variety of functions, and (3) the emphasis on materials within industry has changed. The process of developing this initiative should take its place as an important chapter in the annals of this institute. Now the formulation of comprehensive strategies is under way in other research areas as well. In the area of life science, planning is focusing not only on such existing industries as health care and pharmaceuticals but also on the emergence of new industries. In the information field, deliberations have included the concept of a virtual time machine. Strategies are also being developed in the areas of energy, the environment, geology and marine science, and measurement and standards. I look forward to their completion. Together, these area strategies should form the backbone for the next medium-term plan, to begin in 2005.

What exactly do we mean by "strategy"? Let me offer some ideas based on the example of energy research. Some organizations might proceed by drawing up a graph showing the anticipated change in the contribution of each energy technology to total energy demand through 2030, lay plans in accordance with those anticipated changes, and call that their "strategy." To my mind, however, this is not a strategy. To begin with, there is no way to determine each technology's future contribution based on its potential. Moreover, to blindly follow such a projection as something authoritative would be counterproductive. A projection of this sort should be treated as nothing more than an approximate forecast. A strategy, to the contrary, should be focused on the best future we can imagine while honoring humanity's common goals and restrictions and taking account of our own capacity and potential. A strategy must support our dreams, not circumscribe them.

Honoring humanity's shared goals and restrictions is another way of saying "achieving sustainable development." This means, first, achieving continued development in Japan while reducing the burden on the environment, and second, providing the energy less developed regions need for development without adding to the environmental burden.

In fact, lurking within this basic agenda is an exciting scenario. The only way to meet the challenge facing our own country with regard to sustainable development is to increase our dependence on renewable energy sources. As I suggested above, we should not impose limits by deciding in advance whether solar power, wind energy, or some other source should play the leading role. Hydrogen also holds great potential as an energy source. As Japan pursues renewable energy sources, it will naturally wean itself from its dependence on oil, thereby breaking free from the extreme dependence on energy imports that has

long characterized this country's economy. Well, then, why not let our imaginations soar and consider the possibility of Japan's becoming an energy-exporting country? The ability of the world to meet the pressing challenge of development in the less-developed countries will depend heavily on energy technology. This is not something that can be achieved without cooperation from the industrially developed nations. Why couldn't we use Full Research to develop diverse energy technologies designed to meet various natural and social demands? Of course, a comprehensive scenario for sustainable development would be highly complex, depending on numerous factors relating to international affairs, existing industries, and national cultures, and we do not have the capacity to consider all of these factors in detail. However, as researchers entrusted with the task of using science to develop new technologies, we do have the ability to write a scenario concerning the emergence of a new energy industry with the potential to become a Japanese export industry; moreover, we are the only ones with that ability. Adopted as a pillar of the energy area's strategic research plan, this scenario could produce a truly exciting strategy.

3 Other Lessons

We have learned much over the past three years, and we must put what we have learned to work in the framework of the next medium-term plan. I have discussed Full Research and area strategies. These are supported by some crucial organizational concepts, including the Board of Trustees as executive, the principles governing the emergence of organizations from groups of people, the establishment of the Research Institute and Research Center as our main units, the "flat" structure of units, unit autonomy, systematic evaluation and incorporation of the results of the evaluation in the organization, and the reorganization or elimination of units on the authority of the Board of Trustees. All of these reforms were new experiences for us, and no one would claim that their implementation has been problem-free, particularly when it comes to integrating them all harmoniously. However, I do believe that, thanks to the spirit of inquiry and constructive effort demonstrated by all those attached to AIST, these organizational reforms have accomplished their purpose and enabled the institute to take a giant step forward despite the difficulties encountered along the way. Now might be the time to consider some of the challenges that have emerged during this process.

One issue raised was the fact that when various autonomously operating units of equal rank were evaluated independently of one another, high walls sometimes grew up between those units owing to intense competition. Although units are autonomous entities—or rather, precisely because they are—they cannot be isolated from one another. Any autonomous entity that cuts itself off from the environment will perish. If indeed such a situation arose, then the units that erected these walls need to give more thought to the concept of autonomy, and if the evaluation process encouraged this state of affairs, then we need to reconsider our methods of evaluation. The fact that the area strategies had not yet been developed may have contributed to the situation as well. What we need to do now is move on to the next step while examining these factors in relation to one another. In any case, the crucial task of preserving both competition and close cooperation among units is something we must continue to address.

Where management of the units is concerned, it appears that the principle of autonomy has been accepted. That said, autonomy is surprisingly tough to deal with. It was particularly difficult for the unit directors, who are responsible for the entire operation. I said in the past that the unit director should be an autonomous thinker. In truth, the object of this autonomous thinking extends from the substance of the unit's research to overall management and the training of young researchers. A complex and busy job with wide-ranging duties thus awaited the unit directors. All of them rose courageously to the challenge and accomplished the work required of them. Now we look forward to receiving constructive suggestions from the unit directors on how to go about refining this approach.

Another issue, which may not have been pointed out before, is whether AIST offers a good environment for young researchers in terms of advancing their careers. I do not know if I have an answer to this question. I imagine this depends to some degree on the area of research and also on the individual characteristics of the unit directors. In any case, I certainly think it is something that we should discuss from various angles henceforth.

In terms of our external relationships, I would like to see AIST broaden its international activities. Domestically as well, there is much to be done. Although we have already seen some results in the way of cooperation with universities, venture strategies, tie-ups with medium and small businesses, and comprehensive partnerships with large corporations, greater effort will be needed if we are to move such activity to the next level.

4 In Conclusion

Everything that has been undertaken in AIST over the past three years has been a valuable experience, and we have learned a great deal from all that has happened. Now we must fully digest these lessons and build our second medium-term plan on the achievements of our first period. That job, centered on the Planning Headquarters, is already under way, but I hope that everyone here at AIST, while carrying on their research, will also participate constructively in this critical task.

The National Institute of Advanced Industrial Science and Technology (AIST) is proceeding with an innovative collaboration between the medical and the engineering organizations.

Feature

Aiming at a new patient-centered healthcare system

AIST presents new R&D models

AIST has made a proposal for establishing new R&D (research and development) models based on novel collaboration with the medical and the industrial organizations that in the past were not even closely linked. This issue presents one of these models: an advanced ubiquitous healthcare system (a new patient-centered healthcare system). It also introduces typical results of R&D activities which contribute the innovative collaboration between the medical and the engineering organizations.

What is a "patient-centered healthcare system" ?

Yoshihiro NAKAMURA Research coordinator (in charge of life sciences)

A patient-centered healthcare system guarantees advanced healthcare equally at any time and anywhere.

AIST intends to establish a patient-centered system that guarantees advanced healthcare equally at any time and anywhere. Though conventional healthcare relies on ambiguous cares with visual and tactile observations, or with experiences of physicians, we will adopt a more reliable and advanced style of healthcare that guarantees equal quality of treatments for everyone. This can be achieved through R&D of advanced medical devices or simple and precise clinical testing methods using information technology and through standardization and database establishment. In addition, we will encourage the developmnent of non-invasive testing methods and surgical training systems that reduce pains, and will establish remote diagnosis/treatment system linking hospitals or between the hospitals and homes of patients. We will proceed with the R&D of artificial organs, biomaterials, and regenerative medicine to regenerate and enhance lost functions of patients. Furthermore, we will assist the patients return to the society and become independent through the R&D of healthcare equipment based on human engineering.

Future of our R&D models Strategy for promoting collaboration between the medical and the engineering organizations

AIST is promoting collaboration between the medical and the engineering organizations by the following strategies (See the Figure).

1) Promotion of the fusion of technologies in different fields

Promoting the fusion of technologies in different fields such as life science, telecommunication, nano-technology, and measurement standards under a practical and effective framework.

2) Establishment of an R&D framework in collaboration with industry

We plan to secure the necessary funds and facilities for physicians, developers from industry, and engineering researchers to gather, then to establish an R&D framework for products, and to promote obtaining early legislative approvals.

3) Promotion of venture business start-ups

There are numerous opportunities for venture business in the field of healthcare and homecare services. We plan to promote the foundation of the venture business to spread the results of our R&D for the sake of social benefit.

4) Reinforcement of relationship with academic societies

Academic societies play an important role in the preparation of healthcare guidelines at the state level. We reinforce the relationship with academic societies, especially with young academic leaders.

5) Pool of suitable persons for liaison/consultant staffs.

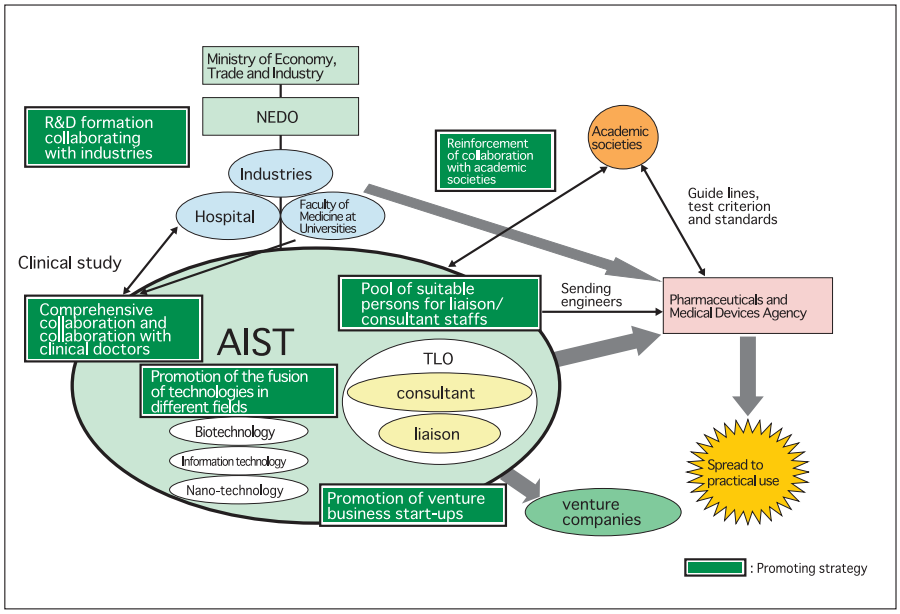
Since the clearance of the legislative requirements is an important step in commercialization, training will be provided for persons with experience in industries to be appointed to liaison/consultant staffs.

6) Comprehensive collaboration with the hospitals and/or the faculties of medicine at the universities.

To establish an environment for promoting collaboration between the medical and the engineering fields, systematic collaboration should be introduced with the hospitals and the faculties of medicine at universities, following the examples in the U. S.

As the primary organization for promoting the collaboration between the medical and the engineering fields, AIST currently studies how the collaboration organization should be, including the set up of a hub for the collaboration.

*Please refer to "AIST Today 2003, Vol. 3 No. 9" for a digest of "The proposal for our new R&D models".



Promoting strategy for collaboration between the medical and the engineering organizations of AIST

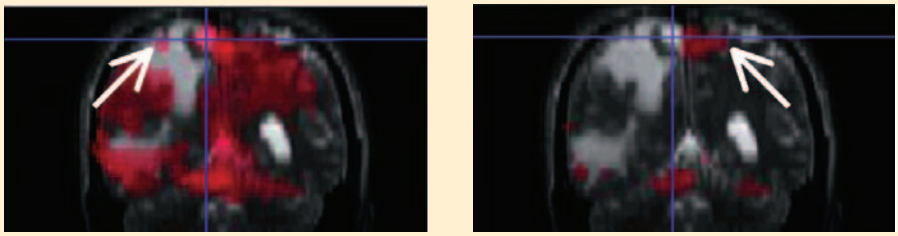
fMRI — a technology to investigate brain function

Endeavoring to push fMRI (functional MRI) to the forefront of healthcare

The technology for investigating brain function utilizing magnetic resonance imaging (MRI), namely, functional magnetic resonance imaging (fMRI) has only recently been invented. AIST is making efforts to advance fMRI into a technology that is practical for clinical health care. The major topics of development are 1) improvement of the image quality in high speed MRI, 2) development of an algorithm for calculating brain function in real time using parallel computing (PC cluster), 3) development of cognitive engineering technology that makes the brain perform according to the objective of diagnosis, 4) enabling the evaluation of brain dynamics, which up to now has been difficult, by analyzing the temporal changes in brain activity.

Applying GRID technology to support healthcare practice

In rapidly advancing technological fields, such as MRI, an innovative invention may soon be out dated unless it is extensively propagated in a quick and cost-effective manner. As a solution to this problem, AIST is making efforts to apply GRID technology, a new network computing system to closely link devices in remote locations, including MRI and computers for data analysis, and to make them work as one integrated device. By using GRID, an analysis system in a single location can support the diagnostic imaging in multiple healthcare facilities.



An example of pre-operative assessment

The red colored region corresponds to the brain activation in response to a task performance and white region to the edema around the tumor. The brain tumor involves the primary motor area of the right lower extremity. By attempting to move the right foot, bilateral primary and higher motor areas are extensively activated, that suggests compensation to the disability (left figure, arrow). When the left foot was moved, the activation map was normal (right figure, arrow).

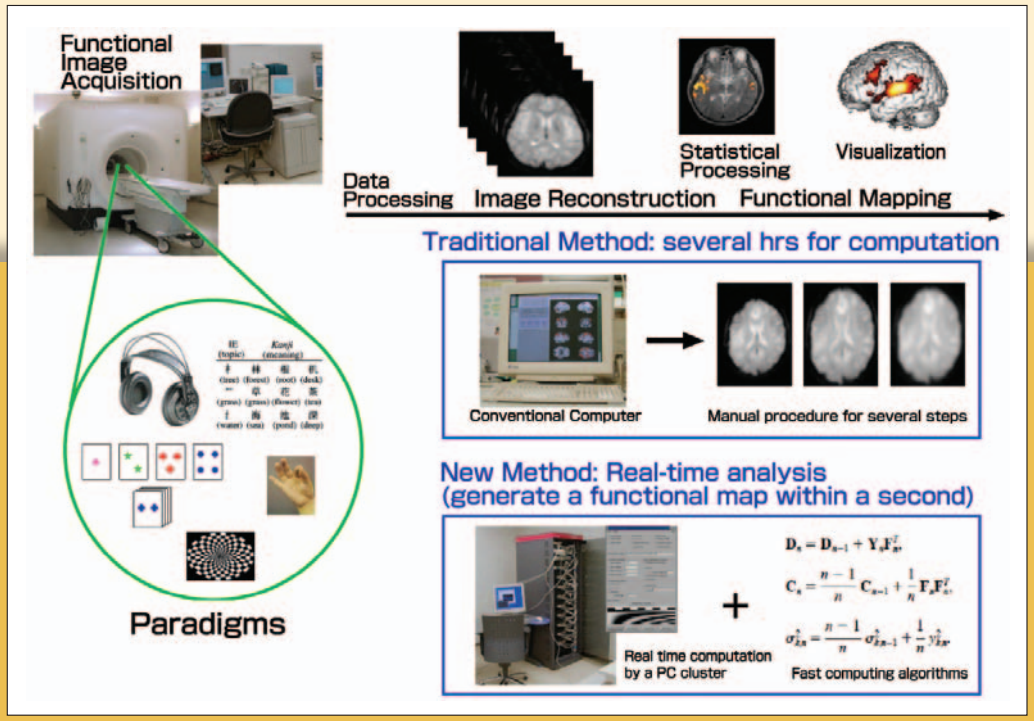
MRI (Magnetic Resonance Imaging)

MRI is based on the principle of NMR (Nuclear Magnetic Resonance), which non-invasively (without damaging any tissue) visualizes in two or three dimensions the spatial distribution of the elements that show magnetic resonance phenomenon, such as hydrogen, phosphorus, sodium, fluorine, or carbon,.

[Collaborating organizations]

- Department of Radiology, Kyoto University, Graduate School of Medicine
- Lucas MRS/MRI Center, Department of Radiology, Stanford University
- Image Based Medicine Center, Institute of Biomedical Research and Innovation

Toshiharu NAKAI
Photonics Research Institute



Real-time functional brain mapping

By using a parallel computing system, a huge amount of functional image data generated by an MRI scanner can be immediately processed, analyzed and visualized within a second. The subjects perform tasks according to instructions to extract the brain activity of interest in the MR scanner. The minute changes of the susceptibility effect representing the neuronal functions are detected as functional images.

Multi-modal technology for the visualization of human brain functions

Visualizing brain activity

It has become important to improve patient quality of life by providing better rehabilitation planning and developing prosthetic devices optimized to each patient suffering from brain dysfunction due to cerebrovascular disorders.

Since the cooperative activities between the distributed areas in the brain play an important role, especially in higher order cognitive functions, it is crucial to develop the technology for quantitatively evaluating the interaction between these areas to provide useful information for clinical treatment for those brain functions.

However, the currently available non-invasive brain imaging techniques are not able to analyze the dynamic brain activities with high temporal and spatial resolution on their own due to inherent constraints on their principles.

Development of a system for visualizing brain functions

AIST is developing a system (Fig. 1) that enables a comprehensive analysis of the huge volumes of data acquired by multiple measurement technologies, including magnetoencephalography (MEG), electroencephalography (EEG), and functional MRI (fMRI) which have different measurement principles.

Right now, AIST is applying the prototype system to the visualization of the brain activities generated by various cognitive processes to assess its usability. Fig. 2 shows how the brain works to perceive a 3-dimensional object shape from the movements of 2-dimensional random dots. This example shows that our prototype has an ability to visualize both the ventral visual pathway for object recognition and the dorsal visual pathway for spatial processing at high temporal and special resolution.

In the next step, we intend to apply these multimodal brain imaging techniques to the clinical application through collaborative study with researchers in the fields of medicine and cerebral neurology.

[Collaborating organizations]
- NMR Center, Massachusetts General Hospital, Harvard Medical School

Sunao IWAKI
Institute for Human Science and Biomedical Engineering

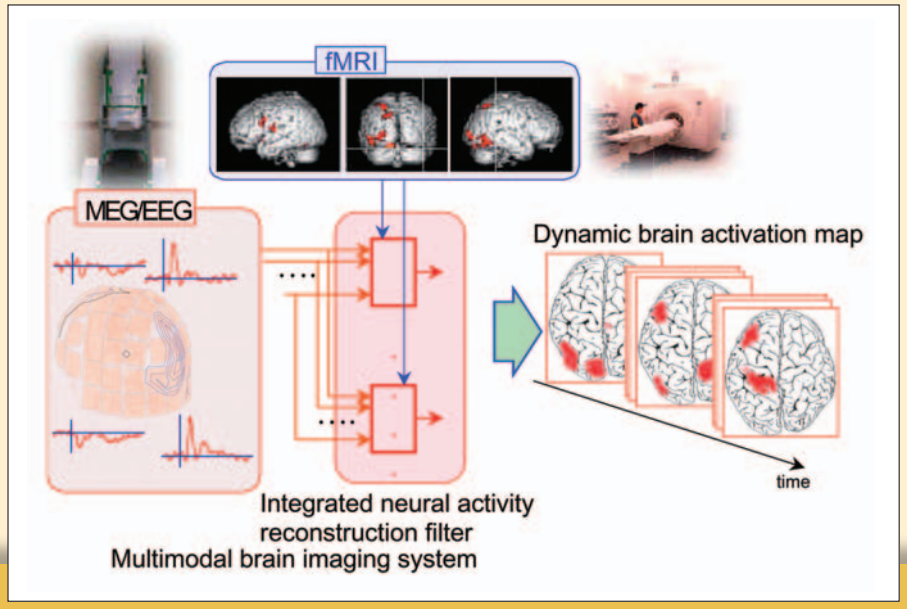


Fig. 1 Visualization of the brain activation with high spatio-temporal resolutions using multimodal non-invasive functional brain imaging technique.

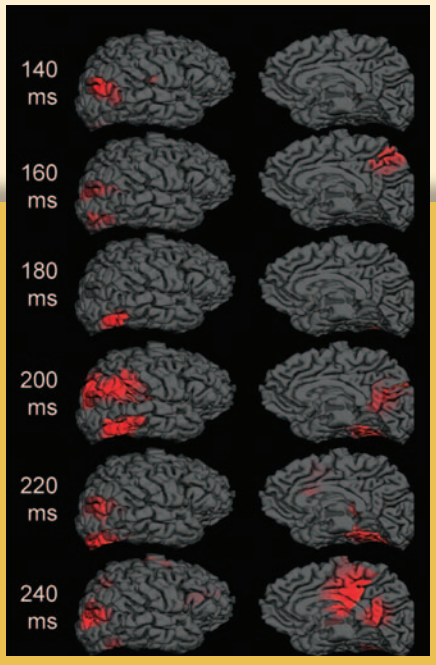


Fig. 2 Reconstructed brain activation during perception of the 3-D structure from the random-dot motion.

Ultra-high-speed Magnetic Resonance Imaging (MRI) for functional analysis of biological tissues

Real-time MRI (Reduction of time for data acquisition in MRI)

The Biomedical Sensing and Imaging (BSI) research group at AIST is actively studying novel MRI technologies. The ultra-fast MRI is a very useful technology for the analysis of the tissue metabolism, dynamic changes of the heart and blood flow mechanism.

1) Image reconstruction with incomplete data acquisition

Some of the image reconstruction for MRI is using the Fourier transform. One the theoretical characteristics of the Fourier transform is that it has a symmetrical distribution of the acquired data in the k-space. One of the MR image reconstruction techniques is named the Half-Fourier method. It can be done by almost half the data in the k-space. In other words, the acquisition time can be halved. The reason is the MRI data is symmetrically distributed at the origin in the k-space. In addition, the minimum volume of data in the k-space is acquired based on the prediction of the dynamics and variation in the object to be imaged. It strongly depends on the dynamics and spatial size of the object's variable region. The contraction ratio is in the range of 1/1-1/N (N is any integer). In an actual measurement, both ways are integrated to shorten the data acquisition time and much faster than a conventional MRI.

2) Parallel data acquisition

Hardware technology contributes to speedup.

Simultaneous data acquisition by multiple coils enables speedup (parallel imaging). Imaging time is shortened in proportion to the number of coils. If M coils are used, the contraction ratio will be 1/M.

Integrate the software and hardware technologies for speedup.

The imaging time has been significantly reduced by integrating the software and hardware technologies, enabling almost real-time imaging. For example, the imaging time was 25.6 seconds when the repetition time was 100 msec using the 256 x 256 GRE (gradient recalled echo)method. The time is now only 0.8 sec because it is shortened to 1/2 NM when N = 4, and M = 4, namely 1/32. This integrated technology can also be applied to echo planar imaging and spiral MR imaging. The 2D imaging time, which used to be about 100 milliseconds, has been decreased to less than 10 milliseconds. No need for TR, EPI and SPI because not used later in the article.

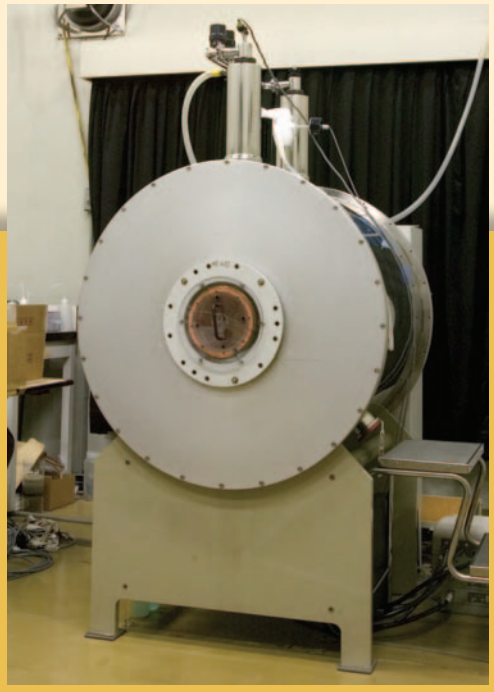
Current issues

Since the image is reconstructed by processing incomplete MRI data, imaging is possible only under limited conditions. Furthermore, the spatial resolution has been reduced because the total volume of data acquisition is reduced. However, the purpose of this method is to analyze the dynamics of organs and tissues and apply it to medical treatment using MRI. Meaningful information on medical diagnosis and treatment can be obtained if this method is used together with imaging technology applied to a conventional MRI.

[Collaborating organizations]

- **Department of Physiology, The University of Tokyo School of Medicine**
- **Department of Neurosurgery, Department of Radiology, Department of Orthopaedic Surgery, and Department of Pediatrics, Institute of Clinical Medicine, University of Tsukuba**
- **Department of Radiology, Hokkaido University School of Medicine**

Kazuhiro HOMMA
Institute for Human Science and Biomedical Engineering



Quantitative analysis of acquired MR images

An MRI system (2 Tesla, superconductive magnet)
Current Research subjects are novel MRI technologies for geometrical and functional analysis of biological tissues. We are starting new research on interventional MRI and fusion imaging.

Opening the brain image database to the publicfunctions

Access to the brain image database is open to the public

AIST has opened access to its database of MRI images of the Japanese macaque, Rhesus monkey, and human brain within its open access database (RIO-DB) so that the data can be used as resources for education and research. Since an MRI image is an ordered series of 'slices', special software is needed to obtain cross-sectional and 3D images at other angles. The server of this database incorporates software that can produce cross-sectional images and 3-dimensional images from any direction using multiple MRI images. This software creates an environment for constructing cross-sectional and 3-dimensional images from any direction that can be accessed using a conventional web browser (in the Figure, the cross-section and the external form are shown with the red line in the thumbnails at the right side of the image).

How to manipulate brain images in the database

The image can be rotated and the cross-section can be shifted by clicking the arrow shown at the lower right of the image. If the cursor is moved over to the brain image, the vertical red line (which can be changed to a horizontal red line using the pull-down menu at the upper right) will be shown. So, move the line to the desired site of the brain image and click the mouse there to show the cross-sectional image at that site. By using the pull-down menu at the upper left, the image can be switched between the brain only and the whole head. Thus, it is possible to browse the brain MRI images using just a few simple commands. MRI images for each step in the growth of one individual Japanese macaque have also been collected. The result is a 4-dimensional database that allows the image to be shifted along the time axis.

For clinical applications

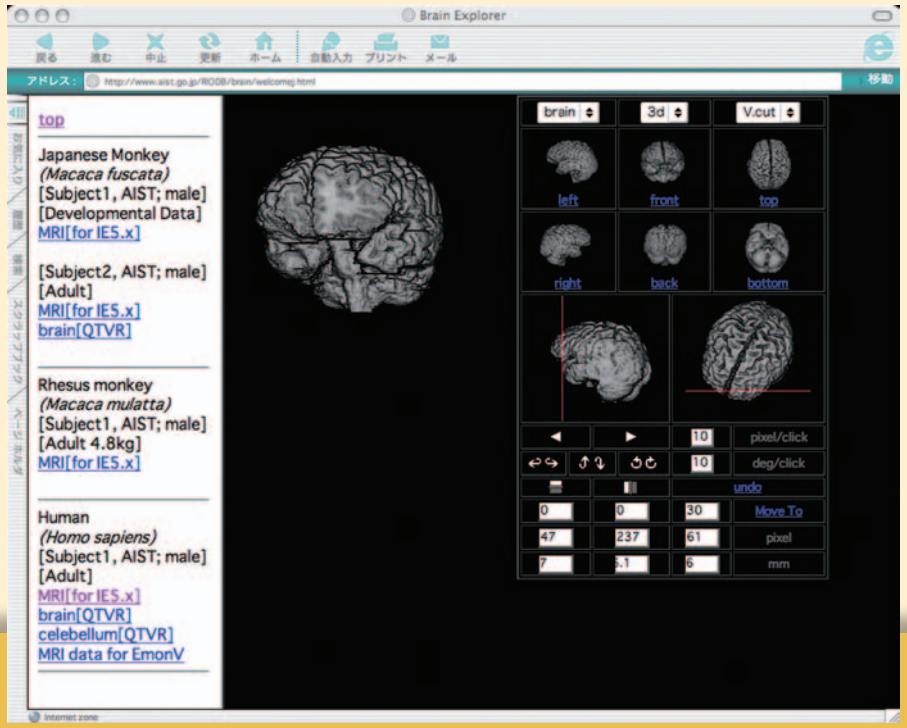
At present, MRI images are maintained in a database in the healthcare facilities. Although a system to allow the viewing of the data using a web browser has been suggested, only the cross-sectional view from the shot direction is available. If the software used for our database is incorporated in the suggested database, 3-dimensional images will be able to be produced and viewed using a normal web browser.

Brain image database

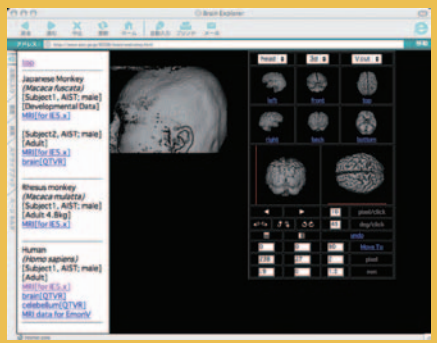
http://www.aist.go.jp/RIODB/brain/welcome.html

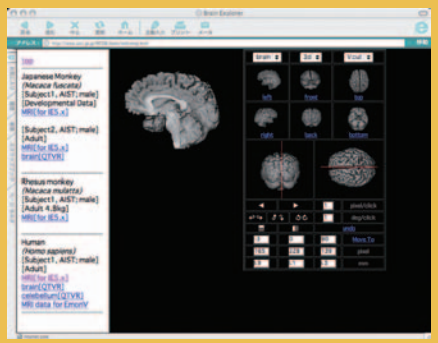
[Collaborating organizations]
- **Primate Research Institute, Kyoto University**

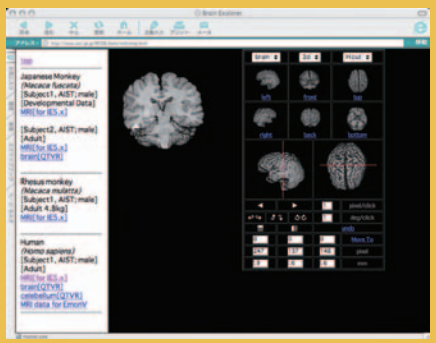
Keiji MATSUDA
Neuroscience Research Institute



brain image database (Human)
This software creates an environment for constructing cross-sectional and 3-dimensional images from any direction that can be accessed using a conventional web browser. The cross-section and the external form are shown with the red line in the thumbnails at the right side of the image.







MR-compatible surgical robot assistance

While surgery in magnetic resonance imaging (MRI) is effective, it has certain restrictions. The body of the scanner limits the space necessary for surgery. Many high-tech medical devices are not MR compatible including endoscopes, which are the key device of minimally invasive surgeries.

AIST is pioneering MR-compatible mechatronics. It integrates MRI as the transparent eye and robots as the surgeon's hands for safer and more precise surgery.

Conventional surgical robots cannot be placed nor used inside the MRI gantry due to the MRI's strong magnetic field and radio-frequency wave. In addition, due to the electromagnetic interference, conventional endoscopes cannot be placed nor used near the imaging region of the MRI when it is imaging.

We addressed these issues one by one and developed the world's first MR-compatible robot. The robot successfully proved that its motion neither affected nor was affected by the MRI. We also developed an MR-compatible endoscope.

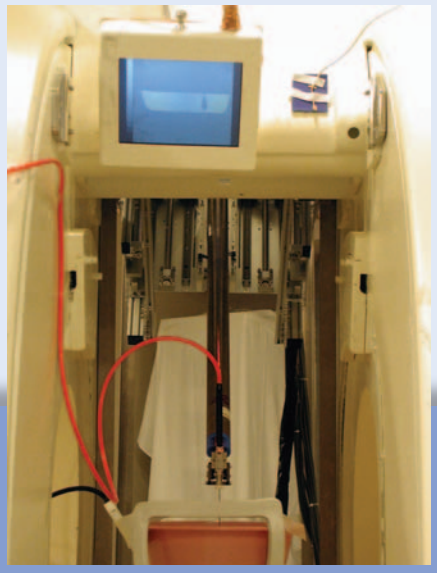
MR-compatible mechatronics

In 2003, a 6-axes robot system was developed, and its performance was examined in an MRI. It had a mean error of 0.1 mm and maximum error of less than 0.6 mm at the attachment of a surgical tool. It was the best accuracy among MR-compatible robots to date.

We aim to establish 'MR-compatible mechatronics' for the optimal design of a robot system that is suitable for MRI gantry and surgical procedure by 1) working together with surgeons on the design, 2) developing MR-compatible components such as sensors and actuators with component manufacturers, and 3) basic study on the optimal design and evaluation of MR-compatible devices.

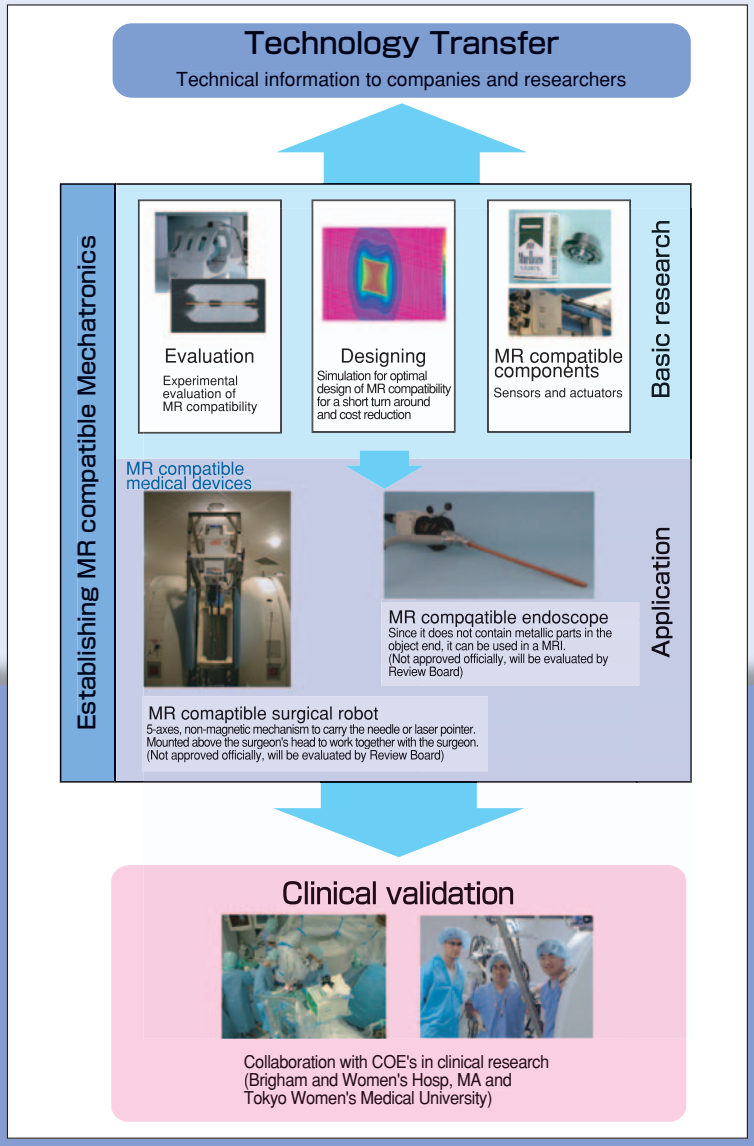
[Collaborating organizations]
- **Harvard Medical School, Brigham and Women's Hospital**
- **Tokyo Women's Medical University, Graduate School of Medicine**

Kiyoyuki CHINZEI
Institute for Human Science and Biomedical Engineering



Motion test of high precision robot with cryoprobe

MRI visualized water in a tray being frozen by the probe for cryotherapy. (A LCD panel shows the water as a white mass, and frozen water part as a black spot.) This robot can carry the probe to a specific position by picking two points from the MRI image displayed on a workstation.
Insertion, the final step is done manually by the surgeon.



Advanced training in endoscopic surgery

Increasing importance of training in highly advanced healthcare technology

Even though unskilled regident surgeons perform surgery under the supervision of the attending surgeons, endoscopic surgery is sometimes technically too hard for them, since they have to insert surgical tools through small holes opened on the body and manipulate them deep inside. It is also difficult for experts to intervene in case of emergency. Training in advanced Minimally Invasive Surgery (that is also called as "keyhole" surgery) is thus becoming more and more important.

AIST aims to build a training system that allows surgeons to train themselves anytime, anywhere, and as much as they want, and which gives them clear feedback on their skill level. We first worked on the basic problem, i.e., how to evaluate surgical skills from an ergonomic point of view. We have succeeded in physically capturing the differences between beginners and an expert (Fig. 1). Our next step is to set objective indices for surgical skills based on these physical differences, and to develop a feedback interface (Fig. 2) for using these indices efficiently during training. We will continue our research to allow this system to be used not only for training, but also for rehearsing surgery; Expert surgeons will be able to rehearse a surgery for each patient using our system in the near future.

*For the details of this technology, see AIST Today 2003, Vol. 3, No. 6.

Commercialization of a precise human nasal model

A "precise model of the human paranasal sinus for training in endoscopic sinus surgery (ESS)" (Fig. 3) was developed during our research on surgical training. To commercialize it, we founded Surg Trainer, Ltd., which has been accredited as an AIST Vencure Company. We hope the model will come into wide use in the field of otorhinolaryngology and skull-base surgery.

[Collaborating organizations]
- **Ibaraki Prefectural University of Health Sciences**
- **ENT Clinic @ Tsukuba South Avenue**
- **University of Tsukuba**
- **Shinko Optical, Ltd.**
- **PENTAX Corporation**
- **KOKEN Co., Ltd.**
- **SurgTrainer, Ltd.**

Juli YAMASHITA
Institute for Human Science and Biomedical Engineering

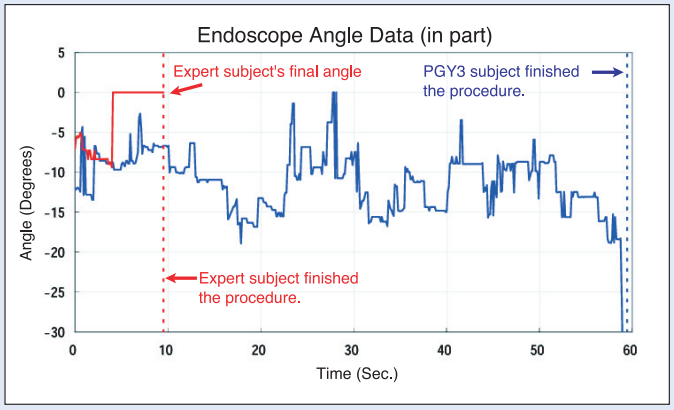


Fig. 1 Endocope angle data (in part) of the same surgical procedure of an expert surgon subject (red line) and a resident subject (blue line; Post Graduate Year: 3)

Apparently the resident's data takes much longer time to finish the same procedure than the expert and varies more widely, which means an unstable endoscopic view.

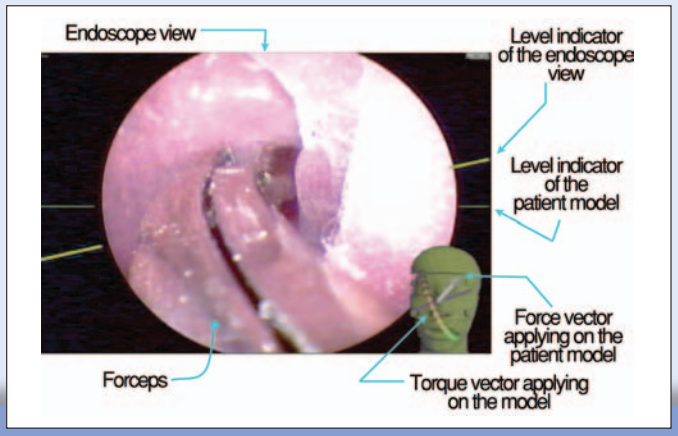
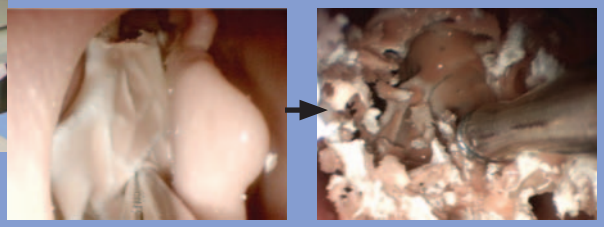


Fig. 2 An experimental design of visual feedback in surgical training

To make surgical training more efficient, we are developing interfaces that feedback real-time information on the trainee during surgery, such as endoscope direction and the applied force on the patient model measured by various sensors.

Fig. 3 A procise human nasal model for endonasal surgery



Snapshots from Ethmoidectomy

The model's shape as well as its haptic sensation in resection are reproduced.
LEFT: The right ethmoidal sinus is approached from the front using forceps.
RIGHT: The posterior part is being exposed.

A new-generation ventricular assist system

Artificial heart to be commercialized: a "mono-pivot circulatory assist pump"

The monopivot centrifugal pump developed by AIST is an circulatory assist pump that can be used for about 2 weeks. The 50 mm-centrifugal impeller of the pump is supported by a pivot bearing at one end and a magnetic bearing at the other. Since destruction of the blood cells, blood coagulation (thrombus), and material wear concentrate to the pivot bearing, flow visualization and animal tests are performed as countermeasures for thrombus formation and material for artificial hip joints is used against material wear. In the flow visualization a high-speed video and a continuous laser light sheet (Fig. 1) are used in addition to the animal tests to prevent thrombus formation. The local shear stress and secondary flow in the spatial gap are evaluated intensively to shorten the period for design improvement.

A next-generation "ventricular assist pump with an impeller levitated with a hydrodynamic bearing"

Moreover, AIST is developing an implantable artificial heart for the next generation with a lifetime over 5 years (Fig 2). The ventricular assist pump is shown in Fig 3. A groove of 30 μm in depth is curved on in the surface of the hydrodynamic bearing whose local pressure lifts up the impeller by approximately 20 μm. To evaluate the blood cell destruction and coagulation in the bearing gap, computational fluid dynamic analysis was conducted to determin the design. The bearing gap was expanded by adjusting the pressure distribution to reduce the destruction of blood cells. In a hemolysis test using animal blood, blood destruction was reduced to a tolerable level. In addition, the shape of the bearing groove was modified to increase the flow through the bearing. It was found in thrombus testing using fresh animal blood that thrombus formation in the bearing was almost eliminated. Comparative studies were performed for the titanium alloys used on the surfaces contacting the blood and for different surface processing techniques. We hope we will be able to perform animal studies of this ventricular assist system in the near future.

Monopivot circulatory assist pump

One-week antithrombogenic tests repeated around 20 times in the left ventricular bypass configuration with sheep and confirmed no thrombus formation. This pump is now being developed as a circulatory assist pump by a medical device manufacturer to make it a product within 2 years.

[Collaborating organizations]
- **Institute of Clinical Medicine, University of Tsukuba**
- **Baylor College of Medicine, Texas, United States**

Takashi YAMANE
Institute for Human Science and Biomedical Engineering

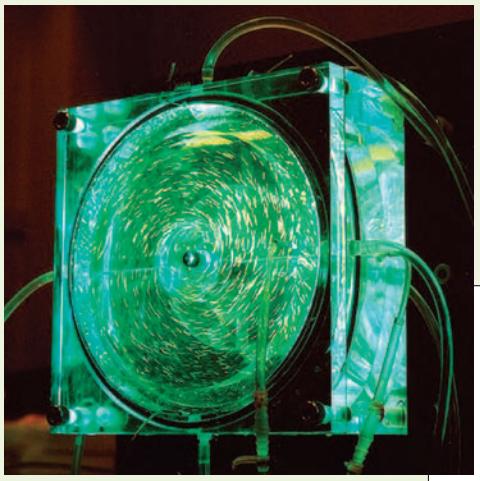


Fig. 1 Blood flow visualization to prevent thrombus formation

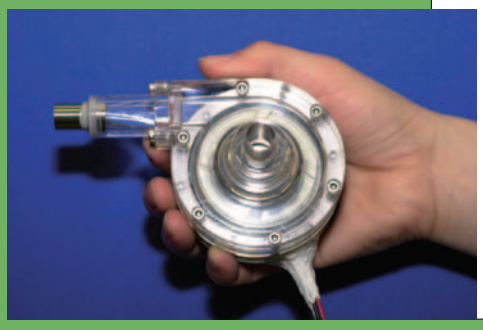


Fig. 2 Centrifugal blood pump with a hydrodynamic bearing

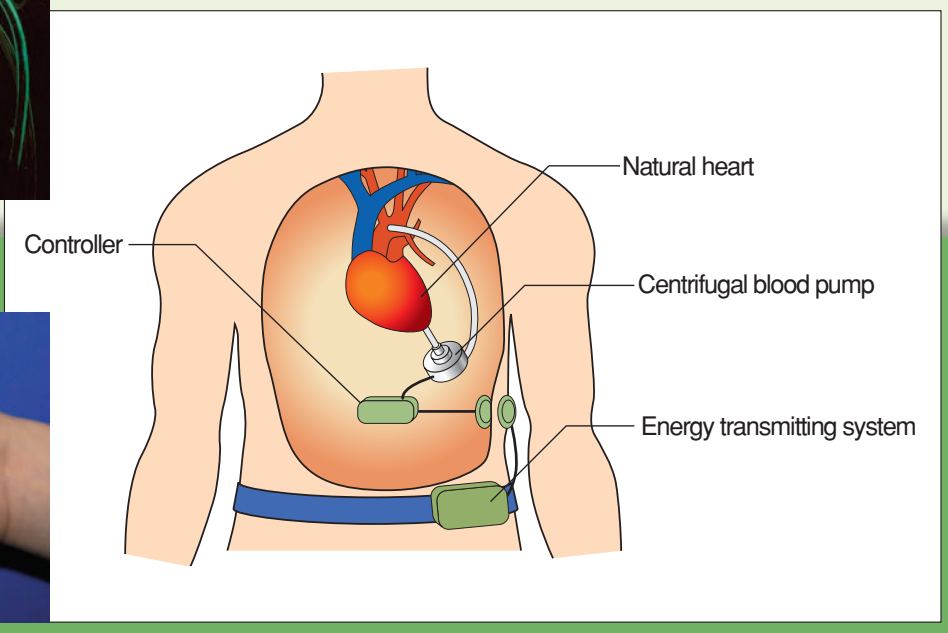


Fig. 3 Concept for implantation of a centrifugal blood pump

Tissue engineered medical technology that fabricates cartilage layer formed on bone

Regeneration of deformed bone

In severe osteoarthritis, the whole joint is sometimes surgically replaced with an artificial joint if the cartilage is seriously damaged. Such surgery is highly invasive, and the patient has to bear a great burden, since the damaged joint surface is removed as a single mass and replaced with the artificial material.

To provide a fundamental solution to osteoarthritis, the most effective approach is to treat the joint before it becomes too badly deformed. However, if only the cartilage has degenerated, it may be possible to regenerate it. Since cartilage deformation is usually localized in the early stages of osteoarthritis, partial regeneration of the cartilage may lead to a complete cure.

Simultaneous regeneration of bone and cartilage.

Advanced stage of osteoarthritis accompanies bone destruction or deformation in addition to cartilage degeneration (Fig. 1). At this stage, it is not possible to cure the disease by only regeneration of the cartilage. For this treatment, a new method is required for regenerating bone and cartilage at the same time.

To achieve this, we are performing basic research. As shown in Fig. 2, we first culture the undifferentiated cells of mesenchymal stem cells, that can be differentiated into bone or cartilage, and increase their numbers. We then differentiate these stem cells into osteoblasts, which have the potency to generate bones in a ceramic structure (formation of cultured regenerative bone). At the same time, the mesenchymal stem cells are also differentiated into cartilage cells in a soft polymer. The mixture of osteoblasts and cartilage cells is then implanted into the osteoarthritic site.

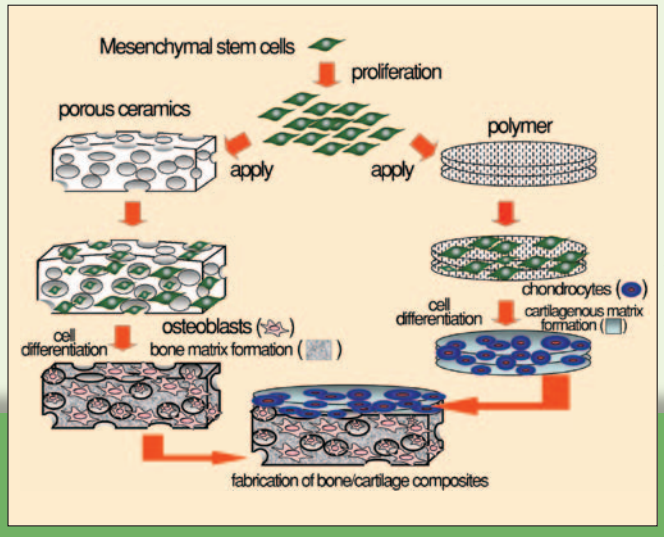
At the moment, it is difficult to differentiate the mesenchymal stem cells into large numbers of cartilage cells. Therefore,we used mesenchymal cell loaded polymer, which expected to differentiate into cartilage within the living body.

Complete cure expected

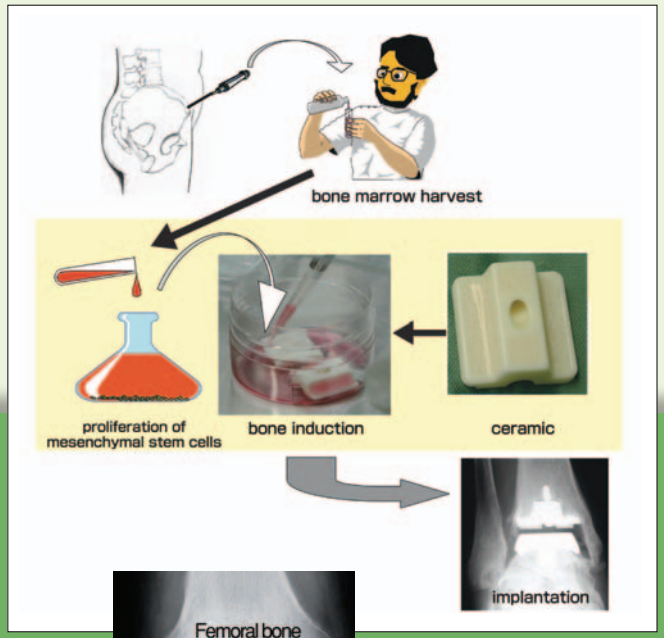
The clinical application of a mixture of mesenchymal cells in a collagen polymer, and cultured regenerative bone has been performed. In the near future, this simultaneous regeneration technique of bone and cartilage is expected to completely cure the severe arthropathy. The population is estimated to be hundreds of thousands in Japan.

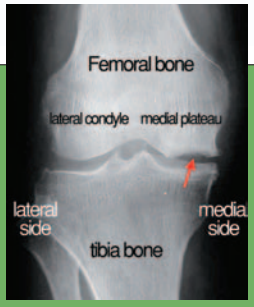
[Collaborating organizations]
- **Nara Medical University, Department of Orthopedics**
- **Shinsyu University, School of Medicine, Department of Orthopedic Surgery**

Hajime OHGUSHI
Research Institute for Cell Engineering



Both cartilage and bone can be regenerated, after expansion of the number of mesenchymal stem cells. The regenerated cartilage/bone could be implanted on affected areas.





XP photo of the osteoarthritis of the knee (affter osteonecrosis)

Cartilagenous layer between femur and tibia can not be seen by X-ray so that the layer is represented by black layer. The X-ray shows good congruency of lateral joint, however it shows the defect of both cartilage and bone on medical side.

Anticipation for central nervous system (CNS) regeneration to restore CNS function

Neural stem cells (NSCs) to regenerate CNS

For long time it has been thought that there is no effective way to restore the function of impaired CNS (like brain damage caused by cerebral infraction and injury in spinal cord). However, recently, regenerative medicine which utilizes NSCs for CNS regeneration is a very attractive and promising treatment.

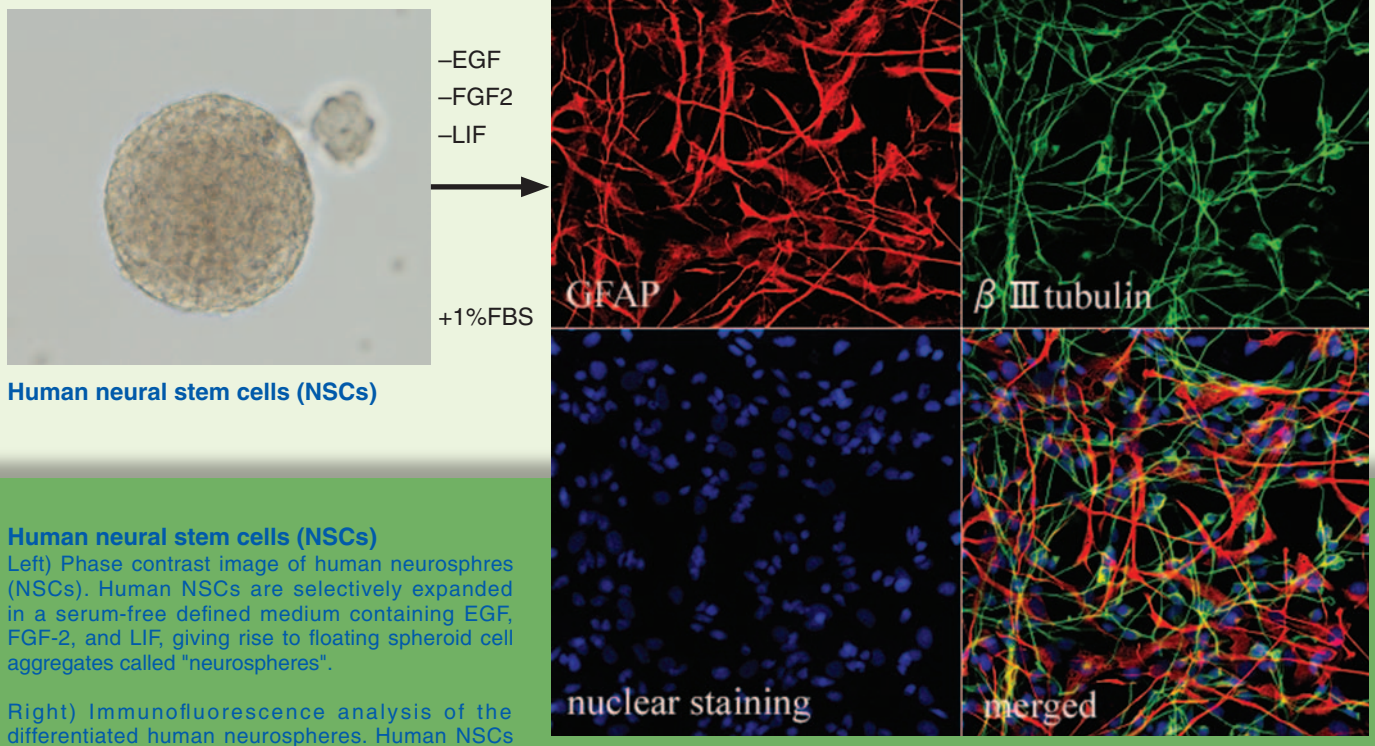
NSCs are self-renewable and immature undifferentiated cells, and have mutipotent capacities to differentiate into neuron, astrocytes and oligodendrocytes (see Fig.). Several reports described the successful restoring of the damaged CNS function by transplanting NSCs or by activating a very small number of endogenous NSCs in adult brains using some activators (drugs, growth factors etc). AIST has succeeded to develop a new method for effective differentiation of NSCs into neurons.

Development of culture technique to proliferate large scale human NSCs

To use NSCs for regenerative medicine, it is very important to develop the technique and devices by which a large number of safe human NSCs could be cultured without any pathogenic and oncogenic contamination. AIST is aiming to early generate the CNS regeneration using human NSCs. To this end, we are developing the techniques to culture large scale human NSCs which would be a reliable source both for basic research and clinical use by systematically linking approaches from two fields: the medical fields of cellular biology, biochemistry, molecular biology and pathology; and the engineering fields of mechanical engineering, process control engineering, etc.

[Collaborating organizations]
- **Institute for Clinical Research, Osaka National Hospital**
- **Department of Physiology, Keio University School of Medicine**

Yonehiro KANEMURA
Research Institute for Cell Engineering



Human neural stem cells (NSCs)

Human neural stem cells (NSCs)
Left) Phase contrast image of human neurosphres (NSCs). Human NSCs are selectively expanded in a serum-free defined medium containing EGF, FGF-2, and LIF, giving rise to floating spheroid cell aggregates called "neurospheres".

Right) Immunofluorescence analysis of the differentiated human neurospheres. Human NSCs were differentiated into neurons and glial cells with 1% FBS containing medium but without growth factors. Confocal images showed the differentiation of neurons (tubulin ßIII; green) and glia (GFAP; red) from the neurospheres, and nuclear staining of the neurospheres with TO-PRO®-3 (blue).

Neuro-tube: An artificial nerve conduit to bridge the nerve defect

Nerve fibers are sprouted and elongated from neurons

The neuronal circuits that run extensively from the brain and the spinal cord to various peripheral tissues enable us to move physically. However, it is almost impossible for a nerve fiber to regenerate autonomously if they were injured. With current medical technology, all that can be done is to suppress the inflammation or to cut out a part of some other nerve bundle in the patient and to implant it instead of the injured nerve. Is it really impossible to re-connect injured nerve fibers? From recent researches, neurons themselves have the potency to sprout and grow nerve fibers. Therefore, if an environment that favors recovery of the injured site is set up quickly, growth of the nerve fiber and the formation of synapses (nerve connectors) can be promoted to restore the nerve circuit.

Is it possible to regenerate a neuronal circuit?

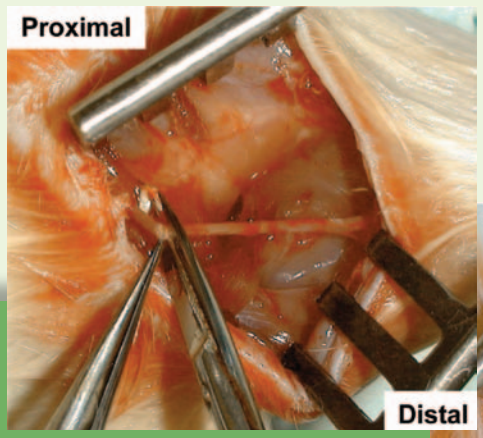
In the course of our researches of nerve regeneration and functional recovery of nervous system, we have discovered neurite-promoting factors, named as neurocrescin and MDP77, that have the potency to grow motor nerves from chick denervated leg muscles. The homologous genes that encode these proteins were conserved evolutionally in the other vertebrates, including humans. We have shown that the administration of these recombinant proteins actually promoted the growth of nerve fibers in cultured neurons and in nerve-defect model animals. If such proteins can be efficiently administered to the nerve defects using the "neuro-tube" which is made by these neurite-promoting proteins in silicone tubes, the damaged nerve fibers will grow quickly and regenerate neuronal circuits (See figures).

Prospective development of biocompatible materials for neuro-tubes

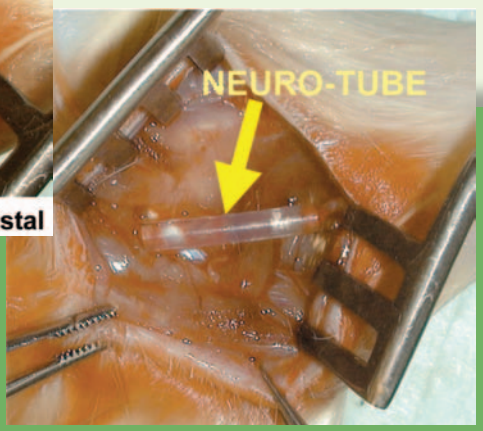
Our peripheral nervous system is composed of a variety of neurons that have different characteristics and functions, such as the motion, senses, and autonomy. The artificial nerves optimally matched to each type of the damaged nerve fibers and also the each patient need to be individually prepared. There are a lot of problems to be overcome before we can apply artificial nerves in clinical situations as a new therapeutic treatment for rapid regeneration of damaged nerve fibers. Right now, to resolve these problems, we try to determine the active site in the neurite-promoting factors, to modify these proteins to intensify the action, and to explore new factors for different nerve fibers such as the muscle sensory and autonomic nerves. Simultaneously, a biocompatible material for the neuro-tube that can be absorbed by the body and used in place of silicon tubes is also being developed. In the near future, the time will come when people have been damaged in the central nervous system by disease or accidents (such as cerebral infarction and spinal cord injury) in addition to their peripheral nerves, will be released from paralysis.

[Collaborating organizations]
- Tokyo Medical and Dental University, Faculty of Medicine

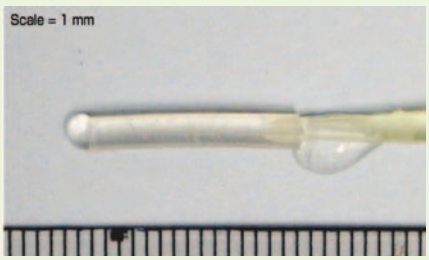
Kazuhiro E. FUJIMORI
Research Institute for Cell Engineering



Nerve defect model: The sciatic nerve was denervated



The neuro-tubes with NC and MDP77 were grafted into the nerve defect made at the center of thigh. The artificial nerve promotes the sprouting and regrowth of the regenerated nerve fivers.



Preparing the neuro-tube: a silicone tube was filled with mixture of type I collagen gel and recombinant NC or MDP77 proteins.

Neuro-tube: An artificial nerve conduit to bridge the nerve defect
Silicone tubes (f1.0 2.0 mm 15mm length) were packed with mixture of type I collagen gel and recombinant NC or MDP77 proteins. After gelation, the tubes were grafted into the defect of the denervated sciatic nerves of rats. After 9 -12 weeks post-operation, the nerves bridged to elongate into the distal nerve fascicle. Interestingly, we found that the neurocrescin and MDP77 were different characteristics, that is neurocrescin increased the number of regenerated fibers and MDP77 promoted to mature the regenerated nerve fibers

Training devices of the lower extremities to prevent bed-ridden condition

Two types of training device for improving neuro-muscular-skeletal functions of the lower limb

The elderly population in Japan will reach its peak around 2020. AIST is developing two types of device for functional training of the lower extremities to prevent elderly people from becoming bed-ridden due to aging in order to realize an active aging society.

1) Training for preventing joint contracture

The first type of training device is to prevent leg joint contracture causing difficulty in joint flexion and extension (Fig. 1). Current devices support to flex and extend only one specific joint. Our device, however, has a high degree of freedom appropriate for flexion and extension, and adduction and abduction of the ankle, knee, and hip joints.

2) Training for preventing atrophy of neuro-muscular functions

The other type of device is to train muscle strength as well as coordination of the muscle force necessary for maintaining daily movements such as walking (Fig. 2). Since usual muscle strength training aims at increasing maximum contraction force of muscles, heavy loads are used for the training. But the loads are not appropriate for bedside training. Either, the training does not consider the improvement of muscle force coordination. AIST investigates the changes in neuro-muscular function caused by disuse as well as low-intensity stimulation, and found that both maximum muscle force and the muscle force coordination can be maintained by the intensity at about 30% of maximum voluntary contraction. Also, AIST is developing a training device for keeping and/or improving the neuro-muscular function of the legs based on these findings.

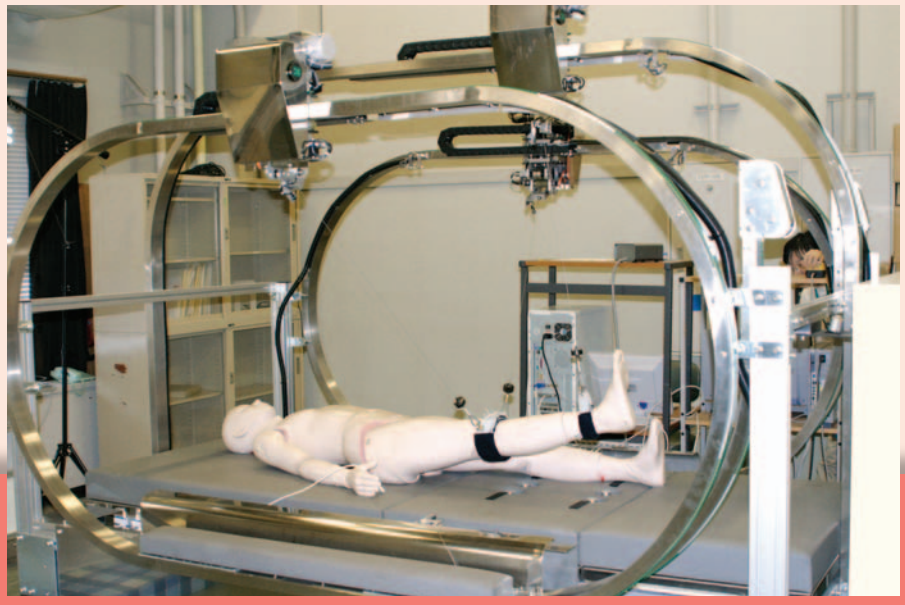
Our research is characterized by:

1) the accumulation of basic research findings concerning human motor characteristics including joint movements and neuro-muscular functions; and 2) the development of training programs and devices based on these research findings and evidences. In this way, we will be able to develop effective and useful training devices.

[Collaborating organizations]

- **Tsukuba College of Technology, Department of Physical Therapy**
- **Ibaraki Prefectural University of Health Sciences, School of Health Sciences**

Takashi YOKOI
Institute for Human Science and Biomedical Engineering



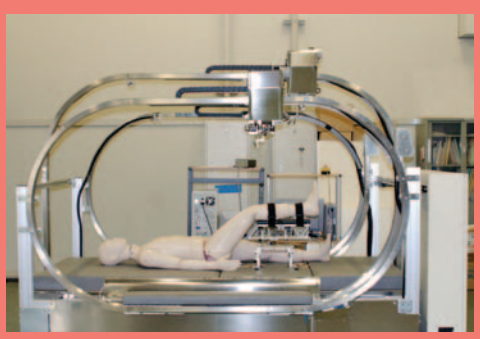


Fig. 1 A prototype of training system to prevent join contracture of the lower limb
This system prevents join contracture by keeping motion range of flexion and extension, and adduction and abduction of the ankle, knee, and hip joints.

Fig. 2 A prototype of training system for neuro-musucular function of the lower limb
This system train neuro-musucular function concerning muscle contraction force and its coordination.

A much-anticipated bone-conducted ultrasonic hearing aid

A revolutionary and effective ultrasonic bone conduction hearing aid

There are about 85,000 severely hearing-impaired people in Japan who cannot hear, even with the use of a conventional hearing aid. Although cochlear implants can restore hearing ability, their performance is not very satisfactory. On the other hand, bone-conducted ultrasonic waves can be experienced as sound, not only by people with normal hearing ability but also by severely hearing-impaired people. AIST has objectively proven, for the first time in the world, that bone-conducted ultrasonic waves can be sensed as sound, and that speech can be detected by this means. AIST is now developing a bone-conducted ultrasonic hearing aid for practical application. Up to now, we have achieved revolutionary results using our prototype bone-conducted ultrasonic hearing aid: more than half of our severely hearing-impaired subjects were able to sense sound, and about 20% were able to understand speech (See Fig.).

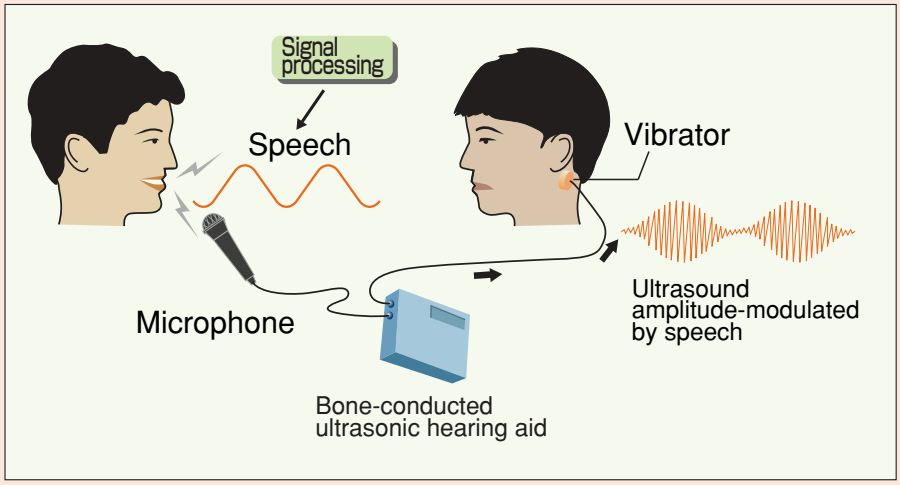
Our bone-conducted ultrasonic hearing aid is far easier to attach than a cochlear implant, which requires surgery. It thus substantially removes the mental and physical burden experienced by cochlear implant users. Moreover, it also can be used to treat tinnitus in severely hearing-impaired people. Thus, substantial clinical effects are expected of the bone-conducted ultrasonic hearing aid.

Aiming for commercialization in 2 years

Since the bone-conducted ultrasonic hearing aid is much cheaper than an cochlear implant, it will help to reduce the cost of medical insurance. We are pressing ahead with development, aiming at commercialization in 2 years.

[Collaborating organizations]
- **RION, Co., Ltd (manufacturer and distributor of the hearing aid)**
- **Department of Otolaryngology, Nara Medical University**
- **Faculty of Engineering, Doshisha University**

Seiji NAKAGAWA
Institute for Human Science and Biomedical Engineering



Development of bone-conducted ultrasonic hearing aid

Bone-conducted ultrasonic hearing aid
It's possible to downsize it like a MD player

Bone-conducted ultrasonic hearing aid

sound presentation by bone-conduction

AIST RESEARCH HOT LINE

UPDATES FROM THE CUTTING EDGE

(Jan.—Mar. 2004)

**The abstracts of the recent research information appeared on the Vol.4 No.1-No.3 of "AIST Today" are introduced and classified by research area.
For inquiry about the full article, please contact the author directly.**

Life Science & Technology

For the Establishment of the Precise Gene Transfer Method

- Enhancement of the cellular uptake and control of the intracellular delivery of oligo DNA/RNA molecule -

Hideki OOBA
Single-molecule Bioanalysis Laboratory
e-mail: h.ooba@aist.go.jp
AIST Today Vol. 4, No.1 (2004) 10

Conjugation of oligonucleotides and peptides or biofunctional molecules is an alternate and fascinating way to generate intelligent nucleic acids for biological and medical applications. In the present study, a novel synthesis of DNA-peptide conjugates and evaluation of their antisense properties are described.

Synthesis of DNA-peptide conjugates were successfully performed by solid phase fragment condensation (SPFC) . Peptides in the conjugates synthesized in this study include nuclear localizing signals (NLSs), nuclear export signals (NESs), and designed amphipathic a-helical peptides. The conjugates were purified by reversed phase HPLC and characterized by MALDI-TOF MS to give satisfactory results.

Intracellular delivery and antisense inhibitory effects of the conjugates against telomerase were also evaluated in human leukemia cells. The results showed that the antisense efficiencies were significantly increased by conjugation with peptides and largely depended on the intracellular localization of oligonucleotides.

N2: 5'-CAGTTAGGGTTAG-3' (Antisense sequence: Telomerase)

No.	DNA	Peptide	Type of Peptide
C1	N2	PKKKRKV	SV40 T antigen (NLS*)
C2	N2	GRKKRRQRRRPPQC	HIV1-Tat (NLS)
C3	N2	ALPPLERLTL	HIV-1 Rev (NES**)

*NLS (Nuclear Localizing Signal)
**NES (Nuclear Export Signal)

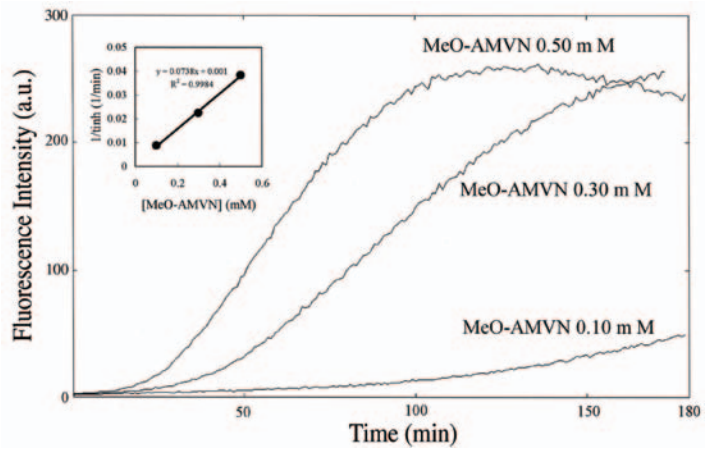
Designed and synthesized DNA-Peptide conjugates

Detection of Lipid Peroxidation in Vivo and Prevention by Antioxidants

- Detection of oxidative stress markers -

Yasukazu YOSHIDA
Human Stress Signal Research Center
yoshida-ya@aist.go.jp
AIST Today Vol. 4, No.1 (2004) 11

The free radical-mediated oxidation of biological molecules and its inhibition by antioxidant have been the subjects of extensive studies in relation to oxidative damage and disorders in vivo. Various methods have been applied to measure oxidative events and also antioxidant action in vitro and in vivo. One of the popular approaches involves the use of fluorogenic probes. We have elucidated the oxidation mechanism of biological samples especially lipoproteins using these probes and also studied to find out the specific oxidative marker. Our final goal is to realize high QOL for human kinds by determining the stress marker and enhancing defense capacity toward disorders.



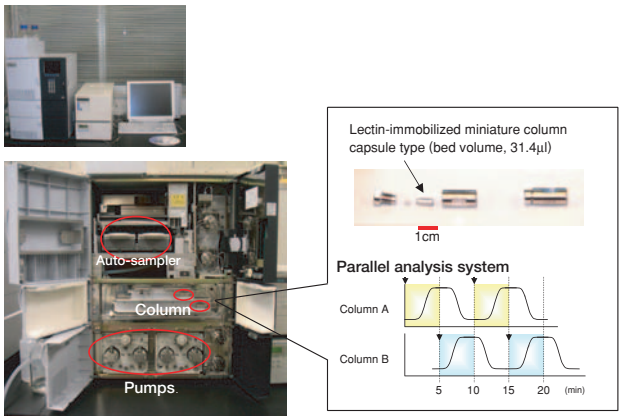
The increase in BODIPY fluorescence in the oxidation of human plasma induced by azo compound

Glycan Profiling by Frontal Affinity Chromatography

- Development of an automated machine in the context of structural glycomics -

Jun HIRABAYASHI
Research Center for Glycoscience
e-mail: jun-hirabayashi @aist.go.jp
AIST Today Vol. 4, No.1 (2004) 12

To understand glycan functions, it is essential to get basic information about complex glycan structures. For this purpose, we are developing a "glycan profiler" under the concept that lectins are "decoder proteins for glycomics". FAC (frontal affinity chromatography) is the first choice for precise determination of affinity constants between lectins and glycans in a highly sensitive and high-throughput manner.



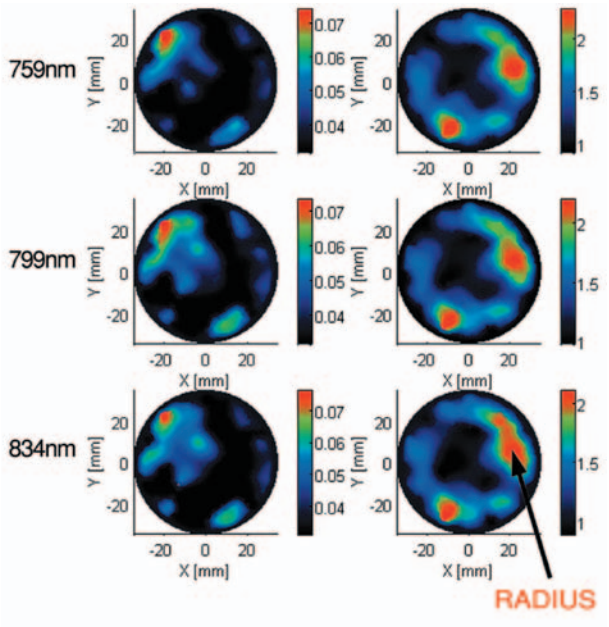
Outline of the automated analyzer FAC-1, a proto type machine for frontal affinity chromatography (above) and the inside view of the machine

Absolute Image Reconstruction from NIR-TR Measurement of Human Forearm

Yukari TANIKAWA

Institute for Human Science and Biomedical Engineering
e-mail: yukari.tanikawa@aist.go.jp
AIST Today Vol. 4, No.1 (2004) 13

Near infra-red (NIR) diffuse optical tomography, which aims at providing both anatomical and functional information of organs, has been increasingly receiving interests. NIR time-resolved (TR) method has ability to measure absolute absorption and scattering images. We developed modified GPST algorithm for the image reconstruction of NIR-TR data. The absolute image of absorption and scattering coefficients of human forearm were reconstructed and compared with MR image. The images revealed the inner structure of the forearm and the bones were clearly distinguished from the muscle.



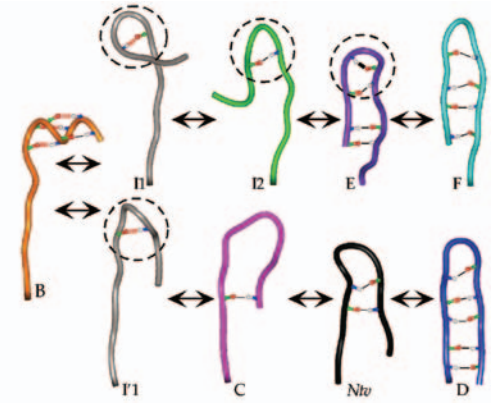
Absolute absoption and scattering images of human forearm

Protein Structural Analysis by Multicanonical Molecular Dynamics

Kazuyoshi IKEDA

Computational Biology Research Center
kazu-ikeda@aist.go.jp
AIST Today Vol. 4, No.1 (2004) 14

Protein folding reaction is one of the fundamental problems in biophysics: how a protein folds into a compact native structure from unfolded random-coil conformations in a second. To calculate the free-energy landscape of a protein is an effective procedure to examine the folding process. In recent decades, the knowledge about the problem has been accumulated by not only experimental, but also theoretical means, such as Molecular Dynamics (MD) Simulation. The multicanonical MD is a novel sampling method that enables to obtain a precise free-energy landscape of a small biomolecule in explicit water. We could reveal the folding mechanism of a chameleon sequence and the stable conformations in water, by calculating the energy landscapes. The current study may be useful to understand the mechanism of abnormal folding that causes the diseases, such as amyloid disease.

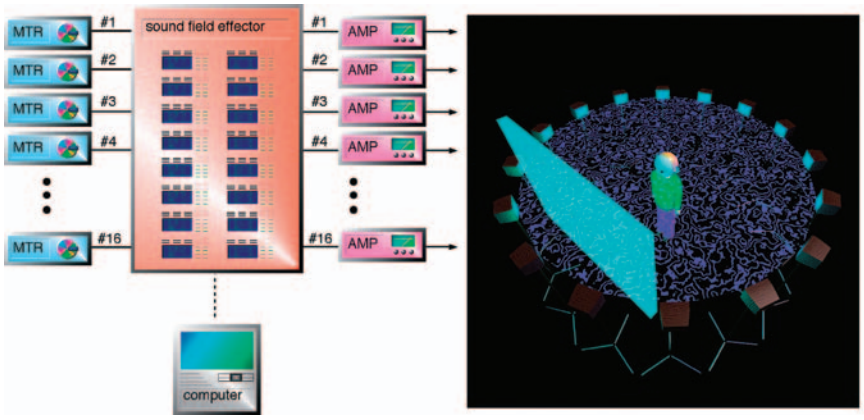


Pathways between alpha-helix and beta-hairpin conformations

Obstacle Perception Training System for the Blind People

Yoshikazu SEKI
Institute for Human Science and Biomedical Engineering
e-mail: yoshikazu-seki@aist.go.jp
AIST Today Vol. 4, No.2 (2004) 7

Obstacle perception is a skill to detect presence of "silent" object, such as wall, etc., by perceiving the acoustical cues, such as reflected sound, etc., through auditory sense. This skill is very important for orientation and mobility (O&M) of the blind. We are studying the training system for acquiring this skill in the blind education and rehabilitation by using acoustical technologies. Our training system can reproduce ideal sound fields for learning the principle of obstacle perception. We are also distributing the audio CD that contains these sound fields to the people concerned with the blind education and rehabilitation.



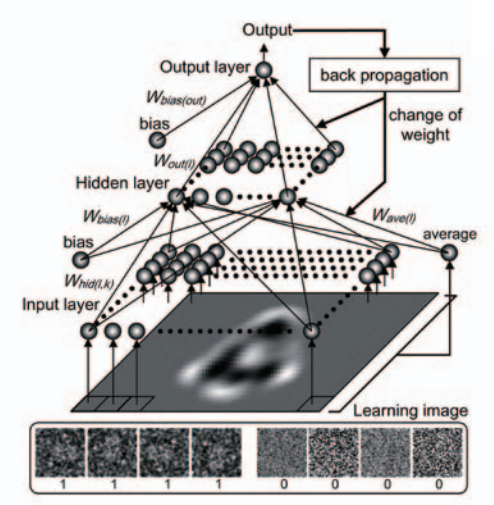
Obstacle Perception Training System. It can reproduce the ideal sound field for the beginners training

An Automatic Particle Pick-up Method using Neural Network Applicable to Cryo-EM

Toshihiko OGURA
Neuroscience Research Institute
e-mail: t-ogura@aist.go.jp
AIST Today Vol. 4, No.2 (2004) 14

Three-dimensional reconstruction from electron micrographs requires the selection of many single particle projection images; more than 10,000 are generally required to obtain 5 ~ 10 Å structural resolution. This paper presents a new automated particle recognition and pick-up procedure based on the three layer neural network. Its use for both faint and noisy electron micrographs is demonstrated. The method only requires 200 selected particles as learning data and is able to detect images of proteins as small as 200 kDa[1].

[1] T. Ogura & C. Sato, J. Struct. Biol., Vol. 136, 227-238 (2001).

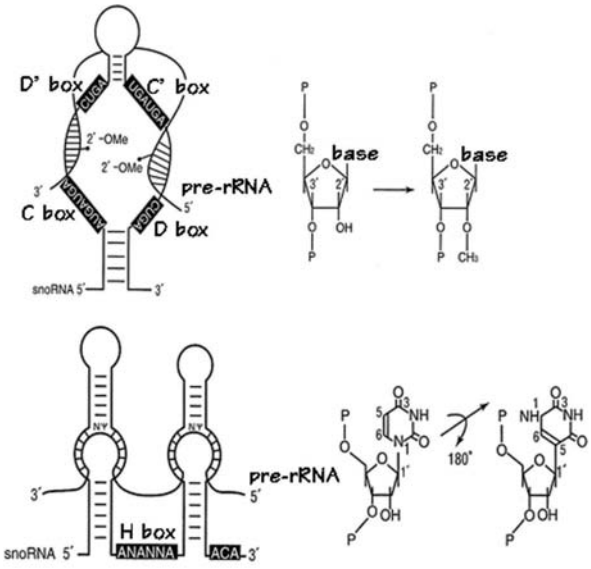


Schematic representation of the three-layer NN and its learning process

Prediction of snoRNAs in Human Genome

Jun-Ichi SAGARA
Computational Biology Research Center
e-mail: jun@neptune.kanazawa-it.ac.jp
AIST Today Vol. 4, No.2 (2004) 15

Small nucleolar RNAs (snoRNAs) are taken part in processing and base modification (2'-O-ribose methylation and pseudouridylation) in precursor ribosomal RNA (pre-rRNA). In this research, we predict snoRNAs in human genome using computational sequence analysis methods which is named "SOKOS" using stochastic context free grammars (SCFGs). We also develop a Predicted Human Intron database produced from exons predicted by Gene Decoder which is a gene finding technology based on Hidden markov models (HMMs).

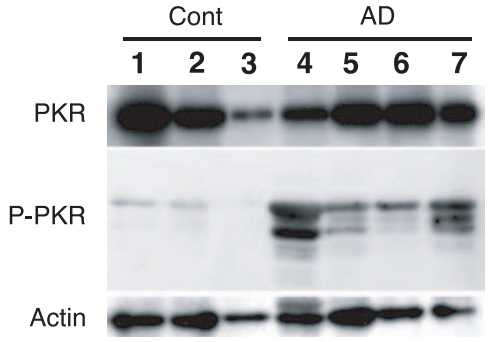


Secondary structure of snoRNAs

Identification of Pro-apoptotic Factors Related to Alzheimer's Disease using a Randomized Ribozyme Library

Reiko ONUKI
Gene Function Research Center
e-mail: onuki@mol.f.u-tokyo.ac.jp
AIST Today Vol. 4, No.3 (2004) 11

Long-term accumulation of unfolded protein depends on several stresses, so called ER-stress, which leads to apoptosis. Recent studies have shown that ER-stress is associated with neurodegenerative disorders, such as Alzheimer's disease (AD). In this study, we employed a randomized ribozyme (Rz) library to identify the pro-apoptotic factors. One of the isolated Rzs effectively suppressed Tunicamycin (Tm)-induced apoptosis, and it recognized the mRNA of a double-stranded RNA-dependent protein kinase (PKR). Nuclear PKR was phosphorylated in an ER stress-dependent manner, and the level of this protein was increased in Tm-mediated SK-N-SH cells. The level of phosphorylated PKR was only increased in nucleus autopsy samples from the brains of AD patients. These results indicate that phosphorylated PKR plays an important role both in ER-stress and AD.

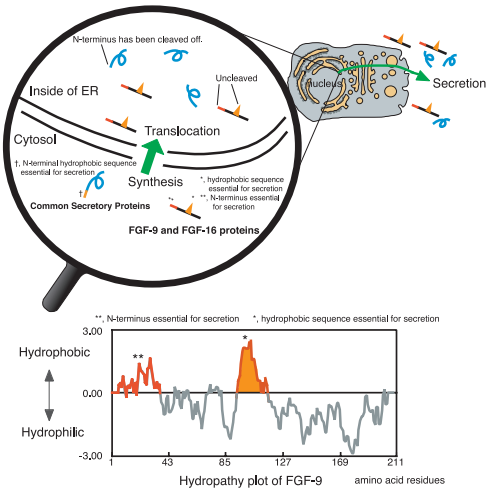


The level of PKR and phosphorylated PKR in nucleus autopsy samples form the brains of AD patients

Identification of Uncleaved Bipartite Signal Sequences for Protein Secretion

Toru IMAMAURA
Age Dimension Reseach Center
e-mail: imamura-toru@aist.go.jp
AIST Today Vol. 4, No.3 (2004) 12

Fibroblast growth factor (FGF)-9 and FGF-16 are rare secreted proteins that do not possess cleavable signal sequences. Inhibition of FGF-16 secretion from COS-1 transfectants by brefeldin A and identification of an N-glycan on the secreted form confirmed that FGF-16 is secreted via the endoplasmic reticulum and Golgi apparatus, like secreted proteins having a conventional cleavable signal sequence. Analysis of various mutants of FGF-9 and -16 have revealed that these proteins employ similar unique bipartite signal sequences – i.e., both the N-terminal region and central hydrophobic region – that is not cleaved, though it shares the same secretory machinery used by secreted proteins with cleavable signal sequences.



Secretion of FGF-9 and FGF-16proteins by uncleaved bipartite signal sequences

A proposal of the New Bacterial Phylum, Gemmatimonadetes

Satoshi HANADA
Institute for Biological Resources and Functions
e-mail: s-hanada@aist.go.jp
AIST Today Vol. 4, No.1 (2004) 7-9

A phylogenetically novel aerobic bacterium was isolated from activated sludge in a wastewater treatment system. The isolate, named *Gemmatimonas aurantiaca* gen. and sp. nov., was a Gram-negative, rod-shaped aerobe. Cells often appeared to divide by budding replication. Comparative analyses of 16S rRNA gene sequences indicated that the new bacterium should be classified a brand-new phylum-level lineage in the bacterial domain. Based on the phylogenetic and phenotypic findings, we proposed a new phylum with the name of *Gemmatimonadetes* phyl. nov. for the new organism, and the proposal was validated on September, 2003.

Transmission electron micrograph of *Gemmatimonas aurantiaca* showing a Gram-negative cell envelope structure (Bar: 0.5μm)

Norovirus Inactivated by using Micro-bubbles, First in the World

- Making it possible to market safe and good-tasting oysters -

Masayoshi TAKAHASHI

Research Institute for Environmental Management Technology
m.taka@aist.go.jp
AIST Today Vol. 4, No.3 (2004)18-20

The Institute for Environmental Management Technology (IEMT) of the National Institute of Advanced Industrial Science and Technology (AIST), an independent administrative institution, has successfully inactivated norovirus, which is one of major pathogens causing food poisoning in winter, and previously designated as small round-structured virus (SRSV), by using micro-bubbles containing low concentration ozone.

The norovirus can be inactivated by adequate heat treatment. However, if shellfish such as fresh oysters infected with norovirus are eaten, acute gastero-intestitis may occur with symptoms of vomiting, stomachache, diarrhea and fever.

The currently available measures against the norovirus include cultivating oysters and other shellfish in sterile seawater, and using chlorine-based germicide. However, sterile cultivation is costly, and cold seawater in winter season lowers filtering capability of oyster to hamper effective viral eradication. The norovirus is resistant to chlorine-based germicide and sterilizing alcohol, and the use of high chlorine concentration will make shellfish unpalatable. For this reason, it has been urgently desired to develop effective method of inactivating norovirus.

The IEMT/AIST has been making basic studies on micro-bubble, with intention of exploring the possibility of its application in engineering. Micro-bubbles are ultra-fine gas bubbles in water of size less than 50 μm (micrometer, = 1/1,000,000 m = 10^{-6} m), and as they are suspended in water, the bubble size shrinks spontaneously to the level of nanometer (= 10^{-9} m), ultimately disappearing with gas within fully dissolved out.

The micro-bubbles are characterized by electrical charging and self-pressurizing effects, suggesting extensive possibility for engineering applications. The IEMT/AIST attempted to utilize these effects for making a breakthrough, and successfully inactivated the norovirus by using micro-bubbles of concentrated oxygen containing about 2 % ozone. The viral inactivation was verified in collaboration with the Tokyo Metropolitan Institute of Public Health (TMIPH).

While the present study proved the effective inactivation of norovirus suspended in water, seawater containing micro-bubbles has good penetrability and is expected to attack not only norovirus in live oysters under cultivation, but also that in unshelled oysters. The IEMT/AIST is going to expand the study further. The technique is expected to be applicable to suppressing legionella bacteria in a circulating bath system and carp herpes virus. With respect to this study, two patents are being filed.

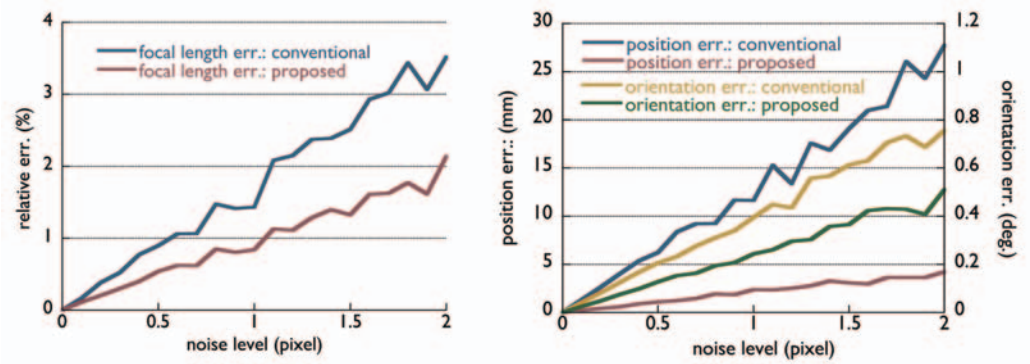
Before the micro-bubble treatment

After the treatment

A Plane-based Calibration Method for Multi-camera Systems

Toshio UESHIBA
Intelligent Systems Institute
e-mail: t.ueshiba@aist.go.jp
AIST Today Vol. 4, No.1 (2004) 15

Vision systems with multiple video cameras is expected to be increasingly applied to a variety of fields such as robotics and human interface owing to their wide visual field and potential for recovering 3D structure of the scene. We have developed a simple technique for calibrating such multi-camera systems using a plane with a known 2D pattern as a reference object. Not only the intrinsic parameters, e.g. focal lengths and lens distortions, of the cameras but also the relative displacement between them are simultaneously estimated with high accuracy by simply showing the plane placed at three or more locations. Thus the algorithm yields a handy and flexible means for calibrating stereo vision systems with the arbitrary number of cameras.

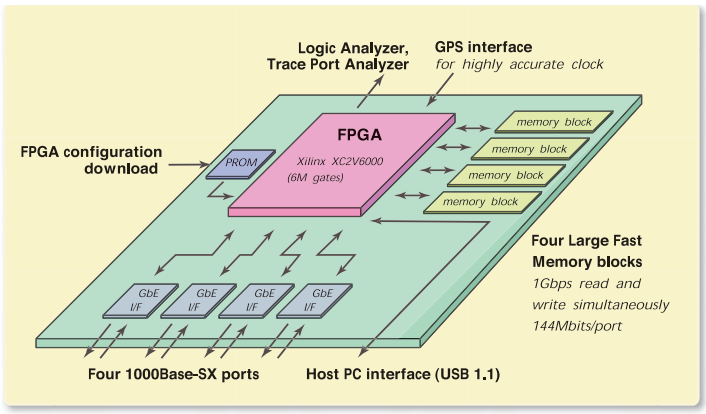


Errors in estimated camera parameters vs. the noise level

Gigabit Ethernet Network Testbed GNET-1

Yuetsu KODAMA
Grid Technology Research Center
e-mail: y-kodama@aist.go.jp
AIST Today Vol. 4, No.2 (2004) 8

We have developed a network testbed GNET-1 so as to observe network traffic, emulate networks and test communication protocols. GNET-1 is provided with four Gigabit Ethernet ports and four high speed RAM banks which are connected to a central large scale FPGA. GNET-1 emulates more than 100 ms delay, which is corresponds to that of a wide area network, and a single frame discard on full speed of Gigabit Ethernet traffic. We can easily add new functions, such as bit error generation and frame header trace by re-programming the FPGA.

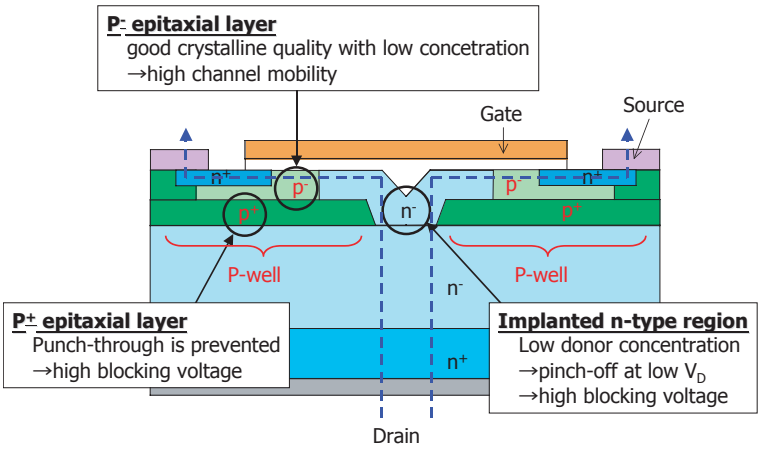


Block diagram of GNET-1

Ultra-low-loss of Electric Power in 4H-SiC Double-epitaxial MOS Transistor

Shinsuke HARADA
Power Electronics Research Center
e-mail: s-harada@aist.go.jp
AIST Today Vol. 4, No.2 (2004) 9

Electric power consumption seems to increase continuously for long term in the future. Consequently, effective use of electric power becomes very important issue. The key technology for this issue is conversion of the electric power using power semiconductor devices. However, performance of existing silicon (Si) based device is approaching to its theoretical limit. Silicon carbide (4H-SiC) based vertical MOS transistor (MOSFET) is one of promising candidates for high-power unipolar switching device because 4H-SiC has superior physical and electrical properties. However, vertical MOSFETs on 4H-SiC showed high on-resistance due to the poor channel mobility on the implanted rough surface. In this study, we developed a novel 4H-SiC vertical MOSFET employing two epitaxially grown layers as a MOS channel region. We named it double-epitaxial MOSFET (DE-MOSFET). Fabricated device exhibits a ultra-low specific on-resistance (Rons) of 7.7 mΩcm^2 with a blocking voltage of 600 V. This is the first Rons lower than 10 mΩcm^2.

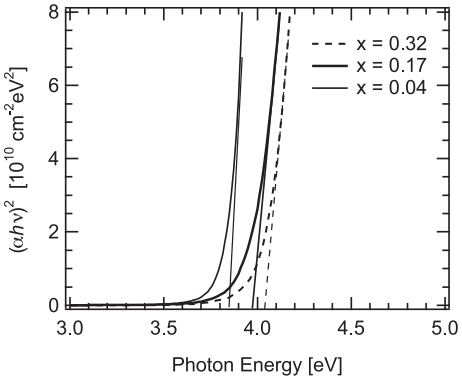


Schematic cross-section of double epitaxial MOSFET

Bandgap Modified Transparent Conducting Films using ZnMgO

Koji MATSUBARA
Research Center for Photovoltaics
e-mail: koji.matsubara@aist.go.jp
AIST Today Vol. 4, No.2 (2004) 10

Bandgap modified transparent conducting films were proposed and demonstrated with Al-doped $Zn_{1-x}Mg_xO$ films deposited on glass substrates by a pulsed laser deposition system. The bandgap energy of these films could be widened up to about 4 eV with increasing Mg content in the films. The maximum bandgap values of the film with an electrical resistivity of less than 1×10^{-3} Ωcm was 3.97 eV. Bandgap of the transparent conducting films was varied from 3.5 eV to about 4.0 eV, keeping the resistivity of less than 1×10^{-3} Ωcm. These films can be used not only as an UV transparent conducting film but also to control the band lineup of the multilayered semiconductor structures.



$(\alpha h\nu)^2$ plots of Al-doped $Zn_{1-x}Mg_xO$ films with different x

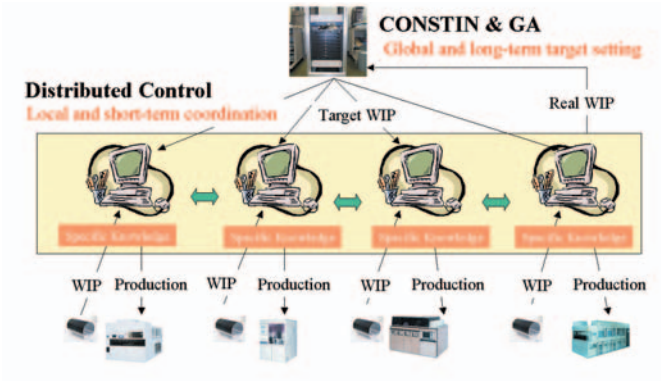
Inventory Reduction Through Accelerated Optimization in Semiconductor Fabrication Process

Kazuo MIYASHITA
Intelligent Systems Institute
e-mail: k.miyashita@aist.go.jp
AIST Today Vol. 4, No.2 (2004) 13

It has been pointed out that the semiconductor industry of Japan is lagging behind the new industrial countries in respect to the production efficiency, as the multi-product, varying volume production system based on the cutting-edge processes advances.

A highly efficient production control method is developed to keep stabilized production despite production variability caused by accidental failures, while reducing the inventory volume of half-finished semiconductor line products, through the optimization technology based on ultra-fast simulation and the distributed production control scheme.

The study will contribute to improving the performance and expanding the market share of the Japanese semiconductor industry, which has been seriously challenged with respect to the production cost in the international competitive market.

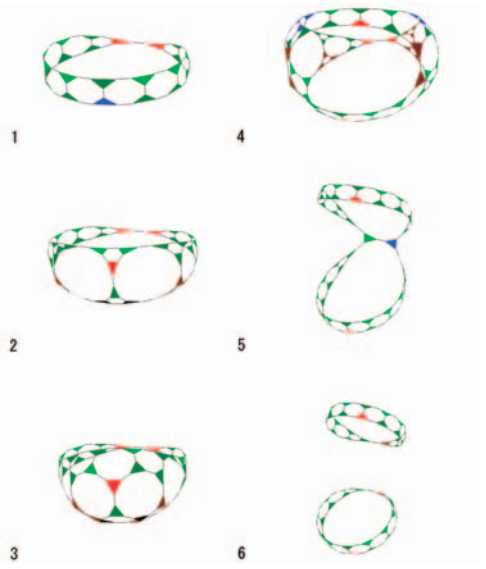


Hierarchical distributed production control system

Development of a Graph Automata Model for Self-Replicating Processes

Kohji TOMITA
Intelligent Systems Institute
e-mail: k.tomita@aist.go.jp
AIST Today Vol. 4, No.3 (2004) 14

A variety of models of self-replicating processes have been proposed within the framework of two-dimensional cellular automata. They are heavily dependent on or limited by the peculiar properties of the lattice spaces. We introduced a new framework called graph automata to obtain a natural description of complicated spatio-temporal developmental processes such as self-replication. As an illustrative example, a self-replication of Turing machine is shown in a simple and straightforward formulation. Graph automata provide a new tool to approach important scientific problems such as evolution of morphology, and also to give the basis of self-replicating and self-repairing artifacts.



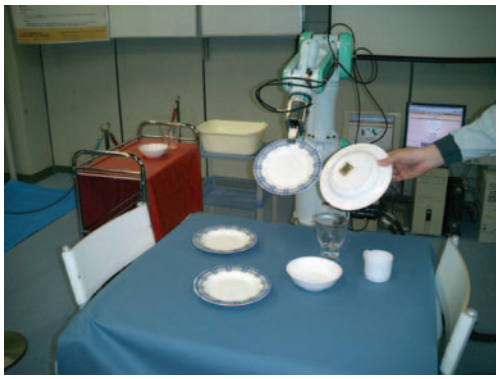
Self-replicating process of a Turing machine

Knowledge Distributed Robot Control System using IC Tags

Kohtaro OHBA
Intelligent Systems Institute
k.ohba@aist.go.jp
AIST Today Vol. 4, No.3
(2004) 15

In the present robot industry, not only robots for industrial purpose but also those for serving in the human living environment are being eagerly sought for. The current robot control based on artificial intelligence and image processing technologies cannot support the robot works in the actual environment, because of difficulty in fully recognizing diverse objects placed in the living environment.

We have proposed a distributed knowledge robot control scheme in which every object is posted with an IC tag containing the manufacturer's network address and the knowledge information required for a robot to handle the object concerned. The scheme allows the robot to recognize objects more easily and the manufacturers to have burden of robotic programming reduced. We have successfully demonstrated the effectiveness of the proposed scheme by using available IC tag, image processing and robot control technologies.



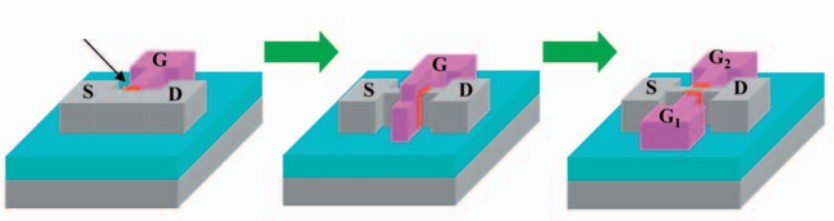
Overview of the knowledge distributed robot control system using IC tags

Four-Terminal Driven Double-Gate MOSFET Developed

- Both low power and high speed controllable by Four-Terminal Drive -

Yongxun LIU
Eiichi SUZUKI
Nanoelectronics Research Institute
e-mail:
yx-liu@aist.go.jp
e.suzuki@aist.go.jp
AIST Today Vol. 4, No.2
(2004) 4-6

The Nanoelectronics Research Institute (NERI) of the National Institute of Advanced Industrial Science and Technology (AIST), one of the independent administrative institutions, succeeded in realizing a new device technology of 4-terminal drive using two independent gates, in the form of a double-gate (DG) MOSFET which is expected to be a transistor of the new generation. The original 4-terminal drive features including flexible threshold voltage control were systematically verified by the fabricated 4-terminal DG MOSFET with the 13-nm-thick ultrathin fin-channel. The study innovates in the DG MOSFET originally proposed by the former Electrotechnical Laboratory (ETL) and will lead the way to the materialization of innovative LSIs, capable of flexible and dynamic control for optimum power consumption and operation speed.

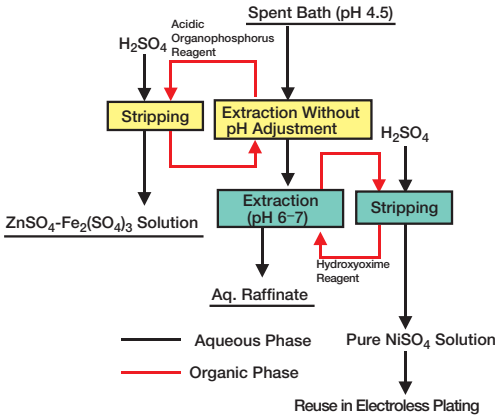


Evolution of MOSFETs: (a) a single gate MOSFET, (b) a conventional (fin-type) double gate MOSFET, and (c) a four-terminal double gate MOSFET

Recycling of Nickel in the Electroless Nickel Plating Baths

Mikiya TANAKA
Research Institute for Environmental Management Technology
e-mail: mky-tanaka@aist.go.jp
AIST Today Vol. 4, No.1 (2004) 16

With increasing importance of the electroless nickel plating technology in many fields such as electronic and automobile industries, the treatment of the spent baths is becoming a serious problem. The spent baths are currently treated by the conventional precipitation method, and nickel in these baths is not recovered. We are developing a recycling process of nickel in the spent baths using solvent extraction (Fig. 1). Nickel in the spent baths is efficiently extracted by a hydroxyoxime reagent at a pH higher than 6 and is readily stripped with sulfuric acid. The impurity metal ions (iron and zinc) are selectively extracted with organophosphorous reagent before extracting nickel.

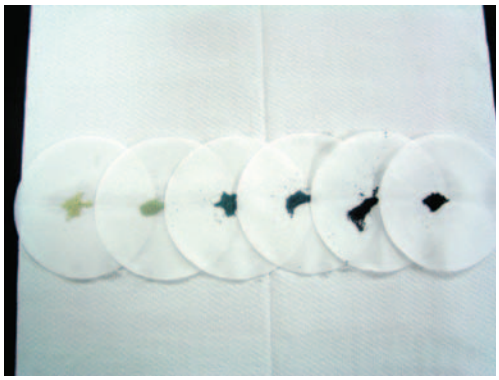


Proposed flowsheet for recycling nickel from the spent baths

Naked-eye Detection of Arsenic(V) using a New Chromogenic Material

Hideyuki MATSUNAGA
Laboratory for Membrane Chemistry
e-mail: hide.matsunaga@aist.go.jp
AIST Today Vol. 4, No.2 (2004) 16

A method of naked-eye detection for trace arsenic in aqueous samples has been newly developed. The proposed method is based on the formation of hetero poly acid in a solid polymer phase. The intensity of the color of the material changes corresponding to the concentration of arsenic(V) in the sample solutions. The detection limit of this method is 5×10^{-8} mol dm^{-3} by the combined use of a preconcentration method. Since the development of the color occurs within 30 min, this system leads a simple, rapid and low-cost detection method of trace arsenic(V) in an aqueous media.

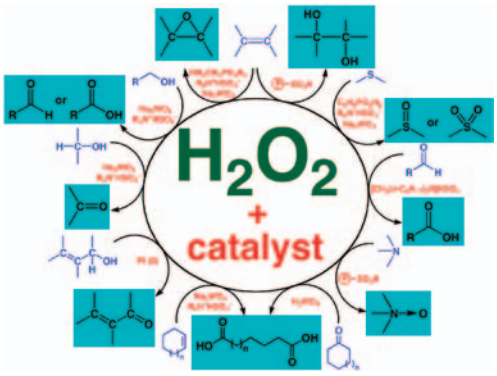


A color change of a chromogenic material with the different concentrations of arsenic(V). [As(V)] = 0ppb, 75ppb, 750, ppb, 1.5ppm, 7.5ppm, 15ppm, from left to right

Green Oxidation with Aqueous Hydrogen Peroxide

Kazuhiko SATO
Research Institute for Innovation in Sustainable Chemistry
e-mail: k.sato@aist.go.jp
AIST Today Vol. 4, No.3 (2004) 7

Oxidation is a core technology for converting petroleum-based materials to useful chemicals of a higher oxidation state. Hydrogen peroxide (H_2O_2) is an ideal oxidant, because the atom efficiency is excellent and water is theoretically the sole co-product. However, H_2O_2 can be a clean oxidant only if it is used in a controlled manner without organic solvents and other toxic compounds. Thus, the discovery of an efficient catalyst and the choice of reaction conditions are the keys to realizing an ideal oxidation procedure. In this context, we developed various oxidation reactions with aqueous H_2O_2 under organic solvent- and halide-free conditions.



Hydrogen peroxide oxidation under organic solvent- and halide-free conditions

Development of Flexible Ceramics Gas Sensing Device

- Microfabrication of ceramics by solution lithography -

Atsushi HOZUMI
Advanced Manufacturing Research Institute
e-mail: a.hozumi@aist.go.jp
AIST Today Vol. 4, No.3 (2004) 8

We have successfully prepared tin dioxide (SnO_2) film showing an excellent gas sensing property against hydrogen on polymer substrate through a liquid phase process. Due to the formation of an ultrathin silicon dioxide (thickness is 2 nm or less) layer prior to the SnO_2 film deposition, the resulting film was tightly attached to the polymer surface and readily bended without cracking. Furthermore, the SnO_2 film was successfully arranged spatially onto the photolithographically micropatterned organosilane layer on the polymer substrate. Our process demonstrated here is not limited to the patterning of SnO_2, but is also applicable to other inorganic materials.


Flexible gas sensing material

Fast Estimation of Environmental Chemical Concentrations in Tokyo Bay

- Simple risk assessment model for Tokyo Bay (Windows edition), (Charge-free distribution) -

Fumio HORIGUCHI

Research Center for Chemical Risk Management
crm-horiguchi@aist.go.jp
AIST Today Vol. 4, No.3 (2004) 10

The AIST-RAMTB makes it possible to calculate the spatial distribution of chemical concentrations in Tokyo Bay by feeding in data on chemicals, such as inflow from rivers and dissolution from ship hulls. Further, the risk to marine organisms can be readily calculated based on chemical concentrations.

One of the crucial contaminants in a coastal sea area is tributyltin (TBT). TBT is lethal to marine organisms and has been widely used in anti-fouling paints for protecting ship hulls and fishing nets from unwanted growth of biological organisms such as barnacles and algae. However, the impacts of TBT to the coastal ecosystem have been reduced internationally since the mid-1980s. The International Maritime Organization (IMO) decided to ban paints containing TBT from January 1, 2003, and drafted a legal framework of constraints to eliminate TBT globally from ship hulls by January 1, 2008. Nevertheless, TBT remains a serious contaminant in coastal waters.

Given these circumstances, a risk evaluation of chemicals, such as TBT, in a specified sea area is very important in assessing impacts to the ecosystem. Conventional models for assessing chemical risks required a mainframe or a workstation, and complicated operations manageable to experts only. In contrast, the AIST-RAMTB model can be operated easily on a personal computer, without an expert, to assess the degree of contamination by chemicals, including those other than TBT, and impacts to the ecosystem in coastal sea areas.

Tokyo Bay is characterized by a constant stream of sea traffic; and it is surrounded by and an extensive, aggregated megalopolis that includes Tokyo and Yokohama, and the Keihin and Keiyo Industrial Belts. The socio-economic activities by a mammoth population of 26,480,360 (National Census of 2000) are discharging diverse materials in great quantities into the Bay. Moreover, the Bay provides a substantial amount of fishery resources, as well an area for marine recreation.

The Model, distributed free of charge, will offer valuable opportunities to the general public for assessing chemical risks in the area, which have hitherto been available only to simulation model specialists and to chemical risk evaluation experts. In this way, the significance of chemical risk assessment will be recognized by an increasing number of people and further research progress will be encouraged.

The CRM is planning to build models applicable to Osaka Bay and Ise Bay, and eventually, a spatio-temporal predictive model by integrating simulation results with atmospheric and fluvial models.

Example of predicted TBT concentration in Tokyo Bay

Development of 3D Si/SiC Filter Enhancing the Efficiency of Photo-Catalyst

- Efficiently decompose pollutants even under FL light -

Eiji TANI

Materials Research Institute for Sustainable Development
e-mail: e.tani@aist.go.jp
AIST Today Vol. 4, No.3 (2004) 9

TiO_2 photo-catalyst incorporated into three-dimensional porous ceramics of Si/SiC with similar structure as that of polyurethane sponge ensured efficient decomposition of NO_X not only under the irradiation with UV rays but also under the illumination with fluorescent lamp. The 3D photo-catalyst filter was characterized by finer bridge elements, providing high transmittance, enhanced contact probability with pollutant and lower pressure loss. These properties are ideal for a carrier of photo-catalyst.

An outer view of 3D Si/SiC filter

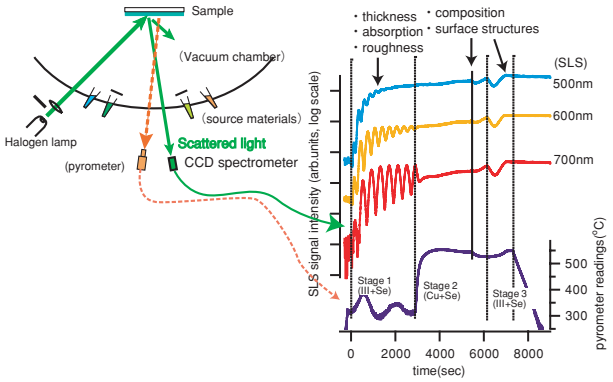
Energy Science & Technology

In-situ Observation of CIGS Thin Film Deposition Process by Light Scattering

Keiichiro SAKURAI

Research Center for Photovoltaics
url: http://staff.aist.go.jp/k-sakurai/
AIST Today Vol. 4, No.1 (2004) 18

Spectroscopic Light Scattering (SLS) is an informative *in-situ* monitoring method that irradiates the surface of thin films by white light, and monitors the scattered light by a spectrometer (Figure). This newly introduced technique provides information on surface roughness, deposition speed, composition and optical properties, while it can be easily attached to existing systems, and also low in cost. We have developed this SLS technique under collaboration with HMI (Germany), and have applied to the three-stage deposition process of $Cu(In,Ga)Se_2$ (CIGS) thin films. We have found SLS useful for controlling the optical and physical properties of the film during the deposition, and consequently improve the performance of the CIGS solar cells. For futher information, see: http://unit.aist.go.jp/energyelec/cispvc/Research/SLS/



Schematic diagram and a typical set of profiles of SLS applied for a deposition process of CIGS thin films

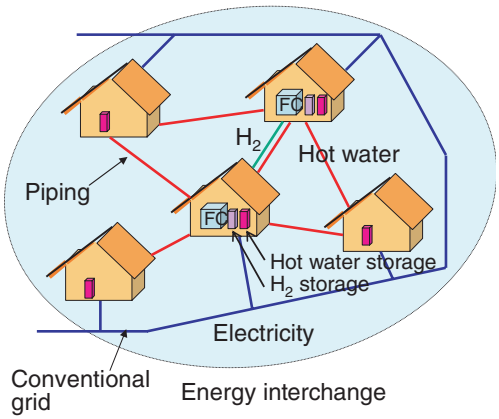
Energy Networks in the Future

Hiroshi AKI
Energy Electronics Institute
e-mail: h-aki@aist.go.jp
AIST Today Vol. 4, No.1 (2004) 19

The mission of the Energy Network Group of Energy Electronics Institute (EEI) is to present new concepts of future energy networks and systems, where fuel cells and hydrogen will play an important role.

The systems involve electricity, hot water and hydrogen networks and interconnection of consumers. Fuel cells will be installed in some of the consumers. Fig. 1 represents an example for residential houses.

The system provides cooperative operation of equipment and energy interchange among the houses. The CO_2 emission and primary energy consumption will be reduced significantly. Both experimental systems and PC-based simulators are being developed for quantitative analyses.



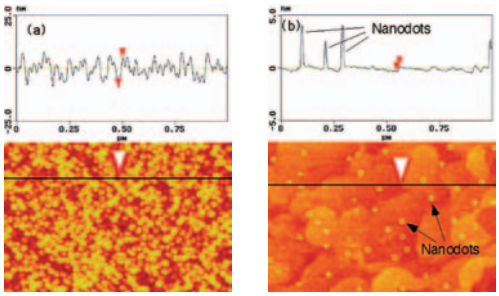
Energy system for residential houses

Nanotechnology and Materials Science & Technology

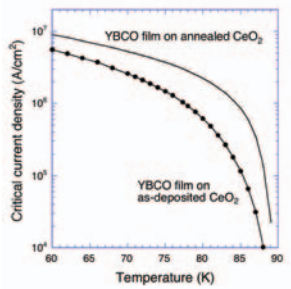
Improvements in Current-Density of $YBa_2Cu_3O_{7-\delta}$ Films on Sapphire Buffered with Atomically-Flat CeO_2 Having High Density of Nanodots

Jiacai NIE
Energy Electronics Institute
e-mail: jc-nie@aist.go.jp
AIST Today Vol. 4, No.3 (2004) 16

$YBa_2Cu_3O_{7-\delta}$ (YBCO) films was fabricated on CeO_2-buffered R-cut sapphire substrate by pulsed laser deposition. Prior to the YBCO deposition, a self-assembly process was performed where high-temperature (1025°C) O_2 annealing induces surface reconstruction of CeO_2 on sapphire substrates. The results reveal an atomically flat surface of CeO_2 film, superior crystalline quality, and the formation of a high density of nanodots on top of the CeO_2 layer (Fig.1). YBCO films grown on such CeO_2-buffered sapphire substrates had a high $T_{c\ \rho=0}$ (> 90 K) and a high J_c (> 3.0×10^6 A/cm^2 at 77.3 K and 0T, see Fig.2).



AFM images and corresponding profiles of a 36.6-nm-thick CeO_2 film grown on R-cut sapphire (a) before and (b) after high-temperature O_2 annealing at 1025°C

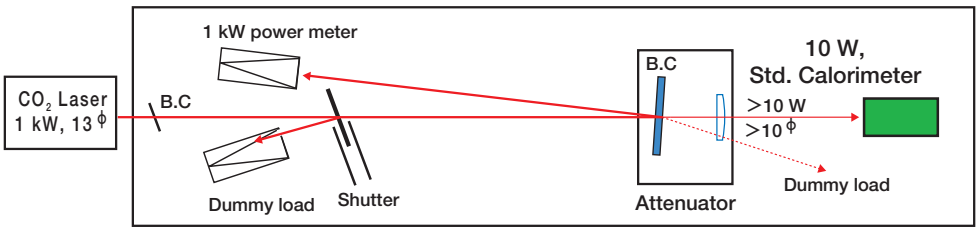


Critical current density J_c as a function of temperature at 0 T for two typical 200-nm-thick YBCO films on R-cut sapphire (a) with a 33-nm-thick annealed CeO_2 buffer layer and (b) with a 33-nm-thick as-grown CeO_2 buffer layer

Development of Precision Power Measurement System for High Output Lasers

Michiyuki ENDO
Metrology Institute of Japan
e-mail:m.endo@aist.go.jp
AIST Today Vol. 4, No.1 (2004) 17

A new method of precision power measurement to 1 kW lasers, where a high-reflection coated beam splitter is used as a high-power optical attenuator, and this attenuator is combined with an isothermal calorimeter. The calorimeter is a double-configuration consisting of an absorbing unit using a disk absorber having a short time constant and a Peltier cooling unit which are operated simultaneously. The principle of the measurement is based on the dc substitution method. The ratio of the substituted laser power to the dc power is determined for the absorbing unit. The design of basic construction is described.

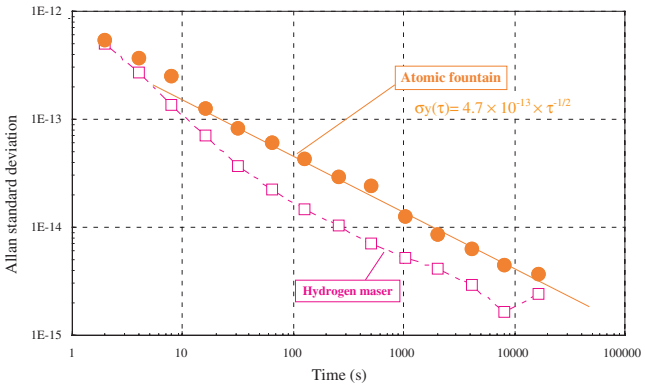


A typical arrangement for 1 kW-level laser power

Development of an Atomic Fountain Time/Frequency Standard

Takayuki KUROSU
Metrology Institute of Japan
e-mail:
t.kurosu@aist.go.jp
AIST Today Vol. 4, No.2 (2004) 11

The motion of atom is the main factor that limits the precision of the time/frequency standard. AIST has developed a cesium atomic fountain frequency standard, in which the motion of atom is frozen to below 1 μK by laser cooling. Due to the low temperature, the linewidth of Ramsey fringes, to which the microwave frequency is stabilized, is reduced to 0.8 Hz. The evaluation of the new frequency standard is in progress, and a frequency stability of $\sigma(\tau) = 4.7 \times 10^{-13} \times \tau^{-1/2}$ is obtained (Fig. 1).

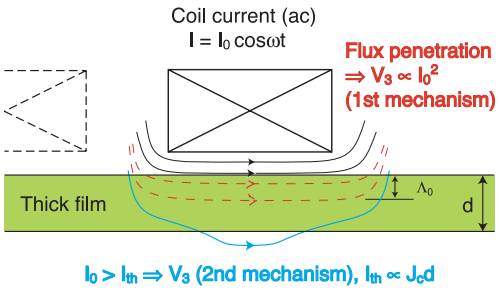


Frequency stability of an atomic fountain frequency standard

Nondestructive Inductive Measurement of Local Critical Current Densities in Large Bulk and Thick-Film Superconductors

Hirofumi YAMASAKI
Energy Electronics Institute
e-mail: h.yamasaki@aist.go.jp
AIST Today Vol. 4, No.2 (2004) 12

We have developed an ac inductive technique that measures local critical current densities J_c of large bulk and thick-film superconductors. In this method an ac magnetic field is generated by an ac drive current ($I_0\cos\omega t$) in a small flat coil placed just above the superconductor, and a third-harmonic voltage ($V_3\cos 3\omega t$) generated in the same coil due to the nonlinear magnetic response of type-II superconductors is measured. Because this V_3 (due to the first mechanism by flux penetration) is proportional to I_0^2 and inversely proportional to J_c, J_c can be measured in the surface region (typically down to $\Lambda_0 \sim$ 0.1 mm beneath the surface) of the superconductor by measuring V_3 as a function of I_0. In case of the thick-film superconductor, it is also possible to measure the J_c for the total thickness. The I_0 vs V_3 curves suddenly change the curvature at a threshold current I_{th} when the magnetic field penetrates the bottom surface of the film (the second mechanism). Because I_{th} is proportional to the product of J_c and the film thickness d, we can obtain the average J_c for the total thickness from I_{th}.

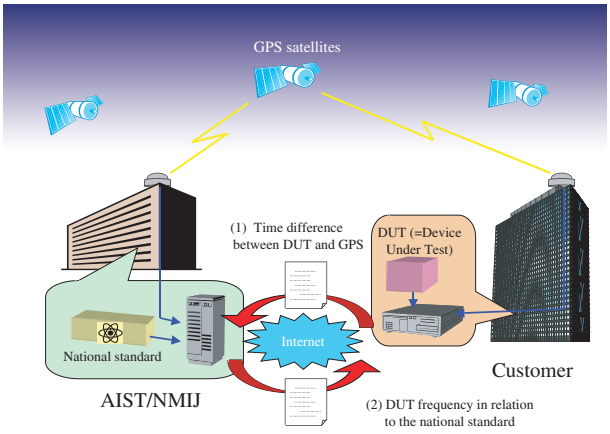


Schematic of the generation mechanisms of third-harmonic voltage V_3 in inductive J_c measurement in thick films

Development of Time and Frequency Calibration System

Yasuhiro FUKUYAMA
Metrology Institute of Japan
e-mail: y.fukuyama@aist.go.jp
AIST Today Vol. 4, No.3 (2004) 13

NMIJ has been giving calibration service of time and frequency standards. At present, the client must carry their frequency standards (DUT = Device under Test) into our laboratory. Therefore, DUT must be stopped and suffer disturbances caused by carrying. And furthermore, the frequency of DUT is never calibrated in usual circumstances. Then, new calibration system using GPS (= Global Positioning System) and the Internet is developed in NMIJ. This system consists of two processes as follows; 1) frequency measurement using GPS common-view technique and 2) data transfer from client to NMIJ via the Internet. We have tested the validity of this system by experiment.



Overview of the time and frequency remote calibration system

AIST Paro won the BEST COMDEX 2003 Award

From November 17 through 20, 2003, COMDEX 2003, one of the world's largest international tradeshows of information technology, was held in Las Vegas, U.S. This year, the tradeshow focused on enterprise technologies and showcased themes such as mobile computing, security, and utility computing. The four-days event attracted some 50 thousand visitors.

AIST and AIST Innovations, in search of new business opportunities, exhibited outcomes available for technology transfer in the field of information technology and venture business technologies created by AIST. The exhibition covered twelve different themes and the booth was crowded with many technology experts right from the start of the tradeshow. More than a dozen negotiations on the technology transfer were begun, which are expected to lead to licensing in the future. AIST's exhibition this year was crowned by an unexpected visit to the booth by Chairperson Bill Gates of Microsoft Corporation, while the seal-like robot called "Paro" receiving the Best of COMDEX 2003 Finalist Award.

European Commission Member Busquin visits Tsukuba Research Center

On December 5, 2003, Philippe Busquin, a member of the European Commission in charge of science, research, development, and joint research centers, visited AIST's Tsukuba Research Center.

Vice President Kodama gave an outline of AIST to him, followed by Director Jigami of the Research Center for Glycoscience, who explained his Center's research activities in glycotechnology, and Dr. Yamaga of the Nanotechnology Research Institute, who introduced his Institute's studies in drug deliveries. Then the European Commission member visited the laboratory of the Intelligent Systems Institute and saw a demonstration of a humanoid robot that walks and greets in French. To conclude the visit, the European Commission people present said, "Thank you for all the explanations which were fascinating, and we hope AIST will continue to strengthen the collaborations with the institutes and laboratories in Europe."

Vice President of Vietnamese Academy of Science and Technology (VAST) visits AIST to strengthen relationship

VAST (re-structured from NCST) representatives, Dr. NGUYEN KHOA SON (Vice President), Dr. CHU TRI THANG (Director of International Cooperation Department), and Dr. BUI CONG QUE (Director, Department of Planning and Finance) visited AIST on March 5th.

VAST, which consists of headquarter and 20 research institutes, is a cabinet-level orga-

nization under Prime Minister's direct supervision like other ministries. The research topics, which have the potential to become joint research, were presented by AIST researchers, being followed by lively discussions and negotiations with the representatives of VAST at the AIST International Affairs Department.

The topics were as follows; Measurement and Standardization by Dr. Akamatsu, Open Source Multilanguage by Dr. Takahashi, Oceanography by Dr. Okamura, and On-the-Job-Training at the Geological Museum by Dr. Aoki.

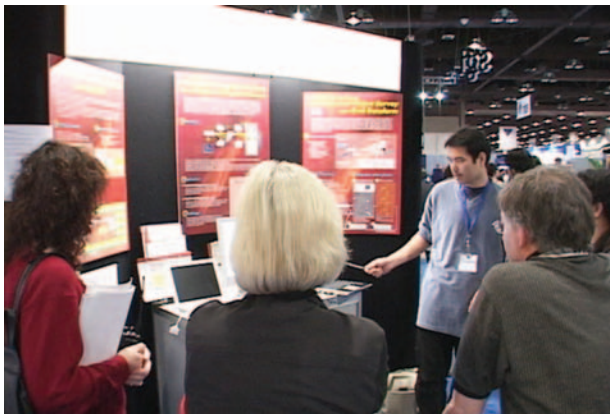
The topics had been selected by research coordinators and directors of research units of AIST. The topics were also introduced to executives and researchers of VAST when AIST representatives visited VAST in February.

The discussions and negotiations were very successful. In order to follow up the discussions and foster a better mutual understanding, the first work shop is planned at VAST, around October 2004. The specific topics and the date of the workshop will be discussed and decided.

AIST Grid technologies were exhibited at Super Computer 2003 International Conference in Phoenix US

More than 7,000 people attended the "SC2003 International Conference," an event co-hosted by the ACM and the IEEE Computer Society from November 15 through 21, 2003 in Phoenix, Arizona, U.S. At the conference, AIST exhibited the outcomes of its Grid Technology Research Center, displaying sixteen explanatory panels spanning a wide range of research fields from cluster technology to middleware and applications, and publishing three kinds of middleware developed by the Center free of charge. Researchers visited the AIST booth were very impressed by the demonstrations and major verification tests held there.

A contest was held as part of the conference, and AIST joined the "HPC Challenge" and "Bandwidth Challenge" competitions in collaboration with some other research institutes. AIST's team won the Most Geographically Distributed Application Award and the Distributed Infrastructure Award. In addition, at "SC Global," a distributed international conference using Access grid technology, AIST, together with Waseda University and XING Inc., harmonized karaoke singers from five different nations into a single global chorus, demonstrating a brand-new usage of grid technology.



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TEL: +81-29-862-6217 FAX: +81-29-862-6212 Email: prpub@m.aist.go.jp URL: http://www.aist.go.jp/