Yamaguchi University Research Activities

2016 Vol.4

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Masaaki OKA
President

Yamaguchi University recently established the Research Center for Advanced Science and Innovation in 2014. We are now cooperating with other universities/research facilities, not only Japan but also other countries, and promoting the creation and independence of research hubs in the center. As of February 2016, research activities are conducted in four research hubs, including the Research Center for Thermotolerant Microbial Resources, and three candidate research hubs, including the East Asia VLBI Science Center. Today, we published Yamaguchi University Research Activities Vol. 4, which is pleased to be able to introduce four researchers working on interesting research projects in these research hubs. Our research activities will be widely introduced to not only Japan but also other countries through this journal, and then I strongly believe this journal will be able to strengthen the excellent interactions among our researchers, local communities, and students.

Contents

Advanced Science and Innovational Research Center

Yamaguchi University launched Research Center for Advanced Science and Innovation in 2014 with the purpose of promoting research which utilizes strengths and characteristics of the university as well as developing sustainable and comprehensive research activities to an advanced degree and reverting its results to the society.

The present center engages in strategic undertakings by providing support for enterprises such as funding, publicity, and management through Industrial-Academic-Administrative Collaborative Center and University Research Administrator Office（URA）. It also places respective faculties' advanced basic research and research projects which lead to innovative creations, as the university's research promotion institute undertakings. It is hoped that this will lead to formation of international research bases and creation of new industries by the university via the research institutes and centers.

The present center consists of the research groups（bases）which promote research projects selected by the center director and the respective faculties. Research bases are certified by the university president, selected from amongst outstanding representative research projects and embryonic but prospective projects. They are then positioned as candidates for future research centers or institutes affiliated with the university, as part of the Research Center for Advanced Science and Innovation. Respective research bases will undertake the following projects within the maximum of 5 years during the certified period:

- Consolidation of research abilities
- Formulation of research strategies with a view to continuous acquisition of research grants
- Development as a research base
- Organizational improvement as a university-affiliated research center

In terms of the research projects certified as research bases, preparation is underway to assist them to become autonomous as university-affiliated research centers in terms of research funding（maximum of 3 years）and research management.

As of December, 2016, the following four have been certified as research bases and additional three are YU Project for Formation of the Core Research Center:

Research Bases	・Research Center for Thermotolerant Microbial Resources ・Translational Research Center for Intractable Disease ・Research Center for Regenerative Medicine and Cell Therapy ・Center for Research and Application of Satellite Remote Sensing（CRASS）
YU Project for Formation of the Core Research Center	・Biomedical Engineering Center（YUBEC） ・East Asia VLBI Science Center ・Opto-Energy Research Center

This issue introduces four researchers selected from one base and three base candidates respectively, along with their fascinating research contents.

http://rcasi.kenkyu.yamaguchi-u.ac.jp/

Birth and Death of Stars Observed by Radio-telescopes

In 2011, it was discovered for the first time in the world that inter-stellar gases, which compose a star, flow in whirls towards the central star in the process of generating with a large-mass. Professor Fujisawa, who made this discovery, was interviewed by URA and he explained, in easy terms, the situation where the observation was made and his projected research on black holes.

[Interview]

Director of the Research Institute for Time Studies

Kenta FUJISAWA

2016	Director of the Research Institute for Time Studies
April 2010	Professor of the Research Institute for Time Studies, Yamaguchi University
March 2010	Professor of Graduate School of Science and Engineering, Yamaguchi University
2007	Assistant professor of Graduate School of Science and Engineering, Yamaguchi University
1995	COE researcher at Institute of Space and Astronautical Science
1995	PhD degree from the University of Tokyo Graduate School of Science

The Research Institute for Time Studies (RITS)

The Research Institute for Time Studies (RITS) at Yamaguchi University was established in 2000 when Dr. Heisuke Hironaka was the president of the university. "Time" is an interdisciplinary field transcending humanities and sciences but connecting various fields. The aim of the institute, therefore, is to create a new academic discipline with time as their focus.

http://www.rits.yamaguchi-u.ac.jp/

URA We understand your current research is about the formation of stars using a radio-telescope. How do you go about it?

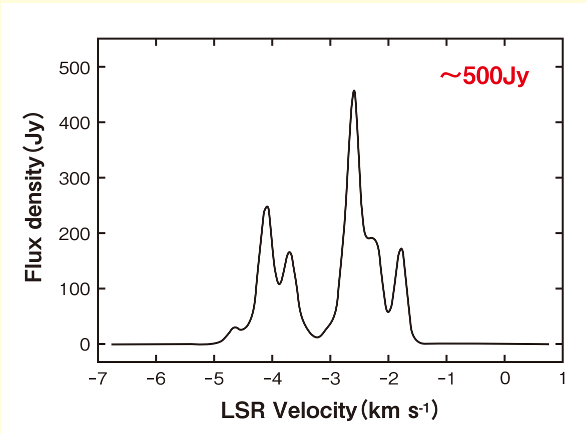
Fujisawa Stars consist of hydrogen and helium. In the space, thin clouds consisting of helium and hydrogen float here and there, which are called interstellar clouds. Dense portions of these clouds attract more clouds because of their gravity, and when they become denser, the gravity becomes even stronger. It is believed that repetition of this process leads to a birth of a star. The special object of our research is a heavy star which weighs 20 or 30 times more than the sun. During the process of congregation of clouds forming a star, radiowaves called *maser* are emitted. We observe them using the radio-telescope.

URA How long is the process of the birth of a star that you are studying?

Fujisawa Let's just say it takes about a million years for interstellar clouds to form a complete star. So I would say the process under our investigation is no more than a 20,000- to 30,000 years. But I am not sure because we are still in the midst of our research.

URA Your articles often show graphs like Figure 1. This shows results of your observation using the radio-telescope, right?

Fujisawa That's right. The first thing we obtain through a radio-telescopic observation is one numerical figure, that is, the strength of a radio wave that is reaching us from the direction the telescope is facing. Next, we conduct an observation called spectrum, which gives us a wave-like figure as shown in Figure 1. Our daily observations indicate various things such as a sudden rise in the numerical value. Later on, we use about 10 radio-telescopes at the same time to do observation. Now,



■Figure 1
Spectra of the 6.7GHz methanol maser obtained with whe Yamaguchi 32-m radio telescope.

this is a very luxurious situation.

URA Do you use them to observe just one astronomical object?

Fujisawa Yes, this observation method is called VLBI, where we record observation data sent from a celestial body on a hard disk and we do multiplication of signals generated. What we find from this is the shape of that body. So we first obtain the wave strength, then the wave spectrum, followed by its changes over time, and finally the shape. When we repeat this process over and over again, we see the changes taking place in the shape. After 1 and 2 years of repeating this process, we observed that the gases flowed in whirls towards the central star. That is the discovery we made for the first time in history（**Figure 2**）.

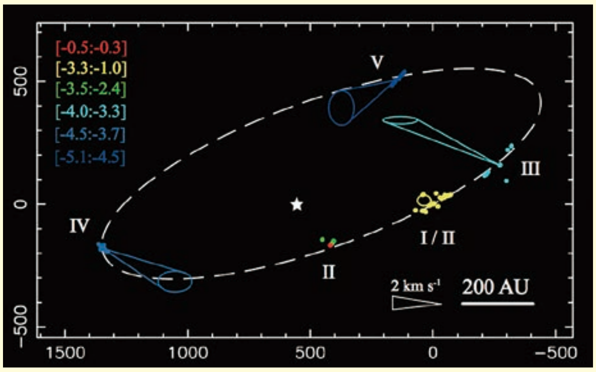


Figure 2　Internal proper motions of methanol masers

Cones: the averaged proper motions
Dashed ellipse: corresponds to the fitted elliptica structure for the methanol maser emission

URA　That is quite a significant discovery. What triggered this research?

Fujisawa　Normally, researchers would have a specific purpose and then use a radio-telescope for that purpose. But for us, it was reverse. We already had this radio-telescope in Yamaguchi, so we thought about what research we could do with it. That was the beginning.

URA　So the encounter with the radio-telescope was the beginning of your inquiry. Could you tell us a little more about this telescope?

Fujisawa　When I started to work at Yamaguchi University, my first undertaking was to turn a communication antenna with a 32-meter diameter into a radio-telescope. This was an unprecedented project so there was no one to give me advice, nor were there any reference materials. So I started with thinking about the question: How can a radio-telescope be made? First, I had to come up with a device which allowed me to observe the risings and settings of stars and to catch their waves. I needed software for this investigation. Thus, I gave a lot of thought to this and created what I needed step by step. All this led to the current research.

This sort of research approach is not permissible in a large research institution because the use of a telescope must be clarified first in order to do research. Very fortunately, Yamaguchi University allowed me to do the study the way I liked, so that helped tremendously.

As far I am concerned, it is natural for an astronomer to want to use the telescope in the way he wants to and spend plenty of time doing research. Such a research environment is almost non-existent in the world; I am just so lucky to have this opportunity as an astronomer.

URA　How are you going to do your research on the birth of stars from now?

Fujisawa　I have observed 36 stars using the method I just described. The observation itself is finished so I am in the process of analyzing the data right now. No one has observed this many stars in the past, so we are definitely at the forefront of this field on the global scale. .

URA　Please tell us about your new research topic.

Fujisawa　I hope to do research on black holes using the radio-telescope. A black hole is a celestial body that has an extremely strong gravity that can even suck in light. It is said to be formed when an extremely heavy stars, for example weighing 20 to 30 times more than the sun, finishes its life and explodes.

URA　Has there been black hole research that used VLBI?

Fujisawa　Yes, it has been around for about 30 years already, so I hope to do something new. So far, the research has been on huge black holes in far-distant galaxies. But I am interested in smaller black holes nearby. There is no doubt that there are many black holes in our galaxy, but actually we have not found them yet. You see black holes themselves do not shine and so can be observed only when they suck in gases. But even so, they do not have dense gases nearby, so they are hard to see, making their observation very difficult. Up to now, much of research has been done using X-ray, so I hope to tackle with my study using the radio-telescope.

Related to this is that, in addition to the 32-meter-diameter radio-telescope used in Yamaguchi since 2002, the university borrowed a 34-meter antenna in 2016, which is located right next to the former; we have also been using it since. The combined use of these two telescopes have greatly improved the observational sensitivity, which is expected to contribute tremendously to the black hole research in our galaxy.

URA　So this research is being conducted at East Asia VLBI Science Center（Note 1）, where you serve as the director. We understand that it is essential that you be able to use the radio-telescope freely.

Introduce a book

In 2016 Minerva Shobo presented "Curious!〈Time〉Big Encyclopedia" for children. It covers a lot of various scientific subjects from the history of "Time" origin to astronomy, earth sciences,astrophysics and biology. 3 volumes in total.［Author: Kenta Fujisawa, Vol.3 in collaboration with Shinichi Inoue（Former Director of The Research Institute for Time Studies）, Supervision: The Research Institute for Time Studies］.

Fujisawa There are about 10 radio-telescopes in Japan. Normally, after you submit an observation proposal and it is approved, you can do 20- to 30-hour observation. To be honest, this does not work for me. I have always wanted to pursue ideas freely that come to my mind even if they are rough ones. I also need more time for observation.
Our environment is also advantageous to my students, who can re-do their research even if it does not go well.

URA What kind of researchers use Yamaguchi's radio-telescope?
Fujisawa Recently, we have added more members to our team; other than myself, we have Associate Professor Niinuma and Assistant Professor Motogi, as well as two other researchers. So we have 5.
I talked about the new discovery regarding the birth of a star earlier. One good thing that came out of this is that the observation was made possible through an international collaboration between Japan, China, and Korea. The VLBI method necessitates a number of radio-telescopes. Right now, there is an increase in the number of radio-telescopes in East Asia, which helps us to expand international observations.
Everyone brings what they have and shares the results. We are all scientists so we know each other very well and respect each other's culture; we have very good cooperative relationships.
URA What are the advantages of having so many radio-telescopes for VLBI?
Fujisawa The image quality of celestial bodies is enhanced and we can see more details more clearly. What may be blurred using fewer telescopes may be sharpened. For that matter, we need to have telescopes close to each other as well as apart from each other, to a certain extent.
URA So you need to meet some geographical requirements as well.
Fujisawa When I am invited to do others' research, I try to participate as much as I can. For example, I am also using it for a communication purpose, that is, to receive electric waves sent by an inter-planetary probe called Procyon.
There are also invitations by European researchers; for example, I participate in observation to determine the precise location of the probes that have been sent to Mars and Venus. So I keep my window quite open and try to join other projects suggested to me from all kinds of places.
URA Thank you for sharing your research activities. What motivated you to do research on astronomical bodies and the universe?

Fujisawa When I was a junior high student, a friend of mine had a telescope and I envied him. That is when I started to long for being an astronomer. When I actually started learning astronomy, many people used optical telescopes. So I wanted to do something different and decided to pursue radioo waves (VLBI). The one in Yamaguchi is neither particularly big nor of the latest model. So it is not the world's best, not even Japan's best. But it can become the best telescope, depending on how you use it. That is what counts most.

Note 1: East Asia VLBI Science Center
*VLBI: very long baseline interferometer

Black Hole Research Base
This is a research base where black holes are researched in both theory and observation; black hole is one of the greatest research areas of astrophysics. It is an ultimate astronomical-spatiotemporal structure that is generated from the evolution of space, time, and matter. How did the current form of the universe come to be in this evolutionary process? What role did black holes play in this process? The significance of black holes is a hot topic in the cosmic evolution theory and proves to be an important research theme not only in astro physics but also in time studies.

http://crasares.eng.yamaguchi-u.ac.jp/

Radio telescopes

Column

Black Holes and a Horologe

During the Age of Navigation, there was a need to know the location of stars and the exact time for the purpose of determining where you were exactly. In order to make an accurate clock that did not lose time on a rolling ship, a new technological development was pursued. Recently, an even more precise atomic clock has been developed, which enabled us to observe that the flow of time slows down as you get closer to a black hole.



Atomic clock (left: haydrogen maser, right: caesium)

Development of a Remote Sensing Method for Measuring Shallow Water Depth

In order to forecast and prevent river flood, it is important to understand the topographic information in rivers and coastal areas. Assistant Professor Kanno developed his own unique method of the analysis for the satellite image and drone pictures. He achieved his grate success on dramatically improving the accuracy of "method to estimate water depth from its color".

Graduate School of Sciences and Technology for Innovation
Assistant Professor

Ariyo KANNO

April, 2010	Assistant Professor, Structural and Geotechnical Engineering in the Division of System Engineering, Graduate School of Science and Engineering at Yamaguchi University
March, 2010	Ph.D（Environmental Science）, Department of Socio-Cultural Environmental Studies at Graduate School of Frontier Sciences, Tokyo University
April, 2009	Recipient of Research fellowship for Young Scientists（DC2）, Japan Society for the Promotion of Science
March, 2007	MS（Environmental Science）, Department of Socio-Cultural Environmental Studies at Graduate School of Frontier Sciences, Tokyo University
March, 2005	BS, major in Environment-Energy System in Socio-Cultural Environmental Studies, Department of Systems Innovation, Faculty of Engineering, Tokyo University

[Research Summary]
My research is in the field of remote sensing and I am developing shallow-water bathymetry methods using satellite or UAV aerial images. I have successfully developed higher-accuracy analysis methods of such images by combining optics and statistics.

Need for a Low-cost Survey Method for Shallow Water

Topographic information in rivers and coastal areas is very important because many people live there. For example, river topography determines how much water can flow without getting flooded. Japanese central and local governments periodically measure the topography by spending large sums of money. Where the flow capacity is not adequate, some countermeasures such as digging are implemented.

The problem addressed in my research is in regards to the high costs of the traditional in-situ surveys. The aerial survey method using laser also suffers from high costs. As a result, currently, surveys are not done with a satisfactory temporal and spatial densities. For example, in many rivers, surveys are done just once in five years and only with 200-meter intervals. These limitations lead to inaccuracies in flow simulations and flood alarms in case of heavy rains. A new technique is needed which can measure the shallow-water topography at low costs.

A Unique Mathematical Remote Sensing Method

I am developing shallow-water remote bathymetry methods using satellite images and UAV-based aerial photographs. There are two physical principles involved; the first is that the apparent color of water seen from above changes with water depths. When we observe the

Column　Center for Research and Application of Satellite Remote Sensing（CRASS）

Yamaguchi University（YU）and the National Udayana University in Indonesia（UNUD）have engaged in international collaborative education and research to apply the satellite remote sensing data to disaster management and environmental issues for about 10 years. During this period, two of our projects were supported by the Ministry of Education, Culture, Sports, Science and Technology for the fiscal years 2009-2011 and 2013-2015; these projects are titled “Fostering human resources in satellite remote sensing through international collaboration” and “Fostering human resources in satellite remote sensing through international collaboration of graduate schools,” respectively. Subsequently, we started 12 courses through simultaneous lectures on the basics and applications of the satellite remote sensing technology between YU and UNUD via the Internet. A double-degree program（DD）was also introduced, where the students from UNUD enter the second year of the Master’s program at YU and some move on to the Doctoral program. Thus, human resources have been cultivated through international collaborative education. Concurrently, international joint research has been pursued in collaboration with other universities inside and outside of Indonesia as well as some national research institutes.

In 2016, it was decided that JAXA’s research Center would come to Yamaguchi Prefecture; this decision was largely influenced by the above-mentioned activities between YU and UNUD. JAXA’s research center will soon start in 2017 April, therefore our CRASS will start the deep collaboration work with JAXA together. JAXA’s satellite data will be utilized to the full, and international research on disaster management and environmental issues while using satellite data will be pursued and expanded in not only Asia but also South America and other parts of the world.

http://crasares.eng.yamaguchi-u.ac.jp/

clear-water coast from an airplane, we notice that the water color changes from bright to dark blue as we move from the coastline to the offshore. This is because the light entering our eyes after being reflected at the sea bottom becomes weaker due to absorption and scattering as the water depth gets greater. Because the red light is more quickly absorbed by water compared with green or blue light, a shallow water with a bright white bottom appears light blue seen from above.

On the basis of this principle, it is possible to estimate the water depth distribution using the color recorded in the satellite or aerial images. Because the apparent color depends on the sea bottom type and the water quality as well as the water depth, the analysis must be done while taking into account their effects. I have been developing a statistical analysis method that allows reliable estimation over various sea bottom types and water qualities.

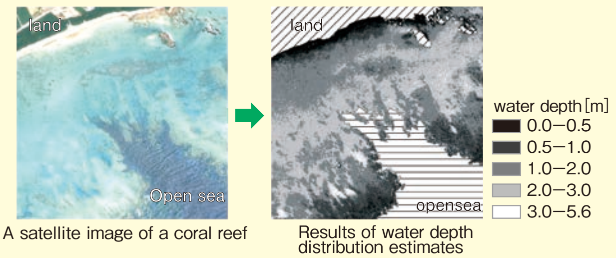


Figure 1 An example of a topographic survey of a coral reef using satellite images

The other principle of remote bathymetry is related to why our eyes can measure the distance to the target. When we see something using both eyes, the direction of the object from the left eye is slightly different from that of the right eye. The smaller the distance to the target is, the larger this difference becomes. This is why we can recognize the 3-dimentional world using two eyes.

If we use a camera instead of our eyes and take downward pictures from multiple points in the sky, we can measure the topography. This is an old technique called photogrammetry. Recently, with the evolution of computers, digital cameras, and UAVs, it has become possible to automatically derive centimeter-resolution topography using a large number of pictures. However, their underwater application is difficult due to the reflection and refraction of the light at the water surface. I am developing a new device and also a geometrically-based analysis method to remove the influence of the water surface.

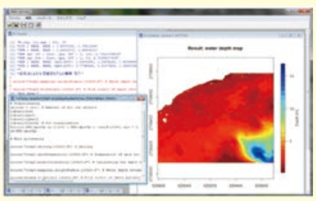


Figure 2 Automatic water-depth mapping software developed.

If it becomes possible to measure the underwater topography from satellite images or aerial photographs, the shallow water survey will be done with less cost but greater speed and density. Modern high-resolution satellite images can cover, for example, a 100-km^2 area with a 1-meter resolution. Modern UAV can observe a 1-km^2 area in one day with a few centimeters of resolution. The disadvantage of the shallow-water remote bathymetry technique is that the maximum measureable depth depends on the water quality. In coral reefs with clear water, a 20-meter depth can be measured. On the other hand, in turbid rivers, even a 1-meter depth may be too great to measure. Therefore, the technique is suitable for complementing, but not for replacing, the conventional survey techniques.

A Message for the Students

In order to foster the students' self-confidence, I supervise their research to help them accumulate successful experiences. In each step of their research, I emphasize the process and their efforts rather than results. Image analyses are complicated, but the students can learn for themselves and overcome the obstacles if enough time and support are provided along the way. Although most students may not become researchers in the future, I believe that their experience in their research will give them the ability and confidence to solve problems in their future life.

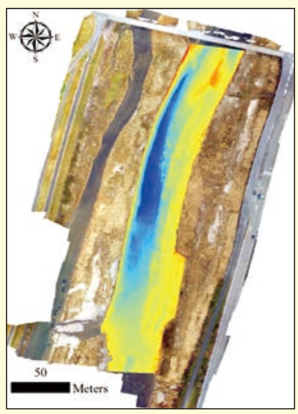


Figure 3 Example of UAV-based Underwater Photogrammetry in Saba River

Chemistry Focusing on “Movement”

Exploiting new potentials of compounds, taking clues from the movement of molecules and ions, which is generally considered undesirable.

Graduate School of Sciences and Technology for Innovation
Associate Professor

Ryo TSUNASHIMA

August 2014 Associate Professor, Yamaguchi University
April 2010-July 2014 Assistant Professor, Yamaguchi University
April 2008-March 2010 Postdoctoral Research Associate, University of Glasgow, UK
April 2007-April 2008 Postdoctoral fellow, Hokkaido University

I specialize in solid materials science. Molecules, ions, and atoms in solids are moving by heat, which is usually regarded as a cause of structural disturbance. Focusing on this movement, we developed an analysis method to control the size and shape of nanomaterials. In addition, we work on discovering unexpected properties of compounds, and elucidating the mechanisms underlying newly discovered compounds.

What is the target of solid materials science? —Energetic children running around in class—

Differences among solids, liquids, and gases are easy to distinguish, even for non-specialists in chemistry. Air is a gas, milk is a liquid, and salt is a solid. To be precise, however, milk is a mixture of a liquid and a solid; the very small size of the solid pieces makes the milk appear cloudy white. This is slightly different from the case of saline water, in which molecules are ionized into sodium ions and chloride ions. Although I will not present a detailed definition of solid, liquid, and gas here, in general terms, the constitutive molecules and ions move differently in each. I still remember the science class in elementary or junior high school, in which molecules were explained by analogy to children in the classroom. Solids were compared to “during class”, in which all the children were seated; liquids were compared to “during breaks”, in which the children were free to move, but only near the classroom; and gases were compared to “after school”. Now I specialize in solid materials science, yet I think this remains a pertinent explanation, even by my current standards. There are no children who do not move at all, even in a solid. They are continuously moving; some drop a pencil, others look restless, probably due to hunger. Illustrations in textbooks are drawn as if they were at rest; however, the molecules, ions, and atoms that constitute a solid are actually not completely at rest, but continuously moving because of heat. And with increasing thermal energy, the picture changes to children running around the classroom and eventually leaving the classroom. After a lengthy preamble, my research interest lies in so-called problem children, who are energetically jumping around their desk, even in class. Actually, I myself was such a problem child.

Taking clues from the “movement” in a solid, which is typically considered undesirable

Some states in which molecules are moving in a solid as if they were in a liquid are known; I chose a liquid crystal, whose molecular state is similar to that described above, from among the terms you are familiar with. Molecules and their aggregates in a liquid crystal are arranged somewhat regularly, with a high degree of structural freedom. Therefore, the molecular arrangement can vary

Column Outline of Opto-Energy Research Center

Yamaguchi University’s Opto-Energy Research Center aims to generate green innovations which realize ‘smart’ creation and utilization and preservation of energies. The purpose is to solve environmental problems such as energy depletion and carbon-dioxide emission as well to resolve issues related to sustainable economic growth. This is done through a fusion of the two fields of optics and energy, transcending the limitations of the current technologies.

Opto-energy research requires unified studies of the three areas: materials, property control, and device. The present center is equipped with the strengths of the three. In particular, advanced research is pursued on the following themes for each of the areas respectively: functional molecules and meta-materials (materials), photo-catalyst and spin control (property control), and emitting device, power device and thermoelectric device (device). The present center maximizes the use of these strengths, offers a major research orientation to the world through its synergetic effects, and creates new realms of research.

Research Topic Group of the Opto-Energy Research Center: Four Pillars of Social Contribution

Environmental Coexistence and Sustainable Economic Growth

- Coexistence with Environment
- Advancement of Information Network
- Creation of New Materials
- Creation of Energy-Saving Devices

http://opto-energy-rc.eng.yamaguchi-u.ac.jp/

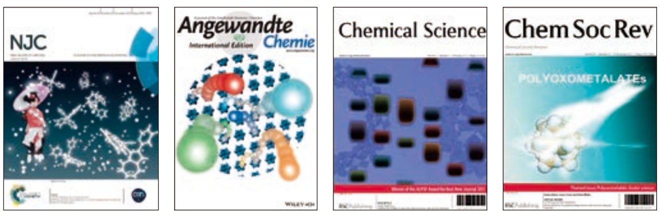
depending on the external electric field, and a liquid crystal display uses such a property. This is an example of using the high molecular freedom in a solid; however, such freedom is generally undesirable because it causes structural disturbance. For example, the presence of such structural disturbance in diamonds makes them appear dull, reducing their value and functionality. We have thus taken clues from the movement of molecules and ions, which is typically undesirable, and have developed new ideas.

Analyzing the formation process of nanomaterials

Nanomaterials form an important substance group that is drawing attention as next-generation material in most scientific fields, including devices, medicine, and the environment. Among them, polyoxometalate has unique properties: it is employed as a catalyst for oxidation and reduction, and is likely to include other molecules. However, extensive analysis was required, due to lack of a simple separation and purification method. In light of this, we employed gel electrophoresis, which is widely used in the fields of biology and biotechnology, to separate and purify nanomaterials. Electrophoresis is a phenomenon in which, when an electric field is applied to molecules and ions in a solution, the molecules begin to move, and positively charged molecules begin to move toward the cathode. The speed at which molecules move is determined by the size and electrical properties of the molecules. Analyzing the formation process of nanomaterials, using electrophoresis, enables us to investigate impurities and reaction intermediates from various perspectives; and this has enabled us to find chemical reaction conditions to arbitrarily control the size and shape of nanomaterials, which had hitherto been too small to control.

In addition, changing the target from molecules to smaller protons and electrons, we attempted to move them actively, and this resulted in an unexpected new discovery. Conceiving the idea of a mechanism for moving electrons has enabled us to improve the conductivity of a compound which had been thought of as a non-conductive glass-like compound, equivalent to that of semiconductor Si.

Furthermore, we recently discovered a mysterious compound whose color changes depending on various conditions. This compound was created by mixing multiple molecules that were likely to move in solids (molecules with high symmetry). A fresh compound appears pink, but changes its color depending on the conditions, turning blue with increasing temperature, and green when water is applied. We are currently working on research whose goal is to elucidate the mechanisms behind such reactions.



From among the papers I've published after transferring to this university, this one was selected for the cover of academic journals.
For the cover on the left they used a picture of my daughter's Shichi-Go-San celebration.

From left

New J. Chem., 2015, 39 (Cover picture)

Angew. Chem. Int. Ed., 2014, 42 (inside back cover)

Chem. Sci., 2012, 3 (cover picture)

Chem. Soc. Rev., 2012, (cover picture)

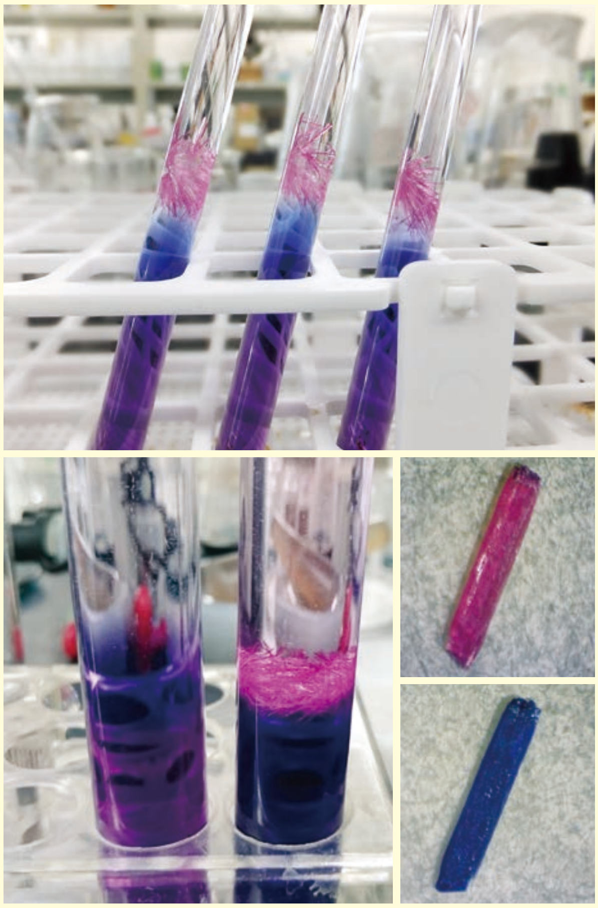


Figure 1 Mysterious compound

After a few days, the state of the test tube depicted on the left changes to the state depicted on the right, and a pink single crystal forms.
If this pink single crystal is heated, the color changes to blue. If we add alcohol, it reverts back to its original pink color without breaking.

Thoughts as a faculty member

I am a person who lives one day at a time, and I am positively enjoying my research life without being distracted by minute details. I would like to take this opportunity to express my appreciation for giving me such a wonderful opportunity, and to thank all those who have listened to and supported me, including students, teachers in the fields and faculties, helpful teachers at other universities, and my family.

Computer-aided Medicine

Associate Professor Hirano specializes in the fields of medical image processing and pattern recognition. He has been developing the medical information technology through collaborative research with medical schools and hospitals.

Graduate School of Sciences and Technology for Innovation
Associate Professor

Yasushi HIRANO

2016	Associate Professor at Graduate School of Sciences and Technology for Innovation, Yamaguchi University
2010	Associate Professor at Graduate School of Medicine, Yamaguchi University
2004	Associate Professor at Information Technology Center, Nagoya University
2002	Assistant Professor at Information Technology Center, Nagoya University
2000	Assistant Professor at Graduate School of Engineering, Nagoya University

The purpose of our research is to provide useful information for diagnosis to patients and medical doctors through computerized analysis of medical images and health records. The topics we are currently working on are a computer-aided diagnosis of lung tumors, a computational simulation based on medical images and a development of a secondary use system for electronic health records.

Objective and Quantitative Decision Support by Using Computers

If you want to have an examination by a medical doctor, which would you want to visit, a novice or a veteran? It is very likely that you would choose the latter. Next, when is the "best" time to visit the doctor? Doctors might be very tired by the end of their consultation hours. As a result, they might make an error in their diagnosis. Diagnostic skills may be improved over time as they gain more experience, but their fatigue might lead to a misdiagnosis. Basically, diagnoses are largely subjective. Different medical doctors might make different diagnoses for the same disease based on their own judgment and experience.

The academic discipline called Computer-Aided Diagnosis (CAD) is intended for supporting medical doctors by providing objective and quantitative information extracted through analysis of medical images and medical records using computers. We have been collaborating with medical schools and hospitals to do research on development of practical computer programs.

There is another advantage of analyzing medical information using computers. The performance level of medical imaging devices has been substantially improved and the information contained in such images is abundant. Although this is beneficial for diagnosis, the amount of information can be too much for doctors to process, making it difficult to extract what is truly useful. But computers can process information much faster than humans; if the computing speed is not fast enough, a technology called parallel processing can speed up the task.

Column: Yamaguchi University Biomedical Engineering Center (YUBEC)

Population aging and the spread of communicable diseases are serious problems in the world. Collaboration between medicine and engineering called "medical engineering" is expected to play an important role for the development of drugs and medical devices, as well as improving information technology on personalized medicine. We have started a new research center of excellence named YUBEC (Yamaguchi University Biomedical Engineering Center). YUBEC will contribute greatly to our prosperous future through the research and development in biomedical engineering.

http://bio-med.eng.yamaguchi-u.ac.jp/

Main Research Achievements

Application of mechano-electrochemical simulation to dynamics analysis of articular cartilage
Simulational modeling of cardiovascular system for developing medical device for cardiac diseases
Application of statistical pattern recognition methods to predicting metastasis and recurrence of cancers
Use of membrane-permeable nano-assemblies to develop next-generation vaccines
Analysis of insemination and developmental mechanisms in vertebrates for the reproductive technology
Development of protein drug purification design models
Development of systems for mass production of vaccines in yeast

Life and Medical Sciences Research Division

Chemistry Unit

conducts basic research in chemistry and biochemical engineering related to synthesis of biomedical materials, bioseparation, drug delivery system, and the artificial cell membrane systems.

Biology Unit

focuses on human functions such as reproduction, regeneration, and brain functions. It also conducts drug development and analyzes the causes of diseases using model organisms and cultured cells.

Clinical Medical Science Unit

conducts etiological and pathological analyses and develops diagnostic methods and treatments based on fundamental and clinical research.

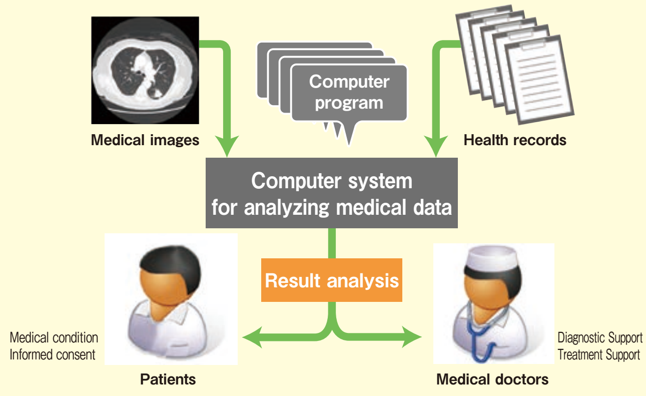
Analysis of Medical Images and Medical Records

Computational simulation based on medical images is one of the studies of our greatest interest (Figure 1). In the computer simulation for industrial products, objects for simulation are defined using CAD (Computer-Aided Design) software. In the computer simulation for medical images, organ regions extracted by clinical medical images by the using image processing technology are used. For instance, if we predict deformation of airways after an operation of lung tumors using computer simulation and perform a fluid simulation using the deformed airways, we might be able to predict the state of the respiratory functioning after the operation. In the future, it may become possible to propose a surgical method that prevents a decline in respiratory functions or a method that improves respiratory functions. Because the physical properties of each patient can be used in the medical image-based simulation, the simulation is expected to contribute to personalized medicine. One of the advantages of the image-based simulation is that the simulation can be done any number of times while varying the conditions of simulations. Patients need to bear a burden for actual examinations such as a respiratory function test. On the other hand, once the medical image for the patient is taken, additional burden is unnecessary for new image-based simulation. The results obtained by the simulations can be used not only for doctors to make decisions on therapeutic strategies, but also for patients to understand their own condition and to decide on what treatment to receive.

The other research using medical images is on the CAD for diagnosing lesions in medical images. Some decades ago, the technology named Artificial Neural Network was developed. Today, a new technology called Deep Learning, based on artificial neural network, is extensively used in academic and industrial fields such as AI in games, automatic driving, and CAD. We have also been developing a Deep-Learning-based CAD system, which has a higher diagnostic ability than that of medical doctors.

The last research introduced here is about an electronic health record system. It mainly consists of open-source software and a computer system which is shared with multiple clinics to build the system inexpensively. This system has been developed for small clinics which are on a strict budget. The other purpose of this research is to develop a method to reuse aggregated health records. This research is in progress in collaboration with core hospitals and rural clinics. We are working on developing new medical information applications by analyzing aggregated health records.

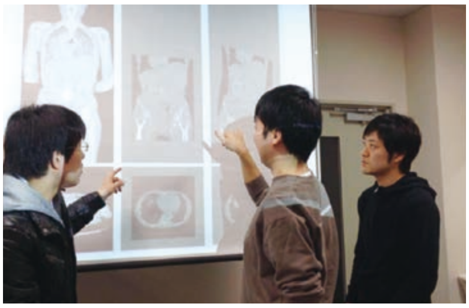
In the research mentioned above, it is most important to develop efficient and useful computer programs. All the data, including medical images and health records, are analyzed by computer programs, and the results are provided to both patients and medical doctors.



■Figure 1 Picture of Computer-Aided Diagnosis System

Thoughts as an Academic

Although I am now specialized in analysis of medical data, this has not always been the subject of my study. During my undergraduate years, I studied a video compression algorithm, and my graduate research was on a CAD system. I had studied a user-authentication system and high performance computing as well as CAD for 8 years after being employed as an academic. Although these studies are not necessarily related to medical data analysis, the human network I have built so far and the knowledge gained hitherto have been helpful for the current research. It is good to master one specialized field, but gaining a wide variety of experiences can broaden your horizon.



Mechanical Informatics and Medical Engineering Research Division

Mechanical Engineering Unit

physically analyzes human body and tissue functions and develops medical equipment utilizing physical factors such as X-rays and ultrasound.

Information Science Unit

develops new diagnostic technologies based on statistical analysis of big data.

Clinical Medical Engineering Unit

unit aims to develop new non-invasive cancer treatments by developing new image analysis methods and imageguided irradiation systems and also intends to develop a learning system using an extensive radiography database.

Contact

[As of July, 2017]

Graduate Schools	URL
Graduate School of Humanities	http://www.hmt.yamaguchi-u.ac.jp/?lang=en
Graduate School of Education	http://www.edu.yamaguchi-u.ac.jp/english
Graduate School of Economics	http://www.econo.yamaguchi-u.ac.jp/gs_e.html
Graduate School of Medicine	http://www.med.yamaguchi-u.ac.jp/graduate/ (Japanese)
Graduate School of Sciences and Technology for Innovation	http://www.gsti.yamaguchi-u.ac.jp/ (Japanese)
Graduate School of East Asian Studies	http://www.eas.yamaguchi-u.ac.jp/
Graduate School of Innovation and Technology Management	http://mot.yamaguchi-u.ac.jp/ (Japanese)
United Graduate School of Veterinary Science	http://ds22.cc.yamaguchi-u.ac.jp/~renju/e.html
The United Graduate School of Agricultural Science, Tottori University	http://rendai.muses.tottori-u.ac.jp/english/index.html

Research Institute	URL
The Research Institute for Time Studies	http://www.rits.yamaguchi-u.ac.jp/?page_id=33

※The United Graduate School of Veterinary Science was established through the cooperation of Tottori University, Kagoshima University and Yamaguchi University.
※The United Graduate School of Agricultural Science was established through the cooperation of Tottori University, Shimane University and Yamaguchi University.

YAMAGUCHI UNIVERSITY

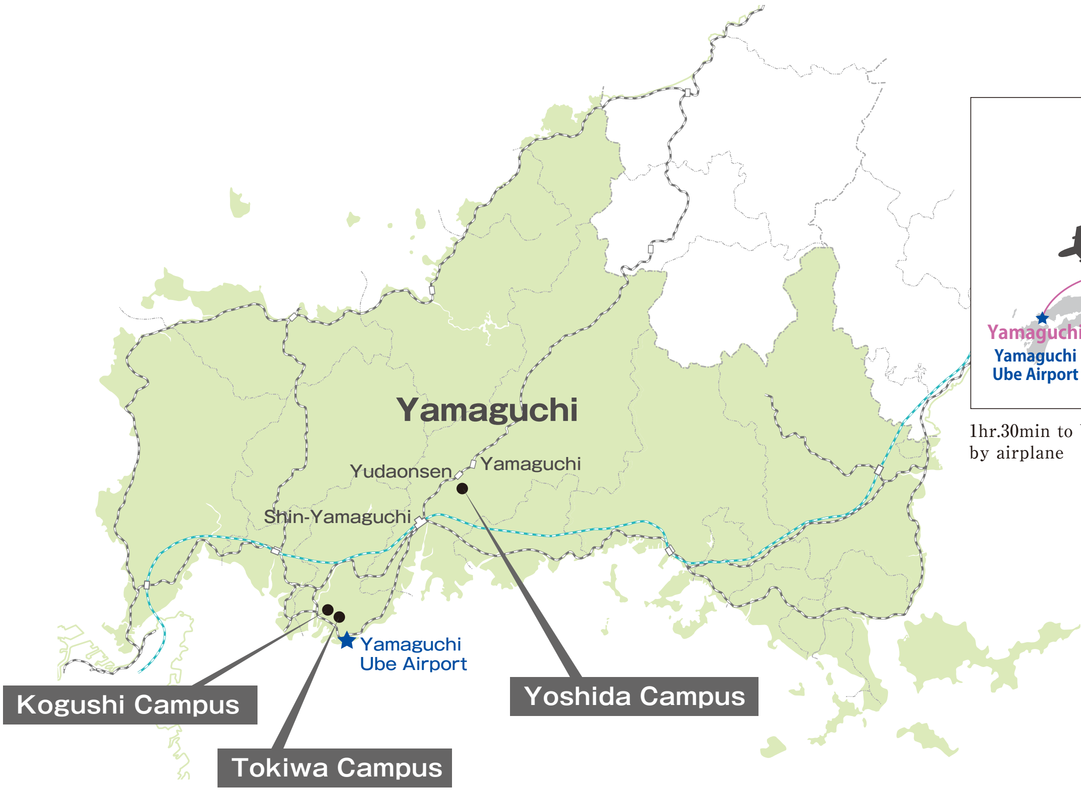
1677-1 Yoshida, Yamaguchi-shi, Yamaguchi 753-8511
http://www.yamaguchi-u.ac.jp/english.html

■ For Research enquiries:
Organization for Research Initiatives
http://kenkyu.yamaguchi-u.ac.jp/index.html (Japanese)

■ For International Exchange enquiries:
Office for International Affairs Strategy
http://www.iassc.jimu.yamaguchi-u.ac.jp/en/index.html

■ For Studying at Yamaguchi University
International Student Center
http://www.isc.yamaguchi-u.ac.jp/english/top.htm

Location



1hr.30min to Yamaguchi Ube Airport by airplane

Yoshida Campus

1677-1 Yoshida, Yamaguchi-shi, Yamaguchi, 753-8511

Graduate School of Humanities, Graduate School of Education, Graduate School of Economics, Graduate School of Medicine (Science, Agriculture), Graduate School of Sciences and Technology for Innovation (Science, Agriculture), Graduate School of East Asian Studies, United Graduate School of Veterinary Science, The United Graduate School of Agricultural Science, Tottori University, The Research Institute for Time Studies

Kogushi Campus

1-1 Minami-Kogushi 1-chome, Ube-shi, Yamaguchi, 755-8505

Graduate School of Medicine (Medicine), Graduate School of Sciences and Technology for Innovation (Medicine)

Tokiwa Campus

16-1 Tokiwadai 2-chome, Ube-shi, Yamaguchi, 755-8611

Graduate School of Medicine (Engineering), Graduate School of Sciences and Technology for Innovation (Engineering), Graduate School of Innovation and Technology Management

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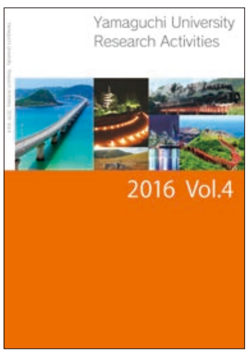

Cover design and art

The pictures show some of the famous sights of Yamaguchi Prefecture and present its long history and rich natural beauty. The vivid color along the bottom is a symbol color of Yamaguchi Prefecture.

YAMAGUCHI UNIVERSITY

200th Anniversary YAMAGUCHI UNIVERSITY

Yamaguchi University Research Activities 2016 Vol.4