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Winds Monitoring with Weather Radars

A new bistatic measurement system for regular monitoring of winds

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After completing doctorate at a graduate school, Seiji Kawamura served as a JSPS fellow on the Postdoctoral Fellowship program of the Japan Society for the Promotion of Science (then located in the Integrated Communications Research Institute) and then joined the NICT in 2006. Currently, Kawamura is engaged in research related mainly to atmospheric physics and radar systems.
Ph.D. in Information Science

Current Status of Wind Observation

Windblasts, local guerrilla downpours, and some other weather disasters have raised social issues in recent years. These disasters with a limited time-space scale prevent us from making normal forecasting even if we use remarkably advanced weather forecast numerical models. One of the factors preventing satisfactory forecasting is the lack of observation data. Even if the resolution of numerical models is further improved, no imminent event can be forecast without knowing current state that is defined with observation data that constitute the initial values of computation.

Winds contribute as one of the critical parameters to these weather disasters. Winds observation covering the entire land of Japan is conducted by the Japan Meteorological Agency using Automated Meteorological Data Acquisition System (AMEDAS, mainly monitoring surface winds) and Wind-profiler Network and Data Acquisition System (WINDAS, monitoring height profiles of winds). While each system supplies important data, the number of observation stations is limited to 850 for AMEDAS and 31 for WINDAS throughout the whole Japanese territory. The limited number of facilities cannot possibly deal with local weather disasters measuring a few hundred meters to several kilometers. If we could monitor winds with much finer time-space scales, we could not only obtain data for weather forecast models but also use them very effectively as disaster-preventive or disaster-mitigating information against local disasters. The demand now exists for such an observation system that can cover a vast area with such high time-space resolution.

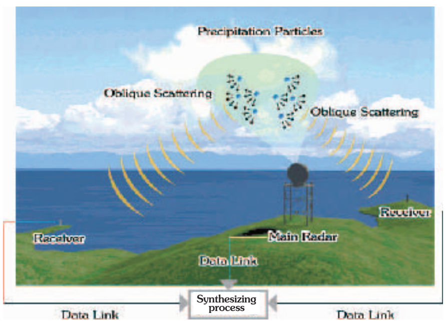


Figure 1 ● Concept of bistatic observation
A conventional radar receives the backward reflected radio wave (backscattering) that has been sent by itself (monostatic observation). In this case, the radio wave is reflected not only backward but also in every direction (scattering). In a bistatic observation system, receiving the scattered waves in the transverse directions (oblique scattering) using other receivers gives another component of wind speed in addition to the wind velocity in the beam direction and thus allows us to determine the true wind velocity distribution.

Wind Observation in Rainy Area by Using a Weather Radar

As one of the promising observation means that can meet such a demand, weather radar deserves consideration. A weather radar can determine the rain locations with a resolution of several hundreds of meters. It is already used for the deployment of observation network covering the total Japanese territory by the Japan Meteorological Agency under the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). The radar that is basically a rain-intensity-measuring system can also determine the wind velocity in the radar beam direction by sensing the Doppler shift[*1] of a radio wave reflected from the rain. The JMA's radars have recently been made capable of determining the wind velocity by measuring the Doppler shift. However, the wind velocity thus obtained is not a true wind velocity but only a wind speed component in the radar beam direction.

One of the effective methods to observe the true wind velocity using a weather radar is the bistatic observation. Figure 1 illustrates the concept of bistatic observation. In a bistatic observation system, additionally installing a certain number of inexpensive dedicated receiving stations allows us to determine the true wind velocity.

Problems in Bistatic Observation

In the course of practical implementation, the bistatic observation has posed a few challenges. Above all, the one that gave rise to a particularly serious problem was false echoes.

Figure 2 gives the schematic diagram of false echoes. In the bistatic observation, a transmitting station sends pulses with an extremely narrow beam and a receiving station receives the oblique scattering[*2] with a broad beam. In this diagram, since the sent beam is oriented to spot A, the desired object that should be observed is the rain at spot A.

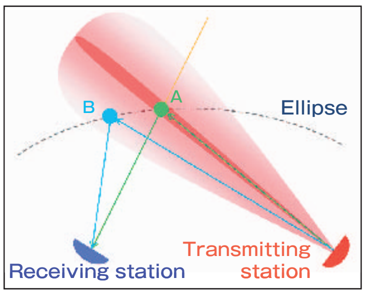


Figure 2 ● Schematic diagram of bistatic observation and false echoing

Here, let us pay attention to another spot B on the same ellipse with positions of transmitting and receiving stations as foci. While almost the whole portion of the radio waves travels from the transmitting station to spot A and further to the receiving station, the existence of side lobe*3 causes a portion of radio wave to travel from the transmitting station to spot B and further to receiving station. Since the length of the two paths is equal, the radio wave emitted at the same time is received at the same time, and thus the data from spots A and B cannot be distinguished. Even if the rainfall at spot A is almost nil, while spot B has a heavy rain, it is observed as if it rained at spot A as well. This is the problem of false echo.

Advanced Bistatic Observation System

Our proposal of the advanced bistatic observation system is illustrated in the schematic diagrams given in Figure 3. It has the following characteristics: (1) in the receiving station, an array antenna consisting of multiple elements is used. (2) A number of fine grating lobes*4 generated because of the longer spacing between elements of the array are utilized. (3) The signal processing of digital beam forming (DBF)*5 is conducted. Using the fine grating lobes and conducting the DBF can significantly suppress the false echo. In Figures 3(c) and 3(d), the influence side lobe is rendered in dense color. In the advanced system, the color of almost the entire portion on the same ellipse is fainter than that of the conventional system, indicating that the generation of false echo is expected to be suppressed.

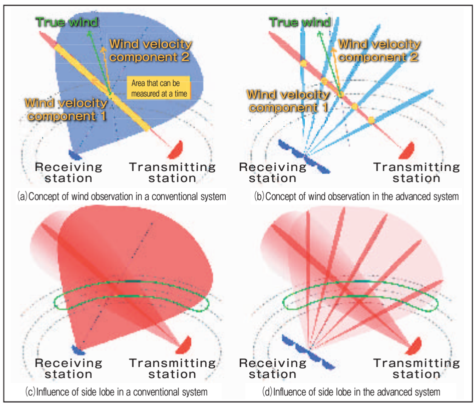


Figure 3 ● Schematic diagram of bistatic observation system

Figure 4 illustrates the results of specific simulations. The received signal time series under the conditions where three isolated heavily raining areas are embedded in the uniform light-rain region is computed. The transmitted beam passes through the rain (2) in the Figure, where the signals of rain (1) and rain (3) are definitely received (false echoes). In the advanced system (after DBF processing), we can see that signals (1) an (3) have been effectively minimized so that the problem of false echoes has been substantially resolved.

Besides the suppression of false echoing, the advanced system presents the advantage that the use of multiple elements array antenna permits the observation of much broader areas. Figure 5 gives the simulated results under uniformly raining conditions to determine the received intensity. Compared to a conventional system, we can understand that the advanced system (after DBF processing) retains higher sensitivity to farther locations.

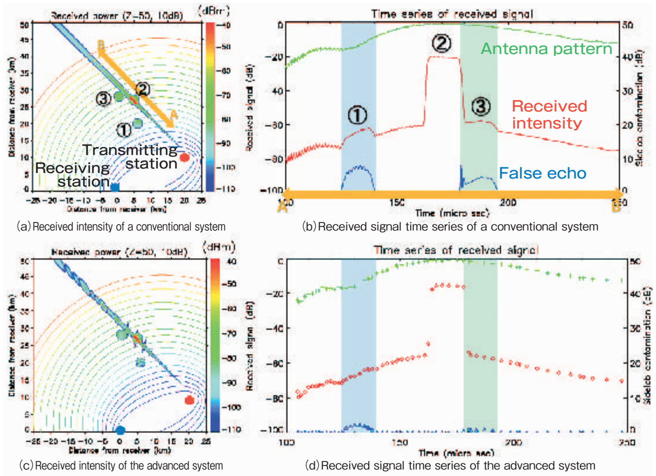


Figure 4 ● Simulation results of received signal time series

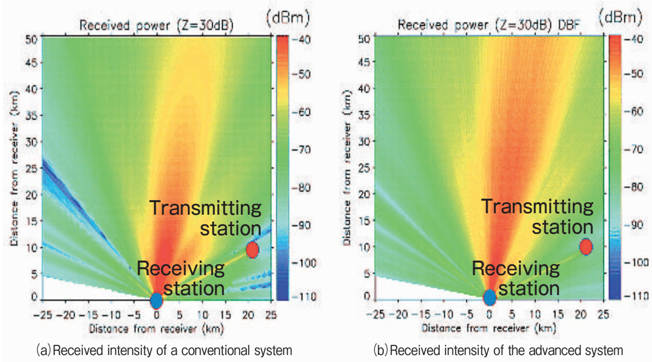


Figure 5 ● Simulation results of received signal time series

Further Development

Currently, we are working on the verification test of this advanced bistatic observation system by using the COBRA, C-band polarimetric weather radar in Okinawa. For the receivers, we will employ the software radio*6 to build up a compact receiving system. For almost all the processing including DBF, software development is an equally important task. Our efforts in this direction are expected to deliver an effective system for local disasters in near future.

The key element of the system introduced here is the receiving system that can function by simply adding it to the existing radar system. By further developing this concept, we may arrive at a "passive radar" that requires no transmitting station and can get necessary data of the atmosphere by receiving radio waves used for other purposes by telecommunication broadcasting. We will further develop this technology, which is attracting interest of the industry from the viewpoint of the effective use of radio frequencies.

*1 Doppler shift: a phenomenon of varying the frequency of radio and sonic waves with the change in the traveling speed of transmitting point, reflecting object, and receiving point. This phenomenon can be observed in the change in sound of a siren when an ambulance vehicle is approaching and then leaving.
In the case of a weather radar, since the extent of variation in the frequency of a reflected radio wave varies with the moving speed of raindrops that constitute the reflector, the moving speed of a raindrop (wind speed) can be calculated from the extent of frequency variation.

*2 Oblique scattering: When a radio wave hits a raindrop, it is reflected not only backward but also in various directions (scattering). While the scattering taking place in backward direction is called backward scattering, the scattering in transverse direction is called oblique scattering. In the bistatic observation, the true wind velocity can be obtained by receiving the backward scattering at the transmitting station by itself and receiving the oblique scattering in parallel at another receiving station.

*3 Side lobe: The beam formed to guide a radio wave in the desired direction is called main lobe. While almost the whole radio wave is directed toward the main lobe, there is a portion of the radio wave leaking in the direction other than the desired one.
The beam of radio wave leaking in undesired directions is called side lobe.

*4 Grating lobe: Although a variation of side lobe, the graiting lobe has a size as large as the main lobe. It is generated when the spacing between elements of an array antenna is made larger than that under certain conditions.

*5 Digital beam forming: A technology to divert the beam direction by applying a post-treatment in the array antenna system.

*6 Software radio: A technology to perform the major portion of control and signal processing on the software. It can adapt to a wide variety of wireless communication systems without modifying the hardware, and thus its low cost and versatility are increasingly attracting interest of the industry in recent years.

Expert Researcher, Space-Time Standards Group, New Generation Network Research Center

Maho Nakamura

● Profile

After acquiring a doctorate in engineering, Maho Nakamura entered the NICT in 2008. Nakamura then engaged in research activities related to the satellite time transfer and the influence of ionosphere on satellite communications.

Compensation Technology Derived from Satellite Time Transfer

Along the progress of GPS in a global framework, high-precision time transfer for the global contribution is being sought

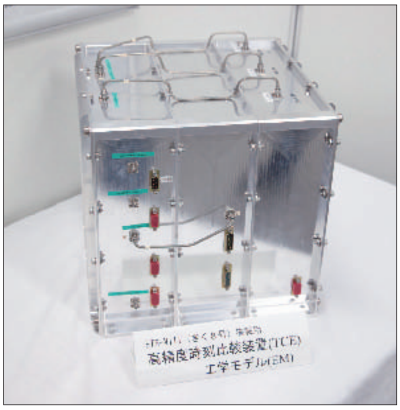
■Ionosphere having a significant influence on communications on the Earth

“The project I am now engaged in is to compare the time difference between the atomic clock on the ground and an on-board atomic clock of the satellite. A TCE (time comparison equipment) is installed on the ETS-VIII (Engineering Test Satellite-Ⅷ “KIKU No. 8”), and the equipment, which has same function of TCE, is also installed on a ground station to determine the time differences by comparing the time transmitted and received from each location. The frequencies can be compared with precision of a picoseconds (10^{-12}).

We measure the time differences by “two-way time and frequency transfer (TWTFT)” method. In this method, the signals are transmitted and received from each of the ground and satellite stations to conduct the measurements. The positioning error reach 30 cm at a deviation of 1 nanosecond (10^{-9}) or 3 cm at 100 picoseconds. Consequently, small precision improvements in time transfer are of critical significance.

The time transfer study has two major purposes. One is to improve the precision in positioning of satellite for such as GPS. Another is to compensate the influence of natural phenomena such as ionosphere with the aim of reaching the ultimate level of precision.

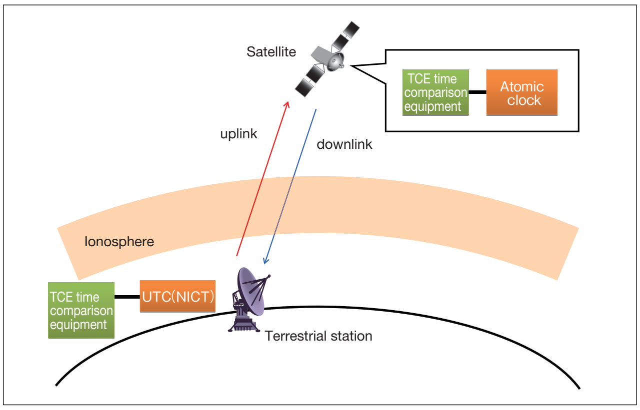
In the operation of satellites and the satellite positioning systems, the time differences give a vital issue. A time difference of a few milliseconds may disable the control of satellites. As a familiar example, GPS may fail to define the correct position without synchronization of time on the ground and on the satellite. That is, the study of time transfer will contribute for precise positioning.



●Engineering model of a TCE on board Kiku 8, a cube with each edge measuring 320 mm and weighing approximately 18.4 kg.

■Shifting from the Study of Ionosphere to That of Time Transfer

“Communications between ground and satellite can be done in light speed when no obstacle exists. In reality, however, the ionosphere and atmosphere affect to the radio propagations and the signal requires to be compensated. Of the geometric path delay obtained by multiplication of radio wave arrival time and light speed (the distance between satellite and ground), the greatest error is due to the clock error itself and followed by delay within the equipment, then ionospheric and atmospheric influence. While each factor requires compensation, since each factor differs in technical and physical aspects, the compensation method requires examination respectively. Compensation of the influence of ionosphere is the subject of my study. The ionosphere consisting of plasma has an electromagnetic influence on radio communications. While the



● Schematic diagram of time comparison: The time indicated on the clock on board the satellite and that on a terrestrial station are compared and the difference between them is calculated two-way time transfer can eliminate all of the errors ideally at the same frequency, the receiving and transmitting signals cannot use the same frequency. Since the difference in frequency between transmitting and receiving leaves the delay due to ionosphere, which must be compensated."

Researcher Nakamura majored in particle physics and high-energy experiments in her university days. After joining the NICT, forecasting ionospheric variations by using neural networks has been her specialty. She is now using her experience for the enhancement of precision in the satellite time transfer.

■Ionosphere having a significant influence on communications on the Earth

The atmosphere covering the Earth consists of a few layers. Of all, the layer ranging from 60 to 800 km is called ionosphere. The ionosphere is sensitive to the influence of the Sun and thus changes its state with the differences of night and day, seasons, and solar activities. Besides the occurrence of abrupt instability (disturbance), complete forecasting has not be established at present. During the occurs of the ionosphereic disturbances, radio communications in low latitude zones near the geomagnetic Equator, such as Southeast Asia, Okinawa, and so on may be significantly affected.

NICT has continuously been observing the ionosphere since it was operating under its former organization called Radio Research Laboratories and conducting studies to forecast ionospheric disturbances through various approaches. Researcher Nakamura makes full use of the data accumulated during the past years for her studies.

■Japan's role in the global collaboration relationships

The United States is so positive in ionosphere observation that it launches satellites for the observation purpose. Japan has so far conducted the observation on the ground and by using GPS network. "Kiku 8" is Japan's first experimental satellite equipped with an atomic clock, which ear-marked the start of full-fledged time transfer studies, and has been accumulating data on ionospheric influences on satellite positioning. In addition to the TCE of the Kiku 8, the newly built time transfer system (TTS) has been installed on the first Quasi-Zenith Satellite "Michibiki." As soon as the Michibiki is launched and successfully operated, the team will start the time transfer experiments.

Unlike the TCE on board the Kiku 8, the TTS on the Michibiki employs high frequencies for the communications that are slightly affected by the ionosphere compare to Kiku 8. Nevertheless, in a period when solar activities are brisk, the required time transfer precision of devices located at Okinawa and other areas near the magnetic Equator may be affected and thus requires continuous monitoring. Accordingly, we would have to formulate some numerical models of ionosphere for application to the required compensation. Furthermore, when the ionosphere is in the state of disturbance, time transfers may be affected and thus we would have to study the required systems be taking such data as space weather forecast.

Researcher Nakamura is occupied with the preparatory work for the time transfer experiments to be conducted on the Michibiki. The data obtained from the Michibiki are expected to serve as basic data for enhancing the precision of time compensation

"The Global Navigation Satellite System (GNSS), which was originally developed for military applications, are now constructed by many countries including Japan in competition as its own system. I hope that all the countries in the world will collaborate to make it a convenient system."

"Monozukuri" Production Systems Satisfying the Researchers

NICT Workshop

(Part II)

Further to the preceding issue, we would introduce our NICT Workshop.

Prototype manufacturing requires handing down expertise to future generations.

── This building for the workshop looks new.

Nakamura: This one has been used since December 2008. The machining section where machine tools are installed is maintained at a fixed temperature to prevent the aging changes in materials. Also, the foundation for precision machinery in the machining room and measuring room has anti-vibration structures.

── How long have these facilities for the NICT Workshop been used?

Komuro: We have had fabrication department ever since the old times of the former organization, Communications Research Laboratory, and far older the Radio Physics Laboratory.

Nakamura: The oldest one documented in the history of Radio Physics Laboratory was here in 1946, which means that the facility was provided already at the start of RPL in 1952.

── For researchers, was such a facility as NICT Workshop required?

Nakamura: Definitely. As we are engaged in research on some leading-edge subjects that do not exist in this world, the components and parts used for our studies and experiments could be unavailable in the market. In other words, we must prepare those things by ourselves.

Particularly in those days after the World War II, there was nothing on the market, and thus we had no choice but make them by improvising those unique things.

Komuro: In those days, there was a woodworking room where carpenters fabricated some objects in wood, and we had a photo developing room for photographers.

Nakamura: Our staff is getting smaller in number. These techniques can be handed down only through person-to-person relationships, and while we must teach our successors, we are having a hard time without having enough number of people.

── Do you have any training program to hand down your skills and techniques?

Komuro: We, the staff of NICT Workshop, have to improve our expertise by ourselves. For our colleagues in other departments, we give a machining training course every year. This year, we held the course from July 7th to 9th (Fig. 1). Some of the researchers come to our room and fabricate objects for their own use. Quite a few researchers can now operate a numerically controlled milling machine*[1] these days.

── It must be tough to support the research activities of NICT with a limited number of staff.

Komuro: Not every request is adequately responded here. Those jobs that could be carried out by external manufacturers are actually subcontracted to them, and a surface treatment such as plating is done by specialized contractors.

Figure 1 ● At a machining training course Expert Jun-ichi Komuro operating a milling machine

Figure 2 ● Fixing a supporting point of a Foucault pendulum Expert Jun-ichi Komuro at work

Nakamura: Categories of fabricated items are on the increase ranging from optical systems to vacuum systems. Thus, we need not only machining aluminum blocks but also stainless steel and titanium fabrication. The range of types of fabrication is always expanding.

Komuro: We would always leave room of our capabilities to meet any demand surge. When someone wants us to prepare something while we are fully occupied, we cannot flatly turn down their request, otherwise they would be at a loss. That's why we always think that someone in our group can handle an urgent request.

── Do you work on each fabrication request separately?

Komuro: Yes, it's the case it goes most frequently. For each request, we assign it to the right person who is good at for the specific request.

Nakamura: When an item must be finished very urgently, three of us would work on it by sharing the job.

── I guess you have to keep up the spirit of craftsmanship.

Komuro: It's amusing to work on an object in different ways. When we improvise a new part by creating a new fabricating technique, we find it very challenging.

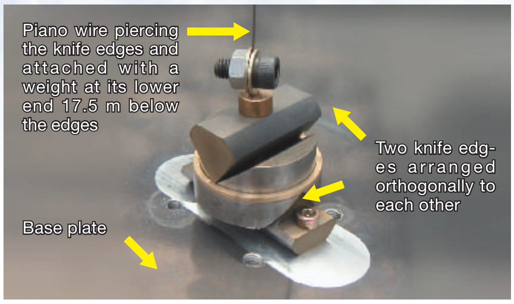


Figure 3 ● Supporting point mechanism of a Foucault pendulum

Unique technique worked out to prepare the Foucault pendulum that has been showed to the public at the open house

── You exhibited the "Foucault pendulum"*[2] at the open house. Could you tell us what sort of implications made you prepare the pendulum?

Komuro: During the event called "Science Camp" intended for high school students, which has been held by NICT every year since 1997, we came to give a lecture on the axial rotation of the Earth in 2001. As the simplest object with which one can understand the axial rotation of the Earth, we thought of showing the "Foucault pendulum" for the start of the project.

Nakamura: At first, we prepared it in only two weeks. As the first product was execellent, we decided to present it at the next open house.

Komuro: When Foucault first made the pendulum, it had a weight in a sphere form. We at NICT fabricated it in a cylindrical form. However, the swinging motion of the cylinder did not last long because of air resistance, and it would need to be pushed every two hours. Then, we did a total design change in 2004.

── How did you elaborate ?

Komuro: The length of time to swing can be longer either by reducing the air resistance of the weight and piano wire or by using a longer suspended wire. However, the pendulum was suspended from the vaulted ceiling of a four-storied building (17.5 meter high), which is the maximum height. While we were carrying on a trial-and-error attempt to get such a shape that has a heavy enough weight and minimum possible air resistance, we found out that making a vertically long weight did not prolong the swinging cycle, but making it wider in the horizontal direction was effective, and thus we finally employed a disk-shaped weight. The swinging cycle was prolonged 2.5 times, and giving a thrust every four hour was found satisfactory. An amplitude of 60 cm was assured even five hours after thrusting.

Besides the shape of the weight, the gravimetric weight of the pendulum was another important subject. Since we installed it by ourselves, the gravimetric weight was already determined to a certain range, and the diameter was determined to a certain upper limit depending on the machining ease. What was left for our review was the material.We decided to select the material having the highest specific gravity per unit volume. Thus, we finally came to pick up a customarily called gunmetal or bronze.

—— Is a disk-shaped work piece easy to machine?

Komuro: While bronze itself is easy to machine, a disk can be machined only by providing a jig (a fixture that holds an objects to be machined in place). We devised such a method using the fixing point for the piano wire to fix it to the jig.

We employed a mechanism called knife edges in combination to fix the piano wire. The sharper the knife edges, the smaller the resistance when the pendulum is inclined. We designed this by the suggenstions given by Mr. Katsuhiro Sasaki, (then, the Director of the Department of Science and Engineering at the National Museum of Nature and Science (current Curator Emeritus), to vary the shape of the edges and other parameters. Also, we employed a tungsten carbide alloy for the edges to prolong the rotation, as the worn edges prevent the pendulum from swinging straight.

To prevent the orthogonally matching edges from staggering, the machining precision of these parts must be highly enough. Accordingly, we maintained the precision within 5 microns by using a wire electric discharge machine.

—— Well, while appearing as a simple device, it had been made on a profound design philosophy. I hope visitors who watched the experiment of Foucault pendulum will be enchanted by the wonders of the movements of celestial bodies and the Earth. Thank you very much for your cordial explanations.

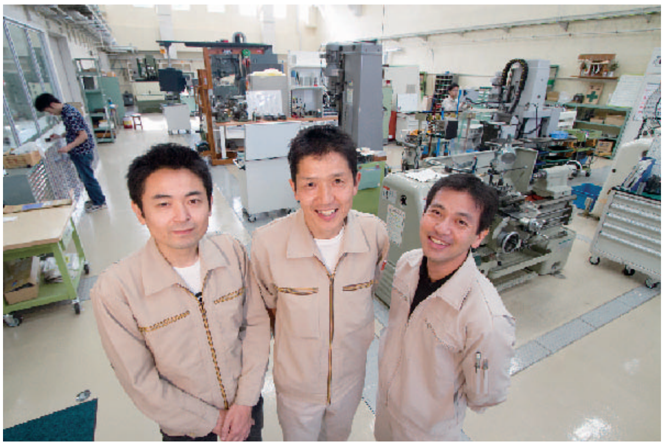


Figure 4 ● From left to right: Shinya Inoue, Jun-ichi Komuro and Kenji Nakamura

Terminology

∗1: Numerically controlled milling machine

Milling machine is a machine tool that performs machining of planes and grooves by using a rotating cutter. A milling machine that can be controlled by a computer by inputting required numeric values is called numerically controlled (NC) milling machine.

∗2: Foucault pendulum

Allowing a pendulum consisting of a sufficiently long string and a weight to swing in a location other than zones close to the Equator, the plane of oscillation will move as if it is rotating. This is caused by the Coriolis force due to the axial rotation of the Earth. Since Foucault performed a public experiment in 1851, it is called Foucault pendulum.

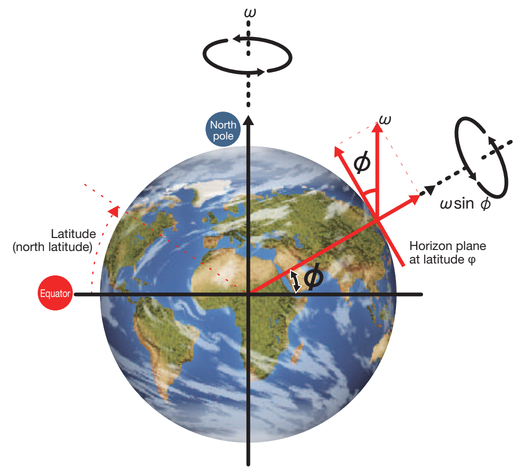
Column: Why can we see the axial rotation of the Earth?

The motive of the NICT Workshop staff for setting up a Foucault pendulum was to explain the axial rotation of the Earth and location to high school students. Then, why the Foucault pendulum can tell the axial rotation of the Earth?

The longer the pendulum, the slower the pendulum swings. The Foucault pendulum exhibited at the NICT open house was hung from 17.5 meters high, and its cycle was 8.4 seconds. Repeating this slow swinging invariably shifts the plane of oscillation at a constant amplitude per swing in the clockwise direction. The impetus causing this shift is in fact the axial rotation of the Earth.

Suppose, we could look down this pendulum from the outer space, we would always see it swinging on a constant plane. The subject that is rotating is in fact our Earth where we live, and the plane on which pendulum is swinging is no more than apparently shifting from the original plane.

First, imagine the pendulum swinging at the North Pole (north latitude of 45 degrees), while the pendulum observed from the outer space is always swinging on the same plane of oscillation; since the Earth is rotating (at a rotating speed of ω) counterclockwise around the axis of the North Pole, when we look at the pendulum from the North Pole, the plane of oscillation of a pendulum appears to be rotating at a speed of ω in the clockwise direction. The rotating cycle is one turn a day.



Then, let us assume swinging the pendulum at a spot on Earth other than the North Pole. The horizontal plane at the spot of latitude ϕ should be rotating counterclockwise at a rotating speed of $\omega \sin \phi$ (see the Figure). That is, at any spot on the northern hemisphere, the Earth should be rotating counterclockwise and the rotating speed is higher at a higher latitude and lower at a lower latitude. In this instance, the pendulum observed from the outer space is constantly swinging on the same plane of oscillation. In contrast, when we look at it while we rotate ourselves together with the Earth, the pendulum appears to be shifting in the clockwise direction (where the apparent force applied to the pendulum is called "Coriolis force"). This is the reason why a Foucault pendulum is shifting in the clockwise direction on the northern hemisphere. Concurrently, the magnitude of the shift is smaller at a lower latitude and greater at a higher latitude.

On the southern hemisphere, since the Earth is rotating clockwise, the shifting direction of a Foucault pendulum is counterclockwise.

On the Equator, while a pendulum continues to swing while constantly keeping the swinging plane in the cosmic space, the Earth is just rotating in the direction perpendicular to the plane of oscillation and thus it does not affect the pendulum plane of oscillation, which does not rotate.

Thus, once you understand the principle of Foucault pendulum, you would find it marvelous to witness the evidence of the Earth actually rotating.

Report on the 2010 NICT Open House

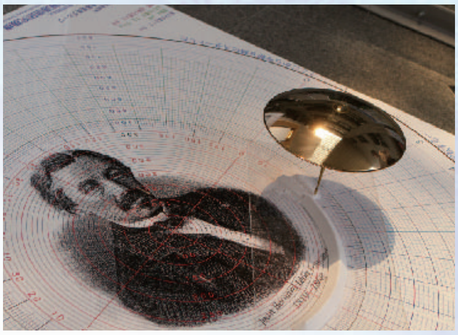
To introduce NICT's research and activities to its neighbors and let visitors enjoy themselves watching the fascinating phenomena of science and technology, we held this annual event throwing the facilities open to the public during the summer vacation of primary and middle school students.

Headquarters: Infinite Possibilities! New Technologies!

Friday 23rd and Saturday 24th of July: 3474 visitors

At the entrance, visitors were welcomed by Foucault pendulum swinging to a slow rhythm. Its several presenters were constantly surrounded by visitors, who were fascinated by the presenters' talk.

On both days, as the temperature soared to 35 ℃, the visitors including families waited in a long queue for the gates to open.



Foucault pendulum

The t-Cup Challenge is a contest organized by NICT since 2009 in collaboration with the Institute of National Colleges of Technology, Japan, with the aim of allowing as many people to relate to the "Japan Standard Time" maintained and operated by the NICT. (In the "Technical Contest," each team consisting of three or less students of a National College and/or a high school build a master piece "mono (goods)" with innovative ideas on the theme of "toki" (time) and compete with other teams to win the prize.)

The rescue robot gains popularity among children.

Observation images photographed by the Polarimetric and Interferometric Synthetic Aperture Radar (Pi-SAR) was one of the attractive spots this year as well.

A girl is operating the sensor-embedded ball with hands, enjoying the variation in the sonic directivity.

Handicraft Workshop for children making "solar locusts" that are activated when exposed to light.

Children playing with "solar locusts" they made in the workshop.

Visitors attracted by 3D display of whole-body voxel human model.

4-dimensional visualization of space and geoscience data on the earth using a spherical screen: four-dimensional digital globe "Dagik Earth" that can be rotated using a controller for home game system.

Researchers' Lecture Meeting

Lecture presentations by NICT researchers were held this year for the first time. Each of the seven lectures given in two days had approximately fifty participants who also took part in question and answer sessions. Comments in the duly filled questionnaire confirmed that "the lectures were easy to understand."

Friday, 23rd of July

"Three-Dimensional Image Technology and NICT's Efforts"
Kenji Yamamoto, Senior Researcher, 3D Spatial Image and Sound Group, Universal Media Research Center

"Looking down the ground from above clouds – Airborne SAR"
Seiho Uratsuka, Group Leader, Radiowave Remote Sensing Group, Applied Electromagnetic Research Center

"Frequency Standards: Foundation for the Accurate Determination of the Space"
Tetsuya Ido, Senior Researcher, Space-Time Standards Group, New Generation Network Research Center

Saturday, 24th of July

"Revolution in Machine Translation"
Eiichiro Sumita, Group Leader, Language Translation Group, Knowledge Creating Communication Research Center

"Disaster Emergency! How Can Communication Systems Stand?"
Osamu Takizawa, Group Leader,, Disaster Management and Mitigation Group, Information Security Research Center

"Controlling "Light" and Linking with "Light"
Tetsuya Kawanishi, Research Manager, Advanced Device Research Group, New Generation Network Research Center

"Ultra-High Difinition VideoCommunications Realized by Wideband InterNetworking engineering test and Demonstration Satellite "Kizuna" (WINDS) and Their Applications"
Ryutaro Suzuki, Group Leader, Space Communication Group, New Generation Wireless Communications Research Center,

Kobe Advanced ICT Research Center Kobe Research Laboratories: Touch the Future of Information and Communications Technology!

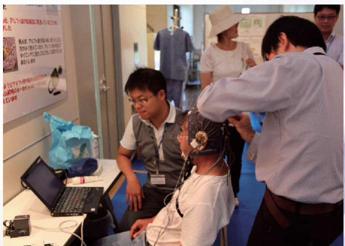
Saturday, 24th of July; 695 visitors

While answering quizzes provided by each research project team, visitors had a close look at exhibition at each of fourteen halls spreading over four research buildings. Among each display booth, they enjoyed hands-on experiments and displays such as "brain wave measurement", "cryogenic temperature experiments", "nanotechnology", and "manufacturing your own microscope", which had been developed by the respective research project groups. Researchers presented their researches to the visitors, whom seeing exclusive research facilities. For those visitors, in particular, sharing time with researchers seemed special.

How will vegetables and balloons turn out if they are frozen at -200°C ? Solid vegetable "komatsuna", pale blue liquid-oxygen that sticks to a magnet, demonstrations of the superconducting light detector, etc. The visitors experienced the world of "cryogenic temperature" and "superconductivity".

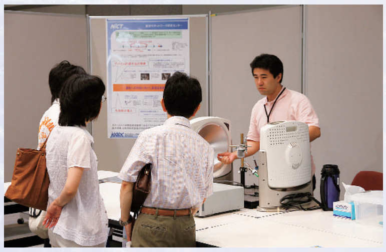
"Manufacturing your own microscope" At this corner, visitors assembled a Leeuwenhoek microscope. Onion cells, pores of tsuyukusa grass, and even living microorganisms were observed with it.

"DNA extraction experiment" The students and other visitors successfully extracted the DNA of broccoli and compared it with that of salmon.



Are you relaxed now? The alpha rhythm was measured by "brain wave measurement" demonstration and the visitors were given explanation on it.

Using technology for making good use of molecules. The small world of the "Nanotechnology" with organic molecule was introduced.



How will a hot object behave when it is placed close to a parabolic reflector? An experience of heat radiation.

Researchers' Lecture Meeting

This year we held the third "Researchers' Lecture Meeting" with the three researchers specializing in biological algorithm, nanotechnology, and neural information science to cover advanced technologies ranging from complex networking science and nanodevices to brain function imaging technology. With the hall packed to capacity, each lecture for morning and afternoon session was held to discuss issues and phenomena at hand and studies on cutting-edge technologies. The audience consisting of different age groups listened to the lectures and eagerly asked questions.

A lecture meeting

"Wonders of Relating"

Hidefumi Sawai, Research Manager, Biological ICT Group

"Invitation to the World of Nanometers"

Toshifumi Terui, Senior Researcher, Nano ICT Group

"How Deep Can You Look into Someone's Mind?"

Liu Guoxiang, Senior Researcher, Biological ICT Group

Kashima Space Research Center Dreams Prevail from the Space

Saturday, July 31; 1268 visitors

When we posed a question to some of the children among the audience, "What did you find most interesting?" they answered: "PET bottle rocket!", "Climbing up the parabolic antenna", " Making a kaleidoscope (in handicraft workshop)." Thus, they seemed to have been attracted by the interactive events. The "antenna touching" event with the giant antenna having a diameter of 34 meters tilted down once every hour made a long line of visitors as well as last year. Some of the parents and children groups were found cheerfully talking while watching the panel displays on satellites and space debris.

A long queue of people waiting more than an hour for the gates to open.

Antenna touching
We allowed the antenna facing the sky to come down close to the ground once every hour so that it could be touched .

Can collapsing
It is an experiment to allow visitors to feel the atmospheric pressure. The heated can is full of vapor. The water in the bath works as a plug and rapidly cools the vapor in the can to create a near-vacuum space inside.

PET bottle rocket
As it flew to an unexpectedly far off spot at a speed of 40–50 km/h, we relocated its launching base again and again.

Children watching space debris images

Handicraft workshop for children who are making kaleidoscopes making use of marbles

Report on the 4th New Generation Network Workshop

Live Demonstration of Current Progress and Further Attempts

Hiroaki Harai, Group Leader, Network Architecture Group, New Generation Network Research Center

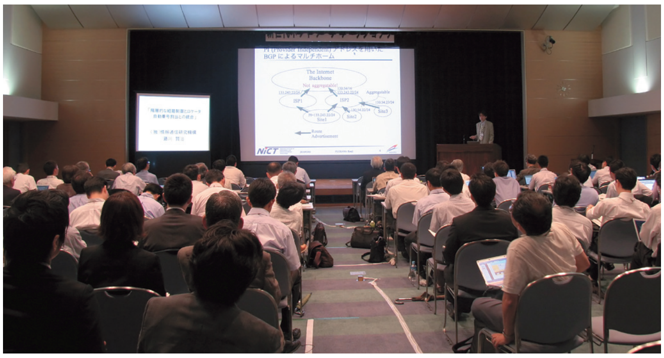
The 4th New Generation Network Workshop was held on Jun. 23, 2010 at NICT headquarters, sponsored by NICT itself and cosponsored by the New Generation Network Promotion Forum, participated by 161 people to make it an exciting event.

In the morning, as a current program of NICT New Generation Network, the members of AKARI Architecture Design Project presented the technologies that will form the core of the new generation network. Specifically, they introduced the "ID/locator split architecture" and "hierarchical automatic locator numbering assignment" as the architecture to meet the diversified requirements of users' needs in the data communications on the increasingly convenient mobile systems and to solve the complexity of network administration. The former will serve as a promising technology to perform communications seamlessly across the future networks and vehicles communication network in addition to the current network of IPv4 and IPv6. The latter is another promising technology to simplify network administration, eliminating human errors, and realize network traffic control for energy saving and at high speeds.

Moreover, optical packet and circuit integrated network that will constitute the high-speed, low-cost, and low power consumption trunk utility network as well as the regional network for information sharing and network virtualization that are wireless access network platforms, each of these systems being introduced as a technology to deal with the services diversification.

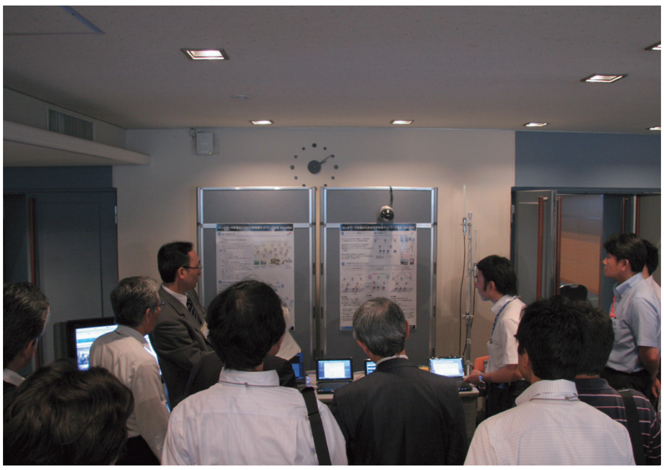
In the afternoon, we performed demonstration of live systems spending two and half hours so that the visitors could watch the actual pictures of new generation networks. As a result, we received direct responses from a number of visitors for their expectations toward the future. We will make feedbacks for the visitors' comments and will work on further development and introduce the results.

In the late afternoon, as an additional new attempt, we introduced our future efforts such as strategic new generation network and new generation network testbed program. Thus, we believe that the workshop successfully presented NICT's current status and future plans to a great number of participants.



Snapshot of a workshop

Snapshot of a demonstration of live objects (Optical packet and circuit integrated network)



Snapshot of live objects (Regional network for information sharing)

Report on a Special Lecture by a Science and Technology Advisor

"Optical Communications Connecting the Satellites with Ground Station"

NICT endeavors to share information and results on its research with educational institutions to further the education and research with the aim of contributing to the growth of both academia, and science and technology. In the Koganei City where NICT headquarters are located, there is the Tama Science and Technology High School of Tokyo Prefecture (Principal Takashi Ekiyama), established in 2010, where a large number of students interested in science and technology are studying. The high school has the "Science and Technology Advisors" system supported by universities, research organizations and some enterprises concerned with research on cutting-edge technologies.

Senior Researcher, Yoshihisa Takayma giving a lecture

As part of the efforts of this institution, special lectures on science and technology were given by the advisors on July 13. Yoshihisa Takayama, Senior Researcher with Space Communication Group, of the New Generation Wireless Communications Research Center gave a lecture addressed to the first grade of the high school. Such lectures are organized twice a year and each advisor is responsible for one of these lectures.

In his lecture, Takayama discussed satellite and space communications.

"Optical communication is a type of communication that makes use of laser beams. It is an original Japanese technology successfully used for the world's first optical communications between ground stations and a satellite, and I am going to talk about the experimental satellite called "Kirari" intended for inter-satellite optical communications that has successfully performed the two-way inter-satellite optical communications." The students enthusiastically took notes and listened to the impressive 90-minute lecture given by the real research engineer.


Students listening to the talk on optical communications

After the lecture, the students asked such specific questions as "How do you operate the satellite?" and "How long is a laser beam?". We believe that we were able to give new perspectives to the high school students who were dreaming of their future activities in the science and technology fields.

Information for Readers

The next issue will feature "Traceable Network Technology" that will help us build networks for detecting, analyzing and guarding against cyber attacks.

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