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Shake Hands

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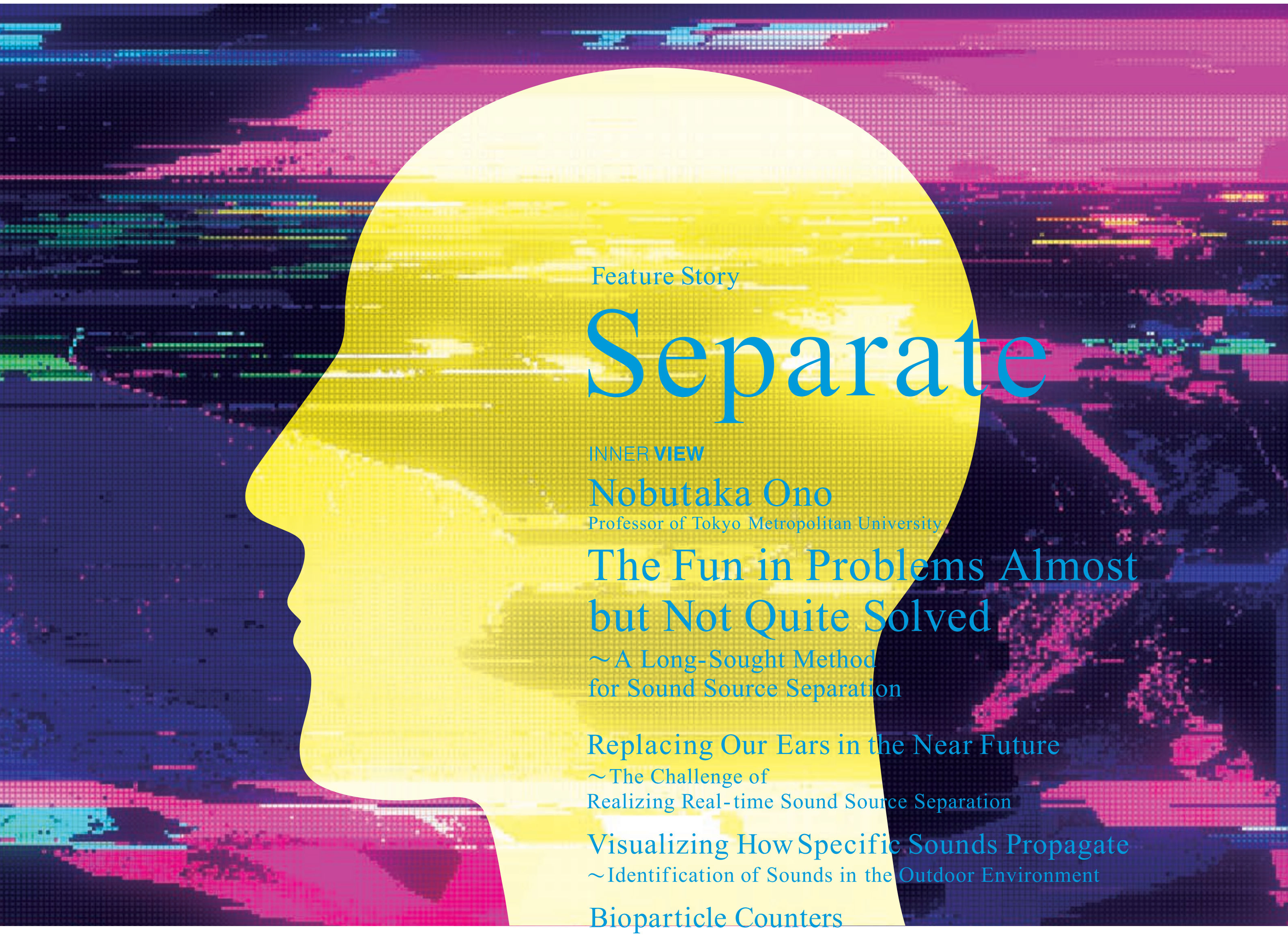

Feature Story

Separate

RION CO., LTD.

Nobutaka Ono

Born in Miyagi prefecture in 1973, Professor Nobutaka Ono earned his Ph.D at the Department of Mathematical Engineering and Information Physics, School of Engineering, University of Tokyo in 2001. After taking positions at the graduate school at the University of Tokyo and then the National Institute of Informatics, he became a full professor at the Tokyo Metropolitan University in October 2017. His research topics involve acoustic signal processing, microphone arrays, sound source separation, sound source localization, music signal processing, and machine learning. He has published numerous research papers and has won many awards for them. During his university years, he was a part of an ethnic music club and played the charango, an instrument from the Andes region in South America (photo).

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The Fun in Problems Almost but Not Quite Solved
~A Long-Sought Method for Sound Source Separation

Text by Michinari Okazaki / Photo by Megumi Yoshitake

A signal processing method that lets the listener hear the voice of just one person through headphones, even when two persons are speaking at once — equations cover the whiteboard of the creator of this magical process.

Conviction Reinforced on a Flight

The first time Professor Ono became truly convinced of the feasibility of the method was on an airplane.

"I'd been thinking about it for a while, but one time, on a flight back from an international workshop (WASPAA[*1]) held in the United States in 2009, I came upon an idea and devised a program, which I then wrote and ran. And I thought to myself, 'Wow, this might actually work.'"

Professor Ono specializes in acoustic signal processing. What he was working on at the time was a method for separating mixed sounds—in other words, sound source separation.

"People in lots of countries have studied sound source separation since around 1990. At the time, I was a doctoral student. I was interested in the topic. But since Japan was one of the leaders in the field, I didn't believe there would be all that much left for me to work on. But, then, I came across a mathematical framework that could very efficiently solve certain types of problems. I had the intuition it could be applied to source separation."

Human beings are capable of carrying on conversations while exposed to background noise because our brain is capable of analyzing the sounds that enter our ears to focus attention on the voice of the person we're talking to. Making machines do this, however, is a major challenge. In cases in which the direction of the sound source is known, we can apply a method known as "beamforming." The method employs a highly directional microphone system to capture sound from the desired direction. In contrast, technology for separating sound in cases in which prior information, such as the direction or kind of the sound source, is unavailable, is called "blind source separation." It's a more sophisticated technique that focuses on voice communications in complex sound environments.

*1 WASPAA: IEEE Workshop on Applications of Signal Processing to Audio and Acoustics

A New Method for Sound Source Separation

The scheme of audio separation is analogous to solving simultaneos of equations.

"When you record sounds from two sources using two microphones, you get a mixed signal of two sounds. If you treat the mixed sound as simultaneous equations, you can, in principle, separate it into the two sources."

But the coefficients needed to formulate the simultaneous equations remain unknown—hence, the name blind source separation. To solve the simultaneous equations, the coefficients must be determined. This task corresponds to

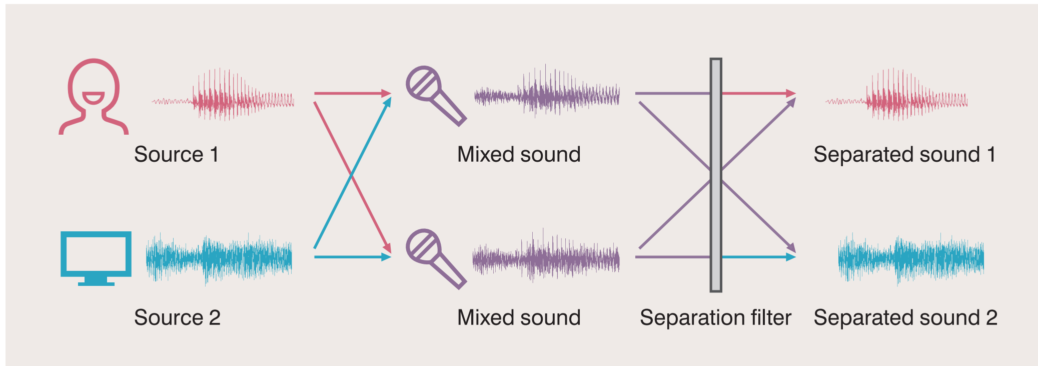


Fig. 1. Scheme of processing for sound source separation focusing on the independence of sound sources

designing a separation filter. To determine the coefficients, some criteria must be established first. One is independence. If sound sources are independent of each other, the best strategy is to find coefficients that will maximize the independence of the solutions. After assigning provisional coefficients to the equations and solving them, the independence of the solutions is checked. The coefficients are then tweaked to see how the independence changes. In this way, we find the optimal set of coefficients (Fig.1). Historically, over the past 20 years, signal processing focused on the independence of sound sources in this sense has been studied. This left unsolved various issues, including the imperfect quality of the separation and massive computational costs. Various techniques have been proposed and separation performance has improved, but the voluminous calculations required remained a major obstacle to the application of the technique.

At WASPAA in 2011, two years after Professor Ono came upon the potentially promising method, in a paper he showed that a new method called an auxiliary-function-based independent vector analysis (AuxIVA*2)could be applied to the blind source separation problem. The paper was subsequently nominated for a best paper award. The new method, in the words of Professor Ono, was "surprisingly effective." The significantly lower computation costs allowed blind source separation to be implemented on iPhones (Fig.2).

"Before this method, calculations had to be repeated hundreds of times. Depending on the set of parameters employed, sometimes the calculations even failed to converge, which made the technique unreliable. Now, calculations only need to be repeated 10 to 15 times to converge and separate sound successfully."

*2 Auxiliary-function-based independent vector analysis: A method that uses auxiliary functions to quickly obtain optimal solutions for determining source separation filter coefficients under the assumption that sound sources are independent of each other.

Fig.2. Sound separation system implemented on an iPhone

©Nobutaka Ono

A sound lasting 10 seconds can be separated in 2-3 seconds. (2012, on iPhone4)
A demo video is available here : https://youtu.be/lLMbflDMMeE

Personal Computers with Voice Synthesizers and Ethnic Music Without Scores

Even as a child, Ono loved to calculate and spent time playing with calculators. What piqued his interest in sound was a personal computer his parents bought for him when he was in the fourth grade.

"The computer my parents got for me was a PC-6001 MK II from NEC. The MK II had a voice synthesizer as a standard feature. I could command it, in BASIC, to make it reproduce the sounds in the Japanese language. The phonology was clear, and the system also pronounced consonants. In the models that followed, you could assign musical intervals to make the computer sing. I found it fascinating. I had no musical talent—I can't play the piano at all—but I could program my computer to perform a magnificent piece using counterpoint by Bach. That excitement was the incentive for experimenting with a kind of a forerunner of DTM (desk top music) all by myself.

His favorite computer magazine carried a section on sound making. Ono used to reproduce sounds and music from his favorite games on his computer.

"There was a section that let you try to reproduce the sounds in commercial games. I tried creating sounds made by a violin or a trumpet, by tuning the parameters of FM tone generator or tried to control the intensity of the sound to produce soft echo effects. I had fun playing around in that way with sound."

In university, he chose to join an ethnic music club that performed Central and South American music. "The club members seemed to be really enjoying themselves when they were recruiting us freshmen," he recalls. There he took up an instrument called a charango, which resembles an ukulele. Since no scores for the ethnic music were sold in the commercial mainstream, he had to transcribe the scores himself for the music he wanted to play.

"I'd listen to the music on a cassette tape recorder we had in the clubroom and try to transcribe the melody parts for the charango. But my fellow members would often tell me, "Ono-kun, I don't think you have this part right." It was so frustrating that I came up with the idea of creating an automatic music transcription system program using a personal computer. That's what got me into signal processing."

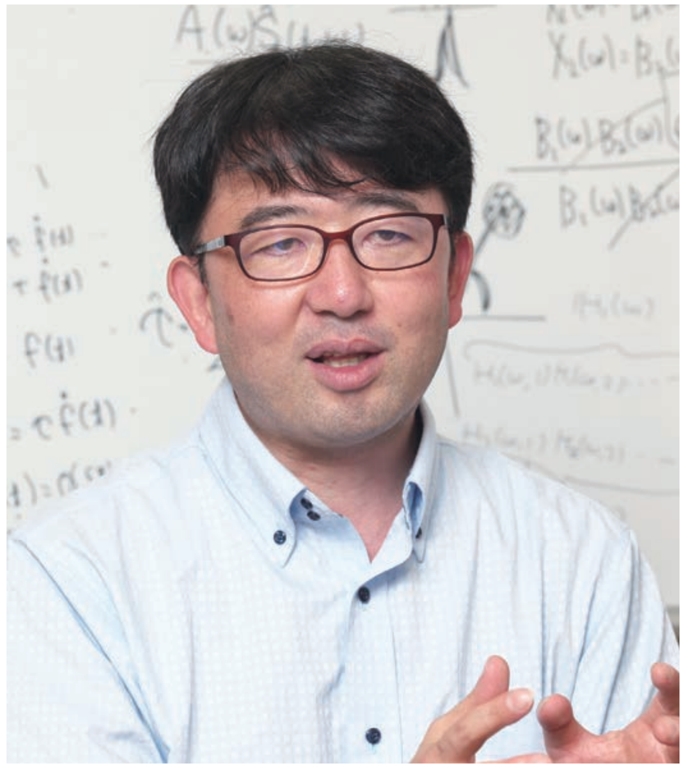
Linking Mathematics to the Real World —— to the Department of Mathematical Engineering and Information Physics

At the same time, Ono was drawn deeper into mathematics. In high school, he began reading Mathematics Toward University, a magazine that prepares students for university entrance exams, which brought the practical implications of matrices and linear transformations and a new-found fascination with computation. But it wasn't mathematics that he studied primarily in university.

"In university, there's math in the strict sense, like mathematical analysis. It's extremely abstract, and some of it doesn't involve numbers per se, even though it's math. And I felt what I liked about math was the process of computation, not the math itself."

In his junior year, during the department introduction seminars in which students choose their major, the department that caught his attention was the Department of Mathematical Engineering and Information Physics. This is the department in the Faculty of Engineering most closely oriented towards the field of science. A unique department in the world of Japanese universities, it had the goal of imparting an understanding of real-world phenomena through mathematical models. The department emphasized approaching phenomena by treating them as a system. The department had introduced computers to its endeavors soon after it was established. Here, computation, Ono's favorite pastime, was being used to understand the real world and to find solutions to problems. He found this a major draw.

"The department introduction presentations included a seminar called 'Systems Science for Intelligent recognition and Behavior.' It introduced applications to image and acoustics processing. That was when I decided, 'This is it!' I realized how useful the differential equations and matrices I'd studied could be. That left me with no doubt it was what I wanted to do."



Later, as Ono studied sensors under Professor Shigeru Ando, and music signal processing under Professor Shigeki Sagayama, he realized engineering was his calling.

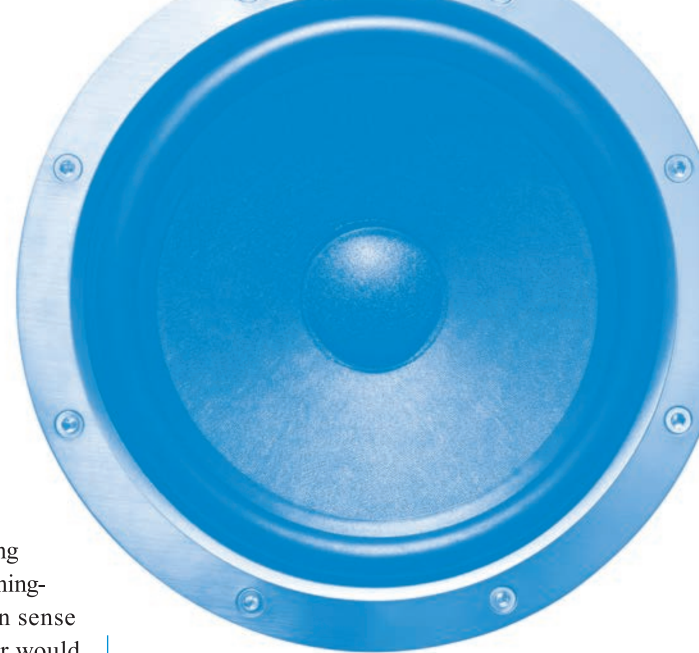
"I love elegant mathematical solutions, of course, but once the problem's solved, I want to code the solution as a program and apply it in the real world. I also don't get much satisfaction from employing all sorts of complicated logic just to achieve a 1-dB enhancement in performance. [laughs] I always feel there have to be reasons for rising to the difficulty of the endeavor."

Problems That Are Fun to Think About

"When I was a child, I wasn't good at asking other kids to let me join them, and I preferred reading books all by myself. So I thought I'd be better off studying or doing research on my own. But once I became a researcher, I found I had to meet and communicate with other people on a regular basis and that I had to go out into the public and make presentations. It ended up being a job that required me to connect with many diverse people. In that way, it turned out to be quite different from what I'd expected. [laughs]"

As a researcher, Professor Ono has published numerous papers and won numerous awards. He feels it's important to approach the most complex problems with patience.

"Even fretting over a seemingly insoluble problem for a while may actually be beneficial. I pondered how to apply auxiliary functions to sound source separation for nearly two years. Some problems can't be solved, and some have already been solved, and somewhere in between are those problems that seem to be on the verge of being solved, but aren't quite. The process of figuring out how to solve these is the most interesting part. I always keep my mind on problems like this —I'm constantly working based on the feeling that a certain approach might work for a certain problem. That's the fun part of my research. If the approach fails, I come up with an alternative method and keep going. I believe the number of different approaches to problem-solving you accumulate over the years—how much you have stocked—is what determines your output capacity."



Separate

Feature Story

Larger things into smaller things
Complex things into simpler things
Humans have always taken things apart
and divided them into smaller pieces
as part of the effort to get the whole picture.
Let's zoom into the technologies
used to discern visual images or sound.

01 Joint Research

Replacing Our Ears in the Near Future ～The Challenge of Realizing Real-time Sound Source Separation

Here we introduce the intensive efforts made to expand the range of applications for sound source separation technologies, which allow the extraction of specific sounds.

*Joint research by Professor Nobutaka Ono of the Tokyo Metropolitan University (see page 2) and Rion

Masahiro Sunohara
(Business Technology Development Section)

What is sound source separation?

In a real-world environment, numerous sounds coexist and are mixed with each other. Sound source separation technologies allow the separation and extraction of specific sounds from this babble of sounds. One technology involves "blind source separation," which separates sound from mixed sounds whose source locations are unknown. This technology has numerous promising applications, including voice manipulation over an AI speaker, noise monitoring of independent sound sources, improving the sound quality of hearing aids, and processing music and movie data.

Challenging auditory perception

In the early 2000s, Masahiro Sunohara and his colleagues at Rion hosted study sessions on blind source separation at the company but felt practical applications of the technology still remained years off. Back then, it took more than 30 minutes for a personal computer to execute the calculations needed to separate mixed sound signals lasting just 10 seconds, and the separation performance was far from satisfactory. Since then, the tide has changed, thanks to the proposal of an innovative algorithm for blind source separation called "auxiliary-function-based independent vector analysis" in 2011 by Professor Nobutaka Ono, who was affiliated with the National Institute of Informatics at the time. His algorithm significantly improved separation performance and computational costs.

"I read Professor Ono's paper and tried implementing his algorithm. To my amazement, I found that the voice of one of the two speakers had completely disappeared. It was totally different from what I'd been able to do up to that point. I thought to myself,' The only thing that remains to be done to get it ready for applications in auditory devices like hearing aids is reducing the algorithmic time delays.'" (Sunohara)

"I knew that this algorithm resulted, in principle, in an algorithmic delay from input to output corresponding to one frame length. For example, for sample data sampled at a frequency of 16 Hz and with a frame length of 4,096 samples, the algorithmic delay is 256 milliseconds. This might not sound like much, but human hearing is incredibly sensitive. If we hear the separated sound together with the original sound, it sounds like the sound is being duplicated. In practice, if a person listens to the results wearing headphones while he's speaking, the audio feedback effect gets in the way of talking fluently or creates an awkward impression due to the delay in lip synchronization." In joint research with Professor Ono, Sunohara has been attempting to reduce this delay to less than 10 milliseconds, the threshold at which humans no longer perceive delays.

"Initially, I wasn't optimistic, but Sunohara-san and his colleagues were so eager to make it work, so I decided to join them and consider the problem. [laughs] From the perspective of an engineer, there's a lot of value in coming up with an optimal solution under the conditions presented." (Professor Ono)

Wow, we did it!

After much trial and error, a system was devised based on two approaches: time-domain estimates to obtain the separated signals using a separation FIR filter; and achieving a major truncation of noncausal components of the separation FIR filter causing algorithmic delays (Fig.1). Especially effective in realizing the low latency was the latter—using a truncated filter—something characterized as a"we-have-nothing-to-lose" attempt, since common sense would dictate using such a filter would impair separation performance. When the researchers tried it and evaluated the results, they found the separation performance wasn't impaired at all compared to conventional methods. The problem then became: why does this method work?

"We'd attempted something all of us had thought probably wouldn't work. Then we found it did work. The solution turned out to be something very simple. Professor Ono subsequently provided the theory for why it worked. After that, we felt comfortable about using it." (Sunohara)

Now that the problem of achieving low latency has been overcome, research will focus on other formidable issues, like tracking a moving sound source and selecting which of the multiple sounds to separate out and focus on. Much work remains ahead to resolve the challenge of reproducing human auditory perception.

Interviewer: Michinari Okazaki

(Reference)
M. Sunohara, C. Haruta, and N. Ono, "Low-latency real-time blind source separation for hearing aids based on time-domain implementation of online independent vector analysis with truncation of noncausal components," in Proc. ICASSP, 2017.

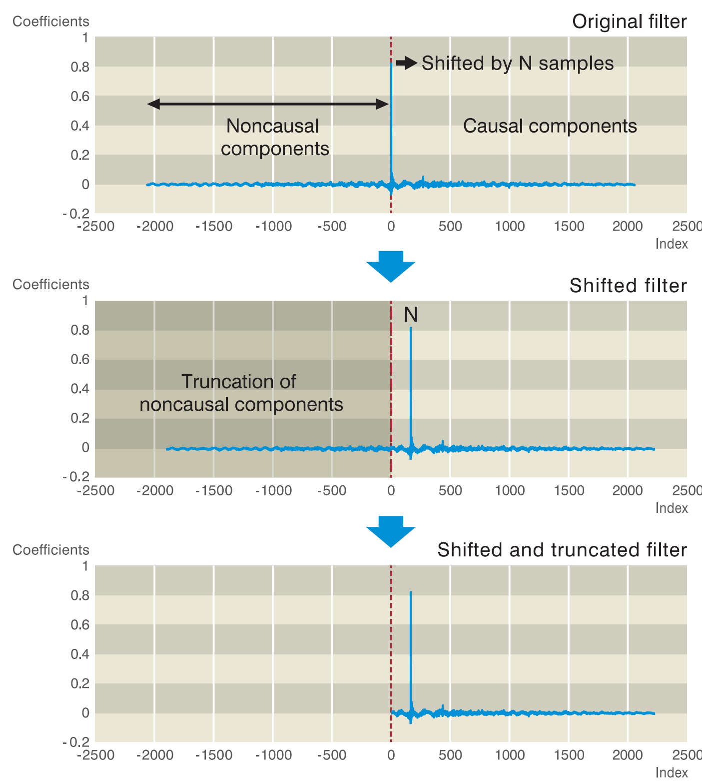


Fig.1. Creating a quasi-causal time-domain FIR filter

Fig.2. Demo device for low-latency source separation

Loudspeakers for four different sound sources: pop music, female voice #1, female voice #2, and classical music. Four microphones are placed on the CD case and connected to the PC via the PC interface on the left. The headphone transmits only the sound from the selected source.

02 Case Study

Visualizing How Specific Sounds Propagate

～Identification of Sounds in the Outdoor Environment

An article in a previous issue [1] introduced a technology that enables automatic sound source identification of specific sounds in the environment.
In this issue, we'll take a step forward and introduce a case study to visualize the propagation of specific target sounds.

Visualizing a specific target sound with automatic sound source identification

In some ways, noise may be more closely associated with our lives than music. Most discussions of noise are based on measurements made using sound level meters. But when we measure traffic noise, for example, it's often difficult to distinguish and eliminate sounds coming from sources besides the one being targeted, like airplanes flying overhead, emergency vehicles, or even thunder. Performed manually, the task is both extremely labor-and cost-intensive.
"For these reasons, we developed a system that identifies a specific target sound with high precision but with minimal need for manual work, one that will visualize the temporal changes in how the sound propagates. And that's the automatic sound source identification system based on deep learning technologies we developed in this research."
Toshiya Ohshima and his colleagues at Rion have succeeded in implementing sound source identification based on deep learning in an environment where various sounds are mixed, capturing how a specific sound propagates, and visualizing it on a map (**Fig. 1**).

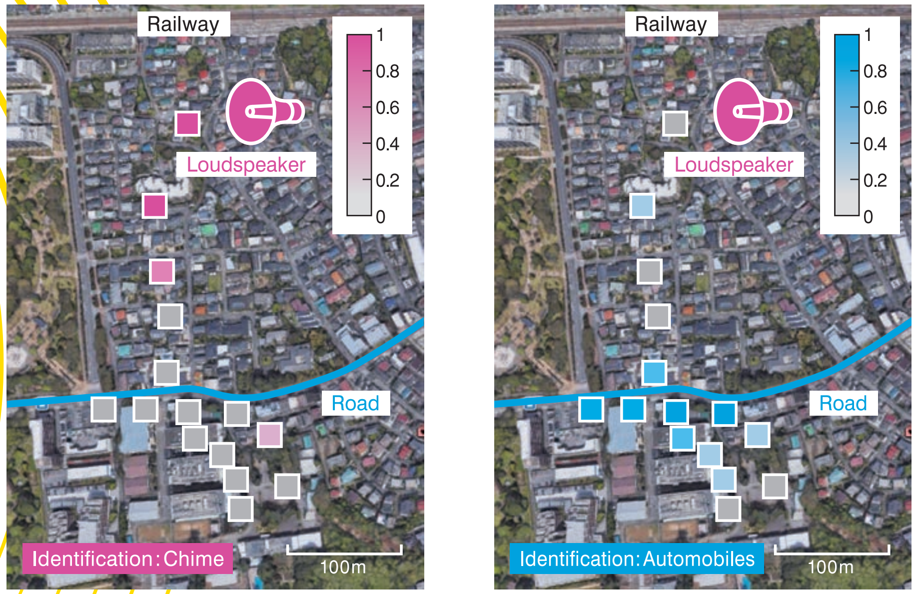


Fig.1. Example of analysis at the time a chime from a disaster prevention loudspeaker is sounded

Shown here is a location with tracks for a conventional railway to the north and a relatively busy two-lane road to the south. The range of vertical relief in the area indicated by the map is approximately 500 meters. Both panels are snapshots for the same instant at which a chime for a routine announcement from a disaster prevention loudspeaker is sounded. The squares on the map show where noise level meters have been placed. The darker the color, the greater the probability that the target sound is present at the spot. The panels shown are still images; an animation shows how the sound from the disaster prevention loudspeaker travels at the speed of sound (340 m/s).

Left : Indicators for sound passed through the classifier for loudspeakers.
Only those located near the loudspeakers show a strong response.

Right : Indicators for sound passed through the classifier for automobiles.
The indicators don't respond to sounds from loudspeaker.
Only noise from automobiles propagates along the road.

A demo movie is available here: https://youtu.be/f1GTA56VX08

Toshiya Ohshima (Development Department)

How a sound propagates reveals the position of its source

The propagation of sound in an outdoor environment is significantly affected by meteorological conditions like wind direction and sunlight. On top of that, some sounds can propagate more than several hundred meters, like the sound emitted by major industrial plants. It's hard to predict how sounds will reach a specific point. In addition, when we measure such sounds, it's often difficult to recognize whether they actually come from the plant or from another source, like a road located between the plant and the measurement site.
Even so, this automatic sound source identification technology can be used to easily isolate, visualize, and observe how a specific target sound from the factory propagates while accounting for the weather conditions. Conversely, this technology may be used to determine the location of the source of a certain sound.
The technology will allow us to deal with sounds that shouldn't be present in an environment, as well as to understand how important audio information propagates through a town, like disaster prevention announcements made over administrative radio. The technology should prove useful for assessing areas where such announcements fail to reach and taking remedial action.

Distinguishing a "good" environment using various sounds

Sound source identification is a new technology with as yet undiscovered potential for making significant contributions to our everyday lives. "As we carry out this study," Ohshima adds, "we'll gradually uncover the town's acoustic environment." Ohshima, who resolved to work on something involving protecting the environment during his high school years, when pollution emerged as a major social issue, has since sought to create better environments through his research on noise. The section in which he currently works, the Development Department, belongs to the Environmental Instrument Division —which, whether by fate or coincidence, contains the word environment.
"What I'd really like to do is not just identify bad sounds, but to evaluate 'good' sounds and ultimately be able to diagnose the acoustic environment. For example, when I measure sounds in a town, I want to be able to identify what species of birds or insects are chirping in the area. From the perspective of evaluating noise, I only need to identify the sounds of aircraft, trains, cars, and factories. But, to create a healthy town, I feel we need, in addition to convenience, a lot of greenery and a diversity of living organisms."

Interview by : Yuichiro Fuse (music technical writer)

(References)
[1] Nakajima,"Automatic sound source identification using deep learning," RION Shake Hands Vol.5, pp. 10-11, 2017

03 Technology

Bioparticle Counters
～Detecting Microbial Particles

Bioparticle counters are instruments that can instantly distinguish whether a microparticle found in water is of biotic or abiotic origins. They're based on a technology that detects a phenomenon unique to living organisms.

Why Measure Microbial Particles?

Ensuring the safety and cleanliness of the water used in production or as an ingredient is a critical task for the pharmaceutical and food industries. It's essential to confirm that the water is free of microbe contamination.
Unlike inanimate microparticles, microbes can proliferate over time and harm the human body. That's why, ideally, real-time inspections and measurements would be performed continuously throughout the manufacturing process. Several methods for detecting microbes in water have been developed, ranging from conventional culturing to fluorescent staining and the bioluminescence method. Of these, culturing is widely used in waterborne microbial contamination control due to the relative simplicity of the procedures. However, the method poses certain drawbacks: It takes time to obtain results, and the method can't detect certain microbes. The results can also vary with the skill of the inspector performing the test. (Table 1)

Table 1. Comparison: culture methods and the bioparticle counter

Performance item	Culture method	Bioparticle counter
Time required for inspection	Three days to one week	Real time
Detectable bacteria	Approximately 1% of those encountered in nature	Nearly all microbes
Pretreatment required	Culture media preparation, sampling	None required
Stability of inspection	Inspector-dependent	No skill required
Integration of inspection processes	Not possible	Possible
Inspection concept	Detect and analyze	Detect (screening)

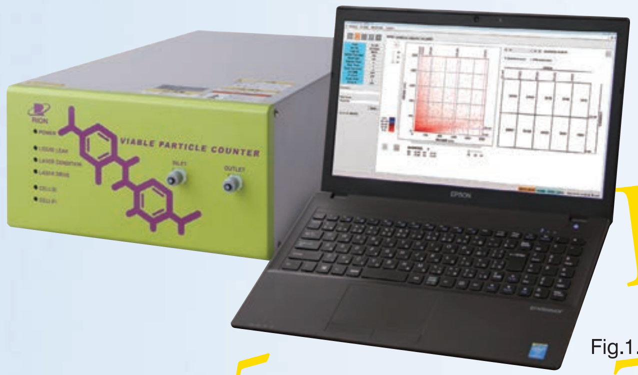


Fig.1. Bioparticle counter

Identifying Microbial Particles

To determine whether a particle has biotic origins, we first have to identify the characteristics unique to living organisms. One useful fact is that all living cells, including microbes, contain riboflavin — a type of vitamin B2 — as an active metabolite. Riboflavin is known to spontaneously fluoresce when irradiated with light of certain wavelengths. Rion's bioparticle counter (Fig.1) zeroes in on this characteristic. A technique has been developed to detect microbe autofluorescence. This makes it possible to identify microbial particles and distinguish them from other particles, as well as to count them.

An Innovative Technique for Enhancing Detection Sensitivity

A bioparticle counter consists of a deep UV irradiation unit placed before a sensor unit (Fig.2).
As in normal particle counters, the sensor unit features a thin pipe called a flow cell through which liquid passes. Laser beams are trained on this section. But unlike normal particle counters, the bioparticle counter is equipped with a high-power laser unit that emit beams at a wavelength selected to induce fluorescence in riboflavin and a sensor unit for detecting the resulting autofluorescence. By sensing fluorescence detection signals, the counter can instantly determine whether a particle has biotic origins.
Unfortunately, the autofluorescence produced by each microbe is extremely weak and often difficult to distinguish from noise. Thus, deep UV (ultraviolet radiation whose wavelength is shorter than 300 nm) irradiates the flow before it enters the sensor unit. The deep UV radiation oxidizes the flavin occurring in the microbes and intensifies the autofluorescence, making the microbial particle detection process more sensitive. (This process has been patented.)
Because the bioparticle counter can capture autofluorescence from the cells of any living organism, it's capable of detecting nearly all microbes. Not just that, the technique also meets the demand for a fast, effortless, automatable detection method for manufacturing processes.
Toru Sakuma (Particle Counter Sales Section)

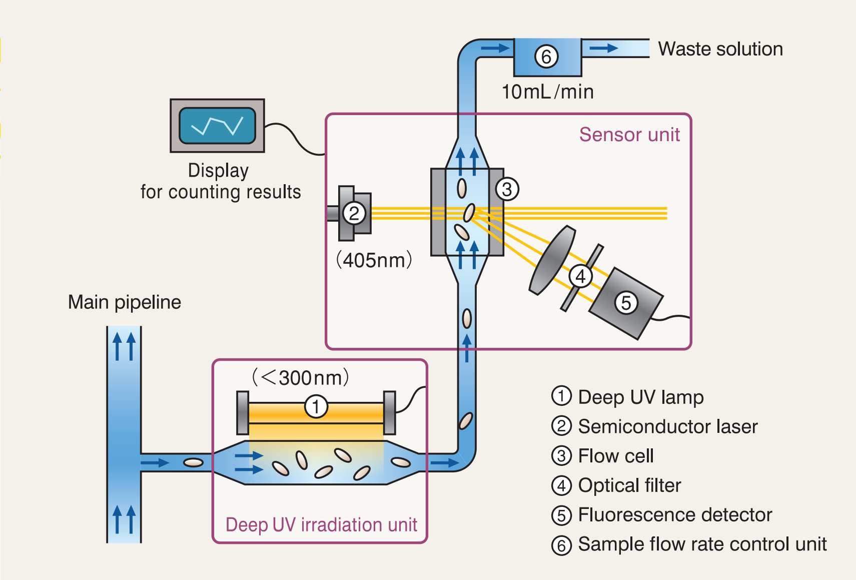


Fig. 2. Schematic diagram of bioparticle counter configuration
Deep UV irradiation unit: Specifically intensifies microbe autofluorescence.
Sensor unit (sensor designed to detect fluorescence only): Detects microbe autofluorescence.

I'm here to answer your questions.

Tell Us More, Mr. Sakuma!

Can the bioparticle counter count organisms that aren't bioluminescent?

Yes. Certain organisms, like fireflies and deep-sea creatures, have internal reactions that allow them to produce fluorescent light. But riboflavin is a fluorescent substance characteristics of all living organisms. It fluoresces when exposed to light near the wavelength of 400 nanometers. This fluorescence is induced externally and generated when exposed to energy from light at specific wavelength (i.e., when it's excited). This instrument detects and counts this fluorescence.

Can the counter also detect dead organisms?

Great question. Since dead microbes don't proliferate, they can't be detected by culture methods. But an organism's cells retain riboflavin even after it dies. That means this instrument detects even dead organisms. It's a rare feature not found in other systems.

Can the system detect abiotic microparticles?

Models that incorporate a light-scattering detector into their sensor unit can detect both biotic and abiotic microparticles simultaneously.

Understanding Measuring Instruments

We will explain a measuring instrument from various angles in a three-part series

Clean Room Standards and Monitoring (#3)

Validation
——A Mechanism to Guarantee Quality

This is the final part of a three-part series introducing pharmaceutical cleanrooms and methods for monitoring cleanliness. In this issue, we'll discuss the validation process as a mechanism to guarantee measurement accuracy.

Guaranteeing the Manufacture of Products of Consistent Quality

Say one sample randomly extracted from a production lot passes a certain inspection. This result doesn't automatically mean the remaining products from the same lot will also pass. If we could devise a method that can guarantee that each product is uniformly manufactured at each production stage, we could reasonably conclude the remaining products will satisfy quality requirements.

Since pharmaceutical products have the potential to directly impact health and life, it is of the utmost importance to ensure the consistent manufacture of products that meet all quality requirements. The GMP[*1] standards stipulate just such requirements and have the following three major goals:

- to minimize human error
- to prevent the contamination of and quality variations in pharmaceuticals
- to design a system that ensures high quality

The validation process is a way to achieve these goals. To achieve the required product quality, inspection and analysis methods must be subject to scientific verification and the results recorded and retained as written documents.

*1 GMP (Good Manufacturing Practice): Ministerial Ordinance for Standards Concerning the Management of Manufacturing and Quality of Pharmaceuticals and Quasi-Pharmaceutical Products

> From the Ministry of Health, Labour and Welfare Ministerial Ordinance No. 179, Article 2
> As used throughout this Ministerial Ordinance, the term validation refers to verifying and documenting that the building and facilities at the manufacturing site and manufacturing and quality control procedures and processes ("manufacturing procedures" hereinafter) provide the expected results.

Validating the Monitoring System

Cleanrooms are validation targets because they're used to manufacture pharmaceuticals. Qualification

evaluations are performed to check compliance with validation standards for the airborne particle counters and multipoint sensor monitoring systems used in cleanroom cleanliness control. Here we'll discuss two types of qualifications: installation qualification and operation qualification.

(1) Installation Qualification (IQ)

Installation qualification is an evaluation carried out to confirm and document that the equipment installed meets requirements. For a multipoint sensor monitoring system, the following issues are generally checked and recorded:

- Does each piece of equipment comprising the system meet the applicable specifications?
- Are any abnormalities visible in the exterior appearance of the equipment?
- Is all of the equipment installed in the correct position?
- Have all cables been connected correctly to their respective devices?
- Has all software been properly installed?

However, some items are confirmed upon shipment of the airborne particle counters with documents such as the product inspection sheets and test record documents. For these items, the inspection isn't repeated at the installation site. Confirmation is deemed complete based on the documents.

(2) Operation Qualification (OQ)

Operation qualification is an evaluation carried out to confirm that the facility in question performed as expected and to document this conclusion. For a multipoint sensor monitoring system, the following points are generally checked and recorded in a sensor performance evaluation:

- Operations check
- Flow rate test
- False positive count test
- Counting efficiency testing

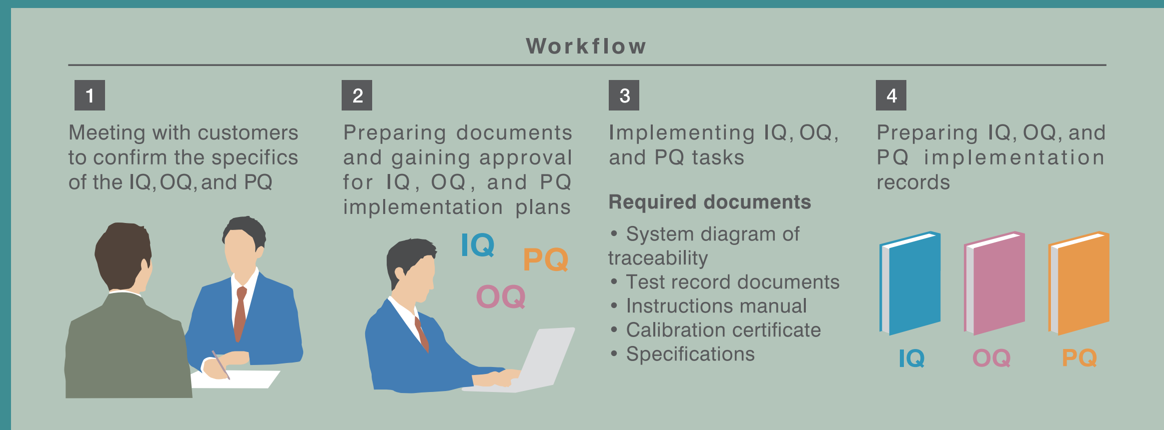
Below are the points checked and recorded in a system performance evaluation:

- Consistency between results measured by the airborne particle counter installed at each monitoring point and results obtained by centralized control software
- Proper issuance of notifications in the event of operational anomalies
- Continuous monitoring enabled at each monitoring point

Some systems have functions for generating hard copies of or regularly backing up monitoring data. If so, qualification evaluations assess these functions as well.

Performance qualification (PQ) is carried out during actual operations after these evaluations are completed. Confirmation results for checklist items are recorded. In this way, to ensure cleanliness control, the cleanroom validations encompass the monitoring system itself.

Souta Kondo
(Particle Counter Development Section)



Workflow associated with validation at Rion

Rion's History of Technology

LEARNING from our Past Products

A Battery-Free Sound Source for Sound Level Meters

An Hourglass-Type Sound Level Checker

The instrument shown above was an accessory
for the sound level meter (N-1101) Rion first introduced in 1955. What can it be?

The instrument bears the name Kobayasi-riken Co., Ltd., Rion's predecessor. Featuring neither battery slots nor switches, this instrument is a sound source for sound level meters. It remained in use for quite some time—until the development of the pistonphone, a battery-operated calibrator. Its basic operating principle, believe it or not, is based on an hourglass. By flipping the instrument 180 degrees upside-down and then back, the sand inside its body falls and impinges upon a metal plate and generates sound which is transmitted through the circular part in the front of the instrument.

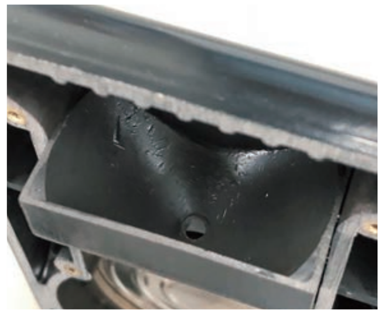
A now-retired company engineer had this to say about the instrument: "This sound level checker is one of the finest acoustic measurement instruments ever developed by Rion… it requires neither a power source nor batteries. All you need to do is flip it upside down and back with your hands. It's the ultimate in eco-friendly products. I have nothing but respect for the engineering staff who came up with such a simple system at that time. It's a powerful demonstration of the essence of technology." (from the fall 2012 issue of RION News)

Let's Take the Sound Level Checker Apart!

① The early models are now regarded as antiques. This is the NC-07, one of the later models we discovered at the workplace. It has a port for a 1-inch microphone.

② The name of the product, manufactured in 1973, is the Sound Level Checker. It produces a 95-phon sound—a phon being a unit used for sound levels in those days. Let's take it apart, shall we?

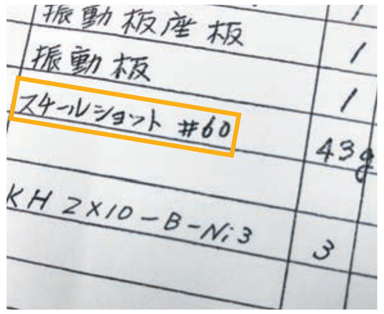
③ Here's a view of the interior. On the left is the front panel; on the right is the back panel. The circular metal plate on the left panel must be the resonator. (The sand has been removed.) As you can see, the design is starkly simple.



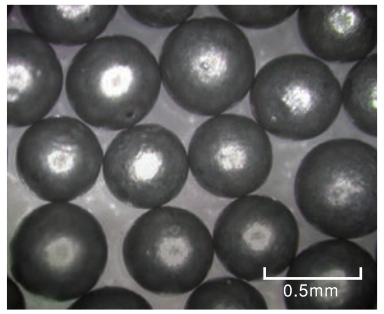
④ Here's the hole through which the sand is to fall. It's indeed shaped like an hourglass. The hole is about 2 mm in diameter.

⑤ This is what the instrument looks like when it's filled with sand. Since the cover is removed, we have to be careful to avoid spilling the sand.

⑥ The falling sand impinges upon this metal plate and generates a sound resembling white noise, like a "sshhh…" How innovative! The sound lasts for a little more than 10 seconds.



⑦ Since we find the term "steel shot" listed in the parts breakdown, we know the sand is made of steel. The "#60" may indicate the size of the particles.



⑧ Here we see an enlarged view of the sand. Steel shot is commercially sold as a polishing material for industrial machining processes. The engineers who developed the instrument must have performed exhaustive trial-and-error testing.

I myself exclaimed "Wow!" when I heard the pouring "sshhh…" sound clearly emitted from the instrument. The instrument shows the "simple is best" principle.
(M.Okazaki)

Hello From the Office

Riding the Waves of China's Giant Market
Rion Science & Technology Shanghai Ltd.

Rion Science & Technology Shanghai Ltd. is the only local overseas subsidiary in which Rion holds a 100% share. After assuming the operations of its predecessor, Shanghai Rion Retail Co., Ltd., is currently entering its fifth fiscal year. The staff has a total of 14 members, including those stationed in Beijing and Guangzhou. They work hard day in and day out to strengthen Rion's presence in China.

Their office is located in a suburb to the west of Shanghai. The surrounding area is what is called a high-tech park, which is a center for IT-related industries. This is where software developers and company back offices are located. Our staff members commute to the office every day by subway amid flocks of the younger generation of programmers and other workers.

Some of you may picture commuters in China refusing to wait their proper turn and pushing and shoving their way on and off crowded buses and trains. In fact, Shanghai has grown into a remarkably sophisticated urban center. Manners involving getting on and off public transportation have likewise improved significantly. Even when the trains are full, people don't feel compelled to force their way in, unlike in Japan. There's simply more space. If people notice a bus or train is full, they simply pass to the next car or wait for the next bus. No one complains. There's a sense of philosophical detachment among the commuters.

Several new business models have been introduced in China during the three years I have lived in Shanghai. Bicycle-sharing systems are one. Another is the cashless payment systems now being intensely covered by Japanese media. There are hints that the QR codes in current use will be replaced by voice or face recognition in the near future. Some of the new models have been successful, but countless others have sunk into oblivion (the automatic pizza vending machine, for example). But the zeal for trial-and-error here is amazing. Maybe we Japanese, who are mocked for being too careful —"tapping a stone bridge too cautiously, and ending up destroying it"— have something to learn from this energetic attitude.

In any case, we hope all of you will come visit Shanghai one day. If you do, stop by our Shanghai office!

Hironori Yamatani (General Manager)

Nightscape in Waitan, Shanghai

Office entrance

At a staff get-together (author in center)

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RION JOURNAL

SCIENCE COLUMN

The Laboratory of Our Dreams: The International Space Station

The International Space Station (ISS) flies with a speed of 9 km per second at an altitude of 400 km above the surface of the earth. Onboard the station, new materials are being developed in the microgravity environment.

For ten years now, the author has participated in the Three-Dimensional Photonic Crystal Growth Space Experiment (3DPC Project) undertaken jointly by JAXA, private businesses, and universities. This experiment involves creating perfect opal crystals in space. The opals have three-demensional periodically arranged structures with glass beads measuring 0.1 μm in diameter. Expectations are high for future applications as optical elements. In that sense, it's a material both old and new.

The opal forming device was assembled at the Baikonur Cosmodrome in Russia and sent into space as a part of the payload for the Progress cargo ship. The author took this photo of the Soyuz rocket on its way to a launch pad during a visit to the Baikonur Cosmodrome in 2005. The rocket, in the horizontal position, was pulled by a diesel locomotive from its assembly plant and slowly made its way towards the launch pad. Temperatures in the early hours of that day were 20 degrees below freezing. Following on a bus, I took in the magnificence of the rocket's profile as it was solemnly brought to the launch pad, from which it was scheduled to be launched that night. The rocket lifted off with a bloom of bright light and a gust of heat right in front of my eyes.

The astronauts have installed the device at its designated area aboard ISS. It takes the device one week to create a crystal that takes nature five million years to form. Other experiments, including the crystallization of proteins, have been implemented to apply to the development of new drugs. One day, people all around the world will reap the benefits of the materials created aboard the ISS.

The ISS is the laboratory of our dreams, a facility that makes it possible to perform experiments under the microgravity conditions that would be impossible to achieve on the earth.

Yoshihiro Takiguchi (Advisor, President of the Graduate School for the Creation of New Photonics Industries)

Soyuz rocket on its way to the launch (photograph by author)

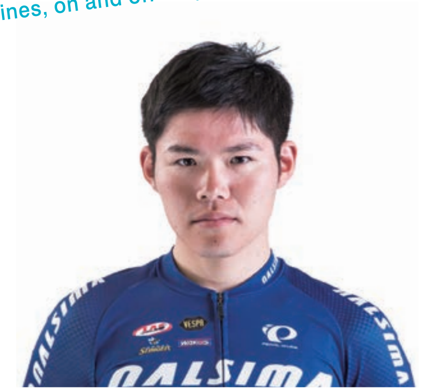
Japanese scenery

At an old traditional house in Enzan City, Yamanashi Prefecture
Photograph by: Haruo Sawamoto (Manufacturing Engineering Department)

Dried persimmons from the Kōshū region are known as *koro-gaki*. Dried outdoors in the sun during the dry days of late autumn, the *shibugaki* (astringent persimmon) turns into a sweet preserved treat.

Shine View!

Introducing one of Rion's shine workers, someone who shines, on and off duty.



Masanori Kondo
S&V Measuring Instrument International Sales Section

Competitive Cycling : Captivated by the Presence of Professional Cyclists

——What got you interested in cycling?

I got started in my second year of high school, when I bought a road bike and went cycling with my friends to the sea. I got into competitive cycling in my third year of high school. During spring break, I went on a trip to Europe all by myself. There I watched a road race of professional cyclists in a suburban region in France, where cycling is a popular sport. I was hooked. All of the competitors were really cool; they had a certain presence. As I was heading off to college, a teacher at my high school introduced me to the company team I still belong to today. That's where I began to compete. The team had many advanced cyclists. I made progress through the experience I gained on the team.

——What's the appeal of competitive cycling?

Competitive cycling has the aspects of both a marathon, which requires sheer stamina, and soccer, in which strategy and tactics matter. It involves a risk of injury and requires strenuous training, but there's remarkable joy in finishing a competitive race with good results. There's also a special sense of camaraderie among teammates because we've shared an extraordinary experience. Encountering the unexpected one after another during a race is part of the challenge, too. It's made me more resilient to challenges in my own life.

——Isn't it hard to balance work and competitive cycling?

It's rare for those who get into competitive cycling to continue after they start working. I wasn't sure I could continue once I got a job. It helps that Rion has two cyclists known to all of us cyclists, Mr.Akira Ito and Mr. Atsushi Saito. They've kept me motivated.

——What's your latest achievement?

In January 2017, I won a 100-km cycling marathon in the expert class held at the Twin Ring Motegi circuit. I remained in the lead from the 50-km point, then sprinted ahead and got to the finish line first.
In terms of types of races, my strengths are in time trials. My proudest achievement is coming in 10th place at the JBCF* Time Trial Championships in September 2017.

*JBCF: Japan Bicyclist Club Federation

Winner of a race
at the Twin Ring Motegi circuit

Time trials

——The company apparently has lots of cycling enthusiasts.

We recently founded a cycling club at our company. I think our shared love of cycling helps us get to know people who work in different sections. I feel I can communicate with anyone here, regardless of differences in age or occupation. I think I owe that to my love of cycling.

Rion Cycling Club
Kondo is 2nd from the left in the back row.

Interviewer : Nobuhisa Okamoto

Hosted by the Japan Institute of Plant Maintenance

2018 TPM Excellence Award Received

The TPM Excellence Award is a screening and award program established to encourage the development of new technologies related to maintenance equipment and to promote the progress of maintenance technology. Among the recipients honored with an award, our product was commended for creativity and forward-looking originality.

TPM 2018TPM優秀商品賞 開発賞 TPM Awards

Vibration Analysis Program SX-A1VA

This program adds vibration measurement functions
to the RIONOTE Multifunction Measurement System.
All essential vibration measurement functions are provided,
enabling equipment diagnosis and trend management for industrial machinery.
The program also supports detailed diagnosis including FFT analysis
and envelope processing, and ISO absolute value evaluation can also be performed.

Japan Community Paper/Free Paper Grand Prize 2018

Honored with an excellence award in the company magazine category

後援:内閣府 / 経済産業省 / 農林水産省 / 観光庁
(公社)日本観光振興協会

The Japan Community Paper/Free Paper Grand Prize is Japan's only yearly program that reviews community publications and free newspapers and magazines from all over the country. The event, now in its 8th year, is organized by the Nippon Community Contents Association.
We entered the previous edition (Vol. 7) of this magazine in the company magazine category. The judgment criteria that earned us the prize include editorial concept, content quality, and originality. We intend to continue our efforts to acquaint readers with the Monozukuri spirit of RION, that is our passion for creating outstanding products. The future is just beginning to unfold.

TOPICS Research presentations, articles, etc.

【Related to sound and vibration measuring instruments】

◎Acoustical Society of Japan Noise and Vibration Association (August 6, Kanagawa Institute of Technology, Japan)

- Automatic Sound Recognition and Methods / Y.Nakajima, C.Fujita, T.Naito, N.Sunago, T.Ohshima (in Japanese)

◎Architectural Institute of Japan Annual Convention 2018 (September 4-6, Tohoku University, Japan)

- Mounting resonances of an accelerometer for measurements of environmental vibrations –Part 3 Influence of plates– /D.Adachi, T.Kotani[*1] (in Japanese)

◎Acoustical Society of Japan 2018 Autumn Meeting (September 12-14, Oita University, Japan)

- DNN-based environmental sound recognition and visualization of sound propagation for individual sound sources/ T.Ohshima, C.Fujita, T.Naito, N.Sunago, Y.Nakajima (in Japanese)
- Pilot study on subjective and objective noise evaluation using a noise log logger / M. Ueda[*2], M.Hiroe[*3], T.Miura[*4], T.Ozaki, Y.Hiraguri[*5], Y.Tsuchida[*6], T.Morihara[*7] (in Japanese)
- Study on methods for localization of the infrasound / T.Doi[*3], K.Iwanaga[*3], T.Kobayashi[*3], Y.Nakajima (in Japanese)
- Influence of visual image of the sound source on noise annoyance of air and high-speed rail transport/I.Yamada, M.Hiroe[*3], M.Ueda[*2] (in Japanese)

◎The Institute of Noise Control Engineering of Japan 2018 Autumn Meeting (October 13-14, Kanagawa University, Japan)

- DNN-based sound recognition for disaster-prevention broadcasting sound and its propagation visualization in residential area/ T.Ohshima, C.Fujita, D.Naito (in Japanese)

【Related to particle counters】

◎The 35th Annual Meeting and Symposium on Aerosol Science and Technology (July 31-August 2 Nagoya University, Japan)

- Counting efficiency evaluation of OPC for pharmaceutical industries - Standardization of the calibration method using Inkjet Aerosol Generator -/D.Shinozaki, T.Minakami, K.Iida[*4], H.Sakurai[*4] (in Japanese)

◎JOURNAL OF JAPAN AIR CLEANING ASSOCIATION Vol.56 No.3

- Counting efficiency evaluation of OPC for pharmaceutical industries - Standardization of the calibration method using Inkjet Aerosol Generator - / K.Iida[*4], H.Sakurai[*4], D.Shinozaki, T.Minakami, (in Japanese),

◎10th International Aerosol Conference (September 2-5 St. Louis, Missouri, USA)

- Counting Efficiency Evaluation of Optical Particle Counters in Micrometer Range by Using Inkjet Aerosol Generator. / K.Iida[*4], H.Sakurai[*4], D.Shinozaki, T.Minakami

◎SEMICON TAIWAN 2018 (September 5-7 Taipei, Taiwan)

- Semiconductor Materials Forum Topic 5: New Liquid-Borne Particle Sensor for Chemicals/K.Iwahashi, M.Shimmura

◎The 26th International Symposium on Semiconductor Manufacturing (ISSM 2018) (December 10-11 KFC Hall, Japan)

- Real Time Measurement of Exact Size and Refractive Index of Particles in Liquid by Flow Particle Tracking Method/T.Tabuchi, K.Bando,S.Kondo, K.Kondo, H.Tomita[*8], E.Shiobara[*8], H. Hayashi[*8] ,H.Kato[*4], Y.Matsuura[*4], A.Nakamura[*4]

*1 Fujita *2 KAIT *3 Kobayasi Institute of Physical Research *4 AIST *5 Kindai Univ. *6 KIT *7 Ishikawa-NCT *8 Toshiba Memory Corporation

Exhibitions

S Related to sound and vibration measuring instruments
P Related to particle counters

- S The 10th Vibration Technology Exhibition (February 7-8, Pacifico Yokohama)
- S Acoustical Society of Japan 2019 Spring Meeting (March 5-7, The University of Electro-Communications)
- S Automotive Engineering Exposition 2019 Yokohama (May 22-24, Pacifico Yokohama)
- P SEMICON KOREA 2019 (January 23-25, Seoul, Korea)
- P 5th INTERPHEX OSAKA (February 20-22, INTEX Osaka)
- P SEMICON CHINA 2019 (March 20-22, Shanghai, China)

Editorial Postscript

The cover of the last issue of Shake Hands (vol. 7) has been acclaimed by many at our company as the best cover yet, and that issue received an award for free papers (see p.19 for details). All of us on the editorial staff took special pleasure in this honor, since each issue is the product of much spirited debate among us. We would like to thank all those whose contributions led to each publication so far, and hope our future issues will continue to be just as excellent.
I encourage you to take a look at the demo videos on sound separation techniques introduced in this issue. I think you' ll find them full of surprises. (M.Okazaki)

About the Front Cover

We humans are endowed with the natural ability to discern sound. Even in noisy environments, without consciously doing so, we turn our focus to the person we're talking to or focus on a work task while ignoring the noise from the air conditioner. It's amazing how the human brain can perform like the most sophisticated computers.
(M.Oana)

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