Innovating for a ***Wise Future***

KKE Vision 2016

Technical Report

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KKE Vision is an annual conference that has been held since 2002 in Tokyo, where guests can explore emerging technologies and innovations.
KKE set its *Thought*: “Innovating for a Wise Future”, as the key message for KKE Vision 2016 and organized to demonstrate a more specific “future society full of wisdom”.

This year, we also held KKE Vision in Fukuoka Prefecture for the first time. The conference was full of intellectual sparks thanks to the presenters and many of the enthusiastic guests.
During those two days in Tokyo and Fukuoka, the venues were greatly enlivened as 15 presenters delivered speeches about their latest findings, and real-time experience of show-cased technologies fascinated the attendees.

Here, we selected six inspirational presentations that we would like to share with you.
We hope you find the contents of this booklet interesting and amusing.

KKE Vision 2016 Organizers
Kozo Keikaku Engineering Inc.

KKE Vision 2016

Technical Report

TOKYO
Date : October 26, 2016
Venue : Toranomon Hills Forum
Attendees : 725

FUKUOKA
Date : November 29, 2016
Venue : Grand Hyatt Fukuoka
Attendees : 275

CONTENTS

TOKYO

▶▶ Toward a truly safe and secure society

Providing information for reducing damage from natural disasters

Yasuo Sekita

Director-General, Forecast Department
Japan Meteorological Agency (JMA)

Providing weather information using a wide range of observations and computer analysis

JMA issues a wide variety of information for the purpose of reducing the damage caused by natural disasters. As for the weather information, the first thing to do is of course observation of the weather in order to issue weather warnings, forecasts, and related information. In addition to satellite observations, upper-air observations, weather radar, and surface weather observations, we also collect data from ships and foreign meteorological organizations. Those data are entered into the high performance computer of JMA that perform analyses and forecasting. If the forecasts of the computer are perfect, we can issue the forecasts without modification. However, in reality, there are some errors in that, so human judgment is necessary.

With respect to the current state of weather forecasting, we have an established forecasting technique, called the numerical weather prediction model. To improve accuracy, it is important to increase resolution, that is, to be able to see finer details and to capture more observation data for updating the initial values of weather situation in the model.

Errors in forecasting occur because of uncertainties in the initial values. When there are errors in the initial values, the errors increase as time passes. Therefore, in order to estimate the possible extent of the errors, we use a technique called "ensemble prediction system". By using a large number of sets of initial values to obtain multiple prediction results, we are able to predict the worst-case scenario or the average scenario.

In the future, we are also planning to introduce ensemble forecasting in our meso-scale forecast model (which uses 5-km horizontal grid spacing).

Current techniques for predicting seismic and volcanic activity, and improving their accuracy

JMA also issues warnings about volcanic eruptions, tsunamis and strong shaking of earthquakes. With respect to volcanoes, we monitor volcanic activities and issue eruption warnings based on the observation data. There is currently no established technique for predicting volcanic eruptions, so we have to make a comprehensive judgment of the possibility of eruption from a variety of observation data.

Currently, practical earthquake prediction is extremely difficult. All we can do therefore is to quickly detect that an earthquake has occurred and to issue information about the earthquake. That is, before strong shakings of the earthquake or tsunamis arrive, we issue information to make sure that people stay safe, evacuate, and find shelter. We, furthermore make sure that emergency measures such as rescue and first-aid are carried out quickly and appropriately.

Earthquake early warnings of JMA are issued fully automatically. Although seismic intensity information is also issued automatically, in the case that the information may not be appropriate, we are able to stop issuing manually. Then the earthquake's epicenter and scale (magnitude) are determined by the officials in charge, and this process is the most important step for determining the correct information.

With respect to tsunami forecasting, we have calculated expected tsunami heights and arrival times using a tsunami simulation technique in advance, based on earthquakes of various epicenters and magnitudes, and have stored the results in a database. When an actual earthquake occurs, we search the database for tsunami calculation results corresponding to the epicenter and magnitude, and then issue tsunami warnings and advisories based on the results.

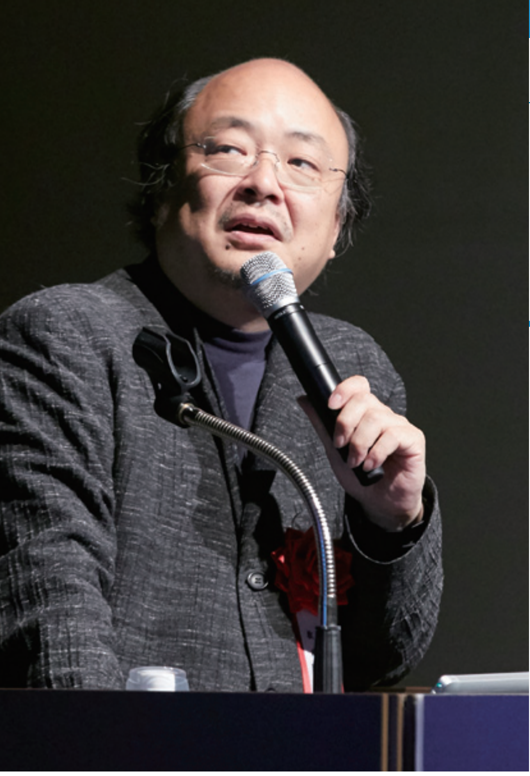
We intend to improve the accuracy of our earthquake early warnings now. By integrating multiple data analysis techniques, we will be able to determine the epicenter and magnitude of an earthquake more correctly. Using this, I believe that we will be able to issue earthquake early warnings correctly even in the case that multiple earthquakes occur at the same time as they occurred just after the Great East Japan Earthquake in 2011.

Profile

Yasuo Sekita earned a master degree from the Graduate School of Science at the University of Tokyo in 1984. He joined the Japan Meteorological Agency (JMA) in April of the same year.

Since joining the JMA, he has acquired more than 30 years of experience in improving information for reducing damage from natural disasters, including serving as Director of Earthquake and Tsunami Observation Division, Seismology and Volcanology Administration Division, and Planning Division in JMA Headquarters, and Director-General of Osaka Reginal Headquarters.

Prior to assuming his current post, he was appointed Director-General of the JMA's Seismology and Volcanology Department in 2014.



▶▶ Achieving a sustainable society

Symbiosis of forest and city : Metropolitan timber architecture as a sustainable resource

Mikio Koshihara

Professor, Engineering and Design for Timber Structures
Institute of Industrial Science, the University of Tokyo

The importance of using wood for high-density urban buildings to boost its demand

In October 2010, the “Act for Promotion of Use of Wood in Public Buildings” took effect in Japan. The aim of this legislation was for the national government take the initiative in increasing the use of wood in public buildings, and to encourage private companies to also use more wood in buildings. The context for the law is the fact that even though Japan is rich in forest resources, it hasn’t effectively utilized them.

One of the advantages of timber is that it is a recyclable resource. Trees are planted in the mountains, and once they mature, they are harvested and used as timber. Then new trees are planted. Planting young trees regenerates the mountain forests and helps reduce CO_2.

In order to keep this cycle functioning successfully, the demand for wood must increase. One way to do this is by utilizing wood not only for houses, but also for large public non-residential buildings. The key here is to find which areas would have a demand for wood. Areas such as Hokkaido, Tohoku, and Kyushu supply plenty of wood and some of these regions are promoting the construction of public buildings out of wood as part of their “local production for local consumption”. However, it is a fact that the amount of consumption in these regions is limited and demand for wood will not increase unless it is used in urban areas as well. Buildings in urban areas are required to have set structural performance and fire resistance, and due to high land prices, it is necessary to build at higher densities, for example 3- to 5-story buildings. This means that we need to completely reconsider our traditional wood-building style.

Necessity for buildings that enable recycling of timber

If the purpose of using wood in buildings is to reinvigorate the mountain forests, we should not limit our options by using only the trees that are convenient to use. However, in the current distribution system of timber for residential use, some trees that do not fit the standard of thickness or length are not appreciated. Since they are not generally valued well, woodcutters do not put them on the market.

To increase demand for wood, we need to consider using a variety of trees for various purposes. For example, one way is to utilize re-constituted materials such as cross-laminated timber (CLT). I serve as chairman of the board of Team Timberize, a non-profit organization that aims to explore new possibilities for wooden buildings and makes proposals to introduce timber as a new building material. For example, we made proposals to use wood for the construction of facilities for the Tokyo Olympics, including a wooden spectator stand and wooden bus shelter.

When I talk about wooden buildings, people might imagine solid wood structures built on a wooden framework without the use of metal fittings or fixtures. But as I mentioned earlier, these images have caused only a particular type of wood to be sold and the key is how to deal with logs or crooked trees that are typically not sold on the market.

While maintaining our traditions, surely our ways of using wood should reflect contemporary values in accordance with changes in our social system. The use of wood from mountain forests, a recyclable resource, without letting it go to waste, is also part of the traditional Japanese culture. By taking over part of these traditions, we hope to devote ourselves to introducing wooden buildings.

Profile

Mikio Koshihara graduated from the Department of Architecture in the Faculty of Engineering at the University of Tokyo in 1992, and completed a Ph.D. (Engineering) in the Graduate School of the University of Tokyo in 2001. Before taking up his current position in 2012 as Professor in the Institute of Industrial Science, the University of Tokyo, he was affiliated with the Structural Design Group (SDG), and with the University of Tokyo, where he served as Research Associate and as Associate Professor at the Institute of Industrial Science. He also serves as chairman of the board of Team Timberize, a non-profit organization.

▶▶ Technology to help people

Manufacturing that harnesses latent human capacities : An introduction to assistive technology

Tohru Ifukube

Professor Emeritus, the University of Tokyo and Hokkaido University
Professor, Faculty of Health Sciences, Hokkaido University of Science

Shifting toward human-centered industries

I have been involved in medical engineering from the start, and have witnessed firsthand the remarkable advances that have been made in the medical field, for example in functional brain imaging and artificial organs. I felt that there would be a rapid increase in the number of people who would lead their lives struggling with disabilities. I thought that in the future we would need an engineering field to support their interaction with society by using technology that assists their mental and physical abilities. So to make this happen, I decided in the early 1970s to focus my efforts on the field now known as "assistive technology".

Having seen both medical technology and assistive technology, I am convinced that there is a major difference between the two. Medical technology, in particular medical treatment technology, is premised on helping people by "modifying" them. Assistive technology adopts the stance of helping people without modifying them. Some examples of this are the use of electric wheelchairs and nursing care robots to help move or transfer people, and wearable technologies that support functions of the body, such as hearing aids and cochlear implants.

The concept of assistive technology originates in the principles of "cybernetics" proposed by the American mathematician and biologist Norbert Wiener. Cybernetics focuses on what is common to animals, humans and machines, namely the "information" that circulates among the senses (sensors), brain (computer), and muscles for motion (actuators). The development of current robots and artificial organs derives from these studies that are built using animal and human functions as a model. The field of assistive technology has been relatively small, carried out through the conviction and effort of only a few researchers and small businesses up to now. This is because engineers find assistive technology difficult to work on since it is based not only on one research field, but across various science fields. Companies also find it difficult to invest in a small market, and they need to strike a balance between public interest and marketability. However, as we enter the era of the super-aged society today, a huge market has taken form. It goes without saying that the field of assistive technology can contribute to challenges such as the rapid decline in the working population, the increase in social security expenditures, and ways to make life meaningful during extended retirements. Many companies are entering an era in which they will not survive unless they link the public interest to marketability and evolve into human-centered industries.

A new approach to exploring and harnessing human potential

Humans are endowed with a feature called "plasticity", which means that a loss of functionality in the body can be compensated for with a capacity that had not been used before. One example is that someone whose hands do not function may be able to type using the digits of the foot. This plasticity can be regarded as the resuscitation, following the loss of some function, of a capacity that grew latent in the course of evolution. Accordingly, since sight and hearing originally evolved out of a tactile sense, if these functions are lost, we can expect the tactile sense to send information to the central brain. The field of artificial intelligence, which is a hot topic lately, is currently based on this plasticity of the brain, and robots that assist humans directly are modeled on the latent functionality of the human senses, brain, and muscles for motion.

My colleagues and I have been developing assistive devices to help people hear, see, and speak from the perspective of harnessing the latent capacities.

An export industry that will drive the economy

These devices must accommodate a wide variety of disabilities. But since the markets are small, their production is generally in small volume for multiple products, where profit margins are low.

Key next-generation technologies for managing the health of the elderly and encouraging social interactions are being developed in a Japan Science and Technology Agency project called "Creation of Science, Technology and Systems to Enrich an Aging Society", which I have been involved with since 2010.

Since Japan is the first developed country to become a super-aged society, we are in a position to find solutions to a variety of challenges by ourselves. Manufacturing that harnesses latent human capacities will not only contribute to reducing social security costs, but also to increasing the working population, and enriching the purpose of life in old age; very soon it will become one of the export industries that drive Japan's economy.

Profile

Tohru Ifukube received the MS and D.Eng. degrees in electronics from Hokkaido University in 1971 and 1977, respectively. After that, he served as a Visiting Associate Professor at Stanford University, as Professor in the Research Institute for Electronic Science Hokkaido University, and as Professor at the Research Center for Advanced Science and Technology the University of Tokyo among other positions. He currently serves as a research fellow at the Institute of Gerontology of the University of Tokyo, as an area representative in the S-Innovation "Aging Society" project by Japan Science and Technology Agency, and as Professor Emeritus at the University of Tokyo and at Hokkaido University. His areas of specialization are biomedical engineering, acoustic engineering, and assistive technology.

"Sound-Based Assistive Technology: Support to Hearing, Speaking and Seeing" (Springer International

Mathematical Engineering: Mathematics to support society

Kazuyuki Aihara
Professor, Institute of Industrial Science, The University of Tokyo
Director, Collaborative Research Center for Innovative Mathematical Modeling

Chaos theory started about 40 years ago

Mathematical Engineering, the topic that I study, is a discipline of mathematics that focuses on various problems that occur in the real world. We try to understand and find solutions for real-world phenomena by creating mathematical models of the phenomena, using mathematics as a kind of language. From an engineering point of view, mathematics is deeply involved in optimization, control, and prediction.

An important concept for understanding real-world phenomena is the concept of non-linearity. This is the property of being curved rather than being a straight line (linear). The simplest description of non-linearity is a quadratic function. For example, consider the quadratic function $y = ax(1-x)$. Letting x be $x(t)$, namely the value of x at time t, and y be the value of x at the next time $t+1$, we obtain $x(t+1) = ax(t)(1-x(t))$, which is a nonlinear recurrence formula (an equation that determines a sequence recursively). By changing the value of the parameter a, you can change the behavior of the solutions that the equation converges on. Depending on the value of a, the solutions may converge on a fixed point or a particular cycle, but if, for example, we let $a = 3.7$ or $a = 4.0$, the solutions will continue to change, never repeating the same value. When the period of the cycle becomes infinite in this way, the behavior is known as "chaos".

Nobody was studying chaos theory until about 40 years ago. Today, however, it is commonplace in the world of science and has revolutionized the analysis of time-series data. For example, Figure 1 shows two temporal waveforms that both exhibit complex changes over time. This kind of complex time-series data is typically analyzed by using a "power spectrum", which represents the temporal waveform as superposition of multiple sine waves. However, these two waveforms, which both have the same characteristics (white noise), cannot be differentiated by their power spectra. On the other hand, when displayed using a "return plot", a method that plots the relationship between the value at a certain time and the value at the next time, the two waveforms exhibit very different characteristics, as shown in Figure 2. The data on top are obtained from the quadratic map above, which is why the corresponding return plot (the upper chart in Fig. 2) shows a perfect parabola. The time-series data on the bottom represent time intervals between emissions of gamma radiation from cobalt. Gamma radiation is a stochastic phenomenon that follows the so-called Poisson process, so its return plot (the lower chart in Fig. 2) shows points scattered in an exponential distribution.

Complex behavior such as these two examples can be generated by two mechanisms, stochastic rules or deterministic rules. Researchers have found that complex behavior can be generated even by simple deterministic rules such as quadratic functions since around 1975, and since then, chaos theory has advanced significantly.

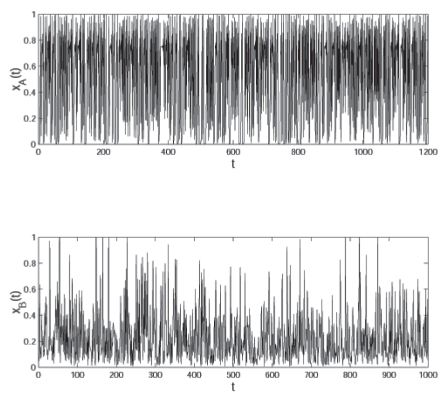


Figure 1 Two temporal waveforms with complex fluctuations

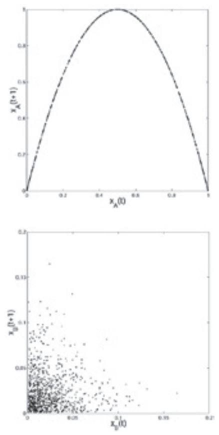


Figure 2 Return plots showing the relationship between the value at a certain time and the value at the next time

Using Mathematical Engineering to tackle complex systems in the real world

When you look at a variety of actual temporal waveforms in the world, you find chaotic phenomena in many different places. The previous example was a 1-variable system, but in fact it is possible to analyze the behavior of chaotic systems with any number of dimensions. The Takens' Embedding Theorem guarantees that even if you are able to observe only 1-dimensional data from a high-dimensional system, you can still reconstruct the behavior in the original high-dimensional space. This means that if you have low-noise data, you can create a computer model of a real phenomenon without necessarily having to write down equations, for example for use in short-term forecasts. We are now in an era where if you have big data, you can create a mathematical model directly from the data on your computer.

Currently, my colleagues and I are working on a variety of initiatives. For example, we are predicting renewable energy. It is extremely difficult to predict fluctuations in the amount of power generated by solar and wind power generation because it depends on the weather. You have resources such as weather forecasts and satellite images, but these alone do not give you sufficient accuracy. To supplement these resources, we are currently measuring time-series data at power plant sites and developing mathematical techniques to enable highly accurate predictions.

Mathematical models can also be applied to a variety of social issues. For example, in the field of medicine, Dynamic Network Biomarkers (DNBs) were discovered that are able to detect early warning signals that predict imminent diseases. The theory behind DNBs can be applied more broadly to the detection of signs of instability in various types of complex networks. For example, it can solve problems such as traffic congestion or instability in power networks caused by the introduction of large amounts of renewable energy. To a certain extent, it can even detect signs of economic fluctuation, such as the recession precipitated by the Lehman Brothers bankruptcy. Economic data have features as point processes in common with brain data and seismic data, and they can all be analyzed within a unified mathematical framework.

Driving advanced research on the brain and artificial intelligence (AI)

My colleagues and I have been also pursuing research on the human brain and artificial intelligence (AI). There are models called artificial neural networks that attempt to reproduce the mechanisms of networks of nerve cells in the brain. The neural network model proposed by McCulloch and Pitts in 1943 was the starting point for this approach. They proved that it is possible, given enough neurons, to create a neural network that can compute any logical function and is therefore equivalent to a Turing machine, which is the abstract archetype of the computer.

Recently, "deep learning" has been attracting attention. Deep learning is a technique that learns using artificial neural networks composed of neurons arranged in many layers. In fact, it has been proven that three layers are sufficient if you only make a mapping between input and output. Since actual brains process information by dividing the processing among deep layers and shallow layers, it does not necessarily mean that deep learning can do everything a brain can do. Recently, deep learning has been in the limelight because of the availability of big data to be used for learning and the availability of computer power that can be harnessed to learn from these big data.

The neuron model has been studied for a long time. In the UK, physiologist Alan Hodgkin and physicist Andrew Huxley formalized the characteristics of nerve membranes using differential equations, for which they were awarded the Nobel Prize in physiology or medicine in 1963. Richard FitzHugh of the US and Professor Jinichi Nagumo of Japan proposed a simplified form of these differential equations called the FitzHugh-Nagumo equations. Professor Nagumo even produced an electronic circuit model, which was entrusted to my laboratory for safekeeping.

My colleagues and I, following in the tradition of Professor Nagumo's research methods, are also pursuing research using analog integrated circuits to create mathematical models of cerebral cortex neurons. In our laboratory, Associate Professor Takashi Kohno has designed a circuit that runs a 1-neuron element on 3 nW (nanowatts) of power. The human brain has about 100 billion neurons, so implementing all of them would require 300 W, or the equivalent of several light bulbs.

Our laboratory is also participating in "Advanced information society infrastructure linking quantum artificial brains in quantum network", part of the Impulsing Paradigm Change through Disruptive Technologies (ImPACT) program, managed by Professor Yoshihisa Yamamoto of the Japan Science and Technology Agency (JST). This research is an attempt to use quantum neural networks to solve so-called "NP-hard" combinatorial optimization problems. Our laboratory is responsible for theoretical parts of the program such as brain-like information processing, synaptic plasticity, and machine learning. Two papers describing the implementations of this quantum neural network by optical electronic technology were published in the November 4, 2016 issue of the scientific journal "Science".

(Continues)

Driving research in areas like AI, robots, and consciousness

Now that AI and robots are popular topics, there are people who worry about whether AI will have consciousness, or will exceed human ability (the singularity). What is clear from the research on actual brains is that computers are not constructed at all like brains. Consequently, the singularity is not going to happen. In the domain of games like *go* and *shogi*, where there are fixed rules and big data for learning, you can achieve very high performance. However, from the perspective of brain research, I doubt that it will be possible to create something that exceeds the human brain in overall capabilities for another 100 or 200 years.

In order to discuss whether AI will have consciousness, you first need to think deeply about consciousness. American cognitive neuroscientist Michael Gazzaniga says that there exists within each brain a constellation of centers of consciousness, all interacting with each other, and that consciousness is an emergent phenomenon. Similarly, American psychiatrist Giulio Tononi associates consciousness with neurons connecting with other neurons, and defines the amount of extra information generated by a network as Φ (phi).

As for me, I would like to understand where consciousness emerges based on changes between states of consciousness and non-consciousness. For example, there is no consciousness in a sleep state, but conscious awareness is resurrected when we wake up. In the theory of evolution, it is thought that consciousness arose after unicellular organisms gradually evolved into multi-cellular organisms. Human babies react to unpleasant stimuli in the womb around the 23rd week of pregnancy. Vegetative states were once thought to lack consciousness, but recent research reveals quite a few examples of patients who were apparently conscious but simply couldn't express themselves. If progress can be made in this kind of research on the transitions between states of consciousness and non-consciousness, I think we will be ready for deeper discussions on topics such as AI, robots, and consciousness.

In February of this year, KKE and the Institute of Industrial Science at the University of Tokyo established a social cooperation program called "Mathematical Engineering for Complex Social Systems in the Future". Over a period of about four years, we will advance basic research on the underlying mathematical engineering for solving various problems associated with the complex social systems of the future, and we will conduct applied research on mathematical engineering aimed at solving a variety of complex social problems of high public interest. This program has just begun, but I hope to have results to report in the near future.

Profile

Kazuyuki Aihara graduated from the Faculty of Engineering at the University of Tokyo in 1977. In 1982 he earned Ph.D. at the Graduate School of Engineering at the University of Tokyo (Doctor of Engineering). Prior to assuming his current position in 1998 as Professor at the University of Tokyo, he served as Associate Professor at Tokyo Denki University and as Associate Professor at the University of Tokyo, among other positions. He served as Research Director on the JST ERATO AIHARA Complexity Modeling Project, and as Principal Researcher on the Cabinet Office/JSPS FIRST Innovative Mathematical Modeling Project, among other projects. Currently, he is affiliated with the University of Tokyo, where he serves as Professor at the Institute of Industrial Science, as Director of the Collaborative Research Center for Innovative Mathematical Modelling, and as Professor in the Graduate School of Information Science and Technology and the Graduate School of Engineering.

Being prepared for natural disasters

Seismic isolation technology for the future

Mineo Takayama

Professor, Department of Architecture Faculty of Engineering,
Fukuoka University

Seismic isolation systems are in use and have proved effective

Seismic isolation systems have been in practical use in Japan for about 30 years. My colleagues and I started our research on laminated rubber in 1979, and successfully developed it in 1981. In 1983, Japan's first seismic isolation building, the Yachiyodai seismic isolation residential building, was constructed in Chiba Prefecture using the developed laminated rubber.

Since then, a variety of seismic isolation devices have been developed, and their scope of application has expanded from single-family homes to skyscrapers. The seismic isolation buildings have experienced major earthquakes, such as the Kobe Earthquake (1995), the Niigata Prefecture Chuetsu Earthquake (2004), the 2005 Fukuoka Earthquake, the Great East Japan Earthquake (2011), and the Kumamoto Earthquake (2016), among others, but none of the buildings were damaged or had their functions disrupted, and the seismic isolation systems performed well as designed.

Profile

Mineo Takayama graduated from the Faculty of Engineering at Fukuoka University in 1982. In 1986, after completing graduate studies at the University of Tokyo, he began working on practical applications of seismic isolation systems at Fukuoka University. He performed actual full-scale experiments on laminated rubber that were indispensable to the development of seismic isolation systems, made contributions to finite element analysis, and clarified the mechanisms behind the excellent load-bearing performance of laminated rubber. For these accomplishments he was awarded the Architectural Institute of Japan Award in 1998. In addition to seismic isolation systems, he has conducted research on measures to reduce disaster risks in regions and towns.

Improvements to be made in seismic isolation technology

While seismic isolation systems have proven to be fully effective, there are still several improvements to be made. For example, when there is long-period, long-duration ground motion such as we saw in the recent Kumamoto Earthquake, the building sways for a longer time than is expected. Thus, when designing a seismic isolation system, you must take into account factors such as long-period, long-duration ground motion and pulse-like ground motion near active faults to ensure the safety of the building. It is important to establish the appropriate degree of seismic safety margin against the expected seismic waves when designing a system.

One way to enhance the safety of seismic isolation systems is to increase the deformation capacity of the seismic isolation layer. We need to properly evaluate the energy absorption performance of seismic isolation devices such as laminated rubber. Japan does not, however, have a testing machine for large-diameter laminated rubber bearings, and we are currently in negotiations with the government about installing a large-scale testing machine in Japan.

In recent years, seismic isolation systems have been used in high-rise buildings. When doing so, it is required to evaluate building responses caused by wind load. The responses of high-rise buildings to wind and seismic load can be in conflict, so with this characteristic in mind, the building's responses must be evaluated under various wind directions and wind speed.

In addition, it is important to evaluate the performance of seismic isolation buildings by observing the results when experiencing an actual earthquake. It is preferable to install marking-type displacement meters in the seismic isolation layer, but there is now a seismograph smartphone app that can be used as an alternative. I believe that taking advantage of the observation data will help us not only to understand seismic performance, but also improve our disaster management capabilities.

The journey and future of seismic isolation system development

Seismic isolation systems started at a primitive stage, but in recent years the technology has grown rapidly, including developments such as three-dimensional seismic isolation and semi-active control. Technological development requires an increase in sophistication, but when a technology becomes too sophisticated, its cost increases and it is no longer able to meet a variety of needs. While pursuing sophistication, I believe it is also important to standardize, generalize or simplify the technology and make the system available at a lower cost.

The “Science & Dream Roadmap” for the natural sciences and engineering fields issued by the Science Council of Japan in July 2011 includes an initiative to improve seismic technology in order to achieve “earthquake hazard-free buildings” by 2050. I hope this will not remain just a dream, but that we will be able to achieve this goal.

▶▶ The power of IoT that changes our lives

The future vision shaped by IoT and geospatial information services

Nobuo Kawaguchi

Vice-Director, Social Innovation Design Center
Professor, Institute of Innovation for Future Society, Nagoya University

The acceleration of IoT: High-performance smartphones and other developments

The Internet of Things (IoT) is becoming familiar in our daily lives. One of the major reasons for this is the increasingly high performance of smartphones. Furthermore, small computers called IoT devices are available today at low cost.
With advanced location information technology, we are shifting toward a "high-accuracy positioning society". Satellite positioning technology will evolve further when the four-satellite Quasi-Zenith Satellite System (QZSS) starts operation in 2018. Thanks to the development of smartphones, which contributed to miniaturizing chips and reducing their cost, you can now determine your position precisely even in a city, using your smartphone. The Japanese government has been promoting its "High-Accuracy Positioning Social Project" and is putting efforts into creating services such as navigation, and disaster prevention and mitigation. Preparations are underway to realize a society with high-accuracy positioning in time for the Tokyo Olympics in 2020.
In addition to the low cost IoT devices and the evolution of positioning technology, the cost of communication is another factor that accelerates IoT. Today, there are communication services that cost only about 30 yen per month by utilizing Mobile Virtual Network Operator (MVNO) services and making use of technologies such as low-power wide-area networks (LPWAN).

Case studies of data collection, analysis, and visualization in Nagoya

IoT enables the collection of large amounts of data such as time series information, location information, and pattern information.
Location information includes the positions of any person or any object. In addition, there is always time data, which means there is also spacio-temporal information consisting of location and time data. In the IoT era, it is possible to analyze where objects move to and from and when they move, and to use this information. This has already been in wide use in navigation control systems for airplanes and ships. Furthermore, data that used to be only available to professionals is now being made available to everyone.
At Nagoya University, we are engaged in research on the collection, analysis, and visualization of location information. For example, "TimeTable.Locky" is a smartphone app that displays the remaining time before the next train departure in the nearest station.
We visualized probe data from taxis in Nagoya City for studies such as taxi ride location analysis and verification of earnings using the taxi data. In addition to calculating revenues per taxi ID, we discovered that picking up passengers from the hospital was more lucrative than picking up passengers in front of the station.
Using probe data from Nishitetsu buses, we are promoting an initiative to visualize traffic congestion (bus delays) at a glance on different days. Nagoya city bus data, including location information, is provided to the Location Information Service Research Agency (Lisra), a non-profit organization that I am affiliated with, and we are currently considering what benefits this data offers and how best to utilize it.
Moreover, we are conducting studies to take advantage of geospatial information from people. We are using Pedestrian Dead Reckoning (PDR) technology to understand the movement of people indoors and using that information to demonstrate experiments such as O2O (Online to Offline) marketing.
I hope to support your business development through IoT and location information.

Profile

Nobuo Kawaguchi earned a doctorate from the Graduate School of Engineering at Nagoya University in 1995. After that, he served as a lecturer at the Graduate School of Engineering at Nagoya University and as Associate Professor in the Department of Information Engineering in the Graduate School of Information Science and Technology at Nagoya University, before assuming the position of Professor in the Department of Computational Science and Engineering in the Graduate School of Engineering at Nagoya University in 2009. His activities span a wide range of specializations including ubiquitous communication systems, information systems, and communication networks. He also participates in scientific societies as a member of the Information Processing Society, the Institute of Electronics, Information and Communication Engineers, the Society for Artificial Intelligence, the IEEE, and the ACM.

Exhibition Gallery

At both KKE Vision 2016 Tokyo and Fukuoka, KKE demonstrated the company's vision of a "Wise Future" through interactive exhibitions.

3D Printing Shoes = Structural analysis + Digital image correlation + Fashion

The 3D printed shoes that were featured in the Milan Collection were showcased at the event. Our company performed the analysis for robustness of the 3D printed shoes in the walking and resting state.

Using XFdtd to analyze the electromagnetic field of the antenna used in neutrino observation

Joining Professor Keiichi Mase from Chiba University in the neutrino observation project, KKE supported downsizing the antenna used in the project. We showcased two types of antennas, the original one that was used to perform electromagnetic field analysis and the antenna that was successfully downsized, based on the computed analysis results.

NavVis indoor digitalizing platform

NavVis's 3D mapping trolley (M3Trolley) and an indoor 3D model of Canal City Hakata (a large shopping complex) were exhibited at the event. We scanned the indoor space by hand, pushing the M3Trolley, and the scanned data was displayed in a 3D model on the NavVis's IndoorViewer.

Simulation of pouring wine from a bottle based on fluid dynamics

To avoid the dripping of wine along the bottle, we conducted a simulation using a CFD software called Particleworks. We actually prepared some bottles of wine and tested whether improvement could be seen using the analysis results.

Sumai IoT – Designing a safe and comfortable environment

KKE, which has many years of experience in the construction field, is developing several cutting-edge IoT solutions, focusing on people's *Sumai* (indoor living space).

GPS/GNSS signal simulator – Experience the "Door to anywhere!?" with your smartphone

The tent-like radio wave shield created using radio waves from a signal simulator allowed guests to explore anywhere they wished to be. When guests checked their current location on their smartphone or tablet while inside the shield, it indicated the location they had looked up as if they had reached the pinpointed location in real-life.

Virtual experience of an earthquake in a super high-rise building

We reproduced realistic indoor damage caused by an earthquake by combining the "Jishin The Vuton" (earthquake simulator) of Hakusan Corporation with the VR device "HTCVive."

Visitors could experience the simulation of how a room shook and furniture overturned or moved during the Great Hanshin-Awaji Earthquake, the Great East Japan Earthquake and the Kumamoto Earthquake.

ITS – The past and future of public transportation

We displayed a chronology table and introduction panels from the KKE transportation business, explaining a wide range of solutions such as a bus location system, automatic vehicles and an optimal arrangement simulation of charging stations.

KKE history chart

The history of KKE, beginning with the company's foundation to its business expansion throughout the years, was displayed in a chart form at the event.

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