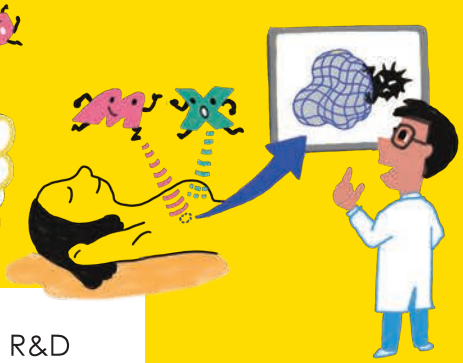


Strategic Information and Communications R&D
Promotion Programme

SCOPE NOW

Introducing of R&D Activities

2017

Ministry of Internal Affairs
and Communications

Contents

R&D Activities(finished FY 2015)

※Professional affiliations of the principal researcher are at the time implementing the research and development.

Electric Motor Cart Dynamic Powering Theory and Experiment for EVER Feasibility Study

Representative research institution
Graduate School of engineering, Toyohashi University of Technology (At the time of implementing the research and development)
(R&D period From 2013 to 2015)

World first! Realized a manned run of an electric motor car only by wireless electric power without batteries

Principal investigator
Prof. Takashi Ohira (Doctor of Engineering)
Department of Electrical and Electronic Information Engineering, Graduate School of engineering,
Toyohashi University of Technology

Message from the Principal investigator

Utilization of light and electric wave, which is a fundamental technology to support the present information communication society, will be associated with how we utilize wave motion, the characteristic of light and electric wave in other words (Wave engineering), in the future. Wave motion engineering has contributed to the fields of "Broadcast" such as radio and TV, and "Communication" represented by Internet, and it will be even more important for the energy field including "electric power transmission", I believe. I wish to be continuously engaged in R&D of this field, widely contributing to the formation of wealthy society, and focus more energy on personnel development in the fields concerned.

Achievements

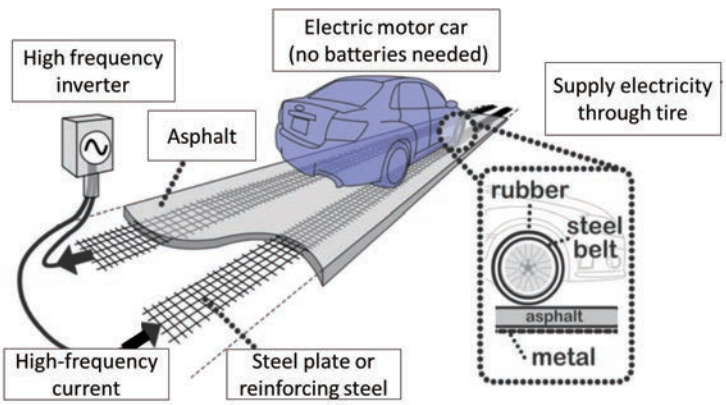
For the full-scale spread of electric motor cars, it will be vital to overcome the insufficient mileage and long charge time. As a means to solve this problem radically, the method to run the car while supplying the electric power to it has been introduced. Aiming at realizing this method, the research group of Professor Ohira has developed a system that electrifies roads like railroads to let electric motor cars run continuously. They've focused on the point that general tires contain material called "steel belt" made of metal to maintain their shape. While environmental variation during running is large for electric power transmission, they have realized the method that enables high-performance power collection from the electrified road through a running tire for the first time in the world. It is an unprecedented method without parallel in the world and they have struggled to establish and demonstrate the theory.

Further, in this R&D period, they have also realized a manned running of an electric motor car that is driven only by wireless electric supply without batteries on the electrified road covered with asphalt in the university campus, which is also the world's first.

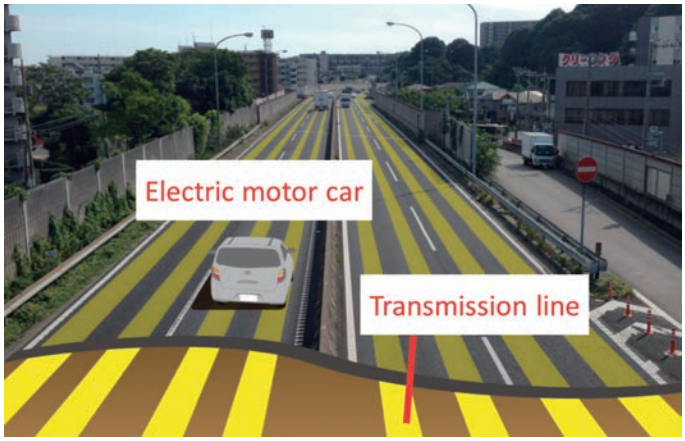
▲ World's first! Manned operation of the electric motor car without batteries

Future plan

One of the specific examples of social implementation based on the obtained result is application development of an unmanned carrier system. They have already developed a prototype of a small size carrier robot based on the wireless electric supply system which transport parts in a factory site of an enterprise, and it will soon be put in practical use. Since the robot is charged by the wireless electric supply system during running, brief stops for charge will become needless and the work which required manpower will be automated flexibly. Further, the electrified road electric motor car they have achieved will be combined with automatic operation in the future. This new technology will support social problems such as lack of drivers in physical distribution and transportation for elderly in depopulated areas.



▲ Mechanism of "electric supply during running" which requires no batteries Wireless electric supply to the electric motor car from electrified road through a tire



▲ Future city: electrified road electric motor car will spread as a brand new transportation method

Research on 100 Gbit/s real-time wireless transmission technology by terahertz wave

Representative research institution
Graduate School of Information Science and Electrical Engineering, Kyushu University (At the time of implementing the research and development)
(R&D period From 2013 to 2015)

Potential of substituting optical fiber Realization of ultra-high-speed real-time wireless transmission technology by terahertz wave

Principal investigator
Prof. Kazutoshi Kato (Doctor of Engineering),
Information Electronics Section, Graduate School of Information Science and Electrical Engineering,
Kyushu University

Message from the Principal investigator

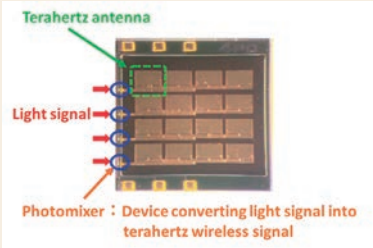
The optical communication technology has greatly contributed to evolution of the network infrastructure through the rapid improvement in transmission speed. I believe the optical communication technology is expected to continuously make progress with further improvement of transmission speed. I presume that it will be even more important to apply leading edge basic studies on the optical communication to other fields like our present study, which incorporates the optical communication into terahertz wireless communication. I am going to focus on various applications of the optical communication technology and proceed with wide range of R&D.

Achievements

Capacity and speed of the wireless communication has been dramatically improved accompanied with the spread of smartphones, though the ultra-high-speed wireless communication of 100 gigabits/s class such as the optical communication has not been in practical use yet.

This time, the research group of Professor Kato has focused on "Terahertz wave", which have properties intermediate between lightwave and electric wave, applied the optical communication technology to it, and successfully achieved 100m transmission and 90 gigabits/s (QPSK modulation) cooperating with Osaka University. These values are the world's highest in the use of terahertz waves.

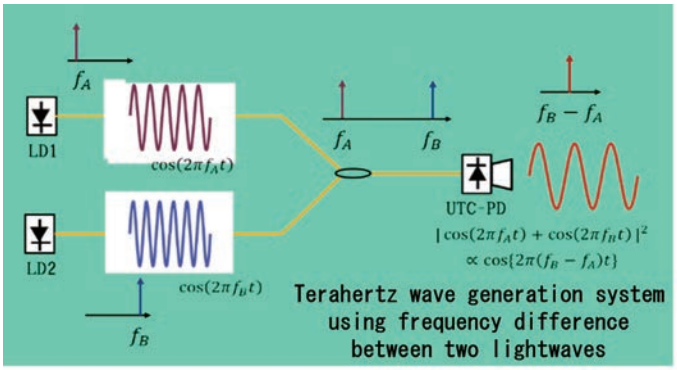
Though terahertz waves were known to be an efficient frequency band for transmitting a large volume of information, it was regarded difficult to control its directions and extend the transmission distance. Professor Kato has worked on generating terahertz wave from plural lightwaves to realize high output terahertz wave, utilizing various knowledge he has acquired through R&D works in the field of optical communication. He has realized a technology to integrate special terahertz wave transmission devices on one chip in which waveforms of each lightwave is precisely synchronized and terahertz wave is generated efficiently for the first time in the world.



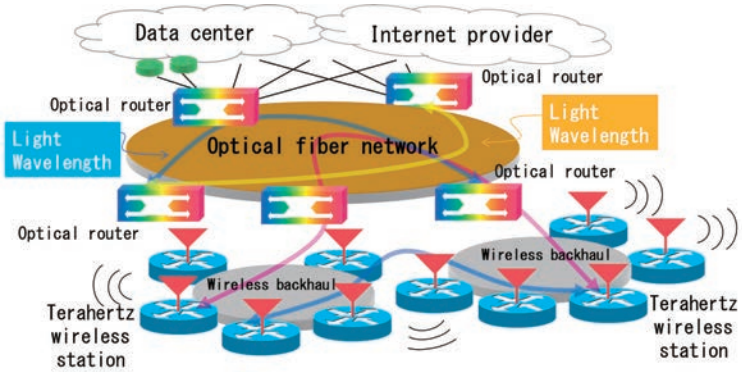
▲ The developed terahertz wave generation device

Future plan

Professor Kato is going to enlarge the frequency band from 300GHz, that was used during the study period, to 600GHz and investigate potential of this technology. In addition, he also intends to improve the technology for achieving 300 gigabits/s although the limit of transmission speed has been thought to be 100 gigabits/s for the terahertz wave of 300GHz. If this technology is put to practical use, real-time transmission of super fine images such as 4K and 8K will be realized for the various areas including those having difficulty in installing optical fibers, and the last-one-mile access tool with transmission speed equal to that of optical fibers will be materialized. Moreover, since terahertz wave is expected to be applied to non-communication fields such as contactless or non-destructive measurements, Professor Kato is also attempting horizontal development of the basic technology established this time into various fields.



▲ Concept for generation of the most efficient terahertz wave by detecting and tuning waveforms of plural lightwaves



▲ Image of ultra-high-speed network by fusion of the terahertz wireless and optical communications

Development of Virtual Network Control Method Based on Social Information

Representative research institution
Graduate School of Humanities and Sciences, Ochanomizu University (At the time of implementing the research and development)
(R&D period From 2014 to 2015)

Realized a new communication control method that effectively utilizes various SNS data occurring at a large-scale disaster

Principal investigator
Prof. Masato Oguchi (Doctor of Engineering)
Department of Information Sciences, Ochanomizu University

Message from the Principal investigator

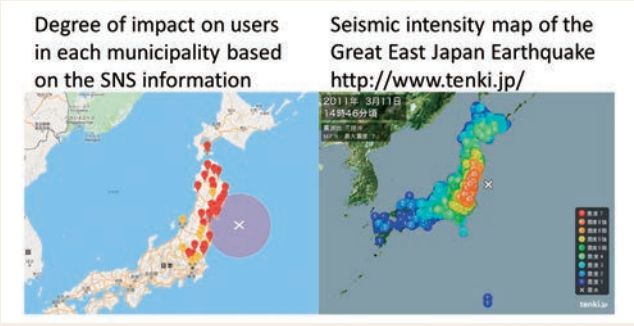
At the time of an emergency disaster, the priority is given to prompt acquisition of necessary information for the victims. Therefore, the security problem including various personal information is treated in a different way in some cases and this particular matter was not focused in our R & D. However, needless to say, on the occasion of data utilization, how we solve the security and privacy issues will be a very important point. For example, a structure for more efficient encrypted data processing would greatly contribute to solution of such problems. In this way, we are going to proceed with the R&D for data utilization from an even wider viewpoint in the future. We aim at contributing to realization of information-driven society that enables securer and safer diverse data utilization by such measures.

Achievements

At the time of an emergency disaster, it is important more than anything else to establish the condition that allows secure transmission of required information to the persons who need it. In order to achieve it, it is required to establish a transmission technique which precisely grasps the damage status of the communications infrastructure and adequately gives priority to emergent communication.

This time, the research team of Professor Oguchi has devised a new analytical technique, focusing on the point that large quantities of SNS information were sent in the Great East Japan Earthquake in a form that is different from those in normal times. They have developed a mechanism that enables to identify damaged spots by analyzing various information contents posted to SNSs even if they are not GPS data. Further, based on such damage statuses grasped, the University of Tokyo and Kogakuin University, which are the collaborators, have developed a system that performs priority control not for every simple data traffics but for every communication contents (every applications) on the occasion of communication control in an emergency disaster.

The control function of this system is capable of treating traffic capacity that is approximately 10 times as great as previous achievements by the University of Tokyo. One of the technologies to control wide area networks from a higher perspective utilizing SNS information has been realized by this time of R&D.

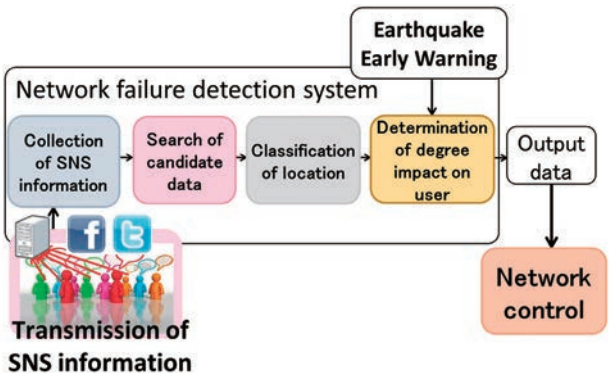


▲ SNS information analysis result and comparison with the actual suffering information based on data in the Great East Japan Earthquake

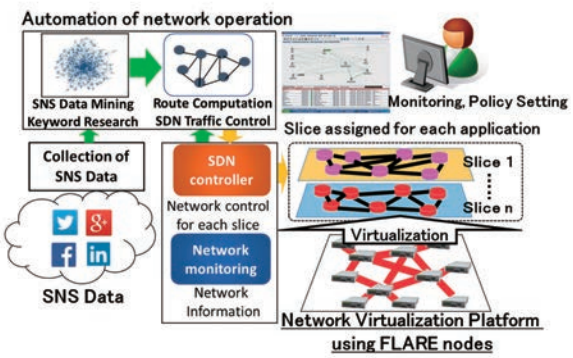
Future plan

We are going to study on construction of a more advanced damage status grasp system by newly introducing an AI technology to the data from communications infrastructure abnormality monitoring system conventionally performed in each carrier as well as to the damage status grasp function based on SNS information developed this time.

Moreover, in advance of the Tokyo Olympics of 2020, the research team is going to proceed with its application to transmission of sightseeing information to foreign tourists as one case of the application development of the technology. It is difficult to gain appropriate sightseeing information unless we go to a "certain place" at a "certain time" in many cases and therefore they are aiming at constructing a mechanism to narrow "place" and "time" and dynamically detect optimum event information at the place where the tourist is staying at the time by applying this analysis technology. Furthermore, they insist that utilization of the automatic translation technology would strengthen further convenience for foreign tourists.



▲ Outline of the system configuration developed this time

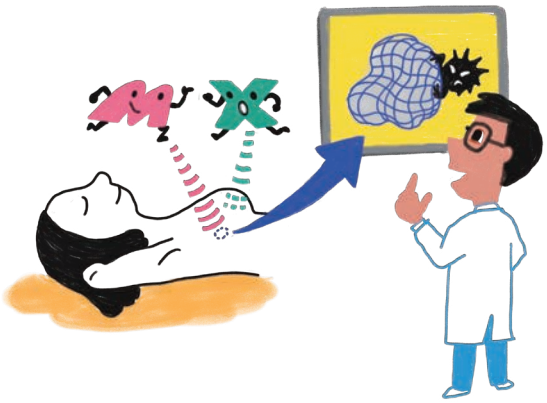


▲ Entire image of the wide area network control system utilizing SNS information

Development of real-time microwave mammography

Representative research institution
Graduate School of Science, Kobe University (At the time of implementing the research and development)
(R&D period From 2013 to 2015)

Early detection of breast cancer ! Developed a novel microwave mammography which has the world's best performance



Principal investigator
Prof. Kenjiro Kimura (Doctor of engineering)
Center for Mathematical and Data Sciences, Kobe University

Message from the Principal investigator

Observation is to obtain signals from unknown material bodies and investigate what they are. Many important theories on basic equations, by which "result" is precisely predicted from the given "cause", are described in textbooks of physics. However, as a matter of course, observation is executed simply because the "cause" is unknown, and observation is to follow this causal relationship in the backward direction. We are researching the theory and methodology to precisely identify causes from sufficient information obtained by observation, "result" in other words, not a process for estimating result by observation for the little unknown part left while almost knowing the "cause" itself beforehand. At the end of this research, we are expecting to detect the "cause" with respect to unexplained structures and phenomena left in the natural world and reach ultimate understanding on the mechanism of the world where we live in beyond the hierarchy from the micro to macro viewpoints.

Achievements

The number of mortalities due to breast cancer is approximately 13,000 (2013) and that of its onsets is approximately 77,000 (2013) in Japan, and they have been increasing year by year. X-ray mammography has conventionally been the global standard for breast cancer examination though the highly-concentrated breasts, "breasts in which tissues that may cut off X rays are clustered such as collagen fibers" in other words, accounts for approximately 80% of Asian women who are below 55 years old . It is extremely difficult to obtain the contrast of cancer tissues present in such breasts with X-rays, and its low efficiency has become a social problem in these days.

The research group of Professor Kimura has succeeded in development of a breast cancer image diagnosis system with the world's best performance using microwave, focusing on the natures that microwave (1) can reach deep in the breast since electric conductivity of major tissues of breasts is low and (2) reflect significantly on the boundary face between breast cancer tissues and normal tissues. The conventional technology that used microwave required long computation time for image reconstruction while it was difficult to acquire highly precise three dimensional images due to "problems on microwave propagation velocity that depends on frequency of the microwave" in a breast, and therefore it was far from practical realization. Based on the invention of the inverse analysis theory of scattering field, Professor Kimura and his group has developed a measurement system to visualize the locations of cancer tissues in a breast precisely and three-dimensionally using weak microwave, whose performance is more than several thousand times as high as that of the conventional image reconstruction method at the case of three-dimensional data of 128 pixels for one side.

Patent of these technology have become established in various countries in the world, and been put into practical use rapidly. Moreover, our achievement has been awarded AMED President Award of the 1st Japan Medical Research and Development Award for its great contribution to R&D promotion in the medical field.

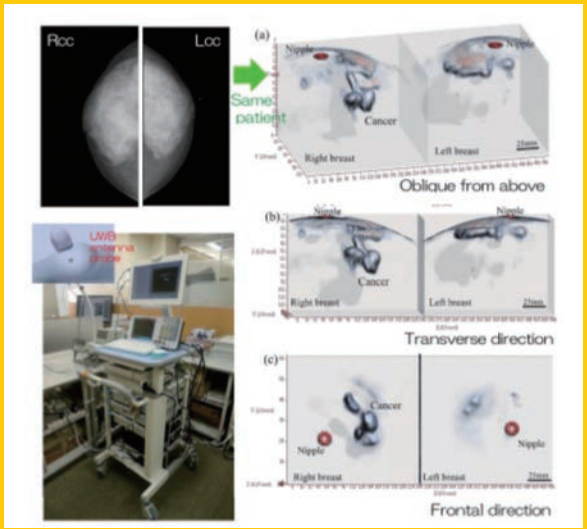
▲ Ceremonial photograph with the prime minister in the Office of the Prime Minister, where the award ceremony of the 1st Japan Medical Research and Development Award took place

Future plan

After completion of the study, this study has been taken over in other research projects, and various verification works are being pushed forward now for its practical realization as medical equipment. They aim to commercialize this system by around The Tokyo Olympics in 2020.

While lack of efficiency of the current breast cancer examination using X-rays mammography is called into question, they intend to spread this high sensitive system which has the potential to detect minute breast cancer tissues and reduce as many mortalities caused by breast cancer as possible in examinations without fear of radiation exposure, without pain and without using contrast medium.

Furthermore, this world's first and highest technology attracts expectations as a global standard for the breast cancer examination, and is greatly expected to be a valuable system to save lives of women in the world.



▲ Conventional X-rays mammography image (left)
Real-time microwave mammography image(right)

Research and Development for PIAX-adaptive Energy Control Gateway

Representative research institution
Department of Information and Computer Science, Faculty of Science and Technology,
Keio University (At the time of implementing the research and development)
(R&D period From 2014 to 2015)

Realized optimum power control communication technology that flexibly corresponds to various electric power supplies and demands from each family

Principal investigator
Prof. Naoaki Yamanaka (Doctor of Engineering)
Department of Information and Computer Science,
Faculty of Science and Technology, Keio University

Message from the Principal investigator

Triggered by the spread of Internet, new society areas (Cyberspace) where various services and communities are formed are occurring consecutively on the Internet. Furthermore, in the future, various events in the real world will be replaced with digital data on information communication terminals, and so-called "cyber physical", by which cyberspace is linked with the real world closely with the Internet, will be developed. In order to accelerate such a movement, it is necessary to make the network intelligence which links the real world and cyberspace. I wish to proceed with required engineering development as a developer, foreseeing the future when the cyber physical will be developed, and contribute to formation of affluent society in the future.

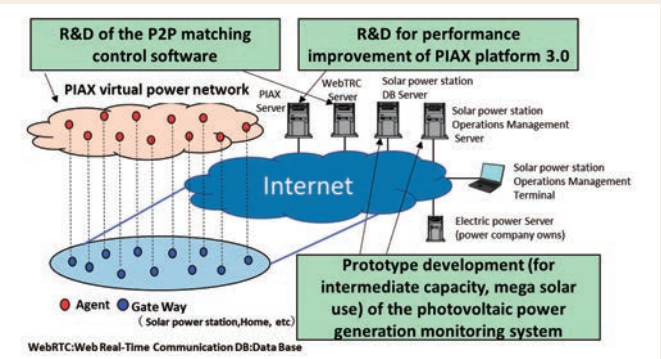
Achievements

With the social background such as the rapid spread of photovoltaic power generations (PV) after the Great East Japan Earthquake, practical realization of electric vehicle (EV), which is expected also as domestic power supply, and liberalization of electricity retailing, creation of a new business model that enables to stably and effectively utilize various electric power resources located dispersedly near consumers is demanded.

The research group of Professor Yamanaka, based on the ideas obtained from the mechanism of MVNO (mobile virtual network operator) of the communication industry, has developed an exclusive gateway (communications device) that enables third parties without having infrastructure such as the existing electric power companies to borrow services and construct a virtual power station on a network by consolidating plural energies including EV and PV by ICT so as to perform matching of the electric power dealing according to the provision (policy) required by each demand side.

Further, they have newly developed and implemented an algorithm to generate constant conditions (search area) dynamically for various policies from the demand sides such as cost or distance to power generating units, and enabled effective and ideal electric power acquisition. Furthermore, they have realized an establishment of stable and effective communication without depending on the existing network environment through the development of a new communication system based on the technique (PIAX) developed by NICT (National Institute of Information and Communications Technology). A prototype that incorporates these R&D results has also been developed, and efficiency of this system has been confirmed in mega solar facilities actually operated.

▲ System verification in mega solar service



▲ Overview of the proposed system

Future plan

The above R&D results are transferred to venture companies and introduced to actual small-size photovoltaic power plants. They are remote-monitored for 24 hours. Moreover, the properties of this technology that is able to effectively perform communication between various terminals without depending on network environments are fully utilized and the use of this system has been expanded to monitoring of aged people living alone.

Furthermore, as a future expansion of the technical achievement which can perform high-speed searching, application to various data trade markets including sensors, images, videos and so on has also been examined for realization of IoT, which attracts attentions from various fields. If a data trade market that gives some kind of incentive to data providers is established, diverse and advanced data supply and demand matching will be realized and new services will be created. For example, not only automatic operation with vehicle sensors that detect traffic conditions but also a technology to control operation based on various data in cyberspace can also be realized. The study shown in the following figures is currently progressing and their R&D achievements will be extensively utilized in various fields in the future.

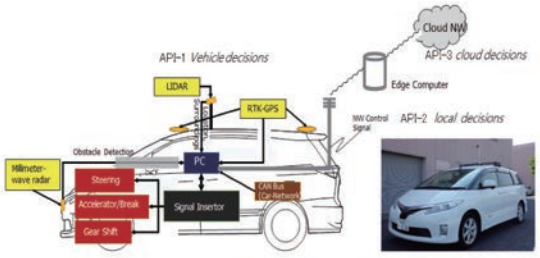


Fig. 16: The Keio test-bed will provide 3 APIs, vehicle, local, and cloud decisions.

▲ Controlling automatic driving vehicle from cyberspace controller

Development of superconducting dual-band bandpass filter for next generation cellar base station

Representative research institution
Department of Electrical and Electronic Engineering, University of Yamanashi (At the time of implementing the research and development)
(R&D period From 2013 to 2015)

Developed a superconducting filter that realizes high-speed and large-capacity communication and effective use of frequency resources simultaneously

Principal investigator
Associate Professor Naoto Sekiya (Doctor of Engineering)
Department of Electrical and Electronic Engineering,
University of Yamanashi

Message from the Principal investigator

Although superconductors are practically used for maglev train, MRI in the healthcare setting and so on, I feel that its social implementation has not been implemented in the society as much as it should be, considering the possibility of the superconductor itself. In particular, the R&D of the filter we performed for SCOPE this time has not been conducted in Japan and therefore I hope its study case increases in the future. I am going to advance the study on superconducting devices and explore its possibility for every field other than communication while proceeding with various actions such as promotion of social cognition about this field.

Achievements

For the needs for high-speed and large-capacity communication in recent mobile network, communication companies have attempted to realize such needs by aggregating two different radio communication channels. For construction of a radio communications system, the device called "filter", which allows the only radio frequency used for the communication concerned to pass (remove other frequencies), is essential. When using plural frequencies in this way, passing all required frequencies with a single filter without setting a filter for each frequency is ideal for system construction.

Further, certain widths (guard band) are required to prevent interference between adjacent bands. If this width is reduced, frequency resources can be utilized more effectively, which would improve the information transmission. However, it was difficult to reduce this width with the conventional filter.

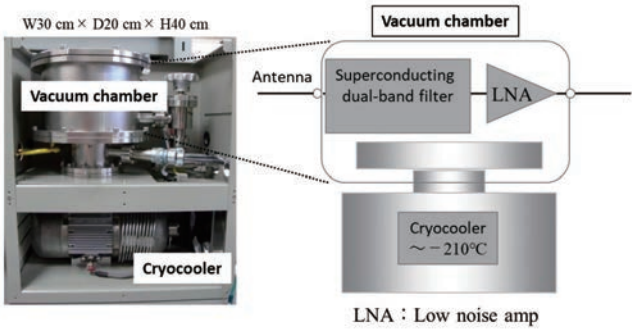
The research group of Associate Professor Sekiya focused on the property of superconductor that its electric resistance becomes extremely small at an ultra-low temperature, and succeeded in development of the superconducting dual-band bandpass filter which extremely reduces the guard band, At the same time, they have also realized the mechanism which let the central radio frequency of the filter be variable according to target radio frequency. Both are the world's first achievement.

Future plan

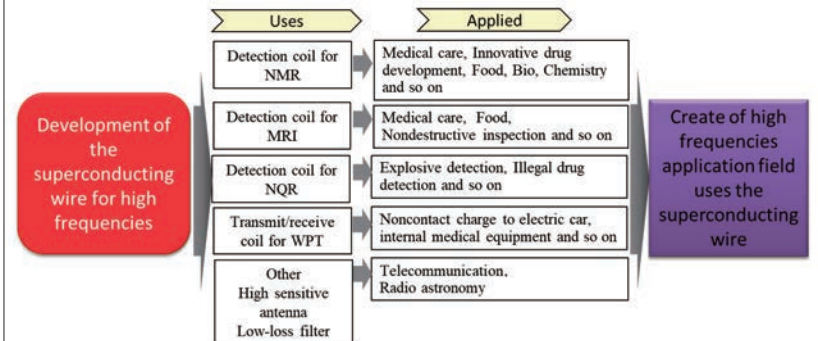
Based on the technology that they have developed this time, they are going to develop superconducting multiband bandpass filters that correspond to three frequency bands, and furthermore to devise those that can treat six frequency bands.

Moreover, they are planning to expand their R&D results to the fields that require higher-performance filters such as satellite communication and radio astronomy.

Furthermore, although high frequencies in the bands that are lower band than those of the high frequency band developed this time were uncultivated frequency bands from which effects were not obtained even with superconductors, a certain result was obtained by applying the key technology developed so far. Therefore, they are going to examine the possibility of its application to various fields such as high performance wireless power transmission system which utilizes the frequency band concerned.



▲ The developed dual band-pass filter system



▲ Possibility of various applied researches which utilize superconductor

Research on automatic annotation method for the analysis of geo-tagged big data

Representative research institution
Graduate School of Information Science, Nara Institute of Science and Technology (At the time of implementing the research and development)
(R&D period From 2013 to 2015)

Development of IoT platform that simplifies and enriches the society and human interaction

Principal investigator
Associate Professor. Yutaka Arakawa (Doctor of Engineering)
Graduate School of Science and Technology,
Nara Institute of Science and Technology

Message from the Principal investigator

I have been engaged in studies on data sensing technologies for many years. The spread of smartphones, wearable computers, and IoT instruments has facilitated data collection and nowadays researchers are competing for data analysis technologies, AI technologies in other words. The further sophistication of the sensing technology and utilization of AI will enable not only identification but also a prediction of various future behaviors of a person. Moreover, it will also be possible to change future behaviors by information. Therefore, I believe that we should not leave problems on privacy in our research field. To establish both convenience and privacy with advancing the technologies, we need to discuss not only with researchers in the field of information communication but also with experts from various fields such as law, psychology and so on for our future research activities.

Achievements

In recent years, the expectation for "town activation" by utilizing big data based on position information to create new attraction and values in the community has been rising. The research team of Associate Professor Arakawa has focused on two types of data stored in the cloud. One is the implicit data which is automatically accumulated when a user uses a social network service. Another is the explicit data which is collected by crowdsourcing of participants. The research group has reached four achievements through research and development activities.

The first one is the development of an application that automatically extracts the useful information for the amateur photographer such as a spot and camera settings from accumulated social data (2nd place in 2014 ACM MobiCom Application Competition, Grand Prix in e-ZUKA Smartphone Contest 2013).

The second one is the development of an application that incorporated elements and ideas to amuse people like a game (gamification) and implemented a mechanism (level-up / ranking) to improve the participants' motivation for cooperating the sensing (ParmoSense).

The third one is the development of an ultra-compact all-in-one sensor (SenStick) equipped with eight kinds of sensors, storage mediums (flash memory), and BLE. It can make various things a sensor easily. Although there has already been a similar sensor board having multiple sensors and BLE, no ultra-compact sensors that can record all the data into storage medium stand-alone. This SenStick have won numerous awards such as The Best Demonstration Award of "ACM Ubicomp/ISWC2016" and been productized.

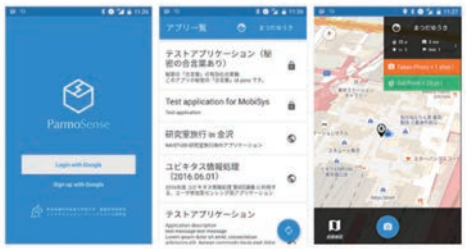
The fourth one is the development of a mechanism which can copy applications between smartphones under the conditions that they cannot be connected to the Internet in emergency disasters (RecurShare).

They have succeed in the development of diverse data sensing technologies as described above and concrete social implementation of the achievements has been steadily progressing.

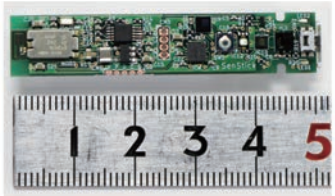
▲ Application which performs urban analysis from accumulated social data (Phorec)

Future plan

The platform of participatory mobile sensing (ParmoSense) is published for free, and it has been utilized in various ways such as an official event taken place in Ayase City, Kanagawa, Town Walk Event of “Code for”, sightseeing data gathering experiment in Kyoto and Nara, and so on. Furthermore, since the software and circuit design of the ultra-compact all-in-one sensor (SenStick) are published as an open source, it is expected to help a rapid prototyping of IoT by other researchers and companies. For example, even elementary and junior high schoolers will be able to turn personal things to "IoT" by utilizing SenStick and learn how to sense various behaviors in everyday life. One of the examples is the educational tool that allows students to learn the mechanism such as what movements an acceleration sensor and a gyro sensor capture, or by what kind of data analyses they identity movements. Moreover, the team is now working on new studies that compositely combines achievements, SenStick and ParmoSense. It measures the interest and satisfaction of tourist by putting a SenStick on glasses in collecting a sightseeing data by ParmoSense. These results will widely contribute to creation of new attraction and values for communities.



▲ Application that implements the function that allows a user to give information voluntarily as though it were a game (ParmoSense)



▲ Ultra-compact all-in-one sensor SenStick, having various sensors,memory and BLE. (Acceleration, gyro, magnetics, temperature, humidity, air pressure, light, UV)

▲ Daily commodities sensorized by SenStick

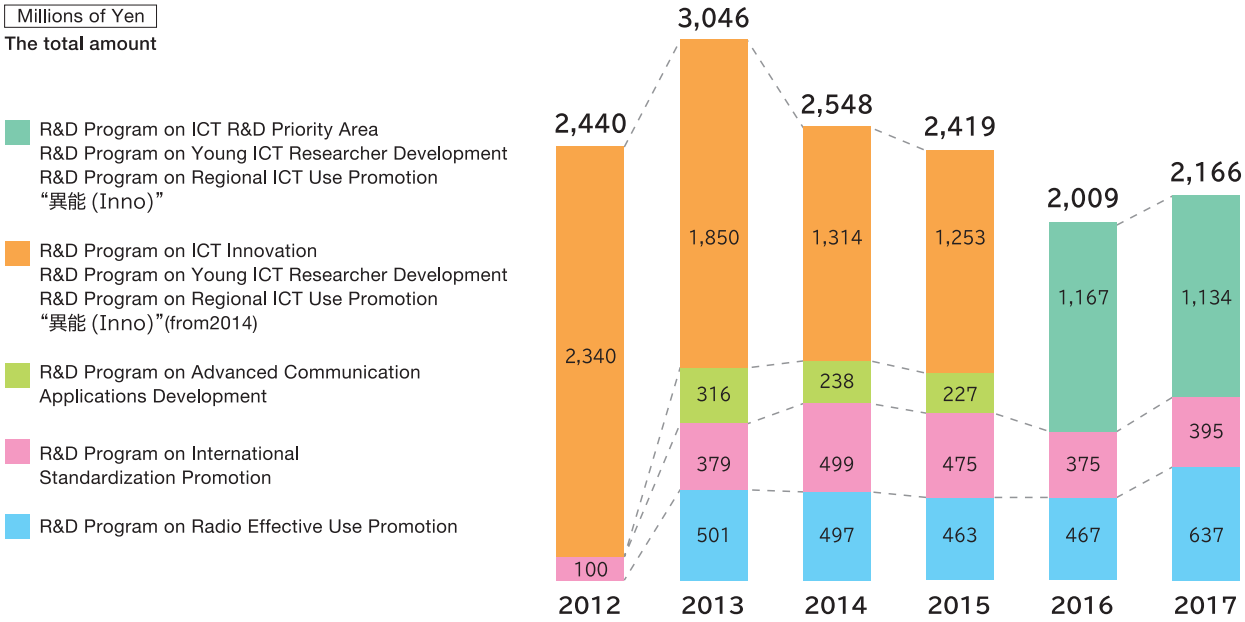
Overview of the SCOPE

Strategic Information and Communications R&D Promotion Programme (SCOPE) is a competitive fund that widely invites proposals for unique and novel R&D subjects in the field of information and communication technology (ICT) from universities, national research and development agencies, enterprises and research facilities of local governments. Researches to be commissioned are selected after competitive selection by external experts.

This programme promotes creation of innovation in the future society, cultivation of young ICT researchers, regional vitalization by ICT use and so on.

1. R&D Program on ICT R&D Priority Area
2. R&D Program on Young ICT Researcher Development
3. R&D Program on Radio Effective Use Promotion
4. R&D Program on Regional ICT Use Promotion
5. R&D Program on International Standardization Promotion
6. “異能 (Inno)” (R&D Program for Support of Extraordinary Ability in a Particular Field)

Transition of the SCOPE budget



Transition of the numbers of proposals and accepted research subjects

	2017			2016			2015		
	Proposals	Acceptances	Competitive rate	Proposals	Acceptances	Competitive rate	Proposals	Acceptances	Competitive rate
R&D Program on ICT R&D Priority Area	36	6	6.0	-	-	-	116	17	6.8
R&D Program on Young ICT Researcher Development	57	11	5.2	82	21	3.9	45	17	2.6
Program for Young Researchers	40	5	8.0	78	20	3.9	-	-	-
Program for Small and Medium Enterprises	17	6	2.8	4	1	4.0	-	-	-
R&D Program on Radio Effective Use Promotion	64	20	3.2	52	27	1.9	38	12	3.2
R&D Program on Advanced Radio Effective Use Promotion	47	15	3.1	39	18	2.2	29	9	3.2
Phase I	19	6	3.2	33	17	1.9	18	7	2.6
Phase II	28	9	3.1	6	1	6.0	11	2	5.5
R&D Program on Young Wireless Researcher Development	17	5	3.4	13	9	1.4	9	3	3.0
R&D Program on International Standardization Promotion	(Updated later)			41	4	10.3	-	-	-
R&D Program on Regional ICT Use Promotion	68	25	2.7	69	22	3.1	65	22	3.0
Total	225	62	3.6	244	74	3.3	264	68	3.9

January 12, 2018

Contact

R&D Program on ICT R&D Priority Area, Young ICT Researcher Development, Radio Effective Use Promotion, and Regional ICT Use Promotion

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R&D Program on International Standardization Promotion

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SCOPE (general)

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Ministry of Internal Affairs
and Communications