OKI's R&D through Industry-Government-Academia Collaboration

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Circumstances surrounding R&D, which is one of the necessary sources for business growth, are changing in recent years. Some specifics are[1]:

- Diverse customer needs.
- Delay in responding to commoditization of IT products.
- Departure from in-sourcing.
- Trend toward more short-term outcomes.

Thus far, OKI's efforts in information communication technology (ICT) have included R&D of sensing, network and data processing technologies[2]. Active promotion of open innovation is now necessary to move toward a society centered on the ever-growing IoT (Internet of Things)[3]. Industry-government-academia collaboration is regarded as one form of open innovation, and this collaboration is indispensable for the acceleration of R&D.

This article presents what OKI is expecting from an industry-government-academia collaboration, and introduces the research achievements obtained through the collaboration with companies, national/regional governments and universities.

Expectations from Industry-Government-Academia Collaboration

OKI is promoting industry-government-academia collaboration in expectation of the following effects.

- Reduced R&D time by implementing technologies not available in-house from universities.
- Reduced R&D risk by entrusting universities with development that differs from OKI's approach.
- Reduced R&D risk and shortened development time by utilizing public support.
- New application discoveries for OKI's technologies by jointly developing with universities and companies in fields different from OKI.

OKI's IoT network, AI/sensing, next generation communication, UI/UX, applied optical and manufacturing technologies achieved through industry-government-academia collaboration are introduced below.

IoT Network Technology

As a technology supporting the IoT network, OKI is using its 920MHz wireless sensor network to monitor the integrity of aging social infrastructures in an attempt to provide disaster prevention through preventive maintenance and crisis prediction of infrastructures (**Figure 1**). OKI is taking advantage of the industry-government-academia collaboration for the development of this monitoring system and is conducting the following activities.

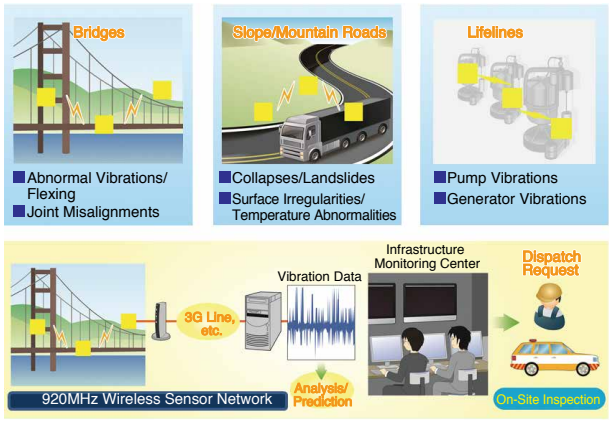

Figure 1. Social Infrastructure Monitoring System Utilizing 920MHz Wireless Sensor Network

(1) Bridge Monitoring

Various sensors are installed on bridges from which data is remotely collected then analyzed to detect abnormalities and perform preventive maintenance. OKI has developed a system that combines a vibration sensor with a low-power wireless module. The system is being evaluated at an actual bridge with the cooperation of other companies participating in the Research Association for Infrastructure Monitoring System (RAIMS)[4] under Research & Development Partnership.

(2) Low-Power Wireless Monitoring

A wireless monitoring system is effective for constantly monitoring the integrity of pumps and other infrastructures

that support lifeline at a low cost. As a participant in a R&D project by the New Energy and Industrial Technology Development Organization (NEDO), OKI is developing low-power wireless communication and congestion avoidance technologies aimed at a network system capable of operating for ten consecutive years on two CR123A type batteries.

(3) Performance Evaluation of Network Access Authentication

Network access authentication is important in building a low-power wireless network not only to secure safety, but also to shorten network construction time. OKI is working in collaboration with the National Institute of Information and Communications Technology (NICT) and utilizing its testbed to evaluate the performance of sensor network authentication.

AI/Sensing Technology

OKI is combining sensing technology using images and radio waves with AI technology, such as data analysis, in an aim to apply the resulting technology to the areas of recognition, detection, prediction, and control related to social infrastructures (**Figure 2**). The technology is undergoing R&D mainly in collaboration with universities.

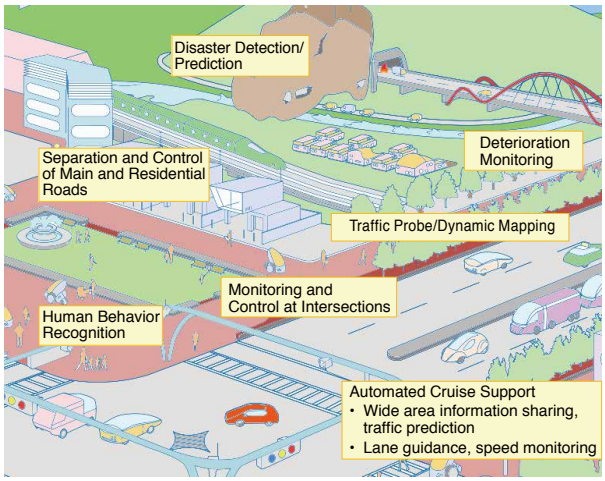

Figure 2. Application Areas of OKI's AI/Sensing Technology

(1) Behavior Tracking

Technology to track each person under crowded conditions has been in increasing demand recently for use in crime prevention and marketing applications. With tracking technology based on general statistical learning, it was difficult to handle all the various appearances of people when they are under concealment. OKI, in collaboration with Keio University, is combining technology that expresses movement of objects (optical flow) and technology that segments similar areas, to develop a technology capable of continuously tracking people even when they are concealed by only using the visible areas. This enables robust behavior tracking against concealment (**Figure 3**).

(2) Data Analysis

Amid the rapidly increasing applications of AI and statistical data analysis technologies, OKI has, through collaborative research with Chuo University, produced several research achievements conducting analysis of data taken from sensors and utilizing statistics to derive value from big data.

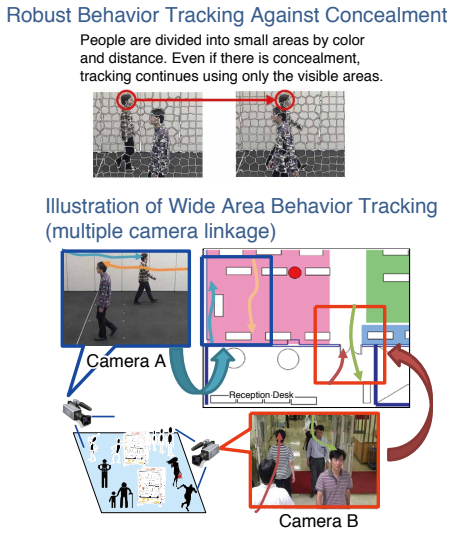

Figure 3. Behavior Tracking Technology

Next Generation Communication Technology

OKI is promoting R&D of the next generation communication technology against a backdrop of the accelerating network speeds and popularization of smart devices. Some specifics include technology to realize and evaluate an ultra-realistic telework system aimed at transforming workstyles and diversify communications, technology to improve sound quality of wireless devices, and transmission technology using wearable devices. Industry-government-academia collaboration is also utilized for these technologies.

(1) Ultra-Realistic Telework

Telework, which enables workers to connect remotely with distant offices, is attracting attention as a means to solve social problems that include declining birthrate and aging population. When a worker is faced with a situation such as nursing care that forces frequent teleworking, communication may become difficult since the status of his/her colleagues is not known. As a result, delay in conveying information or a sense of alienation may become a problem. OKI has focused on this subject and developed an ultra-realistic teleworking system with the ability to see the status and speak to colleagues in the same way as a large office room (**Figure 4**). A part of this R&D was conducted as a commissioned research by NICT, and a forum in which several organizations (companies and universities) collaborate has been formed[5].

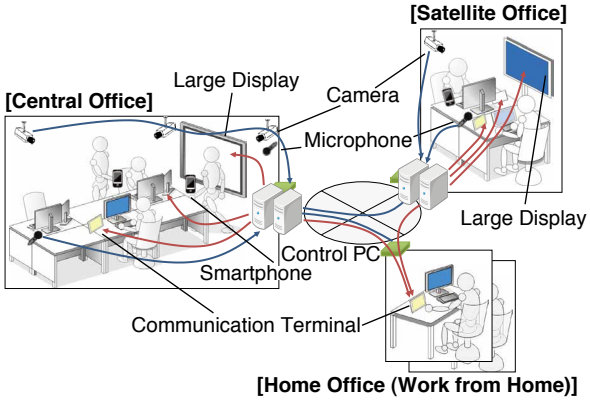

Figure 4. Ultra-Realistic Telework System

For user evaluation, this ultra-realistic telework system was demonstrated empirically under a long-term teleworking environment. As a result, it was shown that this system brings changes to the amount of communication and fosters social capital. Part of the evaluation was done collaboratively with Tokyo Institute of Technology and as a commissioned research by NICT.

(2) Sound Quality Improvement

Even now as mobile phones grow in popularity, communication radios for broadcasting businesses are indispensable at reporting and broadcasting sites as a means to ensure contact when mobile phones are congested and cannot be used, such as in disasters. The communication radio for broadcasting businesses changed from an analog system to digital system several years ago, but in order to secure a large number of channels within a narrow frequency, a vocoder with a high compression ratio must be used. As a result, the audio tends to sound mechanical. Therefore, OKI, Nippon Television Network Corporation and JVC KENWOOD Corporation jointly developed a technology to improve sound quality of digital communication radios, and are in the midst of conducting field tests and trial operations in various environments.

(3) Bodily Information Transmission

OKI is collaborating with University of Tsukuba on the research of wearable devices, remote communication using AR/VR and robot technology, and human-robot interaction. The research is focused on sharing viewpoints and transmitting information of bodily movements, such as change in body direction, through remote communication. The research result will be applied to a remote operation support system that utilizes wearable devices.

UI/UX Technology

OKI develops terminal equipment such as ATMs and printers. There, UI (User Interface) and UX (User Experience) technologies are indispensable as contact points that connect the real world (people) with the virtual world (network connected to the terminal).

(1) User-Assistance for Self-Maintenance

In recent years, “self-maintenance” where users themselves replace consumables of multifunction printers has become the norm. However, it is sometimes difficult for beginners and elderly users to understand the operation. Thus, an easy to understand operation manual is required. Moreover, due to the spread of mobile devices, importance has been placed on providing animated operation manuals. OKI is studying a method to support beginners in the self-maintenance operation of multifunction printers based on cognitive psychology. As a method to promote understanding, study is taking place in the use animation and personified agents, and its effectiveness is being verified in collaboration with University of Tsukuba.

(2) Information Adapted to User Behavior

Due to the continued popularization of mobile devices, a user can obtain various types of information via applications. However, information unsuitable with the user’s behavioral situation can be deemed inconsiderate. In collaboration with Chiba Institute of Technology, OKI is studying a prosocial hypothesis model that considers the user’s behavioral situation and what the user would feel as kind information. Based on the model, a simple

prototype guidance application for a train station, which changes information according to the user's behavioral situation, was created and verification experiment is being conducted.

Applied Optical Technology

Applied optical technology, which is one of the base technologies of ICT, is expected for use in IoT networks. As part of an applied optical technology, OKI is utilizing industry-government-academia collaboration on silicon photonics and coherent detection technologies.

(1) Silicon Photonics

Silicon photonics is a technology capable of manufacturing ultra-compact optical circuits at a low cost. Applying this to optical transceivers of IoT networks, miniaturization in order of magnitude smaller and cost cutting due to significant reduction in the number of parts are expected. For this technology, several companies and organizations have joined forces to form the Photonics Electronics Technology Research Association (PETRA)[6] under Research & Development Partnership and share a silicon semiconductor manufacturing facility to conduct R&D.

(2) Coherent Detection

Coherent detection technology is expected for application on simple quality monitoring of complex coherent optical signals and on high sensitivity optical fiber sensor that utilize phase information. In the NICT commissioned research project, participating organizations share efforts on the development of a detection circuit technology aimed at achieving a stable, high-precision optical phase-lock and the development of an ultra-compact optoelectronic integrated circuit using silicon photonics.

Manufacturing Technology

In Komoro City, Nagano Prefecture, where Nagano OKI, one of the affiliated companies of the OKI Group, is located, Shinshu University-Komoro City Industry-Academia-Government Collaboration Council has been established as a grant project aimed at promoting the research and development of city enterprises. This council coordinates with Shinshu University for collaborative research, and is engaged in subsidizing research expenses. Nagano OKI has been conducting collaborative research utilizing this subsidized project.

Conclusion

An increasingly active movement of open innovation is foreseen in various fields. OKI plans to actively pursue cooperation not only with industry-government-academia collaboration mentioned in this article, but also with venture companies to promote open innovation in a wide range of fields.

For details of the contents outlined in this article, refer to the relevant accompanying articles. ◆◆

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【Glossary】

Research & Development Partnership
Mutual aid organization (non-profit organization) in which members conduct joint research for themselves on technology used in industrial activities. Each member provides researchers, research expenses and facilities to conduct joint research. The research results are managed jointly and utilized mutually among members (quoted from Ministry of Economy, Trade and Industry's HP in Japanese). http://www.meti.go.jp/policy/tech_promotion/kenkyuu/01.html

vocoder
Audio compression technology for communication. When transmitting voice using a digital method, if the voice waveform is directly transmitted, a large bandwidth is required. Therefore, the waveform is parameterized before being sent.