ICT,
Spreading through the World

Seeping into our Life

Electronics and
Telecommunications
Research Institute

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ROLE & RESPONSIBILITY

ETRI

CONTENTS

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Where ICT meets our ROLE

People and their Value are
where the ROLE of ICT starts.

ICT, for the People, toward the People,
and by the People

ETRI is joining hands to bring about
change and technology seeping into our life.

Where ICT
meets our RESPONSIBILITY

The ROLE bestowed upon us
starts with the weight of RESPONSIBILITY.

Effort to make this world one step better
Effort to make this world one step safer

Where all these efforts are brought together with ICT,
a better place for all comes to reality.

WHERE ICT MEETS
OUR RESPONSIBILITY

HISTORY

1976

12. 30

KERTI established

Established for electric research and testing

KIET established

Established for semi-conductors and computers

12. 31

KECRI was founded as an affiliate of KIST

Established for R&D in telecommunications technology

- **Established KERTI, KIET and KECRI, the origins of ETRI**

Dec. 30, 1976 KIET(Korea Institute of Electronics Technology) was established to research in the field of electronics, e. g. semi-conductors, computers

Dec. 30, 1976 KERTI(Korea Electric Research and Testing Institute) was established to research in the field of electrics

Dec. 31, 1976 KECRI was founded as an affiliate of KIST for systematic research and development in the field of communication technology and introduction and development of 'Electronic Switching System.'

1977

12. 10

KTRI established

KECRI became independent from KIST and KTRI was established on Dec 31, 1976 as a research institute specialized in telecommunications

Dec. 10, 1977 Independent from KIST and renamed itself as KTRI

1981

01. 20

KETRI established

(consolidation of KTRI and KERTI)

- **Established KETRI**

Jan. 20, 1981 KETRI(Korea Electrotechnology and Telecommunications Research Institute) was established in consolidation of KTRI and KERTI

1985

03. 26

ETRI established

ETRI Institute specialized in information and telecommunications (consolidation of KIET and KETRI)

- **Established ETRI**

March 26, 1985 ETRI, institute specialized in Information and Telecommunications was established(consolidation of KIET and KETRI) to meet with the emphasize on electronics field

1996

01. 01

SERI transferred to ETRI

SERI, data process department of KIST, transferred to ETRI as an affiliate

- **Data process department of KIST transferred to ETRI as an affiliate**

June 27, 1967 SERI(Systems Engineering Research Institute) was opened as data process department of KIST. In accordance with, government restructuring of the Ministry of Science and Technology to the Ministry of Information and Communication SERI became affiliate of ETRI on January 1, 1996.

May 25, 1998 Incorporated into ETRI

1997

01. 31

ETRI

ETRI's Korean name changed

- **ETRI's Korean name changed**

Jan. 31, 1997 Based on regulations for electronics and telecommunications

R&D MAJOR ACHIEVEMENT

ETRI makes contribution to the nation's economic and social development through research, development and distribution of industrial core technologies in the field of Information, Communications, Electronics, Broadcasting and Convergence technologies.

1970s

1976
- Established ETRI, an affiliate of KIST
- Established KIET
- Established KERTI

1977
- Established KTRI (Korea Telecommunication Research Institute)

1980s

1982
- The nation's first semiconductor product '32K ROM chip'

1983
- 8-bit educational computer

1984
- 16-bit UNIX domestic computer

1986
- Launched TDX-1

1988
- 565Mbps optical communications system

1989
- 4M, 16M, 64M and 256M DRAM

1990s

1990
- 32-bit microprocessor

1991
- Launched TDX-10
- TiCOM II

1995
- Commercialize CDMA for the first time in the world

1996
- CDMA ATM exchanging machine

1999
- Synchronized IMT 2000(CDMA2000) STP system

2000s

2004
- WiBro prototype

2005
- ETRI succeeded in exported embedded SW solution
- Terrestrial DMB service launched

2006
- Wireless home network(UWB)

2007
- The world's first 3.6Gbps 4th generation mobile communication technology(NoLA)

2008
- The world's first digital content vending machine

2010s

2009
- SMMD-based 4D system technology

2010
- 4G LTE-Advanced Technology
- Smart ship technology(SAN)

2011
- Transparency adjustable AMOLED display
- Packet-optical integrated transport network technology

2012
- 100 times faster optical Internet technology
- Korean/English portable automatic interpretation technology

2013
- Automated valet parking technology using a smart phone

2014
- OCESTRA, Optical Internet technology

2015
- High five escort technology

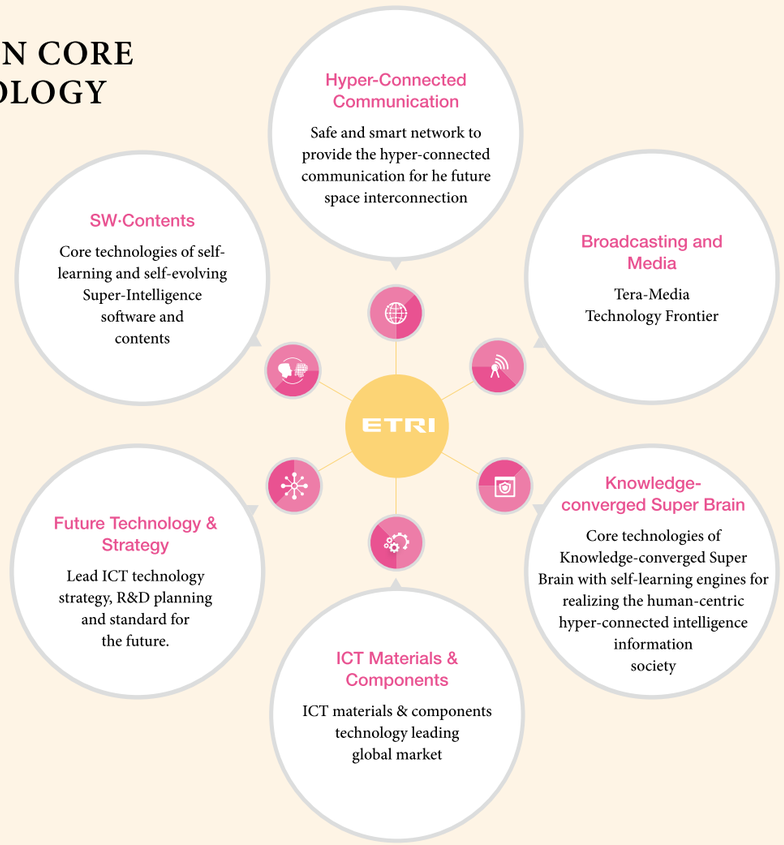
2016
- Exobrain : Natural Language Processing & Question Answering SW.

2017
- UHD mobile broadcasting technology

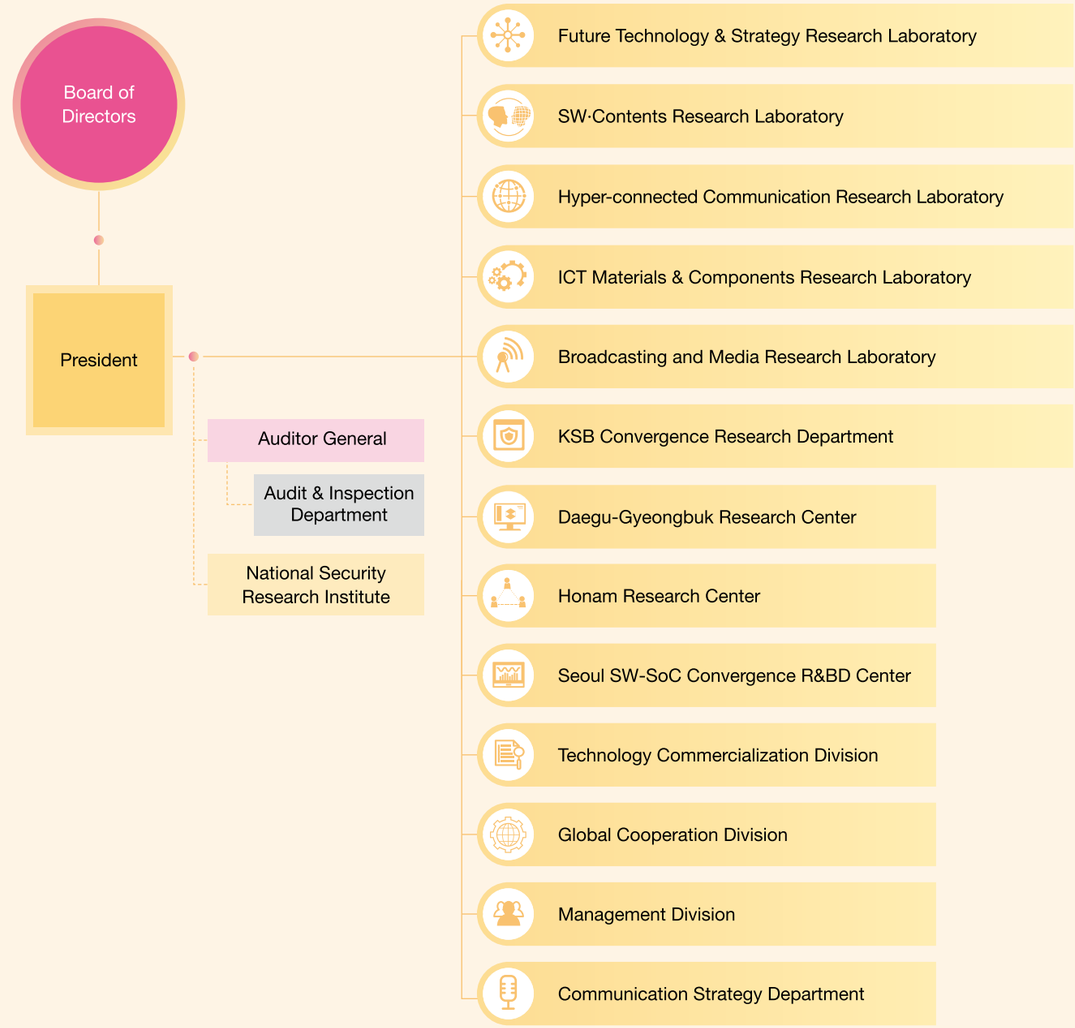
VISION

ICT Innovator
leading the 4th Industrial
Revolution

COMMON CORE TECHNOLOGY



ORGANIZATION



Future Technology & Strategy Research Laboratory

Recent technological advances and ICT growth have been bringing about significant changes to the world. Major advancements in artificial intelligence(AI) technology, converged with multiple technologies underlying various other industrial fields, are turning today's world into a completely different place, something humanity has never experienced.

Many believe that the world is now on the threshold of the Fourth Industrial Revolution. We need to understand how fast and how complex these changes are. In this regard, the Future Technology & Strategy Research Laboratory should keep an eye open for huge changes coming towards us with a comprehensive perspective and come up with strategies to help us lead the way to the future.

Our laboratory sets the direction for ETRI to follow for the future, determines which technologies need to be acquired in advance, and finds optimized resource allocation strategies maximizing efficiency. To that end, multidisciplinary experts and specialists from a broad spectrum of backgrounds, such as promising future technology, industrial, economic, policy, and standardization fields, are working on a variety of tasks across the board here at our laboratory.

Our laboratory is addressing pending issues with a global perspective and, based on a national perspective, we are facilitating resource allocation and driving strategic decision making at ETRI in an attempt to bring technological innovation to ICT and multidisciplinary technological convergence.

Recently, R&D aimed at resolving serious problems that affect the everyday life of people via science and technology is emerging as a focus of particular attention. Based on the strategic direction set by the Future Technology & Strategy Research Laboratory, ETRI started to design and implement in earnest various research projects focusing on people's lives, including the following: research on an AI attending physician for cardiovascular disease as an attempt to prevent diseases frequently reported among Koreans; research on algae bloom analysis, a hyperspectral imaging sensor, and a complex sensor module for monitoring water quality to predict algae blooms; and research on Digital Twin technology, which helps build a smart city model using actual demographic analysis data obtained from Sejong City.

The Fourth Industrial Revolution is a paradigm shift. When a paradigm shift is underway, the most important task is to set the right strategic direction. This strategic direction is the one that leads us to completely different research results. As a core think-tank of ETRI, the Future Technology & Strategy Research Laboratory promises to serve as a navigator, quickly and accurately identifying changes brought to our world, and to set the direction for research and development accordingly.

Senior Vice President of Future Technology & Strategy Research Laboratory **Kim Bong-Tae**

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Future Technology & Strategy Research Laboratory

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Keeping the Golden Hour for Car Accidents!

Emergency Service Control System for Car Accident (e-Call)

It is not an overstatement to say that the survival of car accident victims depends on the golden hour. Korea is ranked third among OECD members in road fatalities, which is attributed to the lack of proper emergency services.

The Future Technology & Strategy Research Laboratory of ETRI is currently developing e-Call, an emergency service control system for car accidents. In case of a car accident, the e-Call function equipped in the car determines whether or not the detected event is a car accident, and if it turns out to be an accident, the system automatically reports it to the control center and saves life.

The e-Call system is a technology that recognizes collision signals via sensors along with other devices equipped inside a car. When an accident occurs, the e-Call system reports the current situation to the call center via a communications terminal equipped in the car so that the accident can be handled in a timely manner. Even if drivers are knocked unconscious, the system is still capable of remotely reporting to the police or making a 119 call. For that reason, when in place, the system is expected to effectively reduce the death toll on roads.

Overall, this technology is a control system using data acquired from a car running on the road. For new cars, the system uses data from sensors embedded in the cars along with an integrated terminal to provide services. For existing cars, services are provided using an external navigation system, black box, and On-board Diagnostic-II(OBD-II) scanner, in conjunction with smartphones.

The e-Call service will be made available through the use of external e-Call devices since it would be highly time-consuming to wait for all vehicles to be equipped with integrated devices.

A representative of ETRI said, “We hope to keep the golden hour and reduce road fatalities through the e-Call system. With the confidence that ICT will help to enhance road safety, we are working hard to establish international standards.”

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Overview of ETRI's Research Achievements!

Knowledge Sharing Platform

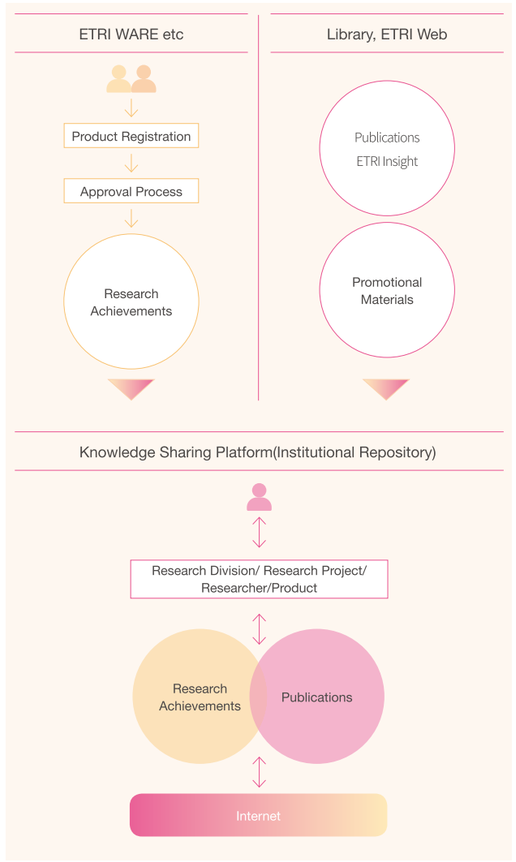
ETRI's Knowledge Sharing Platform(KSP) is where ETRI's research accomplishments are collected and arranged for browsing or viewing. The KSP manages ETRI researchers' research accomplishment items based on researcher, research department, and research project information in a comprehensive manner.

The KSP provides the general public access to a total of 40,000 research accomplishment items from ETRI, including 25,000 research articles, 9,000 patents, 4,700 technology transfer reports, 300 international standard patents, and other research reports and books. Any citizen can view and freely use the full text of the research accomplishments whose copyright belongs to ETRI.

Also, the KSP plays an important role inside ETRI. Knowledge information becomes more valuable when shared and reused. The rapid convergence of ICT is making it more important for ETRI researchers to share knowledge information among them in order to facilitate their research activities. The KSP will serve as an effective platform where more sharing of research and development results takes place, laying the ground for the development of new technologies benefiting people going forward.

Based on its knowledge sharing platform, ETRI is expected to strengthen the nation's research competence, and facilitate the utilization of information.

· Explore Knowledge Sharing Platform systems



SW· Contents Research Laboratory

What people say and do and what they think and write—all of this is SW and content. Computers, smartphones, and ICT surrounding us are tightly packed with SW and content.

On the occasion of the PyeongChang 2018 Olympic Winter Games, at the center of global attention, GenieTalk, an automatic interpretation and translation service application developed by ETRI in cooperation with Hancom Interfree, provided the world an 'Olympics free of language barriers for the first time in the world. The application, highly praised across the globe, let the whole world see Korea's power and potential as a SW powerhouse, again with its real-time simultaneous interpretation of 8 languages.

Today, SW and content technology is serving as an effective tool for improving the quality of life for all of us. Elderly people can make friends with humanoid robots as friendly as pets, and visually challenged people can enjoy books via audiobook services. Likewise, the technology is making our world a more convenient and adequate place.

SW and content technology has become an indispensable part of our life as a core technology. Notably, a shift from personal computing to a mobile-based environment is putting substantial pressure on SW and content technology to renew and innovate.

To this end, the SW·Content Research Laboratory is making significant efforts to promote original basic research and commercialization, taking the country's SW and content technology to the next level on the competitiveness front.

It is not an exaggeration to say that the beauty of the Fourth Industrial Revolution lies in SW. As the focus of value innovation in products is rapidly shifting from machine-centered towards human-centered, SW and content technology is becoming even more significant.

SW and content technology is continuously reaching out to us, making our lives more comfortable and convenient, safer, and happier.

Our researchers desire to stand by our people with 'SW Changing the World.' Our laboratory will serve to facilitate 'SW Changing the World,' contributing to a more convenient and safer world for all.

With ICT that is warm, SW connecting heart to heart, and SW content here with us all the time, our researchers will stand by our people.

The SW·Content Research Laboratory will spare no effort to gain a technological competitive edge that is required for SW to serve as national infrastructure to ensure that intelligence information society based on Assisted, Augmented, Autonomous Intelligence (AAAI) turns into a reality.

Senior Vice President of SW· Contents Research Laboratory **Han Dong-Won**

Creating a Real-World City in Virtual Space!

Digital Twin for Predicting and Addressing Social Issues

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ETRI executed an MOU with Sejong City for research cooperation in which Intelligent Digital Transformation(IDX) technology is applied to Sejong City. This initiative aims to predict and build a smart future city along with the active participation of actual cities as an attempt to prepare for the Fourth Industrial Revolution. The corresponding project, starting from this year, is named 'City Administration Digital Twin.' The idea is to build a twin city in virtual cyberspace, and test various city policies for verification in advance. Before long, we will be seeing another Sejong City, the twin of Sejong City, which is smart and exists in cyberspace.

'Digital Twin' is the software-based virtualized version of the reality. The technology builds a virtual city imitating the real city and carries out trial simulations. Subsequently, based on these simulation results, various status data for the actual city can be estimated, e.g., its current status, productivity, and action scenarios. Based on this project targeting Sejong City, it will be possible to simulate in advance various administrative policy services that closely affect the lives of its citizens, such as the city' traffic, safety, and environment policies, until the year 2030. Among those police services, only effective services are selected and will be provided for the actual city. This will make it possible to turn Sejong City into a future smart city where only effective policies and convenient services are provided.

For example, if the city's birth rate can be estimated, it will be possible to determine the demand for postnatal care centers. Related start-up and housing situations can then also be estimated, along with responding measures, in a scientific manner. If this method is applied to constructing new roads and bridges, predicting the demand for schools, and establishing public infrastructure, the balance between supply and demand will be able to be effectively controlled.

A representative of ETRI said, "The citizens will be able to enjoy a higher quality of life if big data, artificial intelligence (AI), and CPS technology are utilized to establish a digital twin system, and various policies are implemented through anticipatory experiments to address social issues faced by cities. In the age of the fourth industrial revolution, we hope to play a key role in industrial development and job creation based on intelligence and information."

Understanding Images Like the Human Eye?

Behavior Understanding Engine, Deep View

ETRI's SW·Content Research Laboratory started to develop a high-performance visual discovery platform(code name: Deep View), which allows understanding and prediction of real-time, large-scale image data, as an attempt to build a system capable of reading the contents of an image in the same way that humans do. Here, Deep View is a technology to establish a platform for image big data, allowing the system to read an image in the same way it reads text, and use the acquired data for various purposes. It collects large-scale images and videos to help understand multi-dimensional changes and time-series changes occurring in urban areas, and further predict potential threats in real time. It also allows reliable information analysis and future prediction at the national level by establishing large-scale big data related to vision, which are needed for our purposes.

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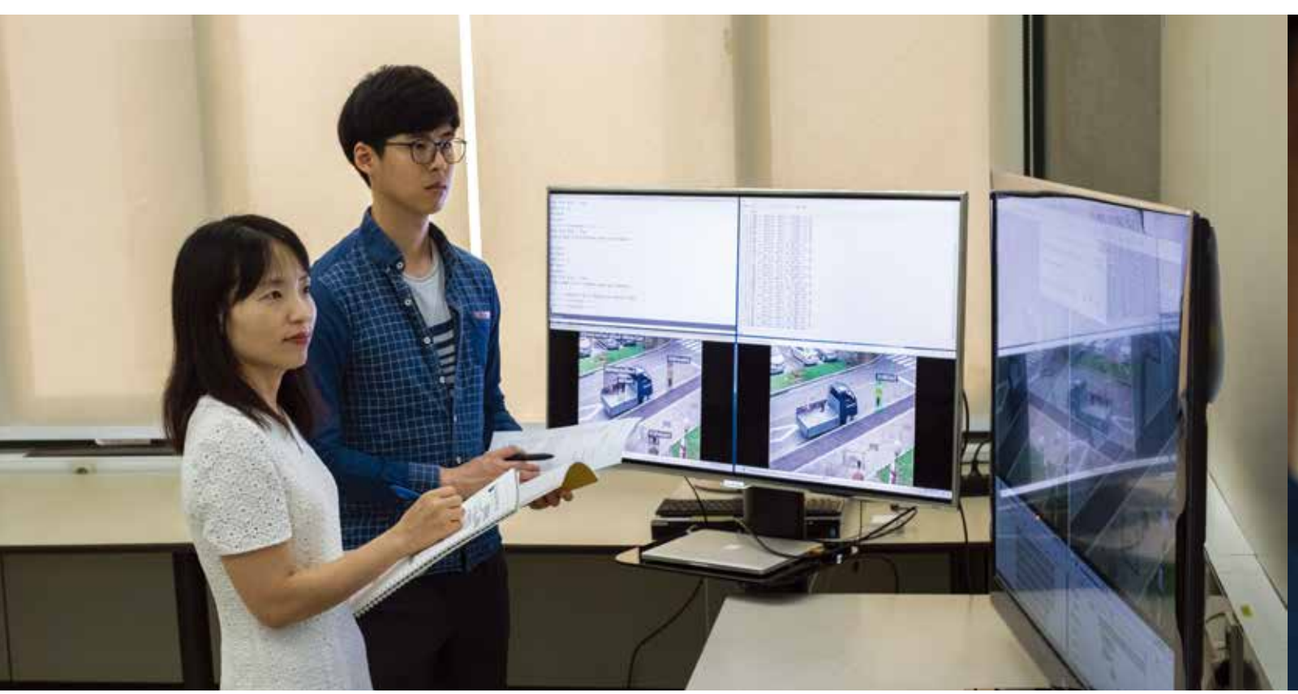
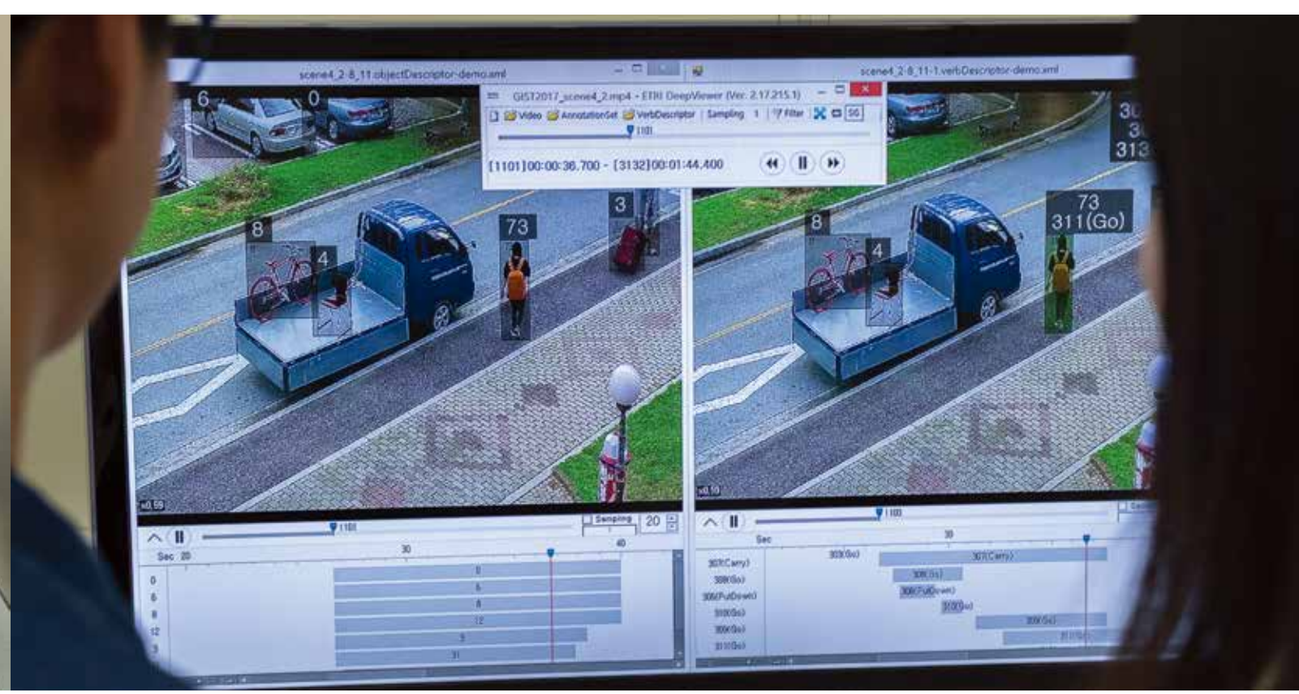
According to the Computer Vision Market, the global image and video analysis market is expected to grow from USD 11.9 billion in 2018 to USD 17.4 billion in 2023 at a yearly growth rate of over 7.8%, representing high value-added technology.
If Deep View technology is commercialized in Korea, it will be possible to acquire a base technology to promote the advancement of the country's social safety net. Also, this will lead to improvement in citizen safety, national defense, and convenience because the technology can be used for various purposes, such as safety monitoring of urban areas using surveillance cameras. Likewise, ICT such as visual knowledge curation technology, mobile visual knowledge augmentation technology, and remote visual intelligence, can make our city a safer and more convenient place, improving the quality of life for citizens.

Going forward, these researchers are planning to develop technologies dedicated to the public sector, such as a surveillance camera-based control system, the Interior and Safety Ministry's city crime prevention system, and expressway surveillance cameras.
A representative of ETRI said, "This technology has been developed with the active involvement of global companies around the world. The team has received global recognition, ranking second in the DET category in last year's ImageNet Large Scale Visual Recognition Challenge(ILSVRC). In the future, related services will be launched for the public sector."
ETRI plans to further develop technology for a more thorough analysis of images and videos generated from national infrastructure, so as to ensure the safety of all citizens.





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Creative Contents Research Division

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SEA Platform Serves as Eyes and Ears for Visually Impaired

Accessible E-book Service for Visually Challenged People

At present, visually impaired students are unable to read mathematical problems on their own. However, thanks to a study by ETRI, they may soon be able to have mathematical problems read out to them. Jeong-in Kim, who is in his second year of middle school, has a passion for the subject. After an unfortunate car accident, he had to undergo three major surgeries and reconstructive facial surgery, which led to gradual deterioration of his eyesight. He heard about an electronic book service for the visually impaired. He thought the service was limited to story books, but was pleasantly surprised when he realized he could use it to solve mathematical problems. While there are mathematical books in Braille, it was not easy for Jeong-in to learn the code since he had acquired the disability only recently. Moreover, it takes several months to transcribe a thin mathematics workbook into Braille, and a person would have to go through seven thick volumes instead of a single book.

The SEA Platform developed by ETRI researchers, designed to read books to visually challenged people, has an advantage in that it allows people with disabilities to directly enjoy E-books published for people without disabilities. Considering that about 90% of books published today are E-books, this technology has made it possible for visually challenged people to comfortably read almost all currently published books.

Notably, the technology is capable of accurately reading out even the technical contents of books, such as complex tables, equations, and graphs contained there. Instead of just reading parts out in a consecutive manner, it tells users about the characteristics and content of each column of a table before going into the main part from their point of view, thus significantly improving their understanding. Knowing this, ETRI researchers are continuing their research on this technology so that visually challenged students such as Jeong-in can fully understand what they read.

There is no doubt that Jeong-in, with his visual disability, will have more difficulty solving math problems than other students who can see the problems directly.

What the researchers are doing here, however, is providing visually challenged people with other tools that help them acquire and learn information with senses other than a sense of vision. This technology is now opening a new door of opportunity for visually challenged people, and this will give them power to move forward with their life.

A representative of ETRI said, “We customized vocal rules to express learning content in the Korean language. The service platform will be continuously upgraded to enhance user experience.”

· **Shall we try the math problem that Jeong-in solved?**

$e^{i\pi} + 1 = 0$

· **This is how the text is read.**

e to the power of i pi plus one equals zero.

· **Shall we solve?**

Robots as Companions for the Elderly!

Human-care Robot Technology in Actual Aging Society Environment

"Did you get a new hair style? It suits you!"
"You skipped dinner yesterday, and again today. You must eat to keep up your strength."
"You seem down today. Is there anything you'd like to share?"

Elderly persons living alone will soon have robots as companions. Like the examples shown above, the robots will engage in conversation with them like friends.
With Korea's populating aging more rapidly than ever, researchers at ETRI are developing human-care robots to assist the elderly in daily life. It won't be long before we get to meet the robots of Big Hero in reality.

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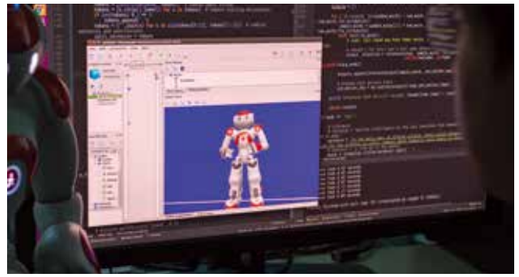

Korean society is aging at the fastest rate among OECD members. By 2031, the proportion of persons aged 65 or older will account for 23% of the population, while those aged 75 or older will constitute 9.7%. Among the total elderly population, the number of seniors living alone is increasing at an annual rate of 5.6%. Among elderly living alone, those classified as pre-frail and frail account for 60%. More than 30% of people suffering from depression are seniors aged 65 or older. The rate of increase in depressed elderly is twofold that of the general rate, and this has emerged as a serious social issue. A rapidly aging society will lead to not only a decrease in quality of life, but also an increase in public expenditure for the treatment of diseases, nursing costs, and recuperation. Against this backdrop, ETRI's researchers have found new hope for the elderly.
ETRI's Intelligent Robotics Research Division is expediting the development of 'Human-care Robots' living together with elderly people, capable of understanding their behavioral characteristics, emotional and physical status, and living patterns, as well as engaging in natural emotional interactions in the same way that humans do. Human-care Robots can be friends to talk to and provide customized services in a timely manner. These robots will always stay close to their elderly users helping them in various aspects, such as health, life, recognition, and emotionally.
Instead of just giving a simple answer or reaction, these robots will focus on engaging in natural exchanges in a given situation, thus promoting emotional interaction with their users. The core value of Human-care Robots lies in the in-depth understanding of individuals and wholehearted interaction, and the research focus will be on strengthening a sense of fellowship between a robot and its elderly user, as well as extending their bilateral relationship.

AI Physicians Who Know All About Patients

Development of AI Attending Physician for Cardiovascular Disease

This technology refers to a set of healthcare AI cloud platforms, including a test system based on on-site diagnosis, an intelligence learning platform for early diagnosis, and a learning platform for predicting complications. The key objective of this technology is to ensure that all Koreans can live up to 100 years in perfect health through early disease diagnosis and prediction of complications using AI healthcare services.

The commercialization of AI attending physicians will make these AI physicians available for serving as a decision-making supporting system for healthcare specialists, and can be used for early diagnosis of cardiovascular disease and prediction of its complications. In small- and medium-sized hospitals with a lack of medical staff or competence, these AI physicians can also be used as an intelligent diagnosis system via joint treatment services using AI. These innovations will allow the general public to enjoy everyday health management and real-time monitoring. Furthermore, this AI attending physician platform can be used as a healthcare engine, and as a high-speed computing infrastructure for processing healthcare intelligence-related data in the future.

It is now the second year since the research started. Although research on this AI attending physician service remains in the initial stage, it is drawing significant attention from the medical community, academia, and other research institutes. Going forward, on-site diagnosis test services will be available at homes and small- and medium-sized hospitals. This technology can also be used as general diagnosis techniques and therefore is highly likely to be applied to various different fields in the future.

The researchers explained that the Asan Medical Center and Ulsan University Hospital provided clinical data about cardiovascular diseases, as well as medical knowledge and information necessary to analyze case studies of cardiovascular disease. Also, they will ensure the quality of research equipment, such as a body scanner, AI cloud, and Dr. AI, via stringent SW quality control. Furthermore, they are planning to develop on-site diagnosis test devices for cardiovascular disease based on biosensor technology that ETRI has accumulated.

A representative of ETRI said, “More accurate analysis and early diagnosis of cardiovascular diseases will be possible once sufficient data is collected. ETRI will do its best to enhance the citizens’ quality of life with its advanced medical ICT.”

DEPARTMENT
Bio-Medical IT Convergence Research Division

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Hyper-connected Communication Research Laboratory

'Connection' represents the essence of the Fourth Industrial Revolution era. Briefly, the Fourth Industrial Revolution is characterized by the rise of a hyper-connected society where everything is closely linked, creating value. Hyper-connectivity blurs boundaries associated with existing industries, businesses, and technologies, and further creates new innovative technologies and businesses. The Hyper-connected Communication Research Laboratory(HCRL) is leading the way in developing core technologies underlying information and communication infrastructure to promote hyper-connectivity.

Person to person connection via phones, ultra-high-speed data connection using optical communications, safe financial connection based on accredited certification, IoT connection linking cutting-edge devices—these are some examples of everything being connected. The HCRL is ceaselessly conducting R&D to help all people feel the reality of 'a hyper-connected society' that is convenient and warm.

Starting with the development of TDX(1982), the first domestic switching system opening a new chapter where every household began to have at least one telephone, the HCRL successfully commercialized a code-division multiple access CDMA-based mobile communication system for the first time in the world. All these efforts have helped the country position itself as a global digital powerhouse. Also, it developed the WiBro mobile communication system(2006), the world's first technology that allowed access to the Internet whenever and wherever desired, along with the LTE-Advanced system(2010), the 4th generation mobile communication system.

Going forward, the HCRL will progress with our people under the vision of 'Safer and Smarter Hyper-connected Infrastructure.' Hyper-connectivity is a technology that creates a borderless, innovative future, which allows and enables people and things to connect seamlessly. This technology, combined with intelligence technology, blurs boundaries in almost all industries and accelerates the speed of innovation, leading us to the Fourth Industrial Revolution.

Today, hyper-connectivity technology is everywhere, from 100 times faster giga Wi-Fi that provides the general public with first-hand experience of giga services to UnderGround Safety(UGS) preventing sinkholes. The HCRL will continue to promote hyper-connectivity that is even safer and smarter beyond the expectations of our people, making their lives even more prosperous.

This new looming wave of changes poses an opportunity and a challenge at the same time to the HCRL. Going forward, we will focus on creating a new digital ecosystem to realize the Open Digital Connectome, a new concept of innovative, future-oriented infrastructure underpinning a hyper-connected society.

Thank you.

Senior Vice President of Hyper-connected Communication Research Laboratory **Hwang Seong-Ku**

Embracing the Age of Biometric Authentication!

FIDO Technology Development

ROLE & RESPONSIBILITY

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Information Security Research Division

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Passwords designated by users tend to be vulnerable to security threats. Hackers and voice phishing scammers say that user passwords are among the easiest to crack.

A solution to the above was the public key certificate, launched by ETRI in 2000. This certificate is required for all financial transactions, but can result in devastating consequences if leaked.

Users have complained about having to download and re-install software with each update to the certificate. This can be resolved with a new technology developed by ETRI's Hyper-connected Communication Research Laboratory.

ETRI's Hyper-connected Communication Research Laboratory developed an accredited certification technology using biometrics, such as fingerprint, iris, face, and voice. The laboratory notes that certification based on not only physical properties but also behavioral or environmental characteristics will also be available in the future.

Fast Identity Online(FIDO) is one of the most representative authentication institutes related to biometrics. FIDO is an international online biometric authentication consortium as a community of businesses who intend to create an authentication technology ecosystem without a password. If this biometric authentication technology is adopted by many companies, users will find it easier to make payments because they no longer will have to download programs for authentication or make updates. In the domestic mobile industry, biometric authentication is already considered a default option. ETRI researchers view biometrics as a powerful, quick authentication tool for simplified online payment that will effectively replace passwords. Seeing the biometric authentication system seen in science fiction films becoming a reality reminds us of how fast things can change in this world. ETRI researchers said they felt rewarded while seeing the technology contributing to improving the quality of life and providing convenience for all.

A representative of ETRI said, "The proposed technology incorporates biometrics and PKI. The research team is comprised of experts who have been involved in the development of certification systems since 1999. ETRI has integrated various novel technologies, including public key certificate technology, smart wallet technology, mobile card technology, touch sign technology, and facial recognition technology. We expect ETRI's new technology will bring more convenience and security to our lives.

Hyper-Intelligence, Hyper-Connectivity, and Hyper-Realism!

Optical Access Technology for Reality Intelligence Service

ETRI's Hyper-connected Communication Research Laboratory is developing core technology for wired and wireless converged optical access networking capable of flexibly adjusting access speed to accommodate rapidly increasing use of wired and wireless services.

Optical access technology for reality intelligence service, currently under development, is an optical access technology with a capacity of 25 Gbps per wavelength, which allows both broadband services including virtual reality and augmented reality services and ultra-low latency services including drone and robot control.

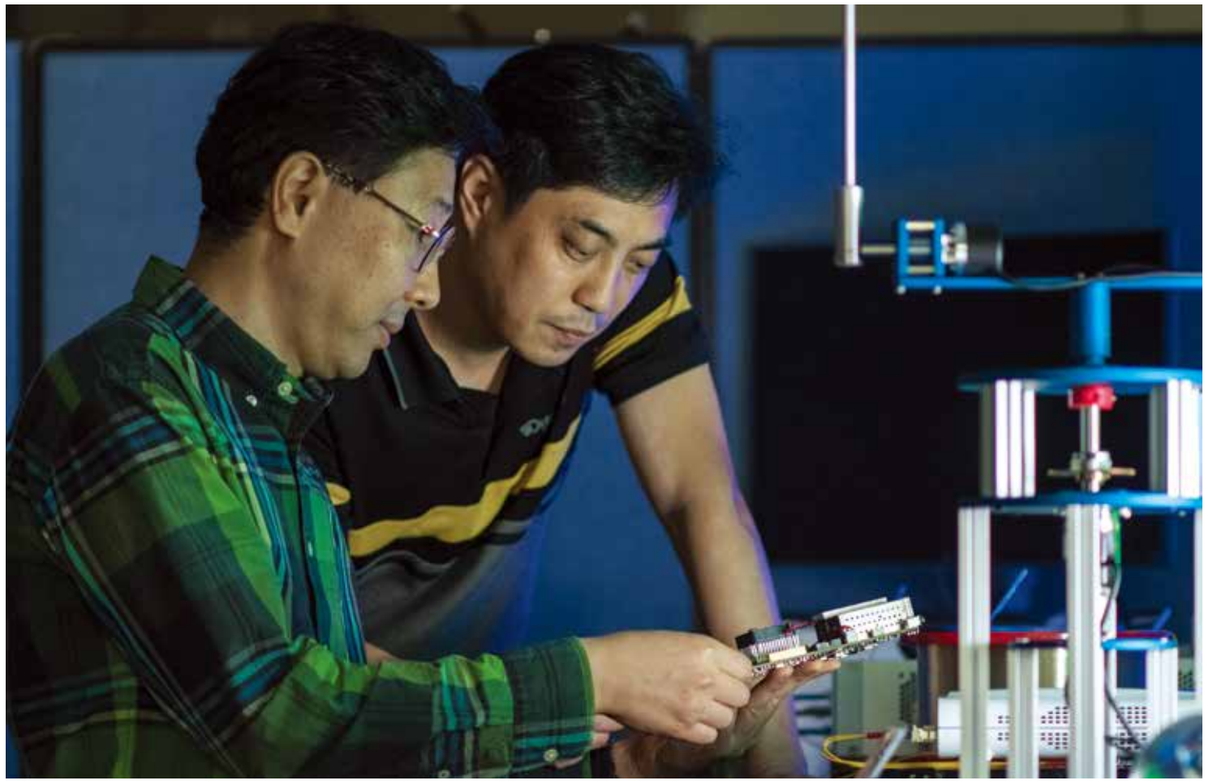
Ensuring that data can be transmitted, when connected to mobile base stations or Wi-Fi, as quick as we feel things with our hands requires the development of optical access technology. An optical access network refers to an optical network that connects service providers and subscribers via optical fibers within a range of up to 20 km to provide wired and wireless services. Currently, the optical access network can transmit data at a rate of up to 10 Gbps, including both mobile fronthaul and backhaul.

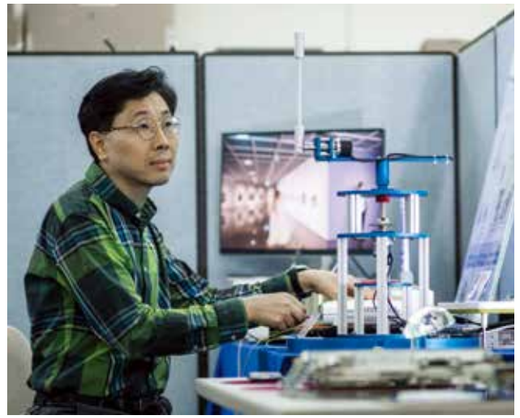
Therefore, a prerequisite for this research is to improve our current access networks in an innovative manner: shifting towards high-speed, low-latency, low-power, low-cost, compact, and intelligent networks. To this end, our Network Research Division is sparing no effort to develop SDN-based wired and wireless converged optical access networking technology(SWAN).

Ultra-low latency optical access technology allows broadband transmitting and receiving with a capacity of 25 Gbps per wavelength, optimized for the access network. Also, it is capable of low-latency traffic transmission via existing optical fiber networks. To this end, it is necessary to develop low-cost, low-power, and compact optical modules and optical transceivers, and improve the efficiency of network usage via SDN-based resource management. In this manner, intelligent optical networking technology will eventually be realized.

Research on optical access technology is being actively conducted by global companies such as Huawei and Nokia at the 25 Gbps level. ETRI's researchers have become the first in the world to develop Time Controlled-Tactile Optical Access (TIC-TOC) technology, which supports data transmission at a rate of 1/1000 seconds and download speeds of 25 Gbps while minimizing chromatic dispersion and optical loss that are associated with existing optical fiber networks.

A representative of ETRI said, "This technology can bridge the information gap by promoting digital lifestyles and improving general accessibility to networks. You can enjoy the same high-speed internet anywhere in the country." ETRI is continuing its research to ensure higher speeds and greater efficiency for all citizens.





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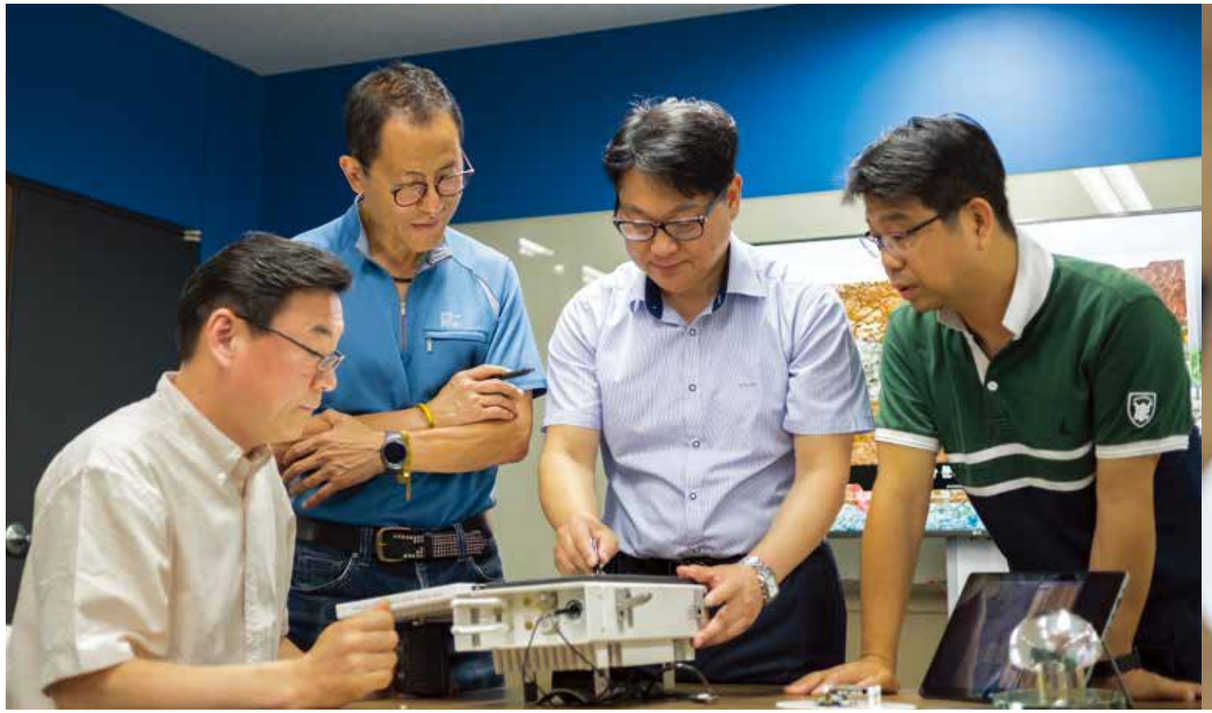


Protecting Citizens From Sinkholes!

Underground Safety Management Technology

ETRI's Hyper-connected Communication Research Laboratory is doing its utmost to address issues of sinkhole development, which refers to a sudden depression in the ground, and protect our people.

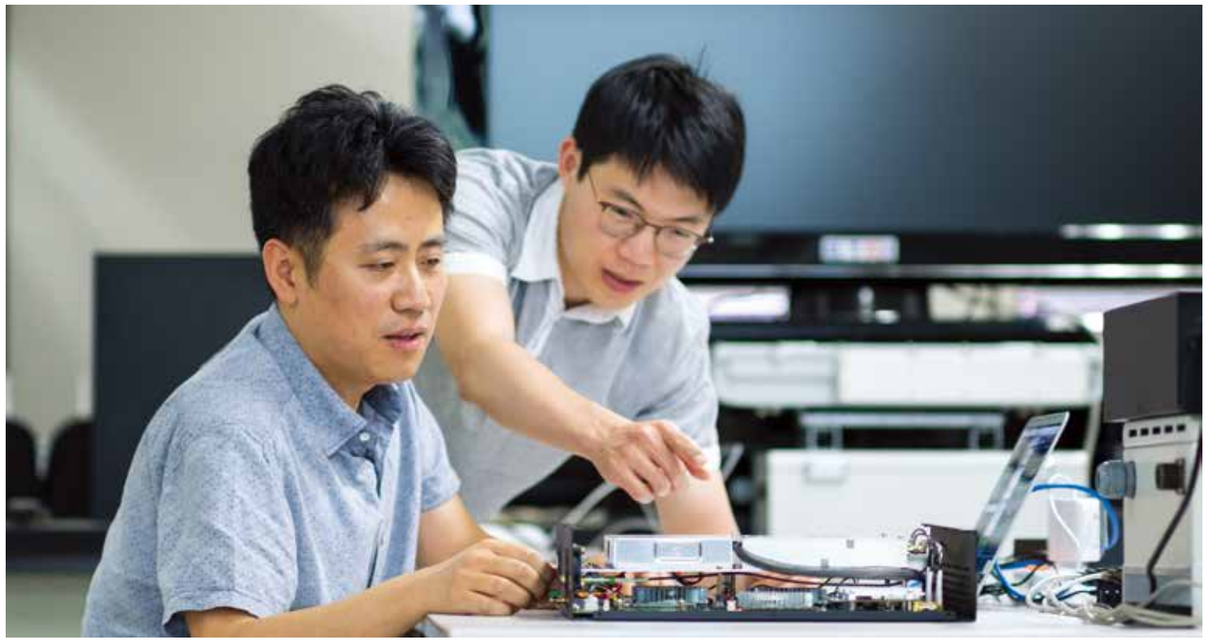
To develop technology capable of monitoring and preventing sinkholes, many research institutes concerning citizen safety were brought together to participate in convergence research supported by the National Research Council of Science and Technology. This gathering for convergence research aimed at promoting public safety was attended by 40 experts from different institutes as follows: Electronics and Telecommunications Research Institute(ETRI), Korea Institute of Geoscience and Mineral Resources(KIGAM), the leading expert in land; Korea Railroad Research Institute(KRRI), extensively experienced in ground depression near railroads; and Korea Institute of Civil Engineering and Building Technology(KICT) with technological prowess in construction and civil works.

The main goal of the UGS(Under Ground Safety) Convergence Research Department is to develop an IoT-based technology to monitor the underground environments and utilities for preventing sinkholes.

First, the researchers thoroughly scrutinized the ground surface of the target areas. They were able to acquire an underground space integrated map with the support of the Ministry of Land, Infrastructure and Transport, and received substantial support from MOUs with Seoul and Daejeon. These efforts have made it possible to view and assess the status of underground utilities in a 3D manner, effectively promoting public safety.

The UGS Convergence Research Department found a solution in manholes. Using empty space below manholes, IoT sensors were installed so that monitoring data can be transmitted to the ground via manhole-embedded antennas. Also, base stations were installed on nearby street light facilities for monitoring purposes. Likewise, tangible outcomes have been achieved. These researchers' wholehearted concerns about public safety have brought changes to the underground space and further to our society, leading to the enactment of relevant laws. They are contributing to making our country a safer and more secure place to live.

A representative of ETRI said, "The technology has been verified through a testbed at Wolpyeong Station in Daejeon, and a trial is being conducted in Seoul's Wangsimni Station. We will prevent major accidents and protect citizens by managing underground safety." Thanks to ETRI, we are now free from the risk of sinkholes.



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Subways Equipped With 100 Times Faster Internet!

Improvement of Quality of Experience of Public Transportation Wi-Fi

ETRI's Future Mobile Communication Research Division is leading the way in improving the quality of public transportation Wi-Fi services so that everyone can have quick and easy access to Wi-Fi when using public transportation. ETRI's efforts to improve the quality of experience of public Wi-Fi are aimed at reducing communication expenses for the general public and narrowing the digital divide. Using the Mobile Hotspot Network(MHN) developed by ETRI and verified for the first time in the world, it is now possible to enjoy giga Wi-Fi while using public transportation, including the subway. The MHN technology is capable of continuously providing high-speed seamless internet services for subway riders using as a mobile wireless backhaul a millimeter-wave Free Band(22-23.6 GHz) newly designated by the government early this year as an attempt to provide applicable frequencies for the Fourth Industrial Revolution. With this technology in place, up to 2,000 subway riders can enjoy Internet streaming videos at the same time.

If this Free Band is used as a mobile wireless backhaul for bus Wi-Fi, 10 Gbps services or better can be provided within a range of 1 km on the road. This means car and bus users can also enjoy high-quality Wi-Fi on the road. If this technology advances to the level of 10 Gbps capacity in the future, 5,000 people, within a range of 1 km on the road, can enjoy real-time HD video services at the same time.

ETRI is actively contributing to allowing fast and clean public Wi-Fi. The application of MHN, a mobile hotspot network developed by ETRI, will allow people to enjoy 100 times faster seamless Wi-Fi. MHN was developed by ETRI for the first time in the world and preferably applied to the Seoul Metropolitan Subway, and its application scope will be extended in a gradual manner. Also, commercialization of relevant technologies is underway in the Seoul Metropolitan Subway in cooperation with businesses.

A representative of ETRI said, "During the PyeongChang Olympics, ETRI succeeded in transmitting multiview media using 5 Gbps MHN-E technology in Yulgok-ro, Gangneung. MHN-E is an advanced version of MHN technology. We will work on providing 5G wireless communication services not only on express buses and intra-city buses, but also future connected cars. In addition to these developments, we will establish international standards." ETRI's public WiFi can soon be enjoyed on all subways and buses throughout Korea.

ICT Materials & Components Research Laboratory

You might have seen an invisible cloak in your childhood cartoons, imagining yourself wearing that cloak and traveling around the world without any limitations.

Having said that, did you know that the core technology for such an invisible cloak is ICT materials and components? Here, we are talking about meta-material that makes things invisible using light reflection.

Recently, researchers have developed a motion-based smart wear technology that helps improve a wearer's posture; it's not an invisible cloak yet, but it does demonstrate what ICT materials can do. Model school students practice their runway walks and golf players correct their swing posture using this product.

Have you ever heard of skintronics? Skintronics is a technology that imitates human skin in an electronic manner. The technology enables an object to feel temperature and the sense of touch in the same way the human skin does. Equipped with this skintronics technology, robots will be able to feel the same way humans do. This means that humanoid robots will come true in real life.

A robot will no longer remain a cold and rigid machine. Instead, it will touch your emotions, and this is enabled by ICT materials and components—technology inspiring human warmth in robots.

Just as fabric and thread are essential components of clothes, materials and components are essential parts of all products, and this goes for ICT products as well. The ICT Materials and Components Research Laboratory has been developing various base technologies underpinning the foundation of ICT products, e.g., materials, components, and modules that are needed for manufacturing ICT products.

From the 2000s to date, our laboratory has expanded the scope of materials and components research to various different fields and, now and going forward, we will pursue a select and focused strategy, shaping the direction we take in a clear manner.

Under the mission of 'Developing ICT Materials and Components for Realizing the Fourth Industrial Revolution,' we will continue to focus on the development of original technologies related to materials and components, reality devices, photonic/wireless convergence technology, and intelligent semiconductors.

The key objective of our laboratory is to contribute to the advancement of the Fourth Industrial Revolution. Materials are brought together to make components, and these components are brought together to make a system. The ICT Materials and Components Research Laboratory is the only laboratory in ETRI that is dedicated to researching materials and components rather than a system.

We will lay the ground for ETRI's three laboratories, pursuing 'hyper-connectivity,' 'hyper-intelligence,' and 'hyper-reality' through our meta-material research, and pave the way for Korea to proactively respond to the Fourth Industrial Revolution.

Senior Vice President of ICT Materials & Components Research Laboratory **Eum Nak-Woong**

Skintronics for Robots and Humans!

Skintronics to build Electronic Skin Reacting in the Same Way as Human Skin

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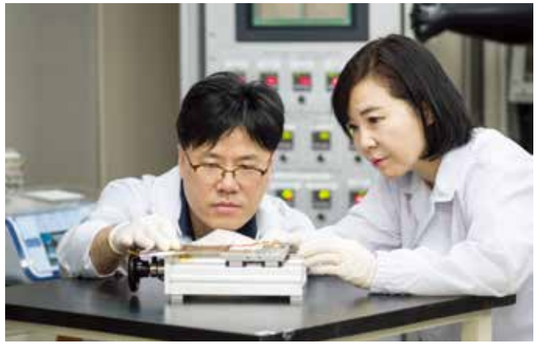
How will the world change if human-like electronic skin is developed? Robots will be equipped with human sensory capabilities, and people with damaged skin will be able to regain their sense of touch through skin implants.

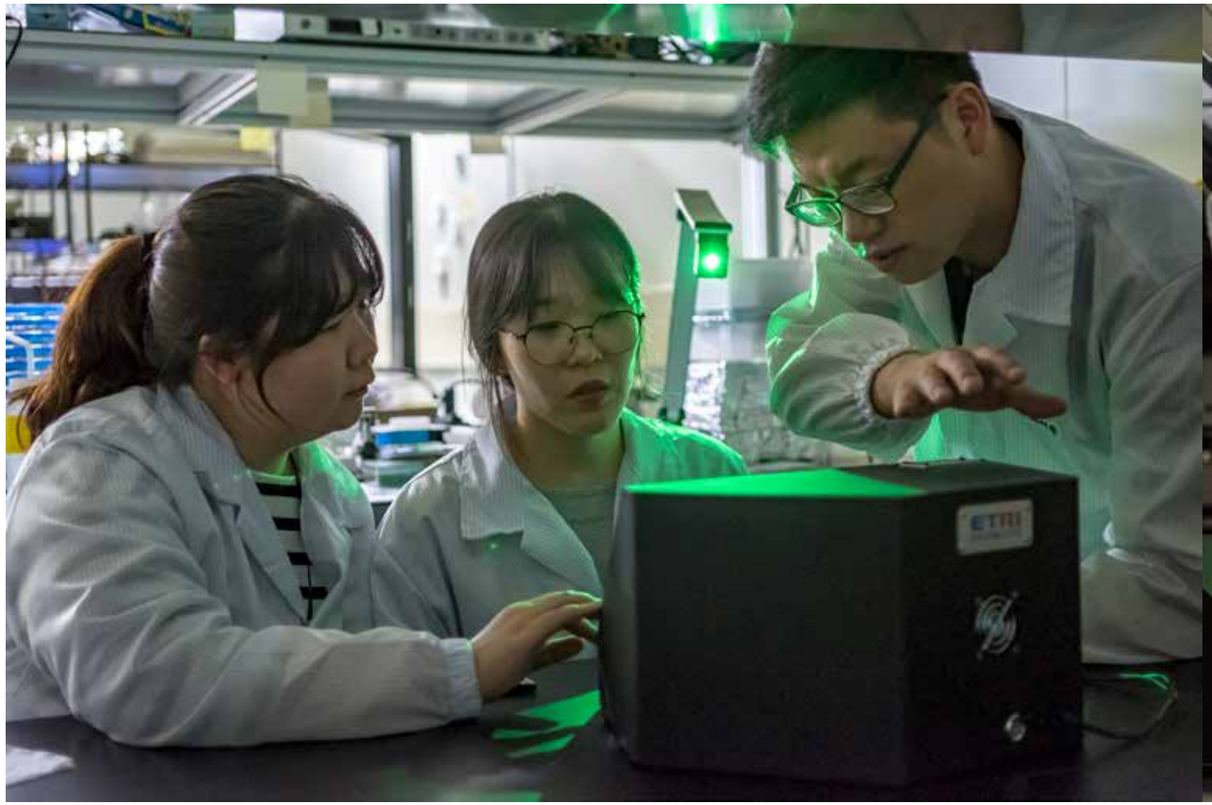
ETRI's ICT Materials and Components Research Laboratory is now developing a technology that would be seen only in science fiction movies: skintronics. This technology aims to build an electronic skin using an electronic device that is as thin and flexible as human skin, and make the virtual sense of touch feel more realistic. If it becomes possible to transplant this electronic skin to a robot using this technology and the transplanted skin looks just like human skin, humanoid robot services will be actualized in real life.

It should be noted that this technology will bring about innovative changes to the ultra-realistic service industry. This technology is expected to evolve into a platform technology, and will be applied in various fields and industries as follows: input and output devices for ultra-realistic skin, intelligent service robot skin, virtual sense of touch, wearable devices, body-attached devices, implantable medical devices, health monitoring device, healthcare, rehabilitation devices, and structure safety monitoring system. ETRI researchers are now working to preemptively secure large-area, high-resolution sensor and actuator array technology suitable for new substrates to acquire core original technologies applicable to the future potential market. The researchers will continue to secure core technologies in a preemptive manner and thus gain a global competitive edge for early occupation of the global market.

According to a survey, the world's stretchable electronics market is expected to amount to 1.6 billion dollars by 2025. The world's haptic technology market will expand at an annual 25.4%, increasing from 7.7 billion in 2014 to 29.8 billion in 2020. The future is bright for the skintronics market.

A representative of ETRI said, "We have accumulated experience in display-related technology over the past 15 years. Using large-scale, high-resolution TFT technology, we can develop skin sensory input/output arrays on very thin elastic surfaces." ETRI, a key player in the ICT powerhouse of Korea, has emerged as a leader of the fourth industrial revolution. There are high expectations for its skintronics research and related electronic components.





Advanced Laser Technology for the Fourth Industrial Revolution

UHD Spatial Light Modulator (SLM) Panel for Holographic Terminal

Hologram is a technology that provides a visual effect that makes a viewer feel as if a virtual object actually exists, and is one of the technologies under development by the Reality Device Research Division of the ICT Materials and Components Research Laboratory.

The researchers are working to improve the quality of life and provide convenience using this digital hologram technology. Contrary to existing 3D technology, where the locations of the actual image and displayed image differ, causing dizziness and headaches after long hours of watching it, digital holograms provide natural 3D images, making viewers feel comfortable after long hours. Among various hologram technologies, the division is now developing a Spatial Light Modulator (SLM), a panel essential to building hologram images.

The core technology underpinning the digital hologram SLM is a UHD panel technology where its unit pixel is as small as the wavelength of light. Developing ultra-fine pitch pixel requires unit device technology, such as pixel switch devices and optical modulation devices, and large-scale data animation technology. ETRI researchers are aiming to develop an SLM with a pixel size of 1um on a glass substrate that is used for displays by jointly using semiconductor technology suitable for refinement applications and display technology suitable for large-area applications. To date, the minimum pixel size reached is 3um, which is the smallest pixel size for a display panel in the world.

Also, the researchers are developing an optical modulation device using nanostructured phase-change materials, capable of handling a pixel size of 1um or below. With the current level of technology, it is only possible to create a still image hologram using phase-change materials, but the researchers will continue research to develop a next-generation light modulator capable of generating animated holograms.

A representative of ETRI said, “Currently, we can generate stationary hologram images using phase transition materials. With further research, we hope to develop light modulators that support video playback.” The hologram market is expected to grow at an annual rate of 17.4%, amounting to 451.7 million dollars in 2020. It is recognized as a blue ocean, and research in related fields is likely to have a positive impact. This is why the researchers at ETRI must exert efforts to maintain their status as the world’s leader in holographic technology. In addition to developing high-resolution panels for use in spatial light modulators, they will pursue technology transfers and commercialization of high-resolution panels for AR/VR and various displays.

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ETRI Promises to Clean Up Algal Blooms With ICT!

Hyperspectral Imaging Sensor for Algae Bloom Analysis, Direct-reading Complex Sensor Module for Monitoring Water Quality, and IoT Wireless Communications and AI Prediction

With global climate change along with other weather events, such as global warming and droughts arising from water shortages, the issue of algal blooms is emerging as a global environmental threat.

The government is now proactively responding to these serious algal problems. ETRI is also actively engaging in these issues to find solutions based on ICT. According to the 2017 Science and Technology Policy Direction of the New Government, the government is establishing the following policies under the vision of 'Relief Society to Protect the Safety and Life of People': 'IoT-based Risk Measurement, Detection, and Response' and 'New Technology to Respond to Algae Bloom.' Above all, addressing this algae problem required measurement to be real-time and dense, and analysis and prediction to be accurate. To that end, ETRI's ICT Materials and Components Research Laboratory changed its measurement method from a method where sampling was conducted by a staff member and the analysis process took two weeks to a method of ICT-based integrated algae bloom monitoring. In this new measurement method, algae bloom monitoring and prediction are enabled by sensor networks and AI.

In fact, algae bloom problems can be easily solved with well-functioning monitoring in place. High-sensitivity, high-resolution, hyperspectral sensors are capable of measuring blue-green algae in areas corresponding to the areas of a wide-range algae bloom map. Notably, this method has more implications because the separation of four types of blue-green algae can provide more options for analysis and predictions. In the past, accurate algae bloom prediction was difficult due to a lack of relevant data, but this sensor network-based AI algae bloom prediction is promising. Previously, on-site sampling was always preceded by the occurrence of algae bloom, but ETRI researchers' technology allows on-site, real-time algae analysis once the monitoring function is initiated. Most importantly, the system predicts the occurrence of algae blooms before it actually happens and therefore it is possible to take preventive measures immediately. Considering that this research is being conducted based on big data, the technology has high potential to be used for multiple applications across the globe. Going forward, the researchers are planning to improve the accuracy of algae bloom prediction using on-site direct-reading probe-type sensors and machine learning(deep learning).

Quantum Cryptography for Wireless Communications Eases Hacking Concerns

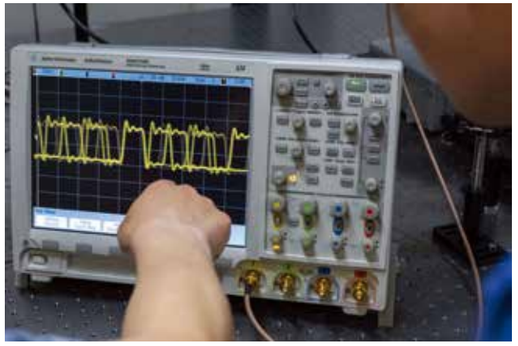
Wireless Quantum Cryptography Network Communications

ETRI's ICT Materials and Components Research Laboratory developed a small terminal system for wireless quantum cryptography network communications capable of completely preventing hacking and tapping, and succeeded in data transmission from a 100-m distance in the actual environment, for the first time in Korea. The quantum cryptography network communications technology is safe and secure because, in case of hacking or tapping attempts during data transmission, the quantum status changes, making hacking completely impossible. Modern cryptography technology creates an encryption key based on mathematical principles that are known to take a great deal of time to decode. Therefore, there is still a possibility of successfully decoding it with the development of a new algorithm or accelerated calculation speed. In contrast, this quantum cryptography technology completely prevents the possibility of tapping because its encryption mechanism is based on the natural law, i.e., quantum physics.

Although there have been successful cases of developing wireless quantum cryptography network communications overseas, there still remains the need for technological advances considering that most of those systems are excessively heavy and big, exhibiting incomplete performance. ETRI developed core integrated components for wireless quantum cryptography network communications based on its own technology and properly systemized them, and therefore the developed system was able to successfully transmit and restore quantum signals in the actual environment under strong sunlight. The wireless quantum cryptography network communications system, developed by ETRI researchers, stores information in photons(light particles), transmits it, and restores it to create an encryption key. If there are hacking or tapping attempts by a third person, quantum information changes, completely preventing hacking or tapping.

The researchers succeeded in maintaining the Quantum Bit Error Rate(QBER) at 1% during daytime and 3% during nighttime while transmitting data from a distance of 100 m or longer. The system's capacity is at the level of 200 kbps, which means the system can create encryption keys of over 200,000 bit per second. The QBER refers to the proportion of transmitting wrong quantum signals, and if the figure is 11% or lower, creating an encryption key is possible. The lower the QBER is, the faster encryption keys are created. In this regard, 3% is an excellent figure.

ETRI is planning to develop a technology to increase the transmission distance using the transmission and receiving of components of the small wireless quantum cryptography network communications system, and further develop another system applicable to moving vehicles, such as cars and drones.



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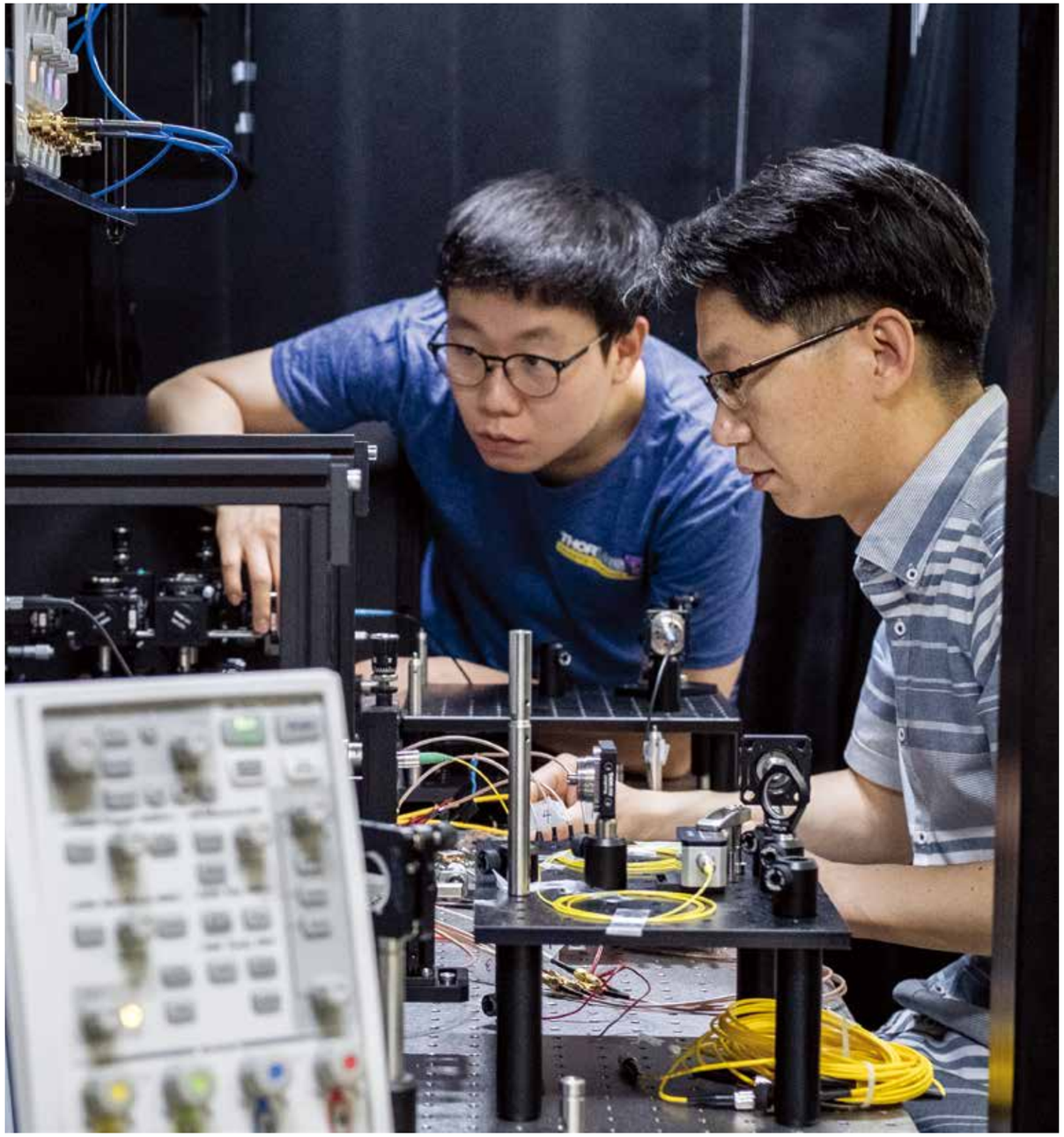
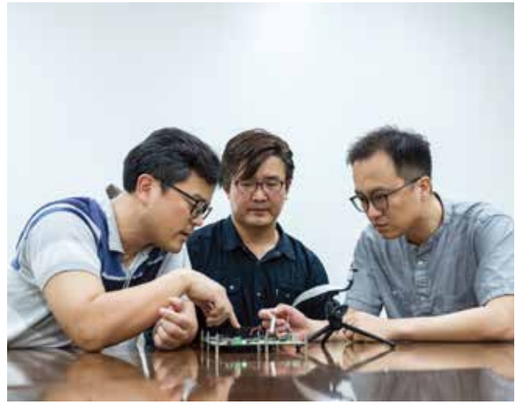


Development of Mobile Visual Intelligence Chip With Human-like Cognitive Skills

Semiconductor with Human-level Visual Intelligence

Modern AI systems identify objects in real time using their excellent pattern analysis capacities based on vision or hearing, just as humans do. Behind all these AI applications is high-speed data processing technology. How far has this technology come and where does it stand now? ETRI researchers recently developed intelligent semiconductor technology. Its fingernail-sized semiconductor chip is capable of recognizing objects as accurately and quickly as humans. In the past, the application scope of object recognition technology was limited to specific fields, such as recognizing vehicle registration plates, highway lanes, or human faces. Today's AI technology, equipped with a recognition processing system resembling the human nerve network, has gone beyond simply processing inputted images to judging and categorizing objects based on learning. Global leading tech companies are striving to develop microprocessor chip technology with similar functions, but the high levels of power consumption needed to process large-capacity date in real time are slowing down the diffusion of the technology.



ETRI researchers have resolved these power consumption issues using their self-developed high energy-efficiency microprocessor design technology, thereby achieving visual intelligence capable of recognizing common objects in real time while being embedded in mobile ICT devices. This technology is expected to be among the highest in the world in terms of power consumption efficiency.

ETRI will continue to develop AI chips with sensory functions such as hearing and other senses, as well as reasoning and judgment abilities. Future research will also focus on developing a technology capable of accurately recognizing all moving objects, including humans. If these technologies become reality, you will see a machine talk to its user, decide where to go, find the way, and reach the destination on its own.

The research team developed visual intelligence technology for mobile ICT devices to detect objects in real-time using a high-efficiency processor. The new visual intelligence chip is the world's best in terms of energy efficiency.

A representative of ETRI said, "We plan to continue developing artificial chips capable of not only sensory functions but also decision-making. Machines will communicate with humans to select destinations and navigate their way around."

Today's AI technology has not reached the standards of movie characters like Jarvis and Samantha, who are able to understand human emotions. However, it is possible to detect and classify objects in real-time using small AI chips. We may someday succeed in developing AI capable of human behavior and emotions.

ROLE & RESPONSIBILITY

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Broadcasting and Media Research Laboratory

Today's media services have adopted highly realistic UHD technology. Next will come the era of ultra-realistic media services; it is just around the corner.

The Broadcasting and Media Research Laboratory intends to take your understanding and insight of the world to the next level via these ultra-realistic media services. Infrastructure of satellites and unmanned vehicles flying over our heads will keep us safe, and provide us a with vision to see what is going on in the outside world while sitting in our living rooms. We will develop a technology that allows the effective use of limited frequency resources so that you can access these ultra-realistic services from anywhere in Korea.

Likewise, the Broadcasting and Media Research Laboratory is determined to keep pace with our people by conducting R&D on convergence technology related to media and broadcasting, electronic wave and satellite technology, and unmanned vehicle technology, based on core original technology research.

The future of media and broadcasting, which will be brought by ultra-realistic technology, will be completely different from what we know today. Instead of being given a specific screen that is unilaterally set, TV viewers will be able to choose what they like the most among a set of given screens, and interact more actively with characters of their choice. It will be as if they zoomed in on those characters by adjusting their virtual camera, and they might feel as if they were watching those characters from a shorter distance. The Cyber-Physical Systems(CPS) technology will go together with media services engaging in every situation and aspect of our lives by freely moving beyond the boundary between physical space and cyber information space. Hologram technology, creating an image in empty space, is a promising technology that will bring breakthrough innovation to the fundamentals of the global media ecosystem in the mid- and long-term.

As a technological leader in the broadcasting industry, the Broadcasting and Media Research Laboratory will contribute to improving the quality of life and safety for all by proactively providing a variety of services, including the following: transmission of broadcasting, realistic video and sound services, ultra-realistic tera-media services blurring borders between digital and physical spaces, hyper-connected broadband wireless services using satellites, unmanned vehicle services making life safer and more convenient, and a user-centered media platform providing new value and knowledge.

We will do our best to ensure that our media and broadcasting technology leads the way not only in Korea but also in the global media industry. Thank you.

Senior Vice President of Broadcasting and Media Research Laboratory **Lee Su-In**

Trust Media Technology Creates Trustworthy Media Environment

Technology to Provide Sound Media Consumption Environment

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A growing concern among parents is the excessive use of smartphones by children and teenagers. Parents buy smartphones for their children to keep in touch in case of emergency, but are worried that they may become addicted to games or be exposed to harmful content.

In the midst of a flood of media content and information, and especially harmful content and information, it is important to establish a media service environment that is clean, healthy, and capable of communicating users in a free and creative manner, by providing well-refined content.

The Media Research Division of ETRI's Broadcasting and Media Research Laboratory developed Trust Media Technology that aims to provide a sound media consumption environment that eliminates harmful and illegal media content while ensuring user privacy.

This technology involves AI learning, which extracts knowledge from various media content, intelligently links all extracted knowledge, and give credence to media content, thereby creating a reliable media consumption environment. By doing so, the technology minimizes cases where users are exposed to specific media content unwittingly or against their will. This will lead to an increase in user satisfaction. Currently, the highest accuracy level of harmful content detection in the world is approximately 98.6%. ETRI researchers are now developing technology to achieve an accuracy of 99%. Going forward, they are also planning to develop technology to spot fake news via association content, and technology to predict sudden, unexpected behavior in personal broadcasting.

ETRI is establishing a sound media environment, which will make both parents and their children smile while improving the quality of life, and thus making this world more prosperous. In that world, we no longer have to worry about our children enjoying their smartphones as they please. It has already begun.

A representative of ETRI said, "This technology will establish an ecosystem of trustworthy media, and promote the use of personalized media services."

· The technology applied to detect the harmfulness of media was deep learning.

What is deep learning?

Deep learning is a machine learning method that enables machines to learn on their own based on deep neural networks. In other words, it is used to train computers to think and learn like human beings.

Free Band Harnesses the Power of IoT

Frequency Sharing to Ensure Adequate Frequency Provision

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In the early days of radio, we would turn the knob to tune the frequency to our favorite radio station. Now that everything has become so much more convenient, all we have to do is tap our smartphone to find the desired station.

Radio waves refer to electromagnetic waves that spread naturally in space without relying on artificial means. The Korean government allocates frequencies according to usage, such as communications, broadcasting, and public. Since 2010, we have seen explosive growth in mobile traffic due to the increase in smart devices and development of mobile communications technology. With the advent of the IoT age, the spotlight has shifted to the joint use of frequency bands. This topic is being extensively studied in the United States and Europe, and ETRI has acquired several patents on joint use of frequencies.

The Radio & Satellite Research Division of ETRI's Broadcasting and Media Research Laboratory is developing a technology that allows the general public to gain access to high-quality, ultra-low-cost wireless data and IoT services even in unlicensed spectrum. This technology involves enabling Free Band and unlicensed spectrum. It aims to develop hardware that establishes frequency sharing criteria and software that serves as a coexistence analysis tool. All these technologies will enable the coexistence of wireless devices, and especially low-output devices, improving efficiency in the use of unlicensed frequencies.

This frequency sharing technology can be applied wherever frequency resources are needed. It saves mobile service providers frequency fees fully or partially so that consumers may pay less for communications services. Also, local governments may use this technology to provide mobile access to residents in remote areas, i.e., the information poor, thereby narrowing the digital gap. Likewise, this frequency sharing technology will significantly contribute to establishing a safe and convenient social infrastructure system. Establishing an IoT-based social safety net via Free Band and unlicensed spectrum, when combined with big data technology, will solve the safety problems that are associated with vulnerable members of society in a technological manner. The provision of appropriate IoT frequencies will effectively promote IoT services so that it will become easier to collect data that make life easier and more convenient, such as urban traffic volume data and power consumption data, thereby improving our future residential environment.

A representative of ETRI said, "The supply of the 6.6 Ghz free band is expected to promote various products and services, such as mobile backhauls for mobile communications, ultra-high speed large image transmission, medical diagnosis, and security searches. The sub-1㎓ bands for IoT services will create new industries and jobs related to smart homes and remote meter reading(smart meters)."

·Shall we learn more about ETRI's TV White Space(TVWS) spectrum sharing technology?

TVWS technology utilizes TV bands that are not being used by licensed services at a particular time and in a particular geographic area. It contributes to bridging the digital divide, reduces communication expenses of households, and promotes IoT services in rural areas.

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ETRI's Drone ICT Serves as Third Eye!

Communications and Safe Navigation Technology for Multicopter UAVs for Disaster and Public Safety

ETRI researchers are developing core technologies associated with the communications and safe navigation of small-sized drones that aim to prevent and respond to disasters and public safety issues. This effort will help us be able to respond to various disasters and public safety threats in a more swift and multidimensional manner, thereby making life safer and happier.

Police drones will patrol crime-prone areas every day to ensure that everyone returns home safely, and search for missing people and chase criminals. They will also confront and defeat 'bad' drones that attempt to peek into others' lives or pose threats.

Firefighting drones will be the eyes and feet of firefighters, flying over their heads. They will arrive at a fire scene before firefighters, and vividly report the situation on the spot. They will enter a dangerous indoor fire scene to explore the inside on behalf of firefighters. In urgent disaster situations where every minute counts, firefighting drones will find the shortest way for firefighting trucks to reach the fire scene so that all necessary missions are completed within the golden time.

The application scope of these drones for disaster and public safety is not limited to land, but they can also be applied offshore. They monitor illegal vessels and detect marine pollution, such as oil spill, in vast sea areas on behalf of the Korea Coast Guard.

In case of a marine accident, the drones will search for the affected vessels and victims, and if they find them, they will immediately come to rescue, throwing life preservers to the victims.

The researchers have been developing an algorithm that enables multicopter unmanned aerial vehicles (UAVs) to automatically identify and avoid obstacles based on their own technology, as well as an integrated modem for UAV control and mission-critical applications in the C-band spectrum for the first time in Korea and the world. These achievements are expected to have profound implications to the future development of drone applications.

A representative of ETRI said, "If the communications and safe navigation technology is commercialized, we will be able to enhance the safety and well-being of citizens. Drones will be like a third eye, protecting us on land and in sky and water."

Accurate Forecasts With the GEO-KOMPSAT-2A Ground Station System

Ground Segment Development for Geostationary Weather Satellite

DEPARTMENT
Meteorological Satellite Ground Segment Development Department

MANAGER
Managing Director Ahn Do-Seob

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Many people start the day by checking the weather. The forecast helps them decide what to wear and whether or not to bring along an umbrella. Such valuable meteorological information is available thanks to artificial satellites.

Satellites are essential for communications, weather forecasts, and space exploration. Weather satellites provide weather forecasts by monitoring the atmosphere and measuring reflected solar radiation from the earth. However, there are times when the forecasts turn out to be completely wrong. Is there a way to get more accurate forecasts?

ETRI researchers' recent achievements will help make weather forecast significantly more reliable: a new ground segment developed by the Meteorological Satellite Ground Segment of ETRI's Broadcasting and Media Research Laboratory. Korea is planning to launch Chollian-2A Satellite in late 2018 in an attempt to improve the accuracy of weather forecast. This Chollian-2A Satellite is a next-generation geostationary weather satellite that will take over the weather observation mission of COMS 1 (Chollian 1) and carry out weather-related and space weather observation missions. The new ground segment system is capable of receiving, processing, analyzing, and managing weather-related and space weather data transmitted from Chollian-2A Satellite, as well as providing services accordingly. This ground segment system also uses weather algorithms, thereby allowing various weather environment analyses. For example, it can estimate various types of satellite-based cloud data, or provide accurate weather forecast using analytical methods customized to the Korean Peninsula. Also, it can be used for multiple purposes, such as monitoring forest fires, detecting and analyzing yellow dust, monitoring typhoons and marine conditions, and other analytical applications. In this regard, the technology has profound implications in many aspects.

The more reliable weather forecast will improve the quality of life and further enable us to respond to national disaster situations. Soon these technologies will help us enjoy much more reliable rainfall probability forecasting. With its cutting-edge technology, ETRI is joining hands in efforts to achieve world-level weather forecast and weather analysis systems.

· Learn how ETRI's ground station system provides accurate weather forecasts.

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Self-Learning AI Takes Care of Our Health!

KSB AI Platform

The Knowledge-converged Super Brain Convergence Research Department(KSBCRD) has been researching and developing core technologies underlying 'Self-learning Based Knowledge-converged Super Brain,' which aims to secure technologies that will enable the realization of 'Human-centric Hyper-connected Intelligent Society' in an attempt to respond to the advent of the era of Internet of Everything(IoE).

This technology aims to realize 'intelligence' by making use of collected data, over 95% of which are now being wasted. The key idea of turning information into intelligence is to provide high-quality data for self-learning and therefore it is essential to develop a KSB AI Platform that self-learns using these high-quality data created. The idea is to refine data real-time collected time from people's everyday living environments; extract knowledge from them via machine learning; converge the extracted knowledge with domain knowledge; and develop an AI system embedded with expert-level intelligence in various fields, such as optimized building energy management solutions by district units, plant leakage prevention and detection, and disease prediction for elderly people. In this manner, we will lead the way in base technology underlying the Fourth Industrial Revolution.

With rapid population aging, a disease prediction service for elderly people, which will be developed based on the KSB AI Platform, is also drawing significant attention. This system, embedded with expert-level intelligence to predict diseases for elderly people, will effectively help those suffering from chronic diseases, and is now being jointly developed by ETRI and the Korea Research Institute of Standards and Science. For example, in the early stage of stroke, the human body undergoes various changes, and if an AI system is able to learn and analyze those changes independently and predict the risk of stroke in advance, early diagnosis and treatment will be possible.

The present technology allows real-time monitoring of the biosignals, and behavioral and motor patterns of elderly people, and connects these results with their health records and medical knowledge database via the KSB AI Platform, thereby identifying warning signs of stroke and predicting its occurrence. It also reports these results to the patients, their family, people near them, and hospitals, making it possible to immediately respond in case of an emergency.

These efforts will contribute to improving public health and quality of life, as well as significantly reducing social costs, such as medical expenses, through preemptive measures centered on prevention and health management.

A representative of ETRI said, "The self-learning super brain technology has the potential to significantly improve everyday life. It has infinite possibilities in various areas such as home, construction, energy, food, environment, and health."

Energy IoT Standardization Technology Brightens Future

Energy-IoT Standardization Technology

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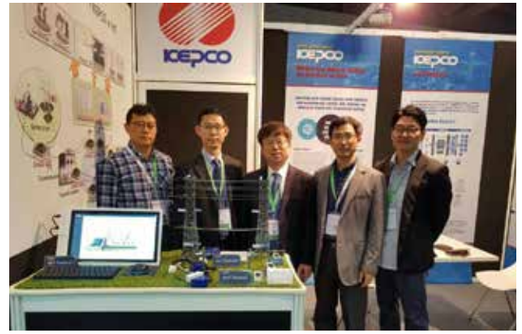
A, a working mother, is able to efficiently handle work and household chores thanks to IoT. The smart home device helps to prepare her children for school, and reminds her of important meetings. She can adjust the temperature and gas even when she is out, and this has allowed her to save on energy bills. The smart refrigerator sends out purchase orders for essential ingredients, and provides dinner recipes for A to cook after getting home from work.

ETRI's Honam Research Center(HRC) has seen the need to apply IoT to the power grid field and therefore developed energy-IoT standardization technology. First, the HRC developed an IoT standard technology in line with international standards that collects sensor data from IoT devices in accordance with the common standard method. Later, the HRC made substantial contribution to achieving domestic standardization based on the developed technology, thereby enhancing technological competitiveness of IoT device and part producers, expanding the IoT market, and reducing costs.

Currently, electricity power grids operate as a closed network, and devices connected to these power systems operate under different communications standards, making it highly difficult for these devices to be linked to each other and for us to collect data. In this regard, standardized sensor protocols are expected to enable a swift response to various situations, and especially extreme situations, such as power grid facilities being compensated by errors or disasters.

The HRC's energy-IoT standardization technology will serve as a core technology to collect data needed for each facility from the power grid established across the country, and deliver those data to the respective corresponding facilities.

ETRI's Energy System Research Section led the way in enabling the realization of IoT standard protocols proposed by the Internet Engineering Task Force(IETF) and improving the level of performance via its software technology, thereby drawing significant attention from the market. It should be noted that it was the world's first attempt to apply an IoT standard to the energy industry.



Automatic Hair Transplant Technology Significantly Reduces Transplant Time

Automatic Hair Transplanter Technology

Most people think of hair loss as occurring only in males. However, the number of people suffering from hair loss in Korea was estimated to be 230,000 in 2015, and this figure is likely to have increased since then. Hair loss is a common condition in modern society, regardless of gender and age. The most effective way of overcoming hair loss is to get a hair transplant. Like A, more and more people experiencing hair loss are choosing to undergo hair transplants.

According to the International Society of Hair Restoration Surgery(ISHRS), the global hair transplant market has increased steadily by 76% from 2006 to 2014. In 2014, the number of hair transplants was 112,409 in the United States alone, and 397,048 in the world.

Despite increasing global demand for hair transplants, there still remain concerns about the treatment; it is laborious for both patients and doctors. A doctor makes incisions at the back of the head and takes about 2,000 hair follicles from that region and inserts them into the target area hair by hair using tweezers or a manual transplanter. Overall, it takes about 4 hours on average, and the doctor's arm movement during a single session amounts to 1 km, when converted to the length unit. Also, high costs are another reason why people worrying about hair loss are hesitating.

To address these limitations, ETRI researchers recently developed an automatic hair transplanter. This automatic hair transplant system is composed of an automatic transplanter that a doctor carries in his hand, a controller that drives the transplanter, and a balance arm that supports other components. It is capable of planting 25 hair follicles at a time, and this means it takes only 2 hours to plant 2,000 follicles.

The treatment time will be reduced by half, significantly reducing a doctor's arm and shoulder fatigue after the treatment. Furthermore, hair transplantation will be regarded as a more common treatment option for people losing hair, leading to a decrease in treatment costs. The present technology, developed by ETRI researchers, is the world's first technology to allow automatic hair transplants, and it will significantly help this treatment in becoming a more common option for the general public.

· ETRI to Introduce Robotic Hair Transplant

Robotic hair transplants require higher survival rate of follicles, reduced transplant time, and automated devices. To perform robotic hair transplant surgery, ETRI's researchers will further develop image and vision processing, real-time position tracking, miniaturized sensors, and multi-axis robot arm control.

ROLE & RESPONSIBILITY

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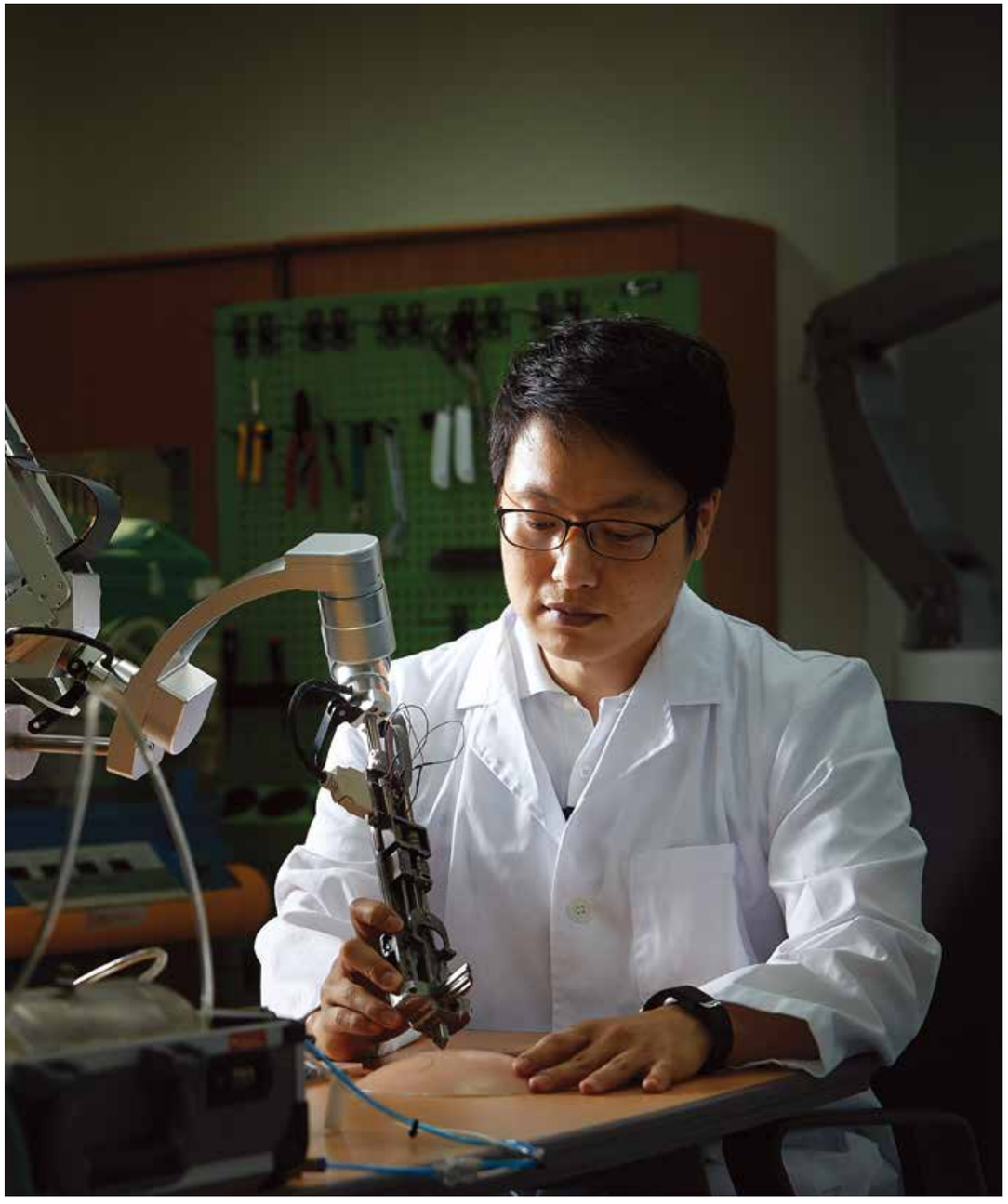

Now You Can Create Your Own AI Application Services!

AI Open API Service

DEPARTMENT
Seoul SW-SoC Convergence R&BD Center

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(At a student entrepreneurial club)

Seo-jun: I'm going to launch an AI-based chatbot service!

Jin-gi: How is that possible when you don't know anything about AI technology and don't have any experience in developing AI applications?

Seo-jun: Didn't you know? ETRI provides AI technologies as open API at its public AI open API and data service portal (http://www.etri.re.kr/aiopen). You can make use of open API to create your own AI applications. Anything is possible!

Jin-gi: Is that true? I want to make my own AI application too!

ETRI's Seoul SW-SoC Convergence R&BD Center's mission is to make smart AI technology accessible to everyone.

ETRI has been making its AI research achievements—from government R&D projects, such as linguistic intelligence (Exobrain) and voice recognition technology—available as Open Application Programming Interface(API), which provides a standard interface. Furthermore, it is providing access via its Open API service to various users, including SMEs, start-ups, universities, and individuals. The researchers are now striving to promote the development of AI application services by providing their expert-level technological support, and establish an ecosystem for the AI industry.

The AI Open API service currently provides 14 APIs associated with various AI technologies, characterized by Exobrain's Korean language analysis technology, which is designed to accept Korean words, sentences, or documents as input data, analyze them and provide results, as well as voice recognition technology for Korean and English. API is a set of routines and protocols under which software developers are allowed to access specific functions in a given software program, and therefore users can develop their own AI-based application services by using these open APIs available.

Since its launch in late October of 2017, ETRI's AI Open API service has about 800 registered users, with a daily average of 10,000 API calls. These users are deeply interested in developing AI technology-based application services, and some of them are enjoying the first-hand experience of AI technologies of today. Impressed by ETRI's AI technology applications, some businesses are pushing forward with commercialization via technology transfer.

ETRI's AI open API service can be readily accessed by anyone. Don't miss this opportunity to utilize ETRI's AI technology and make your own AI applications.

· http://www.etri.re.kr/aiopen

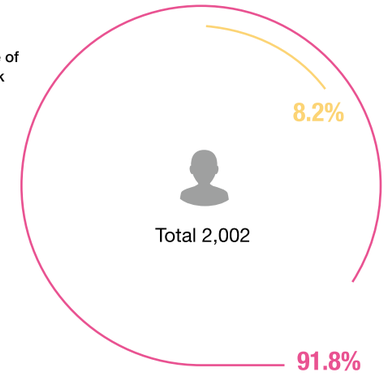
General Status

PERSONNEL & PROJECT STATUS

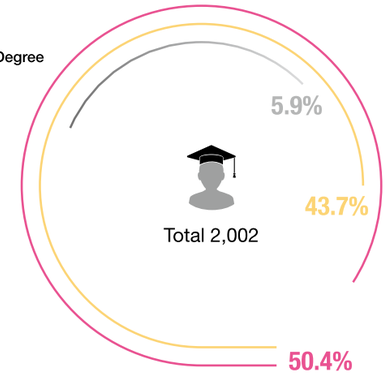
PERSONNEL STATUS

Total : 2,002(as of year 2018)

Type of Work



Status of Degree Holding

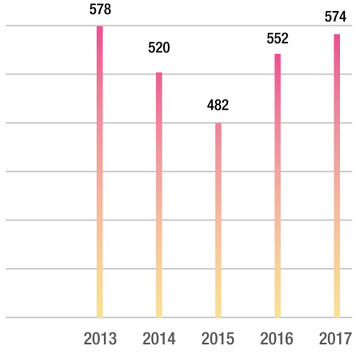


91.8%	8.2%	50.4%	43.7%	5.9%
Research / Technical Staff	Board Member / Administrative Staff	Doctoral	Master	Bachelors
1,838	164	1,009	874	119

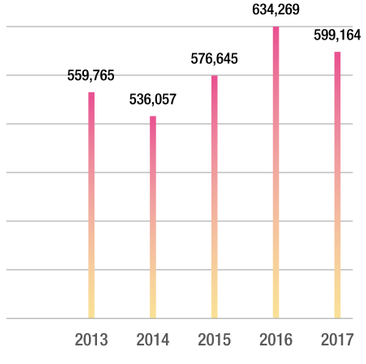
PROJECT STATUS

No. of Project / Budget : 2,706 project / 2,905,900 million won(Total of past 5 years)

No. of Project (unit : cases)



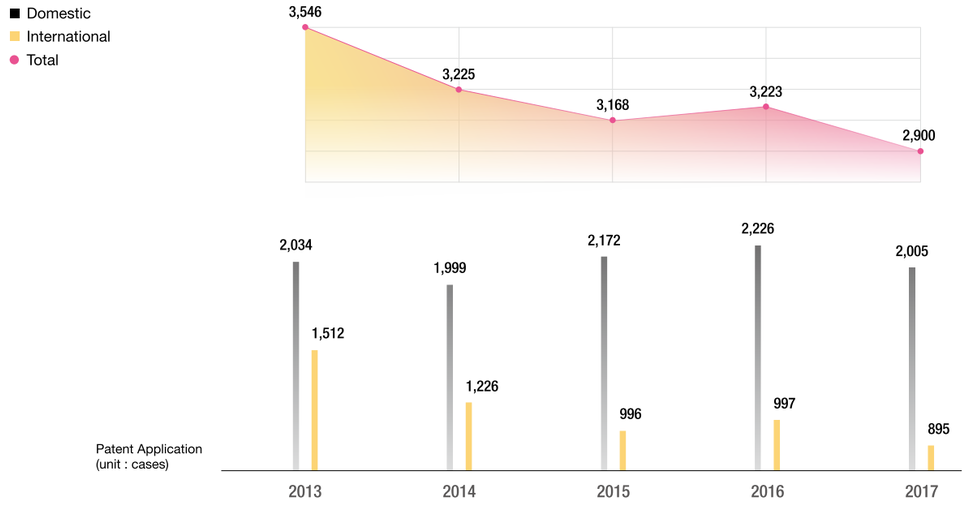
Budget (unit : Million Won)



PATENT APPLICATION & TECHNOLOGY TRANSFER

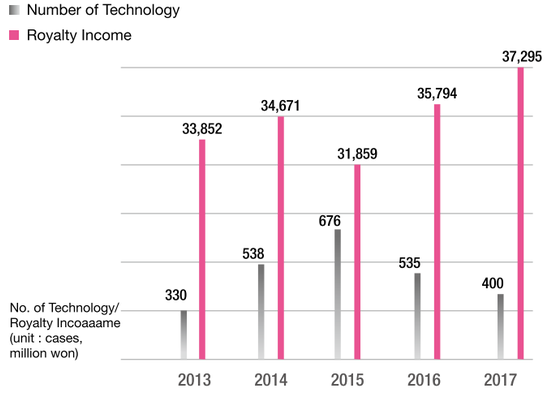
PATENT APPLICATION

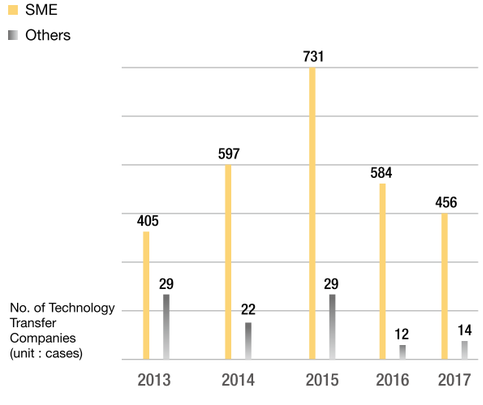
No. of Patent Application : 16,062 cases(Total of past 5 years)



TECHNOLOGY TRANSFER

No. of Technology / Royalty Income : 2,479 cases / 173.4 billion won(Total of past 5 years)

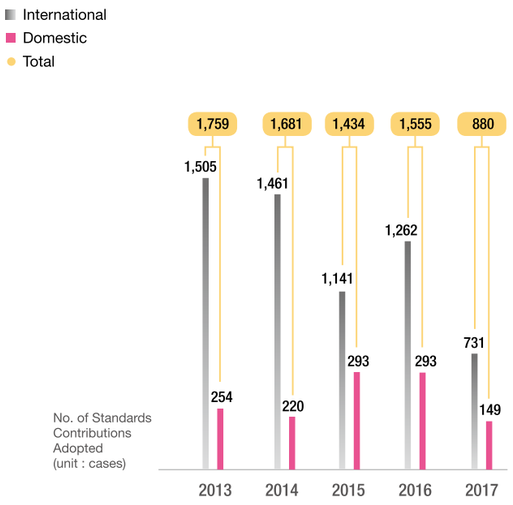


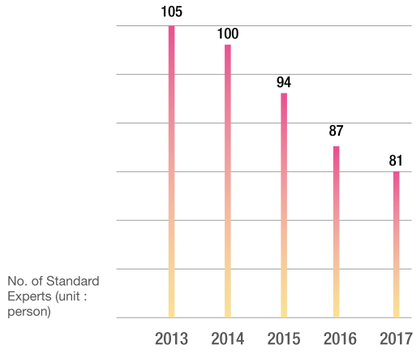


STANDARDIZATION & SCI PAPERS

STANDARDIZATION

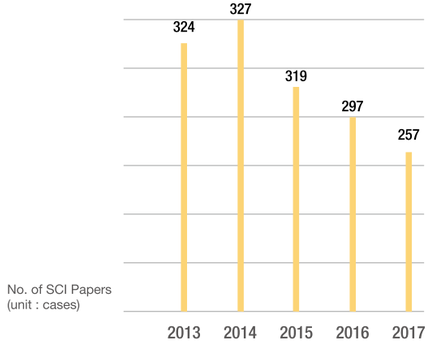
No. of Standards Contributions Adopted for total of past 5 years : 7,309 case / 467 Experts

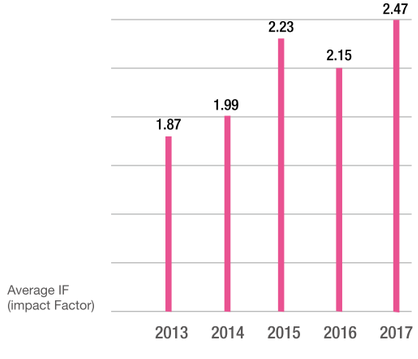




SCI EXPANDED PAPERS

No. of SCI ExpandedPapers / Average IF : 1,5 cases(Total of past 5 years) / 2.14(Average)





STATUS AND PROGRESS OF COMPANIES ESTABLISHED BY ALUMNI

• ETRI Companies

590 Companies

After the establishment of Sambo (Trigem) Computer in 1980 approximately 590 companies have been established

8 Initial Public Offering

8 of ETRI Alumni Companies are listed on the KOSPI [1], KOSDAQ [6], KONEX [1] (As of 2017)

KOSPI : Comtec Systems(Co.)
KOSDAQ : AP Systems(Co.), Innowireless(Co.), SNS Tech(Co.), RF Semi(Co.), ELK(Co.), Secuve(Co.)
KONEX : Wiworld(Co.)

250개 Alumni Companies

2,152.0 Billion KRW

As of 2017 / Among 104 Companies

2,215.2 Billion KRW

As of 2017 / Among 104 Companies

ETRI LABORATORY ENTERPRISE STATUS

48 Registered Companies

ETRI has set up 48 ETRI Laboratory Enterprises through successful commercialization of research outcomes since 2007.

33 Companies in Operation

33 ETRI Laboratory Enterprises in Operation (As of 2017)

BT works(Co.), Sogware(Co.), Sugentech(Co.), Aritel(Co.), (Co.)Gamdong, Hojeonable(Co.), New-run(Co.), MINDs(Co.), Syn-tekabio(Co.), Wooksung Media(Co.), Gamma Spectra(Co.), RNSLab(Co.), (Co.)Eintelligence, JSLIDA(Co.), Bird Letter(Co.), HarborMax(Co.), Optella(Co.), icerti(Co.), Gene System(Co.), HANCOM INTERFREE(Co.), ch soulution Co., Ltd, Devstack Inc, WiseThan(Co.), Gridaenergy(Co.), SNET(Co.), (Co.)ELROIS, (Co.)Antrorse, (Co.)To be smart, (Co.)Dark Horse Games, (Co.) Y-tech, Pdxen Inc, MAG-SOLUTION Inc, MINTROBOT (Co.),

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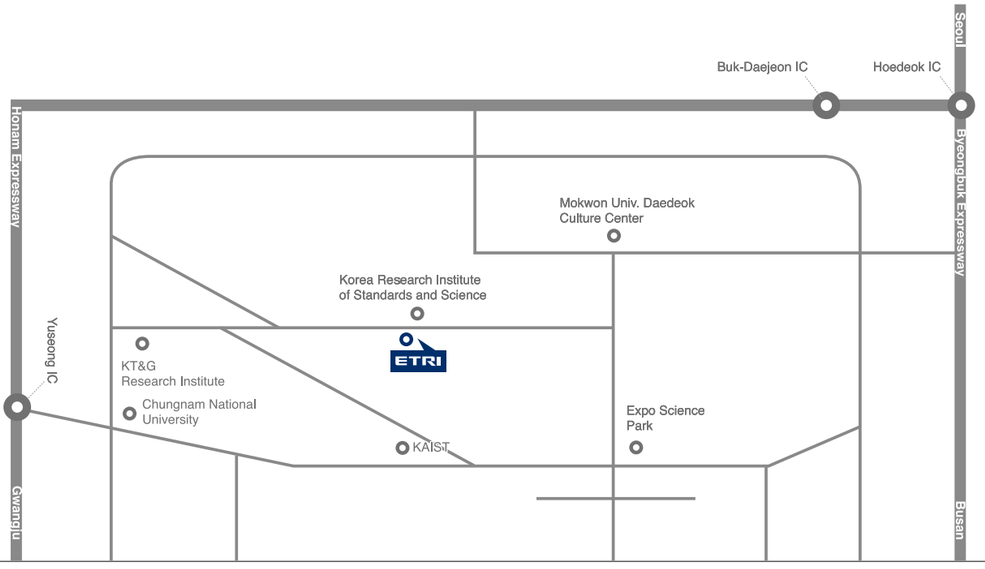

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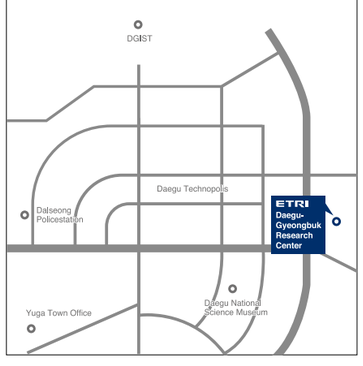
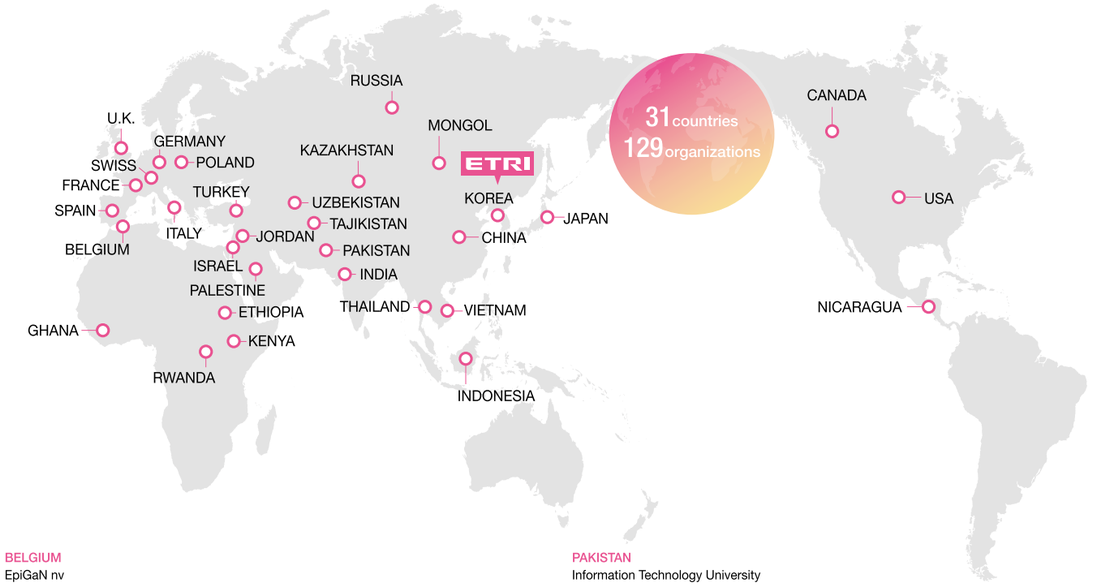


GLOBAL R&D COOPERATION NETWORK



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