Research Institute for
Data Science and AI

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# Research Institute for Data Science and AI

Hallym University

Hallym University is emerging as an icon of structural innovation in higher education by presenting a new university model and vision to lead the future of higher education. At the center of that innovation is the Research Institute for Data Science and AI. The Research Institute for Data Science and AI plays a pivotal role in educating and researching AI, spreading it throughout university operations, and fostering all members as AI experts. This Annual Report shares the research achievements and challenges accumulated by the Research Institute for Data Science and AI, providing an opportunity to reflect on the university's social responsibility.

President of Hallym University

Yang-Hee Choi

Artificial intelligence is no longer an option, but a necessity.
However, what is more important than the technology itself is what we achieve through it. Over the past year, Hallym University Research Institute for Data Science and AI has expanded the boundaries of research by integrating AI technology into the fields of healthcare, education, and social safety to find answers to this question. Above all, we focused on implementing all research so that it works in real-world settings beyond the laboratory. Representative achievements include field-oriented research, such as the AI Edutech Center. We have presented new possibilities for university education by applying AI-based solutions that analyze the learning patterns of professors and students to educational settings, and confirmed that universities can function as hubs for regional innovation by cooperating with industry, medical institutions, and public agencies. In the new year, Hallym University Research Institute for Data Science and AI aims to move beyond technological development to answer ethical and social questions posed by AI and evolve into a platform that creates social value. We will continue to be a trusted partner in creating a sustainable intelligence ecosystem.

Director of the Research Institute for Data Science and AI

Seop-Hyeong Park


## Vision

Realizing an Open University that Fosters AI-Based Creative and Convergent Talent

## Goal

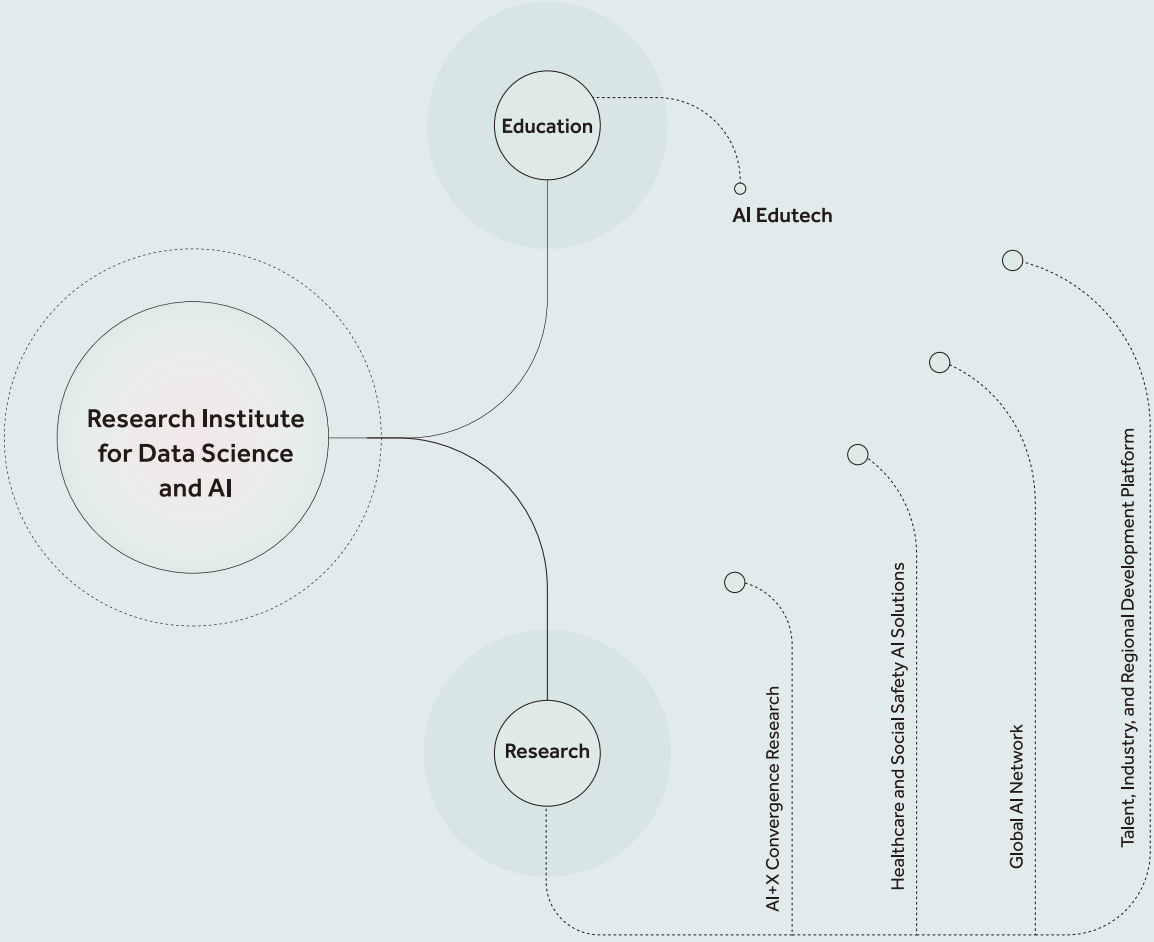
Academic Innovation, Educational Transformation, and Realization of Social Value through AI Technology

## Strategy

- Strengthening personalized learning through AI-based educational platforms and data analysis, and driving qualitative innovation in higher education
- Developing intelligent solutions to respond to future social threats utilizing AI/ICT convergence technology and policy research
- Building a world-class global research community by cultivating core talent in the AI field and fostering international cooperation
- Serving as a cooperative hub leading regional innovation via region-specific AI+X projects

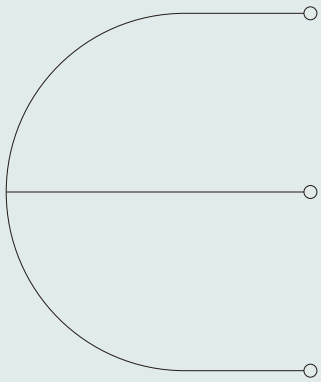
## Hallym University Research Institute for Data Science and AI

Hallym University Research Institute for Data Science and AI is a university-wide research institution leading innovation in research and education by converging AI with various academic fields. Under the vision of **Realizing an Open University that Fosters AI-Based Creative and Convergent Talent,** it promotes academic innovation, educational transformation, and the realization of social value. As a core institution of the Glocal University 30 project, it builds an AI convergence platform connecting the region and the world, playing a pivotal role within a sustainable AI ecosystem.



## Organizational and Operational Structure of the Research Institute for Data Science and AI

The Research Institute for Data Science and AI operates an integrated management system linking strategic and operational committees with research planning organizations, centered on the Director and the Head of the Convergence Division. The institute systematically promotes AI convergence research and technology development in education, social safety, and healthcare via the AI Edutech Center, the Hallym Institute of Intelligent Social Safety Research, and the Cerebrovascular Disease Research Center.



**AI Edutech Center**

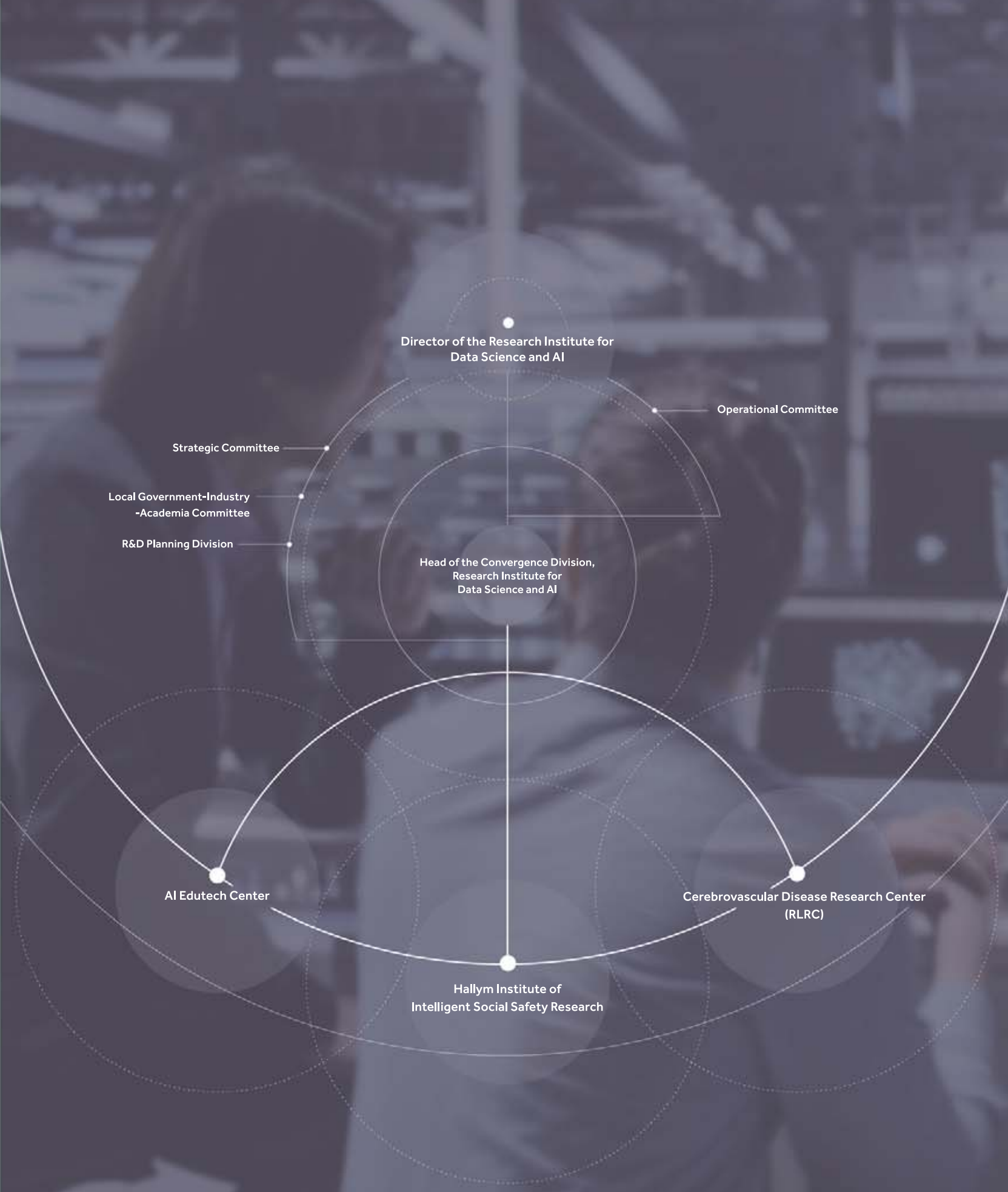
We aim to build a future-oriented education ecosystem through AI-driven educational innovation and personalized learning support, while driving the global expansion of the K-Higher Education model and fostering a sustainable AI Edutech environment.

**Hallym Institute of Intelligent Social Safety Research**

Leveraging ICT and AI convergence technologies, the institute researches core social safety technologies to respond to future risks such as disasters and cybercrime, as well as solutions to strengthen national and regional safety capabilities.

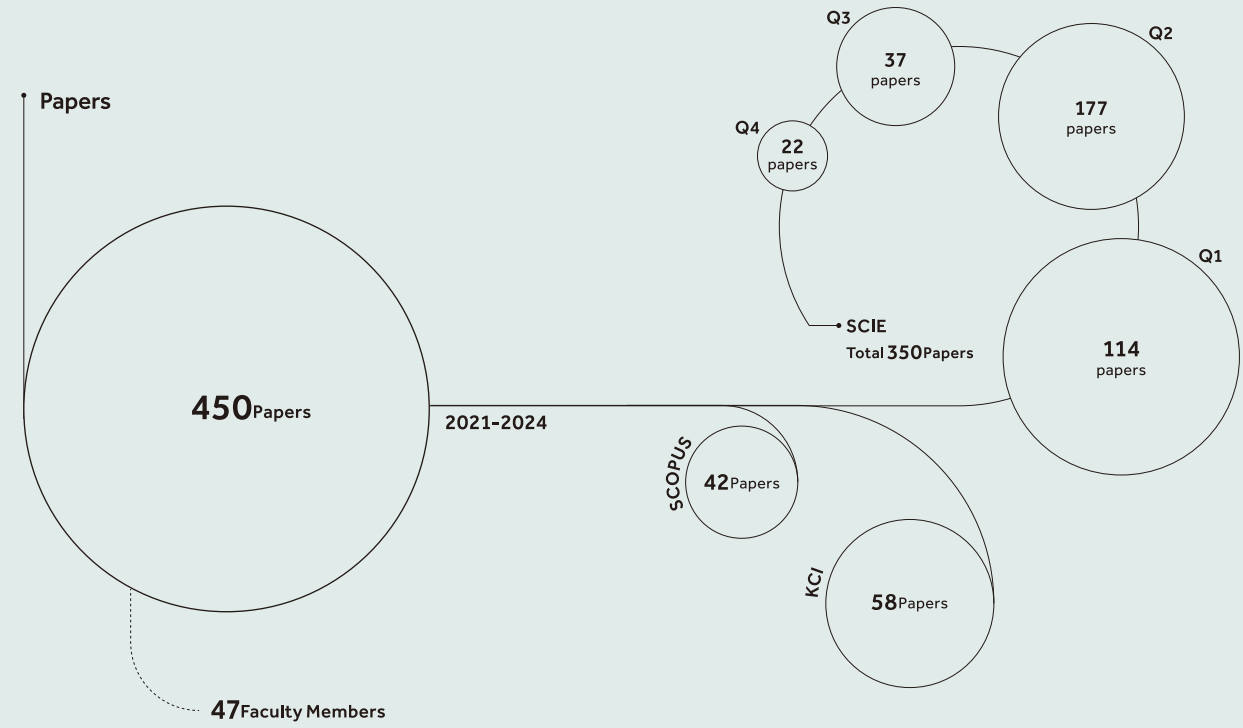
**Cerebrovascular Disease Research Center**

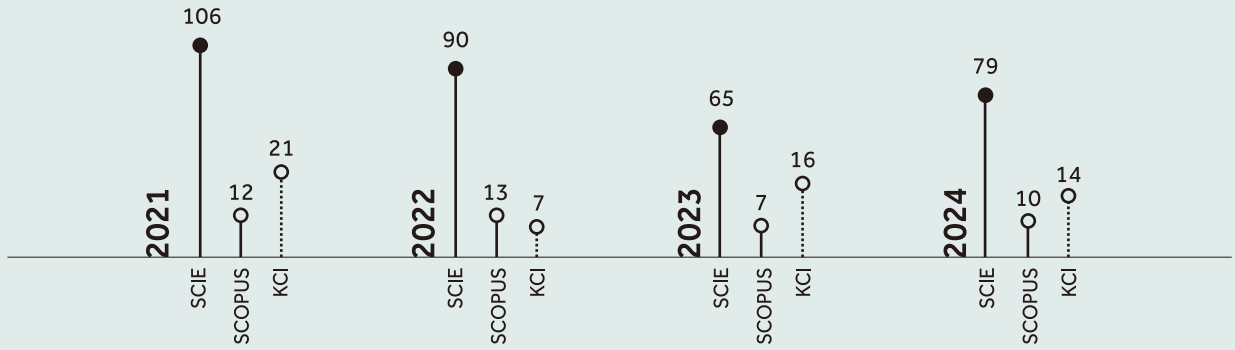
Utilizing AI-driven digital health platforms and lifecycle integrated data, the center realizes precision and customized management of cerebrovascular diseases and contributes to resolving medical inequality and creating a sustainable digital health ecosystem.


Director of the Research Institute for Data Science and AI
Operational Committee
Strategic Committee
Local Government-Industry -Academia Committee
R&D Planning Division
Head of the Convergence Division, Research Institute for Data Science and AI
AI Edutech Center
Cerebrovascular Disease Research Center (RLRC)
Hallym Institute of Intelligent Social Safety Research

## Research Achievements of the Research Institute for Data Science and AI

From 2021 to 2024, the Research Institute for Data Science and AI achieved significant research outcomes, publishing 450 papers in SCIE, SCOPUS, and KCI journals and securing 158 patents (registered and applied). Furthermore, it strengthened the foundation for industry-academic, government, and private sector cooperation by securing approximately 18.2 billion KRW in research funding across 251 projects.



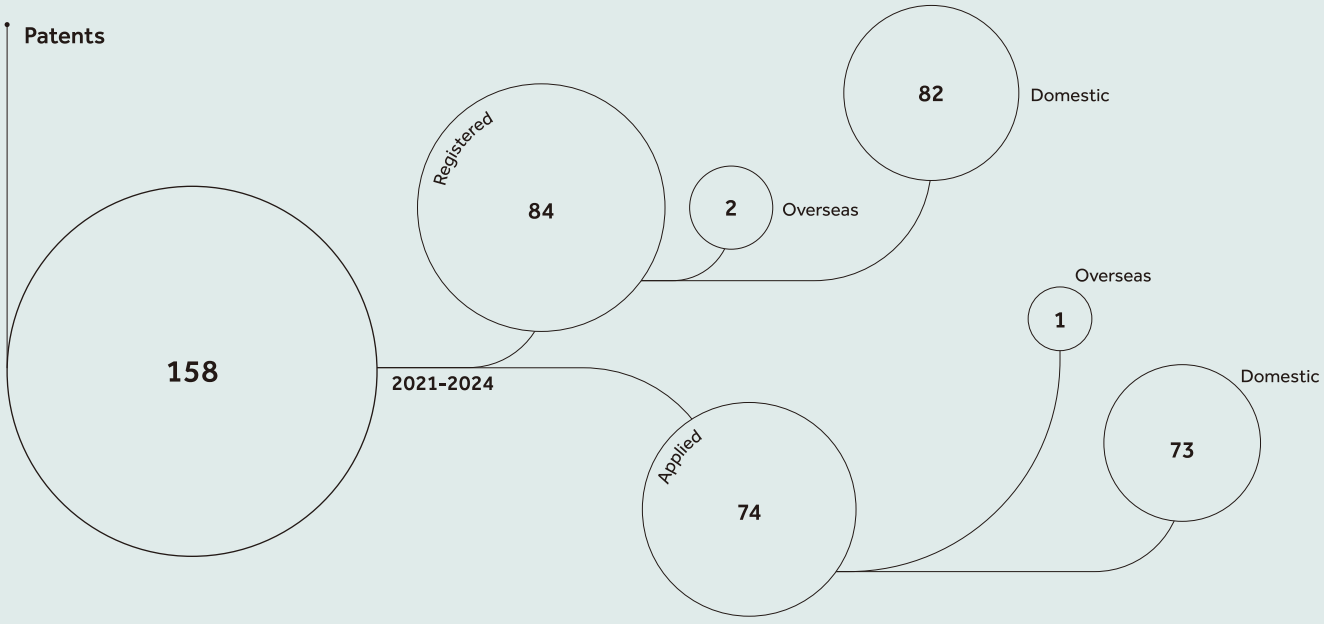
## Research Funding

| | | |
|---|---|---|
| Government | 138 Projects | KRW 15,903,049,000 |
| Private Sector | 34 Projects | KRW 1,171,707,000 |
| Internal | 69 Projects | KRW 696,000,000 |
| Local Government | 9 Projects | KRW 427,317,000 |
| International | 1 Project | KRW 10,000,000 |

2021-2024

**Total**
KRW 18,208,073,000
251 Projects

## Patents



# AI Digital Health Platform for Lifecycle Management of Cerebrovascular Disease

**Participants**

In-Cheol Jeong (Director), Semin Ryu, Hyo-Yeol Moon Youngjun Yun, Ga-Young Choi, Sora An, Dong-Ok Won, Yu-Seop Kim, Cheolkyu Shin, Keun-Tae Kim, Chulho Kim, Jin-Pyeong Jeon, Young-Kyun Suh

Cerebrovascular Disease Research Center, Seoul National University, Hallym University Chuncheon Sacred Heart Hospital, Douzone Bizon, Boditech Med, NUGA BEST, Mezoo, Geomexsoft, Emma Healthcare, DTPlus, Columbia University, J ohns Hopkins University, TU Berlin, Ben-Gurion University, University of Massachusetts Amherst, University of Arizona, New Jersey Institute of Technology (NJIT), University of Haifa, University of Porto, Yale University, etc.

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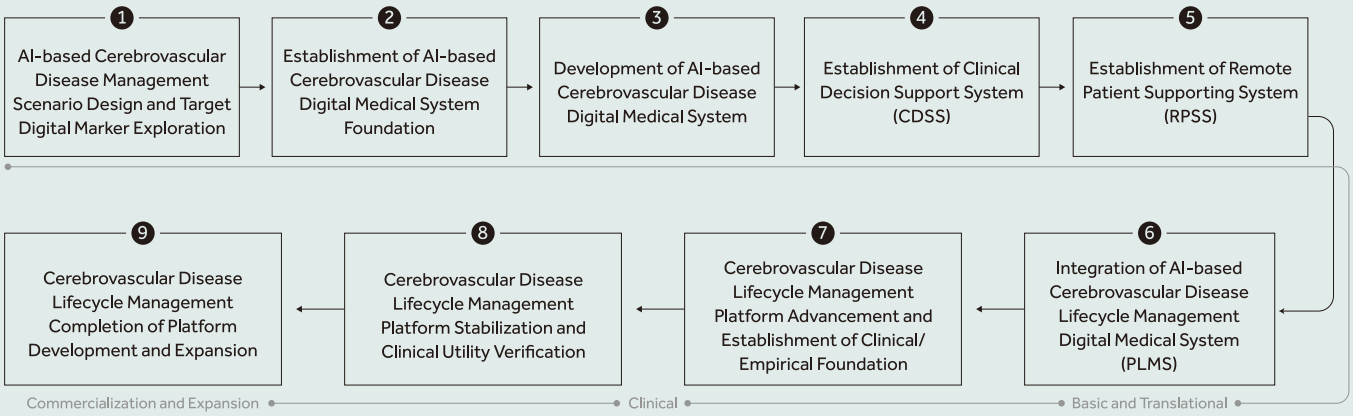
The project "AI Digital Health Platform for Lifecycle Management of Cerebrovascular Disease," led by Hallym University, is a Regional Innovation Leading Research Center (RLRC) project conducted from June 1, 2022 to February 28, 2029 (6 years and 9 months), with a total R&D budget of approximately 16 billion KRW. The core objective of this project is to establish a Patient Lifecycle Management System (PLMS) that connects risk group management, acute phase diagnosis and treatment, post-discharge rehabilitation, recurrence prevention, and long-term follow-up into a single continuous flow.

The PLMS is designed with two core components. First, the Clinical Decision Support System (CDSS) supports medical staff in diagnosis and treatment decision-making by performing integrated analysis of multimodal data—including Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Electronic Medical Records (EMR), test results, and various sensors and patient lifelogs collected in remote environments—to predict prognosis and recurrence risks, and by visualizing cerebral hemorrhage lesions, infarct locations, and key biomarkers using Explainable Artificial Intelligence (XAI). Second, the Remote Patient Supporting System (RPSS) is being progressively integrated to enable patient monitoring and care outside the hospital and to support early intervention by medical staff for warning signs. It interfaces with various devices such as wearable electrocardiogram (ECG), photoplethysmography (PPG), smart bands/beds, non-contact biosignals, Point-of-Care Testing (POCT), High-Intensity Focused Electromagnetic (HIFEM) stimulation rehabilitation equipment, Intensive Care Unit (ICU) monitors, and voice, EEG, and gait sensors.




AI Digital Health Platform for Lifecycle Management of Cerebrovascular Disease

The research operates through an organic system where three groups circulate scenarios, data/platforms, and AI/demonstration. Group 1 establishes a field-based monitoring environment utilizing RPSS and digital biomarker/device requirements; Group 2 develops the data/platform foundation, including a cerebrovascular disease-specific database (DB) and Extract-Transform-Load (ETL) system, as well as unstructured/multimodal AI algorithms (specifically advancing the CDSS); and Group 3 accumulates empirical evidence by designing lifecycle management scenarios, establishing phenotypes, and conducting longitudinal clinical research. In particular, the participation of clinicians from Chuncheon Sacred Heart Hospital facilitates the acquisition of clinical data, derivation of medical staff requirements, and reflection of clinical workflows. Industry-academia cooperation acts as a key pillar for PLMS implementation, with joint development underway with Douzone Bizon (data, ETL, anonymization), Boditech Med (POCT), and NUGA BEST (handheld devices, smart beds). Furthermore, the scope of wearable, non-contact, and rehabilitation device integration is continuously expanding through collaboration with Gangwon-based companies such as Mezoo, Geomexsoft, Emma Healthcare, and DTPlus.

Building on these research activities, we have completed the prototype of the PLMS—including core functions such as web/mobile interfaces, DB, and continuous monitoring scenarios—and are currently awaiting demonstration in actual clinical settings. As a result of these research activities, the project is step-by-step realizing a cerebrovascular digital health ecosystem spanning hospitals, homes, and communities.

Achievements include 9 papers in top-tier journals (within the top 5% JCR) such as Nature Communications and Advanced Functional Materials, 36 papers within the top 30% JCR, 26 domestic and PCT international patents, Local Government-Industry-Academia cooperation with 7 regional companies, and the cultivation of approximately 30 undergraduate and graduate-level researchers.

## Development of a Lifecycle Management Platform for Cerebrovascular Disease and Performance Indicators

### PLMS Implementation System Based on Lifecycle Scenarios and Industry-Academia-Research-Hospital Linkage

The RLRC focuses on implementing the PLMS not as a single-function development but as a system where lifecycle scenarios are actually operational. After aligning the data structure and service flow based on the patient journey (hospitalization–outpatient–home) and key observation indicators defined in clinical settings, we progressively advanced the integrated DB/ETL, inter-module interfaces, and security/anonymization systems supporting them. Additionally, an operational structure was established where hospitals, universities, and companies share roles to immediately reflect real-world user requirements. With Douzone Bizon, we jointly designed the DB/ETL and anonymization systems to ensure stable linkage of clinical, lifelog, and unstructured data with hospital systems. With Boditech Med, we refined

protocols to link POCT-based biomarker inputs to risk calculation.

We are pursuing joint advancement with NUGA BEST to ensure that handheld and smart bed equipment usable in homes and hospital rooms operates according to monitoring scenarios.

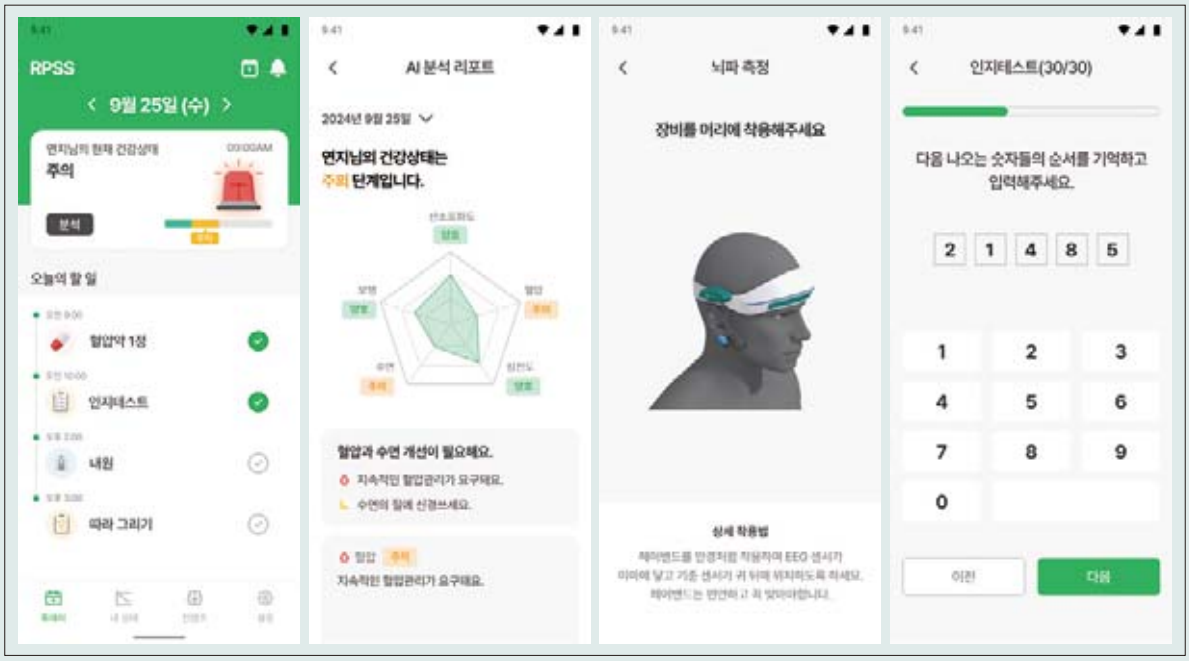
This implementation and linkage system has led to multifaceted achievements, including international papers, patents, talent cultivation, copyrights, awards, and media coverage, providing a foundation for the PLMS to establish itself as an integrated sensor–AI–platform–clinical model for the lifecycle management of cerebrovascular disease.

**CDSS – Integration of Multimodal Clinical Data and XAI-based Precision Diagnosis/Prognosis/Recurrence Risk Prediction**

Aiming to alleviate bottlenecks in acute clinical decision-making, the CDSS provides diagnostic assistance and risk prediction for prognosis, recurrence, and complications by integrating in-hospital multimodal data (CT/MRI, reading reports, EMR, test results) and lifelogs (biosignals, activity indicators, etc.) linked with the RPSS. In particular, we are building a multimodal prediction model utilizing clinical indicators, imaging features, and omics information together by progressively linking KoGES-based epidemiological/genomic information and high-density data such as exosomes and proteomes.

The RLRC maintains "Explainable Clinical AI" as a core principle, using XAI to identify suspected lesion areas (e.g., cerebral hemorrhage lesions/infarct locations) and presenting them along with biomarkers and evidence variables to enhance clinical applicability. Medical staff can simultaneously check the areas highlighted by the model and the underlying evidence on the PACS/EMR-linked screen, and multiple

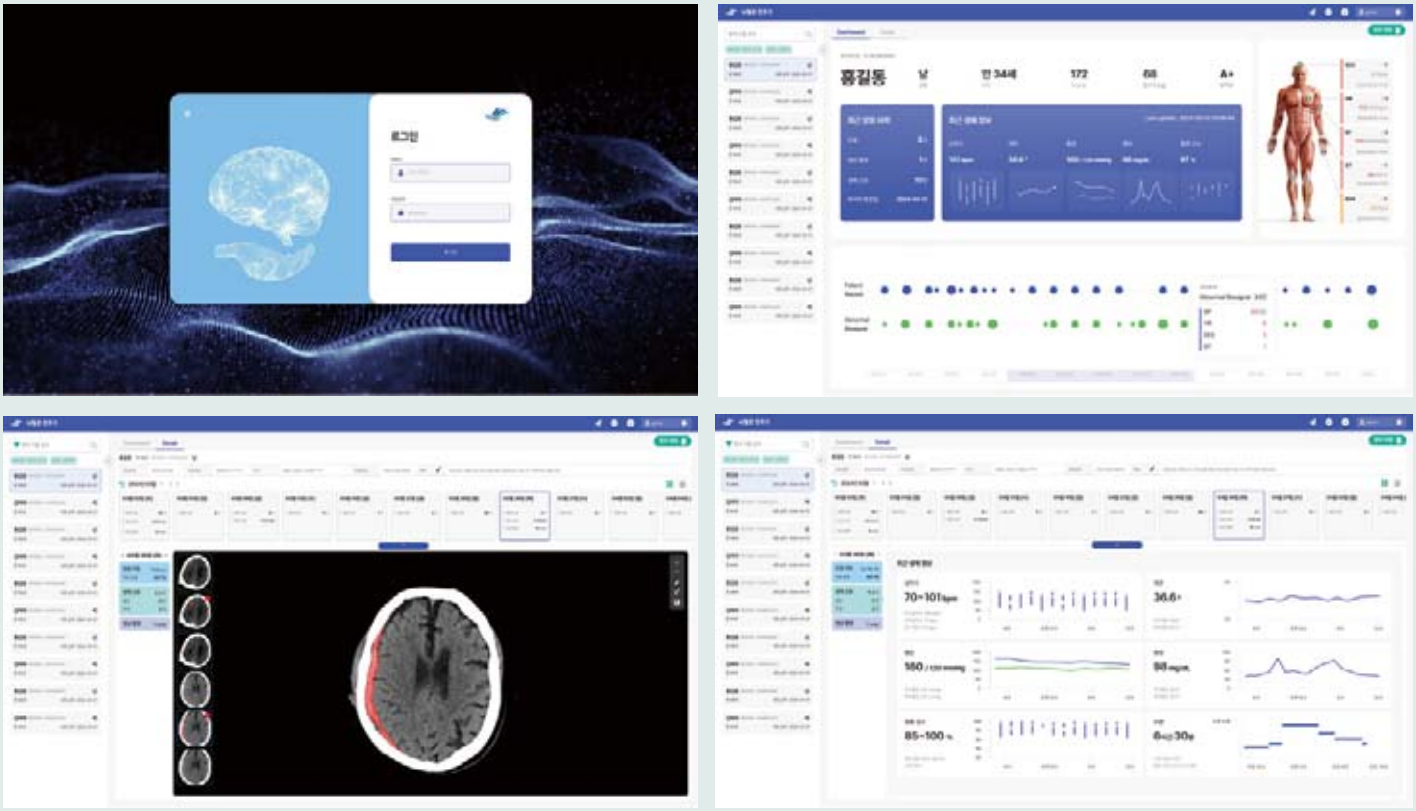
lesions and micro-lesions can be identified more effectively, reducing omissions and allowing for the adjustment of treatment and rehabilitation strategies (e.g., blood pressure control, anticoagulation cessation, early rehabilitation intensity). In this process, representative achievements such as clinical EEG-based motor hotspot estimation (Journal of Neural Engineering) and combined text/numerical data prognosis prediction (Expert Systems with Applications) were derived, and we advanced the CDSS as the "hospital-side diagnosis and prognosis support engine" of the PLMS.



**RPSS – Out-of-Hospital Monitoring, Rehabilitation, Device Integration, and Evidence-Based Advancement**

RPSS is designed as a remote full-cycle monitoring hub that continuously collects and summarizes patients' vital signs, activity, sleep, posture, and rehabilitation data in all remote environments where medical staff are not present, supporting both early intervention by medical staff and self-management by patients and caregivers. We implemented a prototype integrating various digital health inputs—such as wearable ECG, smart bands, smart beds, handheld/non-contact sensors, HIFEM rehabilitation equipment, and voice, gait, and tremor signals—into the app-based RPSS, operating as an integrated PLMS alongside the CDSS connected to hospital systems. Patients and caregivers can record and view prescription history, medication intake, blood pressure, exercise, and symptoms in the app, while medical staff can monitor risk changes and functional recovery trends on a dashboard to adjust early intervention timing and rehabilitation strategies.

As a result of this integrated CDSS–RPSS research, representative achievements such as TOAST subtype classification, stroke/CKD gait analysis, dysarthria/tremor assessment, EEG/genomic-based cognitive function and prognosis prediction, healthcare IoT authentication and security (IEEE Internet of Things Journal), elderly fall (Measurement), and sleep/activity analysis (Computers in Bio) were derived, and we established various wearable sensors, integrated servers, and deep learning/machine learning models for monitoring.



Examples of Developed Prototype PLMS Web Screen and CDSS Function UI/UX

## Cyber C.O.P.

# Development of an Integrated Analysis and Inference System for Cybercrime Investigation Leads

**Participants**

Jion Kim (Principal Investigator), Yong-Tae Lee, Ro-Seop Park, Hansoo Kim, Jeong-Min Ahn, Yun-Sik Jang, Byeong-Kwan Woo, Kwang-Sue Chung, Ui-Jik Kim, Beomju Shin, Cheolkyu Shin, Dong-Ok Won, Sung-Mi Park, Hyoseung Kim

Whitescan, CSLEE, Stone Integrity Co., Ltd., Cyram Co., Ltd., Sky Worldwide Co., Ltd., Yonsei University, Korea University, Sungkyunkwan University, Korean National Police University, ETRI, KETI, Hive System Co., Ltd. (Naver Cloud), The Cheat, Dongsimwoo Co., Ltd., Chainalysis

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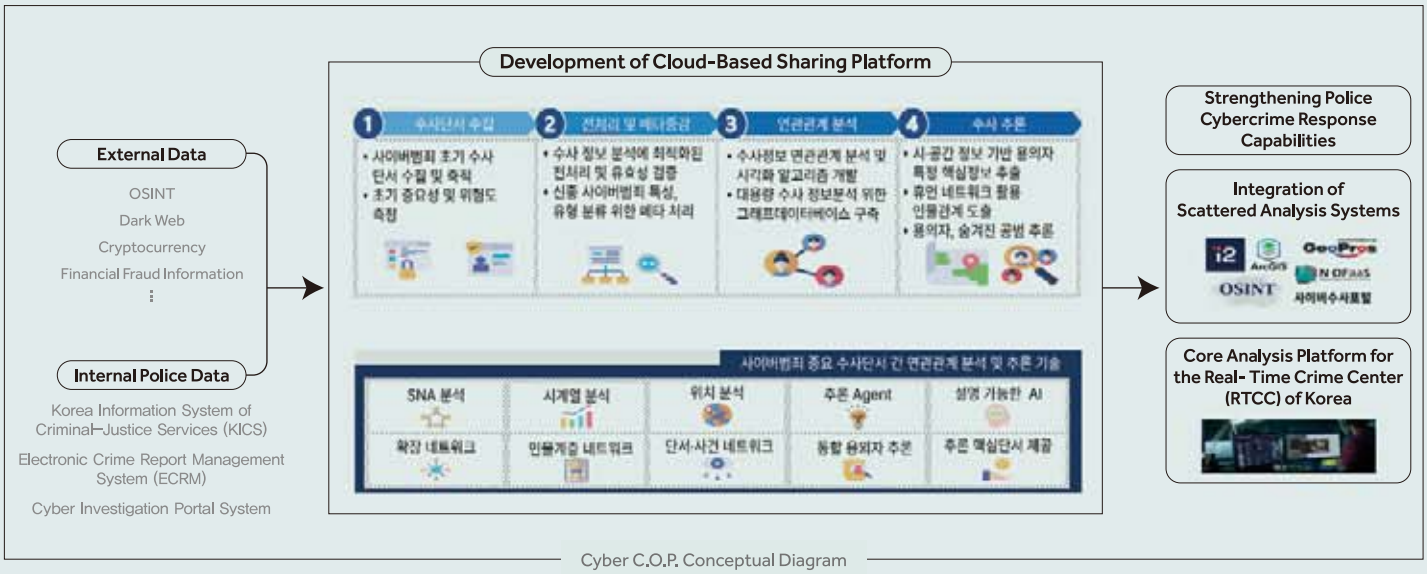
According to the 3rd Comprehensive Plan for Solving Social Problems Based on Science and Technology, cybercrime is one of the five core social problems selected by the public, along with fine dust, microplastics, infectious diseases, and radioactive pollution, and is a social issue that requires a pan-governmental response.

To address cybercrime, which is becoming a serious social problem not only in Korea but worldwide, the project for the development of an integrated analysis and inference system for cybercrime investigation clues was planned. The core goal of this project is to develop an AI-based cybercrime analysis

and inference system that can collect diverse and vast cyber open-source information (OSINT), link it with internal police investigation data to find key investigation clues, and infer suspects. This project is the largest in the 10-year history of the Korean National Police Agency's Public Safety R&D projects, with a total budget of 24 billion KRW over four years.

As the lead research institution, Hallym University will spearhead the establishment of a cybercrime analysis pipeline—ranging from clue collection and preprocessing to analysis and inference—in collaboration with government-funded research institutes such as ETRI and KETI, universities like Yonsei, Korea, and Sungkyunkwan, and companies including CSLEE, Cyram, Skyworld, Stone Integrity, and Whitescan.



Cyber C.O.P. Conceptual Diagram

## Data Collection and Preprocessing/ Meta-Augmentation (Data Collection & Pre-processing)

Investigation clue collection technology is developed to secure extensive data from cyber open-source information. We secured 11,000 Dark Web (Tor) domains, developed crawling technology compatible with new V3 services, and collected over 140,000 fraud-related data points in connection with the fraud prevention service 'The Cheat.' Furthermore, we are developing algorithms to collect structured and unstructured data, such as internal police call logs and bank account records, and to de-identify personal information.

To analyze various investigation clues, it is crucial to standardize structured, unstructured, and semi-structured data into analyzable formats and extract only the key clues essential for investigation. We developed an API to standardize call and transaction record formats that vary by telecommunications provider and bank, and secured technology (F1-Score 84%) to extract key information from unstructured text, such as KakaoTalk conversations, using Large Language Models (LLMs).

Additionally, to reduce the significant time loss caused by manual review of diverse cybercrime data, we developed an automated DataAI Agent at the POC level to perform preprocessing (Parsing, OCR) of digital evidence and data. Furthermore, we developed a deep learning-based image forgery detection model (F1-Score 0.855) to verify the integrity of evidence data and established a Knowledge Graph generation pipeline to classify cybercrime types based on collected text data.

## Correlation Analysis and Investigative Inference (Analysis & Reasoning)

A graph-based correlation analysis algorithm was developed to effectively analyze the relationships between various types of investigation clues. We developed a tool for the integrated management of Relational Databases (RDB) and Graph Databases (GDB), implementing visualization technology to intuitively identify criminal fund flows (e.g., circular transactions, distributed withdrawals) and accomplice structures. In particular, developing a Criminal Network Analysis algorithm that can identify hidden accomplices by analyzing network structures specialized for cybercrime and extract key investigation clues is one of the representative achievements of this R&D from an investigative information profiling perspective.

## Cyber C.O.P.

Along with network analysis, an API for detecting burner phones was developed through an analysis system combining location information and timelines. Additionally, a customized algorithm for financial information analysis was developed to improve financial fraud detection performance by applying a time-aware sliding window technique. A complex reasoning AI Agent specialized for cybercrime was developed using rapidly advancing LLM technology. We established three types of investigation scenarios, including cyber fraud and narcotics, and 19 cold case scenarios. Utilizing these scenarios, we developed a complex reasoning agent to link necessary clues at each stage of the investigation. Using this complex reasoning agent, an HGT (Heterogeneous Graph Transformer)-based person hierarchy inference algorithm was developed to determine the exact status and roles within an organization of members who deny criminal charges.

Furthermore, an sLLM-based module was designed to automatically generate the necessity and grounds for search warrant applications, which investigators find most difficult during cybercrime investigations. Additionally, an automatic core investigation question generation algorithm was developed to recommend and verify investigation techniques or the most suitable tracking methodologies that might be missed during the investigation process.

### Establishment of an Integrated Platform (Integrated Platform)

A system infrastructure environment was designed to enable web-based integrated analysis of the entire process, including investigation clue collection, preprocessing, analysis, and reasoning. We designed a workflow and developed UI/UX to allow investigators to perform the entire process from data registration to modeling, analysis (network, time-series, spatial, etc.), and visualization on the web.

In the first year, we conducted a Proof of Concept (PoC) to verify the platform's core functions in a simulated investigation environment using an 'Internet product fraud scenario.' During this process, we also demonstrated a function to identify additional suspect accounts through connection degree analysis. Scalability was ensured based on Microservices Architecture (MSA), and a data platform based on object storage was designed to enable efficient management and searching of large-scale unstructured data. This completed the system infrastructure design, allowing investigators nationwide to utilize the analysis platform in an optimal environment.

**Protecting the Cyber Safety of Citizens!**

Over four years of R&D, we will advance the Cyber C.O.P. system into a next-generation integrated cyber investigation analysis platform for the National Investigation Headquarters. Furthermore, we plan to expand the system to other investigative agencies such as the prosecution, and export Korea's advanced technology to developing countries via ODA projects like KOICA. We expect that the cybercrime arrest rate in Korea can be increased to over 80% starting from 2029 via the Cyber C.O.P. system. Furthermore, the Cyber C.O.P. system is anticipated to establish itself as a core analysis platform for the Real-Time Crime Center of Korea, capable of responding to crimes in real-time.

# AI Edutech

## Human Resources, Industry, and Regional Development Platform

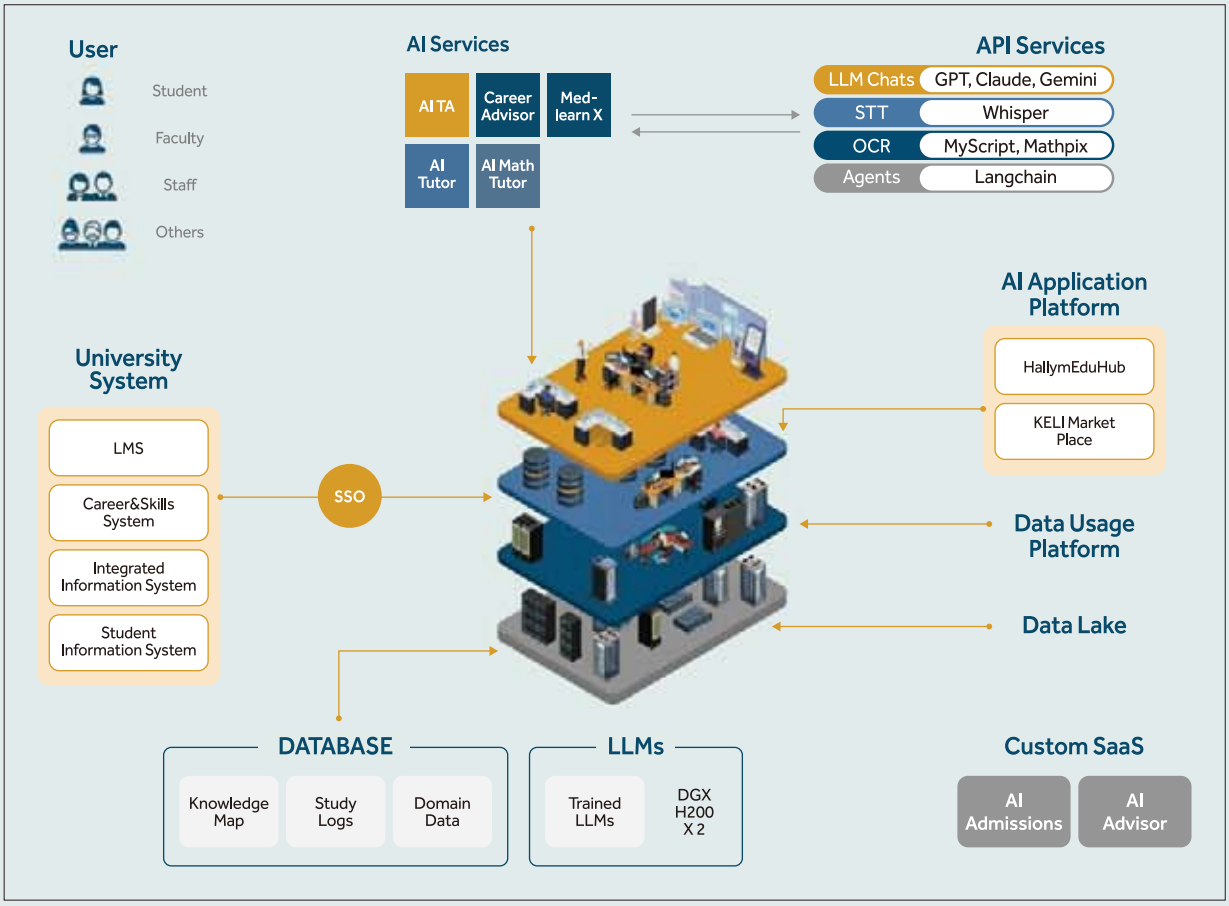
Hallym University Research Institute for Data Science and AI is building an “AI-based Hyper-personalization Learning Ecosystem” to lead the educational paradigm of the AI era. This represents a structural innovation that goes beyond simply introducing digital tools, shifting the essence of education from “Teaching” to “Learning.”

- AI Edutech Innovation and Expansion
- Key AI Educational Services and Platforms
- Expansion of AI-integrated Class Models: Operation of AI-integrated Courses
- Global Expansion
- Building an AI Education Ecosystem
- Future Vision and Strategic Direction

# AI Edutech Innovation and Expansion

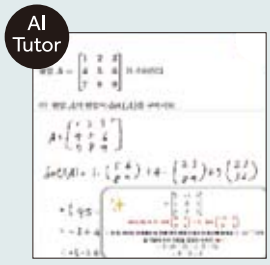
- The Institute is developing an integrated platform providing customized AI services to faculty, students, and staff, utilizing a Large Language Model (LLM) optimized for internal data. We lead intelligent innovation across university life by providing personalized tutoring tailored to student levels, AI assistants that automate repetitive tasks for professors, and AI services that match researchers with optimal collaboration partners.

- These innovations represent key achievements in shifting the university education paradigm toward an AI-centered approach. This initiative transcends simple digital tool adoption, enhancing education's intrinsic value via data-driven decision-making and learning analytics, and leading the global edutech market by establishing the 'K-Higher Education Model (K-University).'



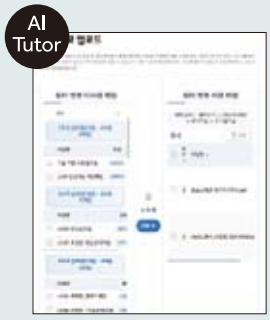
# Key AI Educational Services and Platforms

## AI Math Tutor



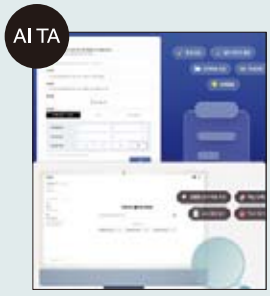

The system utilizes Optical Character Recognition (OCR) technology to digitize learner-written formulas on tablets or paper in real-time and corrects errors by analyzing the solution process step-by-step. We foster critical thinking by applying a 'scaffolding' method that provides hints instead of immediate answers. A Python coding practice environment is also integrated. As of the second semester of 2025, we applied this system to one course in Korea (6 sections, 229 students) and expanded it to overseas universities in Germany and Indonesia.

## Professor-led Autonomous Tutor




Once instructors upload lecture materials (PDF, PPT, etc.), the AI processes them to automatically generate a tutoring bot specialized for that specific course. Students access 24-hour Q&A, and the system supports quiz generation and automated grading. We significantly expanded its application to 12 courses (777 students) in the second semester of 2025.

## AI Teaching Assistant




This agent supports professors with repetitive administrative and educational tasks. It generates weekly syllabi, creates exam questions (multiple-choice, short-answer, descriptive), and performs automated grading. The second-phase advancement project, launched in May 2025, expands functionality to include subjective and essay question grading.

## AI Admissions and Academic Information Assistant

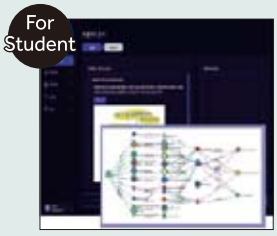
Integrating data from the university website and portal, the assistant provides 24-hour automated responses to inquiries regarding academic information, scholarships, and admissions. It improves administrative efficiency by identifying user intent and guiding them through relevant regulations and procedures.

## AI Researcher Matching Service

The service analyzes researchers' publication and project history data to derive similarities between research topics. When convergence research is required, the system recommends optimal research partners and promotes collaboration via natural language queries (e.g., "Find experts related to AI ethics").

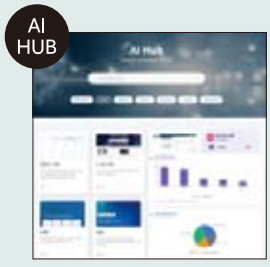

## Career InBody

The system analyzes students' course history and achievement levels to diagnose gaps between current skills and the competencies required for their desired careers. It recommends courses and extracurricular programs to bridge these gaps and provides a C2C (Course to Career) portfolio for employment success, including AI-assisted personal statement drafting.




## AI Hub

This integrated gateway consolidates various AI services required for education both on and off-campus, helping members access desired services quickly and easily. Beyond simple connectivity, we establish a data-driven feedback system that continuously improves education quality by precisely analyzing service usage data.




## Marketplace

The Marketplace serves as an open platform for registering, sharing, and trading education-related technologies, tools, content, and AI models; it acts as a bridgehead for disseminating Hallym University's K-Higher Education model and solutions to other institutions.

# Expansion of AI-integrated Class Models: Operation of AI-integrated Courses

## Operation of Generative AI-Integrated Courses

**Period** 1st and 2nd Semesters, Academic Year 2025

**Description** We operated courses integrating generative AI, selected autonomously by instructors, into lesson designs and learning activities. Instructors enhanced course management efficiency through AI-driven assignment design, feedback provision, and learning material generation, demonstrating generative AI's educational potential across various subjects and majors. A total of 124 courses were offered, with 4,459 students enrolled.

## Operation of Courses Integrated with Hallym AI Education Solutions

**Period** 1st and 2nd Semesters, Academic Year 2025

**Description** We operated courses applying Hallym AI education solutions developed by the AI Edutech Center. Types include the 'AI Teaching Assistant' (supporting problem generation, grading, syllabi creation based on uploaded data), the 'AI Tutor' (providing Q&A, review/preview assistance, group discussion support, and participation monitoring), and the 'AI Math Tutor' (offering handwriting-based problem solving, real-time AI feedback, and Python coding environments). A total of 33 courses were offered, with 1,697 students enrolled.

## Operation of Courses Integrated with Commercial AI Tutors

**Period** 1st and 2nd Semesters, Academic Year 2025

**Description** We operated courses utilizing commercial AI tutors (Classum's AI Dot) featuring automated Q&A based on learning materials. The system supported students' learning flows in real-time through functions like automated Q&A, review/preview support, personalized feedback, and learning participation analysis. Instructors reduced repetitive Q&A burdens, while learners strengthened self-directed learning by receiving immediate answers linked to course materials. A total of 70 courses were offered, with 2,630 students enrolled.

## Dissemination of Research Outcomes on AI-Integrated Teaching Models

- **Seoyeon Jin et al. (2025).** Exploring Learner Difficulties and AI Support Possibilities in University Team Projects: Focusing on the Case of H University. Journal of Educational Information and Media, 31(4), 1703-1727.
- **Hyein Cho et al. (2025).** Recent Trends in Research on Learning Experiences of Engineering Students: A Scoping Review (2021-2025). 2025 Conference on Engineering Education.
- **Seoyeon Jin et al. (2025).** Characteristics of AI Utilization and Changes in Learning Outcomes of University Students Participating in Generative AI-Integrated Classes. 2025 Spring Conference of the Korean Association for Educational Information and Media.
- **Seoyeon Jin et al. (2025).** A Systematic Literature Review on the Design and Utilization of AI Tutors in the Context of Higher Education. 2025 Spring Conference of the Korean Society for Educational Technology.

# Global Expansion: Globalization of the K-University Model

Hallym University's AI education model expands beyond Korea to Europe and Southeast Asia, proving its global technological competitiveness.

## Ostfalia University of Applied Sciences, Germany

**Project Name** Expansion of AI Math Tutor Service to Partner Universities in Germany

**Period** Second Semester of Academic Year 2025

**Description** We introduced the service to improve the basic mathematics proficiency of local students in Germany. We ensured service stability by establishing a German cloud infrastructure tailored to the local environment. This project signifies the verification of global versatility by "reverse-exporting" Korean Edutech technology to Germany, a nation with an advanced education system.

## Jakarta International University, Indonesia

**Project Name** Expansion of AI Math Tutor Service to Partner Universities in Indonesia

**Period** Second Semester of Academic Year 2025

**Description** This expansion model features ODA (Official Development Assistance) characteristics aimed at bridging the educational gap in developing countries. Reflecting local Indonesian curriculum specificities, we developed a "Chapter Editing Function" allowing instructors to reorganize tutor learning units. This establishes a foothold for the K-Higher Education model to expand into the ASEAN region.


# Building an AI Education Ecosystem: KELI (K-University AI Edutech and Learning Initiative)

## Vision and Launch

Hallym University officially launched KELI on October 30, 2025, as an open alliance designed to break down inter-university barriers and share AI educational resources. At the 1st KELI International Symposium, President Yang-Hee Choi declared, "KELI marks the starting point for building an 'AI Campus Alliance' based on 'sharing' and 'cooperation,' moving beyond infinite inter-university competition." This innovative governance overcomes the limitations of AI infrastructure investment and technology development that individual universities face, creating a sustainable AI education ecosystem.

**KELI Membership Status**
**Total of 33 Institutions**

KELI is growing into Korea's largest AI education alliance, where industry, academia, and research institutes collaborate with the participation of public and private universities and leading edutech companies nationwide.

**Participating Universities**
**22 Universities**

Konyang University, Keimyung College University, Daejeon Institute of Science and Technology, Daejeon University, Dongseo University, Dong-eui University, Pai Chai University, Baekseok Culture University, Pusan National University, University of Seoul, Seoul Theological University, Ajou University, Ansan University, Woosong University, Wonkwang University, Uiduk University, Inha University, Jeju National University, Chungnam National University, Pohang University of Science and Technology (POSTECH), Hallym Sacred Heart University, Hoseo University

**Participating Companies**
**11 Companies**

UBION, CLASSUM, Freewheelin, Plang, HM Company, NEARNETWORKS, Difinition, Untactedu, NAITEDU, i-Scream Arts, Chungwoon Information Co., Ltd.


KELI International Symposium and Launch Ceremony


Hallym Edutech Council Launch Ceremony

# Building an AI Education Ecosystem: Hallym Edutech Council

## Vision and Launch

On December 5, 2025, Hallym University launched the Hallym Edutech Council to innovate AI-based education and build an edutech ecosystem linked to the region and industry. The council links the university's education and research capabilities with edutech companies' technological prowess to jointly discover AI-based educational solutions and transform them into practical projects. In particular, we sought to establish industry-academic collaborative AI education governance by developing software and courseware reflecting actual field needs through professor-company matching and by promoting AI edutech development and verification within a cooperative structure.

**Hallym Edutech Council Member Status**
**Total of 19 companies and 15 Faculty Members**

The Hallym Edutech Council promotes the joint discovery of AI edutech and the creation of an industry-academic collaborative edutech ecosystem with the participation of university faculty, provincial IT companies, and nationwide edutech firms.

**Participating Companies**
**19 Companies**

Gareuchim Edu Co., Ltd., NAITEDU Co., Ltd., DQ Co., Ltd., Sopoong & Company Co., Ltd., Super Learning Co., Ltd., Springworks Co., Ltd., SeedsSoft Co., Ltd., IoTED Co., Ltd., OnyulT Co., Ltd., Chungwoon Information Co., Ltd., Day-D, Difinition Co., Ltd., ELLEXI, CLASSUM, Freewheelin, Plang, CAMORIX, HM COMPANY, etc.

**Participating Faculty**
**19 Companies**

15 faculty members from the Department of Psychology, Digital Humanities and Arts Major, School of Software, Department of Business Administration, Department of Convergence Forensic Science, Media School, Ilsong College of Liberal Arts, and Graduate School of Global Cooperation.

## Future Vision

With the vision of **"The university that utilizes AI in the most human-like way,"** the Research Institute for Data Science and AI implements a **'Mastery Learning'** system by 2040, enabling anyone to receive optimal education without constraints of time and space through AI technology. KELI serves as the foundation for our leap into a global AI education hub connected with universities worldwide, marking our evolution from a traditional educational institution to a platform driving the edutech industry.

## Strategy

### Advanced Hyper-personalization

By introducing multi-modal AI that analyzes not only learners' behavioral data but also bio-signals and emotional states, we realize truly personalized education that maximizes learning immersion.

### Expansion of AI+X Convergence

We will significantly expand the lineup of "subject-specific AI courseware" by 2026, extending current mathematics and programming-centered tutors to all academic fields, including medicine (MedLearn-X), humanities, and social sciences.

### Performance Dissemination and Ecosystem Self–reliance

We will build a self-sustaining ecosystem that distributes high-quality AI content and data among member universities and generates revenue by activating the KELI Marketplace. Furthermore, cooperation with international standards organizations such as 1Edutech establishes the "K-University" model as a global standard.

# AI+X Convergence Research

Hallym University Research Institute for Data Science and AI aims to be “the university that utilizes AI in the most human-like way,” building a convergence research ecosystem that breaks down boundaries between disciplines and creates new knowledge by integrating AI into various academic fields.


Development of AI-based technologies for defense, security, disaster prediction, cybercrime, and social safety response
Development of precision medicine, medical image analysis, and AI-based diagnosis/prediction systems in collaboration with Hallym University Medical Center
Development of AI-based smart factory solutions, including semiconductor design optimization and manufacturing process automation
Development of AI-based language/cultural data analysis and social phenomenon prediction models
Solving social issues such as defense, disasters, and social safety
Strengthening Medical and Bio Convergence
Industrial Convergence and Innovation in Semiconductors and Smart Manufacturing
Humanities and Social Sciences Convergence Research

# Convergence Research on AI Copyright Protection to Address AI Neural Rendering Technology

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Neural Rendering, an AI-based 3D technology capable of freely recreating objects from any desired angle using just a few images, is proliferating rapidly. This is the very technology used to rotate products in Google Shopping or view avatars freely in the metaverse. Thanks to this, original 3D models

can be recreated as nearly identical 3D content by AI with just a few public photos, even without direct file exchange. This study represents the first attempt to directly address this issue by combining advanced artificial intelligence technology (AI) with content copyright security (X). We proposed a watermarking framework that covers the entire process—from a 3D model becoming a photo, to an AI 3D representation trained on those photos, and finally to the creation of photos from new angles—within a single integrated system. No matter how the AI generates or transforms data, the hidden security marks survive to the end, enabling copyright verification.

## An era of replication from just a few photos: 3D copyright protection technology that follows to the end

### Research that blocks even newly emerged leakage paths

New paths for copyright infringement have emerged due to Neural Rendering technology, which can infinitely generate images from any desired angle using just a few photos. The paper categorizes these into nine representative scenarios, and this study covers all of them within a single framework for the first time.

Most existing technologies were limited to protecting either only 3D model files or only 2D images. However, we now face an era where nearly identical 3D content can be reproduced with just a few public photos, even without original files. Reflecting this reality, this study presents a practical watermarking method that withstands the entire process of modality changes. This research impacts nearly all industries producing and distributing photo-based 3D content, such as the metaverse, AR shopping, game characters, and movie VFX.

### A technical structure that detects leaks to the end, regardless of the method

This technology covers four modalities: the 3D model file itself, general photos rendered from that model, AI-based 3D representations (Neural Radiance Fields) trained on those photos, and new-angle photos generated by that AI. Since each modality possesses completely different data structures and noise characteristics, we designed and trained separate decoders optimized for each stage in an end-to-end manner. In practice, whether someone leaks the original 3D file, spreads only photos, trains and distributes a new AI using those photos, or even generates thousands of new views with that AI, the system detects the same watermark message.

# AI Replicating Human Reasoning: Verifying ALEX's Hypothesis Reasoning and Cognitive Scalability

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Previously, artificial intelligence remained limited to searching or summarizing legal data. This study transcends those limits, replicating human legal reasoning where AI independently formulates hypotheses, provides counterarguments, and narrows down logic. ALEX (Argumentation system for Legal Explanation), developed by the research team, integrates the reasoning capabilities of Large Language Models (LLMs) with legal argumentation structures to sequentially generate and eliminate claims and counter-arguments in criminal cases, deriving an optimal network of arguments. ALEX acts as a practical system that automates courtroom argumentation, transcending the role of a simple sentence generator.

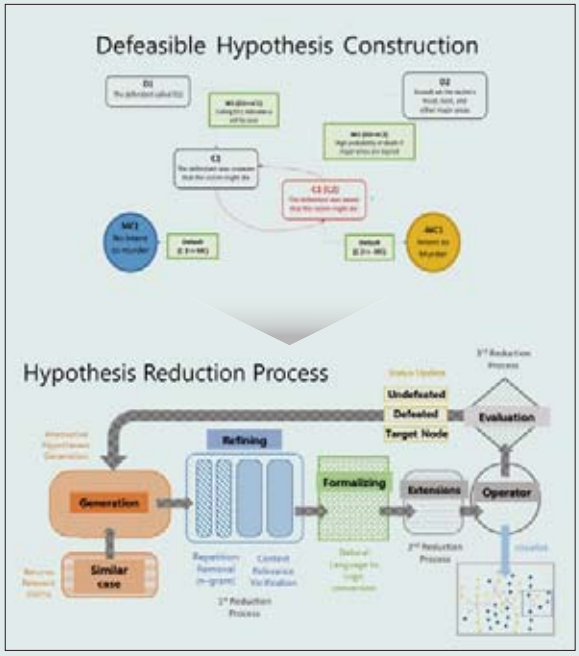
## Hypothesis-Based Argumentation Generation AI System for Criminal Case Analysis

### Argumentation System Replicating the Reasoning of Human Investigators and Lawyers

ALEX combines GPT-4 series LLMs with the Toulmin Argumentation Model to automatically extract case claims and counter-arguments and generate new grounds for reasoning. The system treats each claim unit as a hypothesis and performs logical elimination by iteratively generating and refuting these hypotheses. Furthermore, it utilizes a Retrieval-Augmented Generation (RAG) structure to incorporate logic from similar precedents, reinforcing evidence and progressively completing a case-specific logical network. ALEX transcends the mere restatement of given facts to implement a reasoning process that explores legal possibilities and verifies their validity. Evaluations indicate that ALEX generated arguments more consistent with expert judgment than existing reasoning models, and demonstrated improved quality in logical structure and semantic validity.

### The Emergence of 'Persuadable AI' that Identifies Logic Missed by Humans

ALEX's true potential lies in its cognitive scalability. When 11 investigation experts and reviewers examined arguments generated by ALEX, half aligned with actual field judgments, while the remainder were evaluated as new hypotheses that humans had not previously considered. ALEX generates multiple hypotheses within a case context and identifies optimal logic through iterative review and elimination. This process complements perspectives that humans might overlook and reconfirms the validity of existing judgments. This study demonstrates that AI functions as a collaborator in argumentative thinking and an explainable reasoning agent in investigation and law, moving beyond a simple information processing tool. ALEX presents a new paradigm balancing cognitive scalability and legal verification for future applications in trial support, investigation analysis, and legal education.



# Multi-sensory Research in XR Environments

**Participants**

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Multi-sensory research in XR environments transcends traditional vision-centric XR experiences by integrating various sensory information—such as smell, sound, and touch—to understand and enhance users' cognitive, emotional, and behavioral responses. This study experimentally analyzes how sensory cues in virtual spaces influence spatial perception, movement/navigation, memory, emotional judgment, and interaction decisions, aiming to derive natural and reliable user-centered XR interaction design principles. In particular, we verify the effects of multi-sensory XR and explore its practical utility in fields where human-centricity is vital, such as healthcare, education, and therapy.

### Beyond the Portal: Enhancing Recognition in Virtual Reality Through Multisensory Cues

This paper experimentally analyzes the contribution of multi-sensory auxiliary signals, such as scent and sound, to scene recognition to overcome cognitive limitations occurring when VR environments rely excessively on visual information. We demonstrate that providing additional olfactory cues in situations where visual information is limited through virtual portals significantly improves users' scene identification accuracy. We scientifically prove that multi-sensory elements, including scent, play a key role in substantially enhancing users' cognitive performance in VR environments, beyond simply increasing immersion.

### What if Virtual Agents Had Scents? User's Judgments of Virtual Agent Personality and Appeals in Encounters

This paper analyzes the impact of olfactory cues emitted by virtual agents on social impression formation when users interact with them in a virtual reality (VR) environment. In addition to scent, complex non-verbal cues such as emotional expression and gender were presented to measure how users judge the agent's personality traits (Big 5 Personality) and appeal. The results show that scent interacts with other non-verbal cues, such as emotional expression, to influence users' social impression judgments, proving that scent is a key element determining the quality of social interaction in VR environments. We suggest that scent serves as a powerful multi-sensory social cue deeply involved in social cognitive processes within virtual environments and that olfactory elements should be strategically utilized in agent design.


Figure 1: Experimental environment in the multisensory portal study. (A) The city street scene contained contextual elements such as cars, a flower, and a dog. (B) Through the portal, participants viewed only a restricted subset of the scene. (C) In multisensory conditions, additional cues could be introduced (e.g., auditory barking from the dog or a floral fragrance from the flower) to support scene identification under limited visual information.

# SSPNet : Spatio-Spectral Potraits-Based Deep Learning Framework for Neurodegenerative Disease

**Participants**

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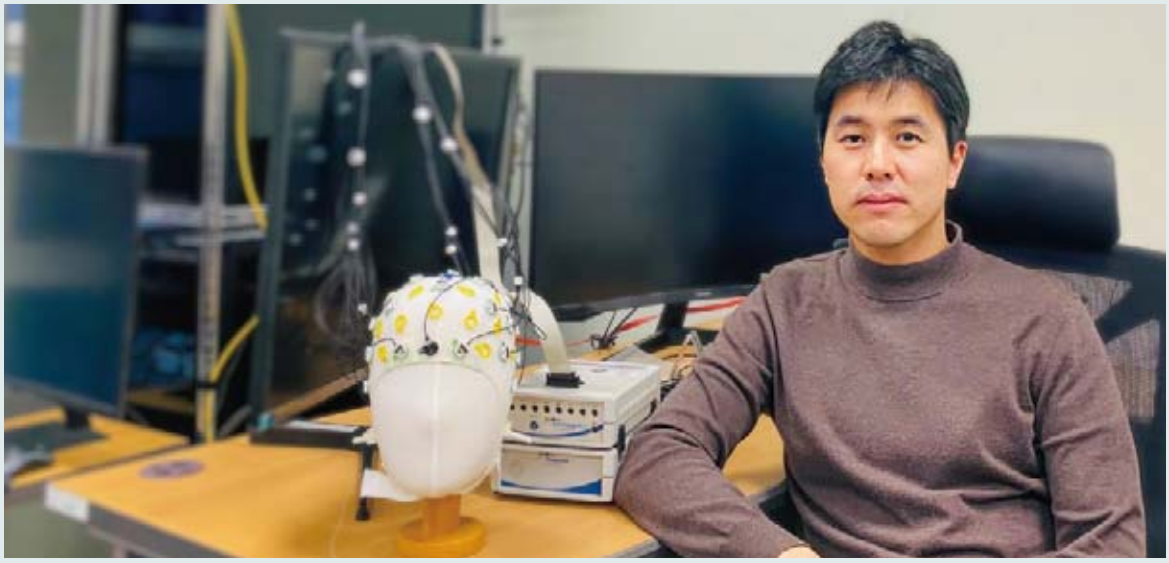

We proposed a deep learning framework based on the spatial-frequency features of EEG for the multi-class classification of neurodegenerative diseases, improving multi-classification for dementia subtypes and addressing false negative issues associated with existing subtypes. This accelerates early identification and therapeutic intervention by supplementing existing screening tests in actual clinical environments.

## Development of a Spatial-Frequency Feature-Based Deep Learning Framework for Multi-Classification of Neurodegenerative Diseases

### Problems and Alternatives for Current Early Screening Systems for Neurodegenerative Diseases

Early diagnosis of neurodegenerative diseases is critical for effective therapeutic intervention, but existing screening tests frequently result in false negatives. In particular, patients with frontotemporal dementia often show normal screening scores in early stages. Although EEG contains neurophysiological information, multi-class classification to distinguish between Alzheimer's disease, frontotemporal dementia, and healthy individuals remains a challenge due to subtle differences between conditions.

### Core Technology of the Proposed Methodology (SSPNet)

This study proposes SSPNet, a new deep learning framework utilizing spatial-spectral portraits extracted from EEG signals. Guided by neurophysiological evidence, we selectively utilize only two frequency bands—alpha (8-12 Hz) and delta (0.5-4 Hz)—and convert power values from 19 electrodes into EEG spatial frequency feature images. Features are extracted through asymmetric convolution blocks and multi-attention techniques specialized for alpha- and delta-based images, respectively. A cross-attention mechanism integrates complementary information from the two frequency bands, and multi-head attention fuses final features for learning.

# Development and Validation of an Interpretable Triage Model for Predicting Mortality Risk in the Field Using Trauma Patient Data from Asian Countries

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Field triage constitutes the critical first decision for trauma patient survival before hospital arrival. Existing triage scores suffer from low patient suitability and complexity, reducing their effective field application.

We developed GIFT (Grade for Interpretable Field Triage), an interpretable AI-based triage prediction model, using large-scale patient data from Asian countries. The design enables medical personnel to immediately calculate mortality risk using only the patient's vital signs and injury sites. This novel intelligent triage system supports decision-making directly in the field.

## Development of GIFT: An Interpretable Machine Learning-Based Trauma Triage System for the Asian Region

### Construction of an interpretable mortality prediction model mirroring the judgment of field medical personnel

Existing ML-based models excel in prediction but suffer from the "black box" problem, failing to explain the reasons behind results. GIFT secures both high predictive power and interpretability by applying an explainable AI framework. The model quickly calculates in-ER mortality risk using only seven key predictors, including heart rate, blood pressure, oxygen saturation, GCS, and chest injury. Notably, it demonstrated an internal validation AUROC of 0.938 (95% CI 0.907–0.969), significantly outperforming existing scores like RTS and MGAP.

### Robust external validity verified across four Asian countries

External performance evaluation using data from Malaysia, Taiwan, and Vietnam based on the Korean model confirmed that sensitivity—crucial for triage—remained very high at 0.79–0.92 across all countries. The structure summarizes overall injury characteristics by reflecting the injury mechanism, vital signs, and field procedures. This represents the first multi-country interpretable scoring system reflecting East and Southeast Asian patient characteristics, overcoming the limitations of MGAP and RTS. We developed an R Shiny-based GIFT web application to enable immediate utilization in the field.

### Potential as a "Clinical Decision-Making Partner" beyond simple prediction

GIFT provides more than survival predictions; it interprets variable contributions and scores, allowing expansion into ER decision support and national standard triage development. Its modular structure offers a distinct advantage, allowing weight adjustments based on the latest data and modifications to suit specific national characteristics. This demonstrates that AI-based triage can evolve to assist and expand clinical reasoning rather than functioning as simple automation.

# Patch-type ECG–IPG Signal-based Home Sleep Stage Classification AI and Sleep and Respiratory Digital Biomarkers

**Participants**

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Sleep quality directly affects cerebrovascular disease recurrence and cognitive decline, yet standard polysomnography (PSG) limits repeated measurement due to cost, time, and patient discomfort. The RLRC aims to develop digital health-based sleep monitoring technology that allows stroke and cardiovascular patients to continuously measure ECG, respiration, and activity at home. We developed an ultra-lightweight wearable combining patch-type single-lead ECG, impedance pneumography (IPG), and motion/skin temperature sensors, achieving clinical-grade sleep stage classification matching hospital PSG, and proposed the "Home Sleep & Biosignal Monitoring Module," a core component of the RLRC full-cycle cerebrovascular disease management platform.

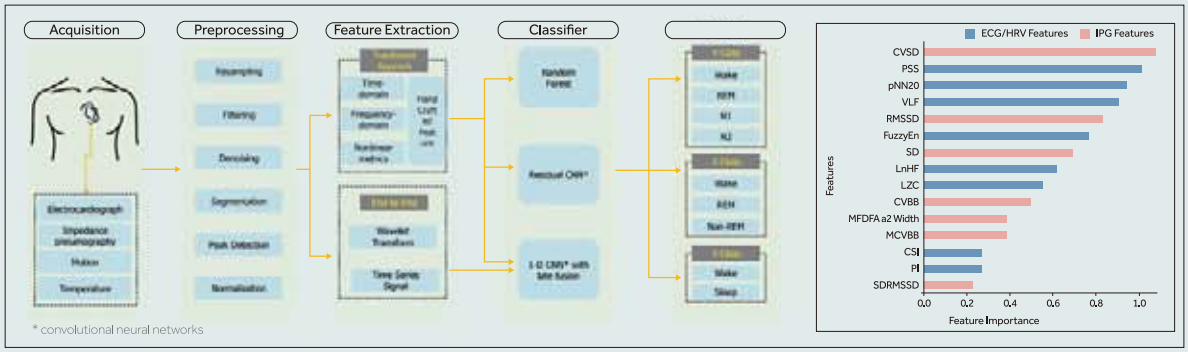
## Patch-type ECG–IPG-based Sleep Stage Classification AI

### Portable Sensor-based Multi-biosignal Sleep Classification Model

This study simultaneously collected data using a patch-type ECG–IPG wearable and PSG from 92 patients with sleep disorders. We constructed a multi-class classification model combining 130 features (including HRV, respiration, and non-linear indices) with a 1D-CNN -based end-to-end signal representation, utilizing a 5-minute window and a 30-second sliding step. In the 2-class (wake/sleep) classification, the combined model achieved an accuracy of 83.6% and an AUROC of 86.0%, outperforming existing single-signal models. Furthermore, the Residual CNN demonstrated stable performance in 3-class (wake/REM/NREM) and 4-class (wake/REM/N1/N2) settings, proving precision comparable to hospital-grade sleep tests.

### Integrated Sleep and Respiratory Digital Biomarkers for the RLRC Digital Health Platform

Modality analysis revealed that the combination of IPG (respiration), ECG-RRI, and motion showed optimal performance, confirming respiratory patterns and autonomic variability as key digital biomarkers linking sleep stages to cerebrovascular prognosis. Furthermore, mRMR-based feature selection maintained 99% of overall performance with only the top 15 features while reducing training time by 73%, presenting a lightweight AI model applicable to large- scale RLRC cohorts and remote monitoring. This research establishes the core infrastructure for the RLRC digital health platform, enabling simultaneous capture of nocturnal apnea, atrial fibrillation, and sleep disorders in high-risk stroke groups through patch-type wearables and precise cardiopulmonary algorithms.



# PPGAIHI: PPG-based Lightweight Biometric Authentication and Dynamic Threshold Optimization for Healthcare IoT

**Participants**

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Secure authentication technology distinguishing the "sender" of biosignals from wearables and home devices becomes essential infrastructure as remote monitoring and virtual ward operations for cerebrovascular patients expand. The RLRC has developed lightweight biometric authentication algorithms to guarantee patient data security and privacy while building a digital health platform utilizing PPG/ECG-based digital biomarkers. The PPGAIHI project serves as a "secure digital twin gateway" for the RLRC platform by performing high-precision user authentication using only everyday PPG signals and providing practical model structures and threshold guides for hospital, home, and mobile devices.

## Lightweight PPG Biometric Authentication ramework for Healthcare IoT

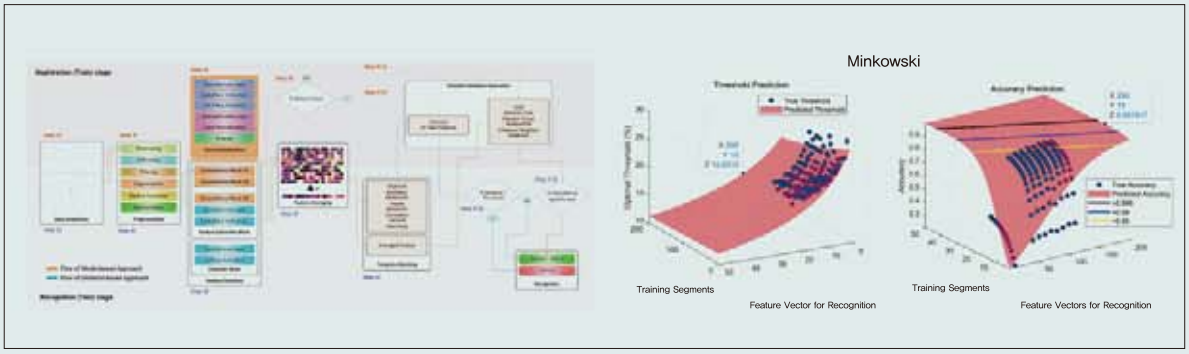
### High-Precision Authentication System Combining 1D-CNN and Distance-based Thresholds

PPGAIHI extracts 1×100 feature vectors from PPG waveforms using 1D-CNN and proposes an ideal structure by simultaneously evaluating model-based authentication (SVM, Shallow FCN) and distance-based authentication (Minkowski, Euclidean). Experiments across three PPG databases showed that model-based methods reached near-perfect accuracy with sufficient segments, while the distance-based Minkowski model achieved 0.9779 accuracy with a 160-second registration/24-second authentication setup, enabling high-performance, low-cost operation. This ensures reliable patient identification under various device and network conditions within the RLRC's remote cardiovascular monitoring and virtual ward environments.

### Achieving Digital Health Security and Convenience Simultaneously through Dynamic Threshold Prediction

Fixed thresholds fail to balance security and re-authentication convenience in the actual RLRC platform, where patient status, activity levels, and sensor quality fluctuate constantly.

This study proposed a regression model predicting authentication accuracy and optimal thresholds based on segment count, presenting a "dynamic threshold" strategy that automatically adjusts to data volume. This allows FAR/FRR control across hospital servers, home hubs, and on-device wearables, establishing the security foundation for the RLRC digital health and digital twin architecture that safely integrates long-term monitoring data.



# Soft Magnetite–PEDOT: PSS Composite Microactuator Fabrication via Meniscus-Assisted 3D Printing

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We developed a flexible micro-actuator driven by a magnetic field. The device ensures structural flexibility using PEDOT:PSS and enables precise control with magnetic nanoparticles, realizing stable and reversible movement through high-resolution manufacturing. We expect applications in soft robotics, bioelectronics, and MEMS.

## Implementation of Precision Manufacturing Technology for Meniscus-based Composite Structure Micro-actuators

**This study successfully fabricated a soft micro-actuator composed of a composite of magnetic nanoparticles (magnetite) and the flexible conductive polymer PEDOT:**

PSS. We employed a micro-meniscus-based 3D printing technique to form micron-scale pillar structures at precise locations and heights. Specifically, we first formed a PEDOT: PSS pillar (~300 μm high) and then deposited magnetic nanoparticle ink (~200 μm high) on top, realizing a composite micropillar with a heterogeneous structure. SEM and EDS analysis confirmed the clear distinction between the PEDOT:PSS bottom layer and the magnetic layer, with a firmly bonded interface. This design overcomes the brittleness of magnetic nanoparticles, enabling a composite microstructure that secures both flexibility and structural stability.

### Verification of Magnetic Field-Based Flexible Actuation Characteristics and Application Potential

The fabricated composite micropillar exhibited stable, reproducible flexible movement under external magnetic fields and demonstrated significant durability during repeated actuation. In experiments, we placed a small solenoid 500 μm from the microactuator and controlled the magnetic field by varying the voltage from 0 to 24 V. Consequently, the pillar angle changed linearly with magnetic field strength (e.g., 0.45°/V), achieving an angular transition exceeding 10°. Furthermore, the return error remained around 1° even after 500 ON-OFF cycles, and the operating angle showed little change, proving stability for long-term actuation. Additionally, demonstrations with Quantum Dots (QDs) coated on the pillar tip showed potential as a light source with spatially precise movement control. These results strongly suggest wide applicability in soft robot manipulation, bio-implantable devices, micro-optical elements, and MEMS-based micro-manipulation systems.

# Healthcare and Social Safety AI Solutions

The Hallym University Research Institute for Data Science and AI established the Hallym Institute of Intelligent Social Safety Research (HI-SSR) to develop social safety AI solutions responding to rapidly changing risks, new crimes, disasters, national defense, and cyber threats.


Development of real-time risk prediction and response platforms combining IoT/sensor data and AI
Promotion of international joint research and technical standardization through a global hub
Cultivation of professional talent through field-oriented practical training and AI-based educational platforms
Development of AI-based social safety solutions
Strengthening of convergence research networks
Virtuous cycle of education and research based on the CORE strategy

# Development of AI Content Tracking and Verification Solutions for Social Safety and Trust

## - From autonomous driving forensics to generative AI content tracking technology

**Participants**

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Verifying data authenticity and responsibility emerges as a key social safety topic as AI-generated data and content directly impact daily safety. Professor Jong-Uk Hou's team develops preemptive AI safety solutions, selected for the National Research Foundation Basic Research Laboratory (BRL) program in 2022 and 2025 to prevent AI adverse effects and build trust.

This solution develops in two main directions. The first is 'Autonomous Driving Safety AI Forensics,' which determines liability between driver and system in accidents. The second is 'Trustworthy Generative AI Watermarking,' which embeds sources into content to prevent deepfakes or copyright infringement. By consecutively winning national collective research projects—a rare feat in computer engineering—the team gains recognition for simultaneously securing AI ethical transparency and social safety.

### Two Pillars of AI Solutions for Social Safety

We have entered an era where AI-generated data directly links to our safety. However, rapid AI development paradoxically breeds serious social distrust regarding "who created this data" and "who is responsible for accidents." In particular, autonomous vehicle accidents or sophisticated deepfake videos pose significant threats causing casualties and social chaos beyond simple technical errors. Professor Jong-Uk Hou's team develops two core AI solutions to clarify data sources and responsibility through the National Research Foundation Basic Research Laboratory (BRL) project, aiming to eliminate anxiety and build a social safety net.

### The First Solution for Social Safety

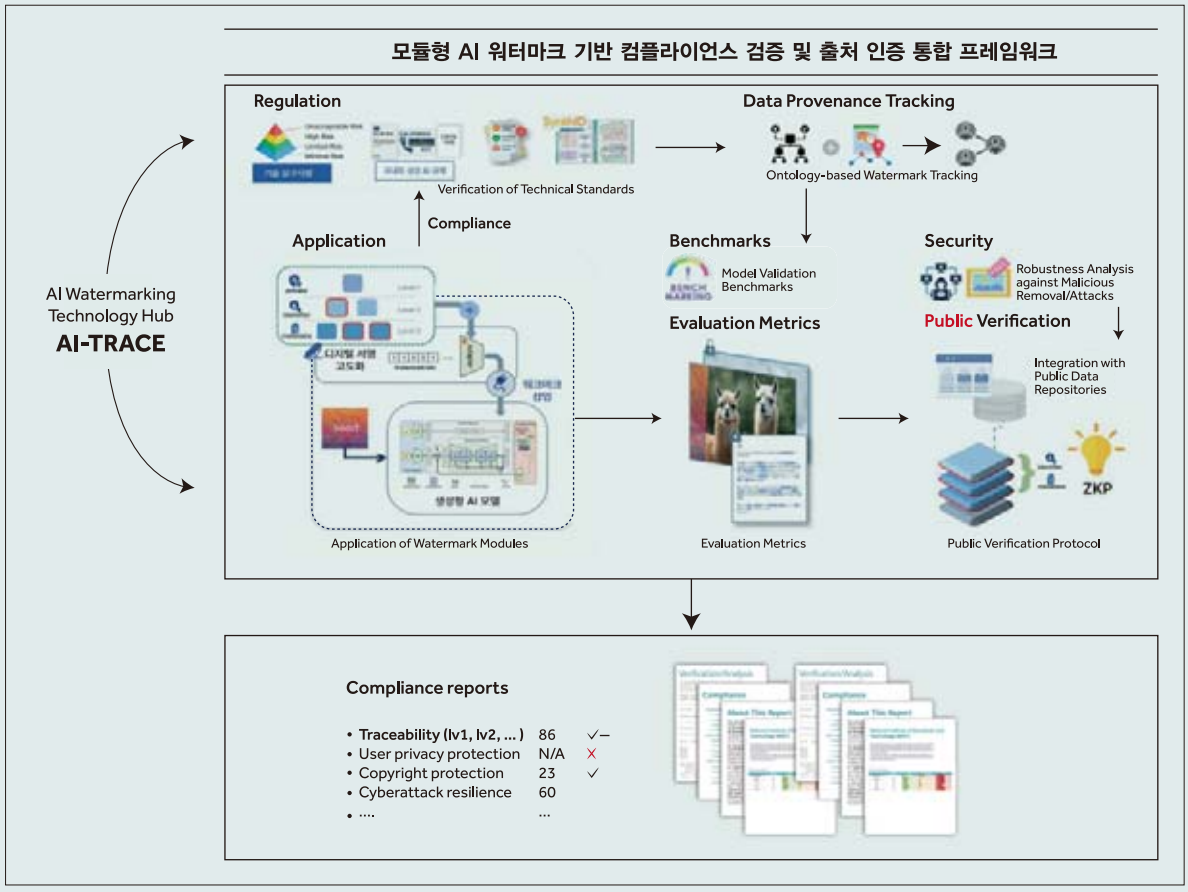
Autonomous Driving AI Forensics Technology (2022–2025): Determining responsibility between the driver and the autonomous system during accidents is crucial for social safety and legal justice. Our team is developing an AI forensic solution that analyzes black box footage, internal sensor data, and V2X communication data exchanged with road infrastructure.

The core technology goes beyond recording; AI profiles driver gaze, hand position, and system signals to precisely recreate accident scenarios in virtual space at 0.1-second intervals. This allows investigative agencies or courts to clearly determine responsibility based on objective, scientific data rather than subjective judgment. This serves as an essential social trust mechanism for the safe integration of autonomous driving technology.

## The Second Solution for Social Safety

Generative AI Reliability and Compliance Technology (2025–2028): Fake news or deepfakes created by generative AI risk undermining democracy and aiding crime. Professor Jong-Uk Hou's team develops modular watermarking technology that prevents the removal of "tags" from such generated content, thereby aiming to secure social trust. Our technology embeds a unique identification mark directly into the AI model's content generation process, unlike conventional watermarks easily removed by cropping or modification. This allows immediate tracing of original sources and generation paths via dedicated verification tools, even if AI-created images or texts are modified or distributed online. This solution perfectly supports strengthening global AI regulatory guidelines (compliance), such as the recent EU AI Act. The ultimate goal is to prevent deepfake damage, protect creator rights, and build a society that trusts information authenticity.

Professor Jong-Uk Hou's team collaborates closely with global researchers at the University of Maryland and Utrecht University to accelerate the "AI-TRACE" global data tracking framework. The integrated digital forensic platform currently under development paves the way for verifying AI-generated data transparency in courts, investigative agencies, and major content platforms. Creating a future where the safety and reliability of AI are guaranteed—a society that maximizes technological benefits while minimizing potential risks—is the research objective of the AI solutions pursued by Professor Jong-Uk Hou's team.



# AI-Based Criminal Investigation Support

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The transition to a responsible investigation system and digitalized data requires investigators to rapidly analyze vast documents and derive results with logical structures verifiable in court. These changes reveal the limitations of experience-based methods, increasing the need for intelligent support technologies that bolster investigative objectivity and consistency.

Professor Ro-Seop Park's research team at Hallym University developed an AI-based integrated criminal investigation support system that analyzes and visualizes data based on criminal elements and argumentation, supporting report writing and verification. This technology received an "Excellent" rating from the National Police Agency and was selected as the top achievement in "Social Problem Solving R&D" among the 2025 National R&D Excellence Awards. Notably, it received the Minister of Science and ICT Award, given only to the top six projects across all ministries, recognizing its innovation and contribution to the field.

## A New Investigation Paradigm Opened by AI: From Analysis to Verification and Reporting

### Automated Extraction Technology for Key Information Based on Criminal Elements

The most significant achievement is the technology that automatically extracts and structures key information corresponding to criminal elements, going beyond simple classification or search. The system analyzes documents like complaints and interrogation protocols to automatically identify essential elements for criminal liability, including perpetrator, act details, time, location, intent, and deception. This information is standardized into schemas by crime type, allowing investigators to quickly grasp the legal framework without manual review of extensive documents.

This significantly improved initial case comprehension speed and structurally mitigated analysis quality deviations caused by investigator experience differences.

### Automated Case Flow Reconstruction and Visualization of Timelines and Keyword Maps

Effective investigation requires a comprehensive understanding of temporal and causal development, not just a listing of facts. The system combines extracted temporal and behavioral information to automatically reconstruct the case flow, visualizing it as timelines and keyword maps. It aligns statement timing, action occurrence, and evidence collection into a single flow, visually highlighting inconsistencies or temporal gaps.

Keyword maps structurally represent relationships between core issues and concepts, enabling intuitive context understanding for complex cases. These visualization features reduce the analytical burden on investigators while enhancing the explanatory power and persuasiveness of results.

### Argumentative Structure Visualization and Logical Consistency Review Technology

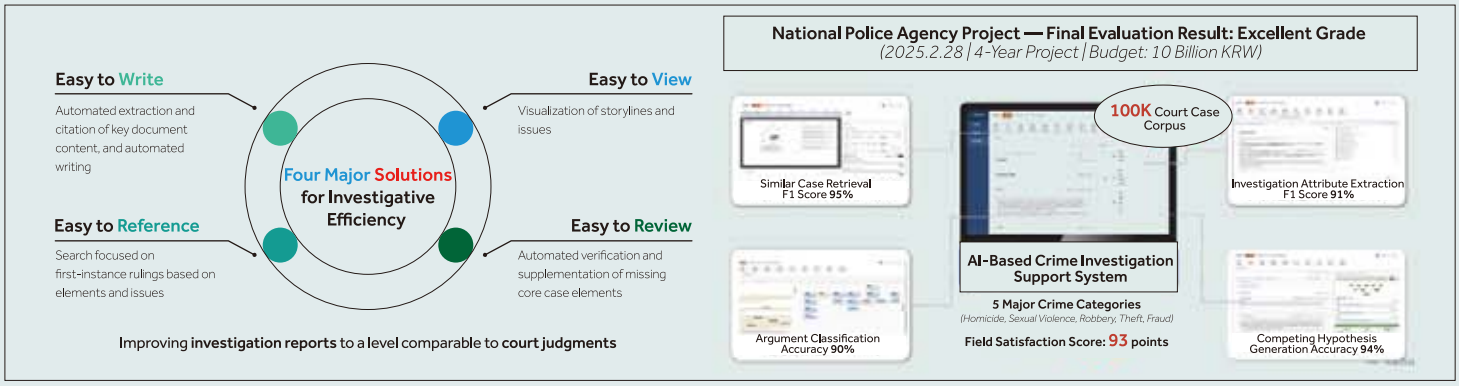
A distinguishing achievement is the implementation of technology that verifies investigative results at the level of argumentative structure. The system analyzes reports and rulings to automatically classify argumentative components—claims, evidence, reasoning, corroboration—and represents their relationships as visual graphs. This allows investigators to visualize how conclusions derive from evidence and reasoning, enabling preemptive checks for weak logical connections or missing evidence. In particular, AI automatically detects potential logical issues and suggests areas for supplementation, technically supporting the self-verification required by the responsible investigation system. Consequently, structural verification at the system level secures objectivity and consistency in investigative judgments.

### Promoting the Practical Application of Automated Investigative Report Generation Technology

We are actively pursuing the field deployment of automated draft investigative report generation technology through a commercialization project. This project, part of the COMPA "Pilot Project to Promote Practical Application," aims to transform verified core technologies into systems usable in actual investigations.

The system applies latest RAG techniques to contextually search documents and generate evidence-based responses, automatically proposing report drafts for criminal facts and reviews, and is currently under design. The system maintains the "Human-in-the-Loop" principle by enabling immediate source verification through highlight-based evidence checking linked to original documents.

This commercialization project aims to integrate these automated writing and verification functions into actual investigative workflows. Furthermore, by promoting their adoption within public procurement and police organizations through innovative product registration, it seeks to establish the research outcomes as sustainable public safety technologies.



# Multimodal Fall Detection Framework Based on Bed Load Cell and Wrist Accelerometer Fusion

Participants

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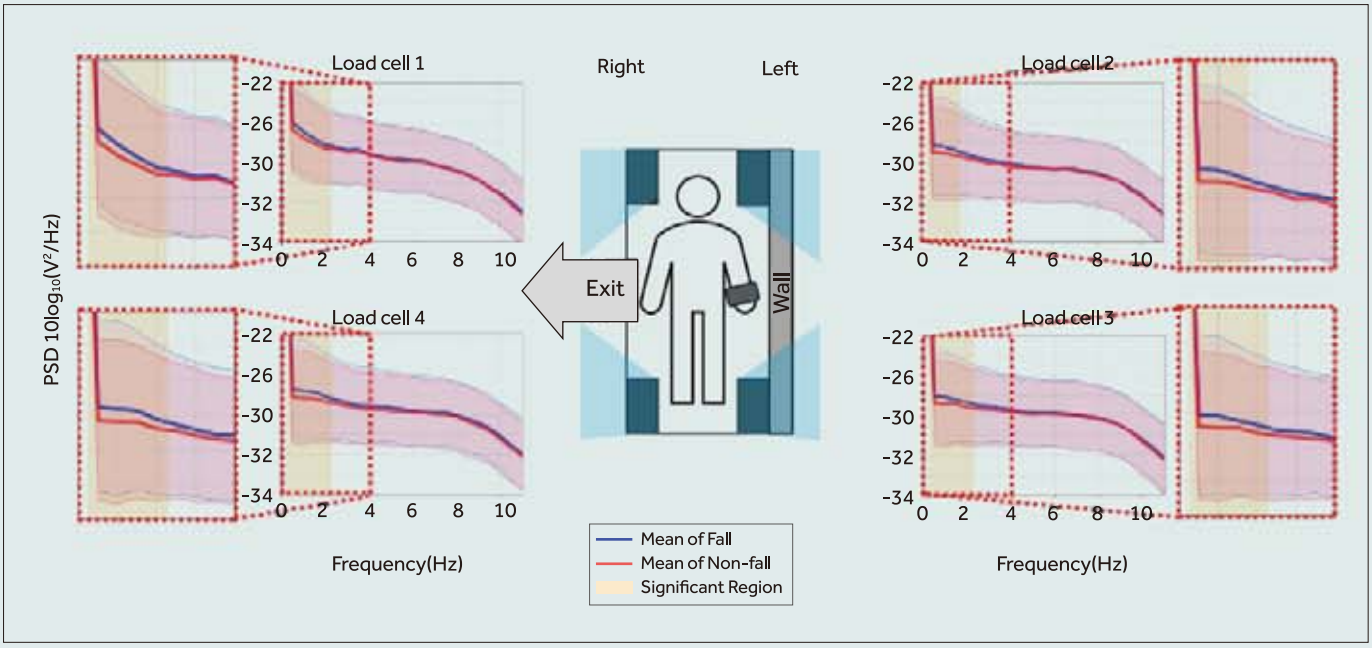
Falls are a major cause of injury and death among the elderly, occurring particularly frequently around the bed (during bed exit/movement) in these settings. Existing wearable-based detection is limited by compliance and charging issues, while vision-based detection faces privacy and processing challenges. We propose a hybrid fall detection system combining non-contact load cells on bed legs and wrist-worn 3-axis accelerometers. By fusing weight distribution changes (low frequency) from load cells and sudden movements (high frequency) from accelerometers, we precisely detect falls and offer a practical solution for medical and care settings.

## Advanced Bed Fall Detection Technology Fusing Load Cells and Accelerometers

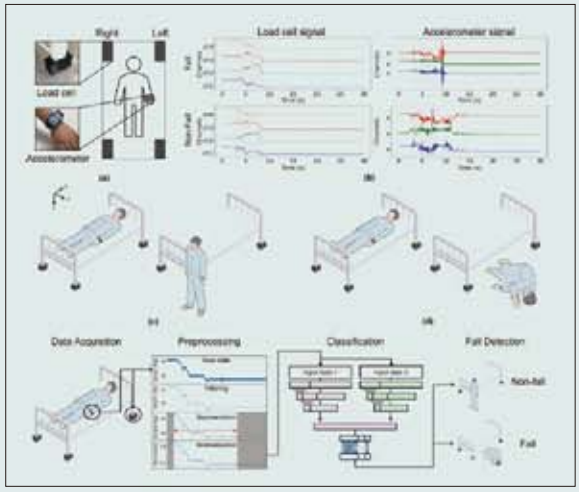
### Characterization of Non-contact Fall Signals Through Low-frequency Band Analysis

We designed the study with 40 adults performing repeated fall and non-fall (normal bed exit) scenarios across six postures (e.g., supine, lateral, semi-lateral) to replicate actual transitions around the bed. Load cells under the four bed legs measured weight distribution changes at 100 Hz, while a wrist accelerometer recorded movements at 1000 Hz. We synchronized data via hardware triggers and segmented it into 30-second windows for cross-validation.

Signal analysis identified the 0–2 Hz ultra-low frequency band in load cell signals as a key feature




distinguishing falls from non-falls. Weight redistribution patterns varied by bed edge during falls, with significant spectral differences repeatedly observed in the 0–2 Hz range. This proves that load cells sensitively capture subtle load distribution changes due to center of gravity shifts and posture, rather than just "large impacts," offering meaningful biomarkers without vision systems.



### Maximizing Detection Performance Through Hybrid Sensor Fusion

We validated the fall classifier by comparing three configurations: load cell only, accelerometer only, and a multimodal (late fusion) 1-D CNN combining both. Load cells optimized performance in low-frequency (0–10 Hz) components, while accelerometers showed stability across a wider band (0–50 Hz). The standalone model accuracies were 74.44% (load cell) and 95.05% (accelerometer); the multimodal model achieved the highest performance with 96.26% accuracy, 95.21% precision, and 97.27% sensitivity, significantly reducing misclassifications compared to the single-sensor models.

From an analytical perspective, confirming the complementary information of the load cell (low-frequency weight shifts) and the accelerometer (sudden movements), we propose an operational strategy: maintaining a load cell-based safety net at night (addressing patient compliance and charging issues) and combining wearables when necessary to boost accuracy. Considering the high fall risk around beds, this framework offers a practical alternative for establishing real-time alerts in hospitals and nursing facilities while ensuring privacy. Furthermore, moving beyond trigger-based experimental designs, future goals aim for actual field deployment by expanding to sliding window-based asynchronous detection, on-device lightweighting (compression and quantization), and integration with hospital IoT/information systems (automatic notifications).

# Global AI Network

We have led education and research innovation by executing national projects such as University Innovation Support, LINC 3.0, SW-Centered University, Medical AI Talent Cultivation, and Semiconductor Specialist Training. We are expanding the global network for AI+X convergence research through collaboration with overseas universities (Portsmouth, Utrecht), global companies (ASML, Samsung Research), and international institutes.


Development of Semiconductor and Display AI Solutions in Cooperation with Global Companies such as ASML and Samsung Research
Vitalizing Global Researcher Exchange Through the Operation of the Open Research Hub
Joint Execution of AI+X Convergence Research Projects with Overseas Universities and Research Institutes
Strengthening Global AI Joint Research
Expanding Global Industrial Cooperation
Expansion of Networks Based on Open Innovation

# Research on Constructing an International Forensic Knowledge Graph and Analyzing Statement and DNA Argumentation

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Forensic science and courtroom technology are converging rapidly, expanding investigation from simple fact-finding to logical verification. Researchers from South Korea, the Netherlands, and Sweden have joined forces to identify persuasive facts within complex webs of evidence and statements. The "International Forensic Knowledge Graph Construction and Statement/DNA Argumentation Analysis Research," a joint initiative of these three nations, employs AI to analyze argumentation structures in court judgments, statements, and expert reports, visualizing them as knowledge graphs. South Korea handles vast court judgment data and automated argumentation extraction, while the Netherlands verifies story-based statement validity, and Sweden interprets the legal implications of mixed DNA. Ultimately, the team aims to establish a transparent investigative language that explains how scientific evidence translates into legal judgments, transcending national borders.

## Rewriting the Language of Forensic Science Beyond Borders

### Statement-based Storyline Verification (Netherlands)

Professor Floris Bex's team at Utrecht University has advanced the 'Hybrid Theory of Stories and Arguments,' interpreting the interaction between stories and arguments as an investigative structure. The core objective involves restructuring statements into logical patterns and causal flows—rather than mere information—to verify their validity and reliability. Collaborating with Hallym University, the team is developing a model that decomposes statements into data-warrant-claim units, organizes them into an AIF-based structure, and visually exposes event flows, rebuttability, and logical gaps. South Korea converts this structure into LLM-trainable inputs to enable automated argument extraction, aiming to evaluate story validity during investigations and ensure transparency in courtroom explanations.

### DNA Judgment Analysis and Argument Structuring (Sweden)

The International Centre for Evidence-Based Criminal Law (EB-Crime) at Uppsala University, a European hub for mixed DNA analysis and courtroom evidence evaluation, combines Professor Marie Allen's scientific DNA interpretation expertise with Professor Moa Lidén's interdisciplinary legal and psychological research. They focus on identifying the precise point where DNA evidence gains or loses reliability and analyzing how courts interpret these scientific results. In collaboration with Hallym University, the EB-Crime center compares Korean judgments and Swedish cases to automatically visualize the persuasiveness, rebuttal structures, and acceptance criteria of DNA evidence via argument graphs, quantifying cross-national interpretation differences using LLM-based analysis. The research ultimately seeks to empirically elucidate the transformation of scientific evidence into legal conviction and judicial rulings.

# AI for Disease Lifecycle Management: Establishing a Global Cerebrovascular Digital Health Collaboration Hub via International Science Forums

**Participants**

RLRC researchers including In-Cheol Jeong, Columbia University, Invited international speakers and collaborating researchers from Johns Hopkins University, TU Berlin, Ben-Gurion University, University of Massachusetts Amherst, University of Arizona, New Jersey Institute of Technology (NJIT), University of Haifa, University of Porto, Yale University, etc.

Cerebrovascular Disease Research Center, Columbia University, Johns Hopkins University, TU Berlin, Ben-Gurion University, University of Massachusetts Amherst, University of Arizona, New Jersey Institute of Technology (NJIT), University of Haifa, University of Porto, Yale University, etc.

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Hallym University Cerebrovascular Disease Research Center (RLRC) promotes full-lifecycle stroke management—spanning acute care, post-discharge rehabilitation, recurrence prevention, and long-term follow-up—centered on the Patient Lifecycle Management System (PLMS). PLMS integrates CDSS (clinical decision support) and RPSS (remote monitoring, self-management, education); utilizing wearable ECGs, smart bands, and PPG, we co-design collaboration agendas with Columbia, Johns Hopkins, TU Berlin, Ben-Gurion, and NJIT through the Eurasia AI & Data Science Forum, and are finalizing joint research agreements with NJIT and Johns Hopkins University.

## Global Collaboration Cases: RLRC International Forum and Eurasia AI & Data Science Forum Centered on the PLMS Vision

### RLRC International Week – Setting the Agenda for AI-Based Full-Lifecycle Disease Management

In 2025, the RLRC hosted 'The 2nd RLRC International Week: AI for Disease Lifecycle Management,' gathering domestic research groups and international scholars to discuss AI-driven stroke management systems. Speakers from Columbia, Johns Hopkins, TU Berlin, Ben-Gurion, UMass Amherst, Arizona, and NJIT addressed the role of AI and data science in full-lifecycle stroke management, sharing clinical cases and strategies for medical data infrastructure. The forum showcased the RLRC's full-lifecycle digital health platform, detailing data flow and verification strategies across prediction, diagnosis, treatment, rehabilitation, and lifestyle management through panel discussions. Furthermore, we established the RLRC's global collaboration roadmap, linking industry-academic-research studies, talent cultivation, policy recommendations, and technology commercialization.

### Expanding Global Networks and Establishing a Foundation for Follow-up Collaboration via the Eurasia AI & Data Science Forum

The RLRC attended the Eurasia AI & Data Science Forum for two consecutive years (2024–2025) as a representative institution in digital health AI and medical data science. At the forum, we presented the latest research and clinical translation strategies, discussed cerebrovascular/cardiovascular digital health collaboration with researchers from major universities (Haifa, Porto, Yale, IIT, Columbia, MIPT), and explored opportunities for multi-center verification. These activities positioned the RLRC as a key partner in co-designing global agendas encompassing full-lifecycle stroke management, digital twins, remote monitoring, and medical AI ethics/policy. Currently, we are pursuing participatory joint research and joint center agreements with NJIT and Johns Hopkins University, evolving into an international joint research hub by establishing multi-center cohorts, conducting CDM-based analysis, and running joint education programs.

# Development of an AI-Based Cardiopulmonary Monitoring System Using Real-Time Biosignal Measurement Devices

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This project, executed under the Ministry of Trade, Industry and Energy and KIAT's International Joint Technology Development Program, built a digital health infrastructure for "precise cardiopulmonary monitoring anytime, anywhere" by combining patch-type wearable ECG/respiratory sensors with AI. Utilizing Mezoo's HiCardi wearable patch and real-time monitoring platform, the Korea-US consortium (Mezoo, Hallym University Cerebrovascular Disease Research Center, Dongguk University, Johns Hopkins University, and Rice University) jointly developed deep learning algorithms for arrhythmia, sleep apnea, and sleep stage analysis. This initiative generated international joint research achievements that extend cardiovascular and cerebrovascular risk assessment from short-term hospital tests to long-term, daily life-based AI monitoring.

## Korea-US Industry-Academic-Hospital Consortium's International Joint Real-Time Cardiopulmonary Monitoring and Arrhythmia Analysis Platform

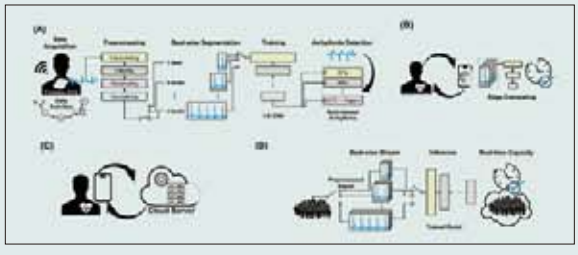
### Establishment of a Patch-Type Wearable and Cloud-Linked Cardiopulmonary Monitoring System, Global Licensing, and Commercialization

The Korea-US consortium, consisting of Mezoo, Hallym University, Dongguk University, Johns Hopkins University, and Rice University, developed a comprehensive cardiopulmonary monitoring system integrating the HiCardi patch (ECG, respiration, body temperature, and activity), a mobile app, a cloud server (LiveStudio), and a clinician web viewer. This system enables users to measure biosignals continuously for over 72 hours and allows medical staff to verify integrated indicators (arrhythmia, sleep, respiration, activity) via the web, facilitating operations in virtual wards and remote monitoring environments.

The device obtained South Korean MFDS Class II, US FDA 510(k), Japanese PMDA, and Thai TFDA certifications, achieving cumulative domestic and overseas sales of approximately 640 million KRW for HiCardi+H100. Simultaneously, we secured 15,750 records of fall IMU data and high user satisfaction (wearability score > 4.7), creating a digital health infrastructure that integrates cardiopulmonary monitoring with fall risk management.

### International Joint Research Achievements Spanning Papers, AI Algorithms, Patents, and Databases

Collaborating with Rice University and Johns Hopkins University, we researched a hierarchical deep learning model for multi-label (7 types) arrhythmia classification and 1-D CNN-based beat-wise optimal input length, optimizing the performance-resource balance for real-time analysis using actual wearable ECG and MIT-BIH data. These efforts yielded five SCIE and two non-SCIE papers (seven total) and five presentations at international (EMBC) and domestic conferences. Furthermore, we secured 14 domestic and international patent applications for biometric monitoring, simultaneous ECG/respiration output, sleep apnea detection, and ECG-based user authentication, completing a full-cycle achievement package spanning hardware, algorithms, clinical studies, and IP. This project exemplifies global digital health collaboration, integrating the consortium's capabilities to link research and patents with commercialization, and laying the foundation for future cerebrovascular digital twin and virtual ward research.

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# Talent, Industry, and Regional Development Platform

We have established a solid foundation for a future-oriented ecosystem integrating education and industry through the successful implementation of national projects across various advanced fields. Building on these accumulated achievements, we are driving national and regional development while continuously expanding the 'AI+X' convergence ecosystem through close collaboration with external partners.


Development of AI-Based Solutions Linked to Gangwon's Specialized Industries (Tourism, Healthcare, Safety)
Strengthening Field Training and Job Placement Programs in Semiconductor and Display Sectors
Cultivating Industry-Tailored Software Talent through AI/SW Convergence Education
Expansion of AI+X Convergence Education Programs
Establishment of a Region-Tailored Innovation Ecosystem
Realization of an Industry-Regional Innovation Platform

# SW-Centered University Cultivating AI-Based Creative and Convergence Talent

**Participants**

Sun-Jeong Kim and 66 Professors, 153 Partner Institutions (Douzone Bizon, Springworks Co., Ltd., Hancom With Co., Ltd., etc.)

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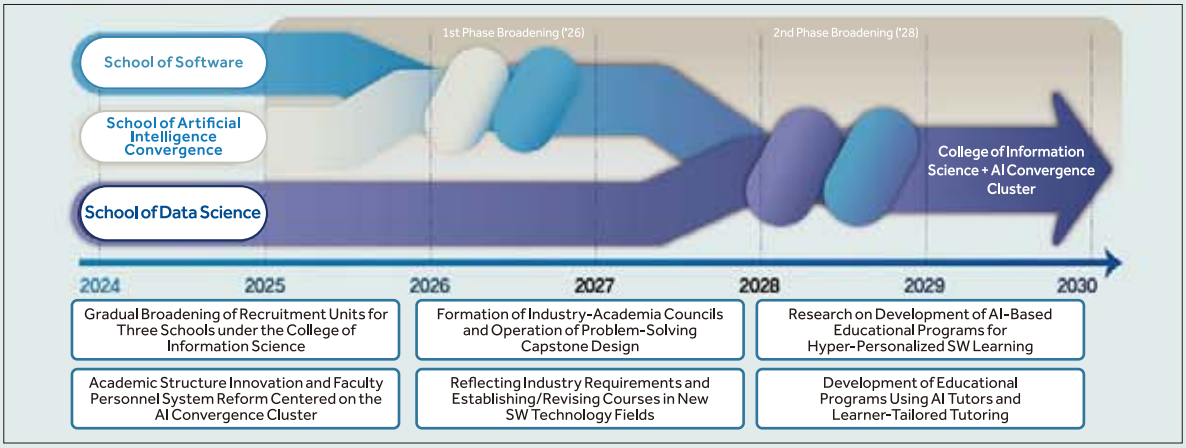
The SW-Centered University has consistently pursued innovation across education, research, and industry-academia cooperation to cultivate creative convergence talent based on AI and SW, responding to the digital transformation era. Notably, we established a talent cultivation system fostering problem-solving and practical skills by organically linking mandatory SW/AI basic competency reinforcement for all students with specialized major education and industry-linked training.

For basic SW education, we mandated computational thinking and AI basics for all students and improved learning outcomes for both majors and non-majors by operating customized courses tailored to major characteristics. We also provided personalized education based on learner level and progress by introducing adaptive learning methods using generative AI and AI tutors, and narrowed the educational gap by establishing a feedback system based on learning process data analysis.

In major education, we created a practical learning environment through step-by-step SW/AI curricula and project-based course operations. We empowered students to solve real-world industrial problems by strengthening capstone design, industry-academia cooperation projects, and internship-linked education that reflect industry demand. Furthermore, we expanded research participation opportunities through undergraduate-graduate linkage education, apprentice-style undergraduate research programs, and open graduate courses, laying the foundation for advanced talent cultivation and graduate studies.

We also achieved significant results in industry-academia cooperation and global competency reinforcement. Our collaboration with domestic and overseas industries and universities facilitated field-centered education and global training programs, allowing students to experience global technology trends and strengthen collaboration skills through overseas field training and international joint projects. Additionally, we expanded students' career options by systematically supporting technology startup capabilities through startup education and AI-based startup programs.

Concurrently, we built a sustainable educational innovation foundation by introducing a system that reflects educational and industry-academia cooperation performance in faculty evaluation and management. The SW-Centered University aims to position itself as a leading institution for AI-based creative convergence talent by completing an innovation model where education, research, and industry create a virtuous cycle through advancing the AI-centered education system, expanding new technology-based courses, and strengthening industry-regional links.



# Gangwon Metaverse Campus Education

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'Gangwon Metaverse Campus Education' is a region-linked human resource development project operated from April to December 2025, designed to cultivate professional talent for the regional metaverse industry and provide practical digital competencies to youth and university students in Gangwon-do. Conducting training primarily at Hallym University Engineering Building and Kangwon National University Seoam Hall, we produced 120 graduates through an intensive course of 15 sessions (15 hours each) targeting the general public and university students.

We designed this practice-oriented curriculum to reflect the latest technological trends in the metaverse and XR industries. In the "Metaverse Starting with Unity" course, students practiced Unity3D basics, 360-degree camera filming, and VR/AR application production, grounded in a solid understanding of XR and the metaverse.

The "Augmented Reality and Artificial Intelligence Starting with Unity" course strengthened practical technical competencies by covering GPS-based markerless AR development using AR Foundation, furniture arrangement simulation, and basic/advanced AI model development using ML-Agents. Additionally, the "Creating and Utilizing My Own 3D Character" course demonstrated the convergence potential of content creation and AI technology through 3D character production using Vroid Studio and Unity, along with GPT-based AI character application practice. Furthermore, we established a comprehensive educational system covering the entire spectrum of metaverse content production, including 2D metaverse space creation, online world implementation, and Blender-based 3D modeling.

The program operated with a strong focus on practical work through close cooperation with the industry. Lead instructors, including the CEO of Orcasoft Co., Ltd. and other field experts, incorporated diverse industrial experiences—such as VR/AR platform development, web/mobile content production, and XR applications in medical/educational fields—into the training. This approach allowed trainees to gain practical experience resembling actual project execution, moving beyond simple theoretical learning. Consequently, the program achieved a high education satisfaction score of 95.7, proving its quality and effectiveness.

Upon completion, we held a performance report meeting to share student results and review educational outcomes. Outcomes such as 3D characters, 2D metaverse spaces, and Blender-based 3D models served as proof that the acquired technologies could be implemented as actual content. Furthermore, the program extended to employment and entrepreneurship support, resulting in three outstanding trainees successfully finding jobs or starting businesses in service, ICT, and professional technical sectors.

Overall, Gangwon Metaverse Campus Education successfully achieved the goal of nurturing regional-based metaverse experts and established a virtuous cycle model where education, industry, and the community grow together. This project demonstrated significant potential as a sustainable educational model contributing to the revitalization of the Gangwon digital content industry and the creation of youth jobs.

# RLRC–Enterprise Local Government-Industry-Academia Cooperation and Talent Nurturing for Regional-Based Digital Health and Smart Healthcare Innovation

**Participants**

Researchers from RLRC and School of AI Convergence including In-Cheol Jeong, Douzone Bizon, Boditech Med, NUGA BEST, Mezoo, Geomexsoft, Emma Healthcare, DTPlus, and other Gangwon healthcare/smart city companies

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Hallym University Cerebrovascular Disease Research Center (RLRC) promotes Local Government-Industry-Academia cooperation with local and domestic digital health and medical device companies, centered on the Patient Lifecycle Management System (PLMS), which covers hospitalization, discharge, rehabilitation, recurrence prevention, and long-term follow-up for stroke patients. Starting with three companies (Douzone Bizon, Boditech Med, and NUGA BEST), the project has expanded to seven participating companies, adding Mezoo (wearable ECG), Geomexsoft (AI-based fall detection vision), Emma Healthcare (non-contact patient monitoring), and DTPlus (HIFEM-based exercise rehabilitation). Furthermore, additional collaborations are under discussion with six more companies, including HAII, Oceans Bio, Daeyang Medical, bneware, and TEMPS. Centered on the PLMS, the RLRC is building a regional digital health hub model that connects research, education, and commercialization by linking data, equipment, and algorithms among universities, companies, and hospitals to advance monitoring, risk prediction, and rehabilitation modules.

## Establishment of a Regional Enterprise Cooperation System Based on the Cerebrovascular Disease Lifecycle Management PLMS

### Joint Research on the Entire Lifecycle of Cerebrovascular Disease Leveraging the Strengths of Each Company

The RLRC promotes joint research by connecting corporate technologies to stroke lifecycle care scenarios centered on the PLMS. Douzone Bizon develops an integrated clinical and lifestyle data management model based on WEHAGO H, while Boditech Med develops recurrence risk assessment logic based on biomarker POCT. NUGA BEST links handheld at-home biosignal monitoring devices to the PLMS to advance the tracking of post-discharge compliance and lifestyle indicators. Mezoo connects a cardiovascular (arrhythmia, sleep, activity) monitoring module using HiCardi patch data to the PLMS, and Geomexsoft links a fisheye CCTV-based fall detection model with the PLMS. Emma Healthcare integrates non-contact (rPPG/video) patient monitoring into the PLMS, and DTPlus integrates a HIFEM-based personalized rehabilitation intensity recommendation model into the PLMS rehabilitation module. Additionally, we are discussing further linkages involving digital twins, electroceuticals, smart beds/environmental sensors, and home monitoring with six companies including HAII, Oceans Bio, Daeyang Medical, bneware, TEMPS, and Weda.

### Education-Research Linkage Based on Mezoo Wearable ECG

In the education sector, we operate project-based practical training using HiCardi+H100 patches in graduate classes in cooperation with Mezoo. Students execute the entire process from measuring/collecting ECGs to preprocessing, modeling, and performance evaluation for classifying arrhythmia, sleep apnea, and sleep stages. Code and ideas developed in class feed into joint research and analysis of actual HiCardi-based data (ECG, sleep, fall DB), leading to publications in international journals such as Digital Health, CMPB, and CIBM. This creates a practical feedback loop where class outputs drive research results, and analysis methods accumulated during research inform the curriculum.

# Improvement and New Development of Local Government-Industry-Academia Cooperation Courses

**Participants**

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This platform aims to nurture professional talent with regional settlement capabilities by organically connecting local industrial sites with university education. Industry experts directly participate in curriculum planning and operation, establishing a structure where students understand actual industry needs and expand contact points with the local community and companies. This structure yields multi-layered benefits: improved educational quality, strengthened regional familiarity, and secured manpower for local industries.

### Establishment of Industry-Academia Cooperation Courses

We realized an industry-participatory educational model by improving the 'Nano Process' course in the second semester of 2025. BNOSIS Co., Ltd., a local company, directly participated in curriculum planning and operation, ensuring educational content reflects the needs and technical trends of the actual industrial field. Consequently, students gained a deeper understanding of field process concepts and problem-solving, while the company secured opportunities to discover potential local talent. This cooperative structure serves as a benchmark for practical local government-industry-academia cooperation where the industry participates as a user of education.

### Expansion into Local Government-Industry-Academia Cooperation Courses

In the winter session of 2025, we expanded local government-industry-academia cooperation to 'Semiconductor Analysis Practice' and 'Optical Analysis Practice' courses. For 'Semiconductor Analysis Practice,' BNOSIS Co., Ltd. and Gangwon Technopark, a key regional institution, participated jointly to support students in gaining hands-on experience with analysis equipment used in industrial sites. This initiative expands regional industrial infrastructure into an educational platform beyond simple lecture delivery, enhancing students' experimental equipment operation skills and adaptability to industrial sites. It represents a meaningful achievement as companies and institutions increase the possibility of securing locally settled manpower by strengthening the foundation for linkage with regional talent.

# Participation of ASML Korea in the Bootcamp Program

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Hallym University and ASML Korea have established an education-industry cooperation model to foster advanced semiconductor talent. Starting with a joint educational program in April 2024, we laid the foundation to integrate the company's cutting-edge know-how into the curriculum. Building on this continuous cooperation, ASML now substantially participates in educational program development and operation, strengthening an industry-academic ecosystem where key industrial companies and regional universities grow together.

### Commencement of Cooperation with ASML Korea

The first achievement involves establishing an industry- academia cooperation structure based on the joint educational program launched in April 2024. ASML reflected technical and job competencies required in actual industrial sites into lecture and practice content, offering students opportunities to experience the technical philosophy and operations of a global semiconductor company. Specifically, integrating ASML's expertise in exposure and lithography into education allowed students to build practical understanding linked to industrial duties. This course marked a milestone in enhancing the qualitative level of the industry-academia cooperation model, as the company participated as a designer and user of education rather than a simple sponsor.

### Strengthening Cooperation with ASML Korea

In 2025, ASML's formal participation in the semiconductor bootcamp project to support educational program development and operation marked another significant achievement. ASML supports students in preemptively acquiring industry-required competencies through course consulting, practical curriculum design, and industrial site-based educational module implementation. Consequently, students achieve practical results like in-depth understanding of advanced semiconductor technology and building practical skills, while ASML expands contact points with regional talent and lays the foundation for securing future semiconductor personnel. This sustained cooperation contributes to establishing a mutual-growth innovation platform between global semiconductor companies and regional universities.

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## Leaping Forward as a Leading Global University through "Innovation via Deconstruction"

We have transitioned from the traditional department-centered system to an open university operating system centered on the three core convergence research institutes. This flexible innovation structure actively responds to a changing society by deconstructing boundaries between majors and organizations and linking education, research, and operations. We strengthen open governance by recruiting external experts and identifying innovative fields, while revitalizing research and education to foster creative talent and solve regional issues based on free interdisciplinary convergence.

We establish a Local Government-Industry-Academia cooperation system centered on the Research Institute of Medical-Bio Convergence, Research Institute for Data Science and AI, and Research Institute of Humanities & Social Science Convergence, leading a global leap where research outcomes disseminate throughout society.

**Research Institute of Medical-Bio Convergence :** Research Hub & Network

Overseeing healthcare convergence research linked with Colleges of Medicine, Nursing, and Natural Sciences, and leading government-funded projects.

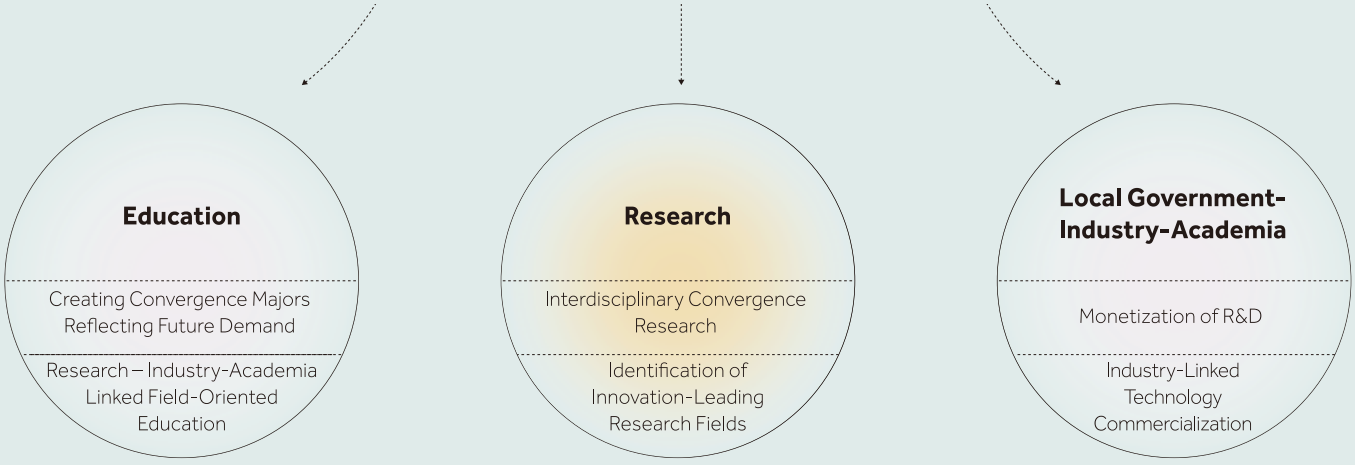
**Research Institute for Data Science and AI :** Fostering AI Specialists

A comprehensive hub for AI research centered on the College of Information Science, integrating the Departments of Software, AI, and Data Science.

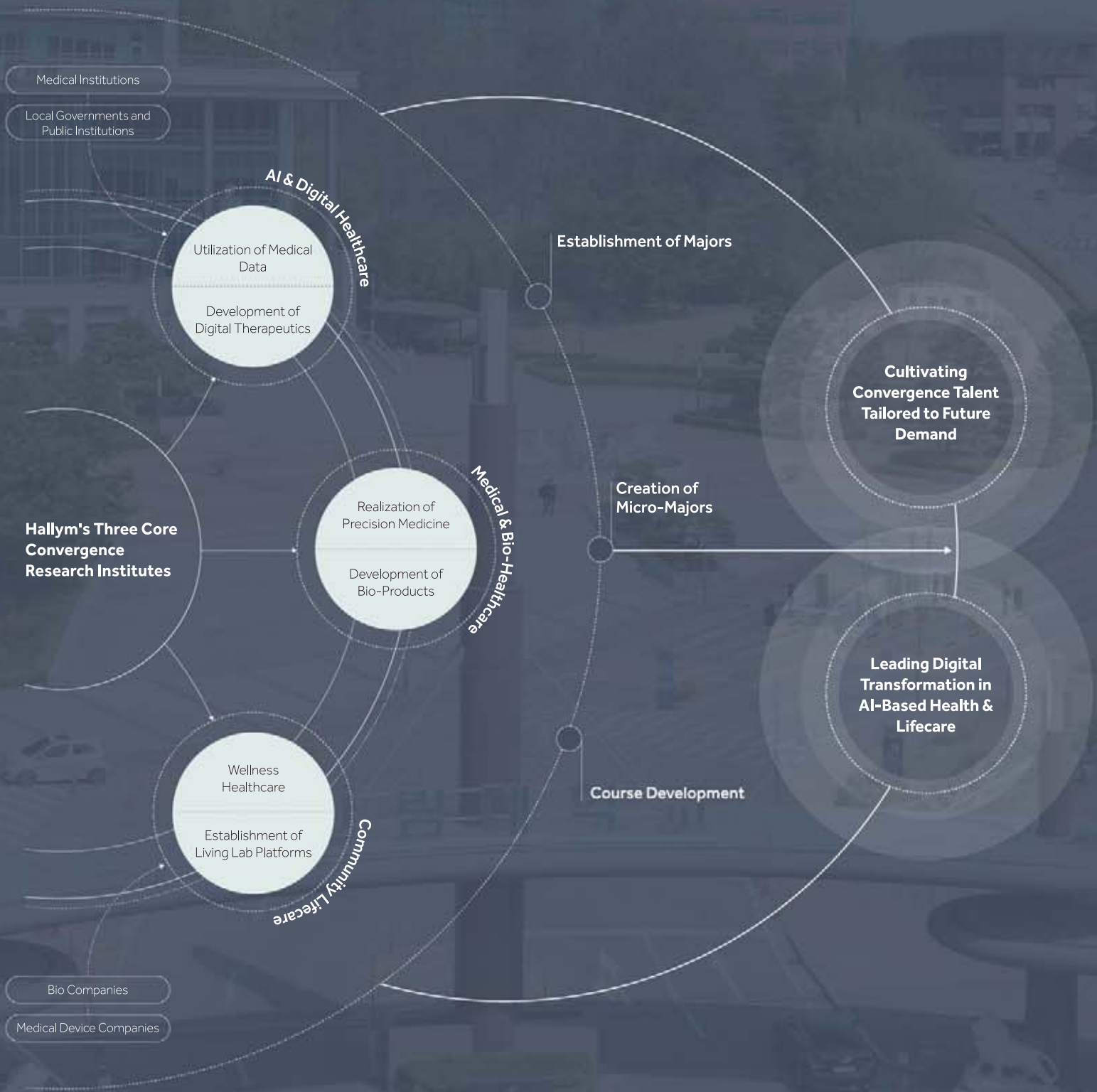
**Research Institute of Humanities & Social Science Convergence :** Regional Coexistence Think-Tank

Reorganizing humanities and social science research organizations to present policies and visions for regional community and cultural development.

**Three Core Convergence Research Institutes:**
**Platforms for Innovating University Operating Systems**



## Establishing an Education-Research-Local Government-Industry-Academia Cooperation Ecosystem Based on Convergence Research Institutes



**Research Institute for Data Science and AI**

Hallym University