Research area in the Strategic Objective "Creation of integration technology to enable utilizations of diverse and massive data using Artificial Intelligence core technologies rapidly growing in sophistication and complexity"

6.1.8 Development and Integration of Artificial Intelligence Technologies for Innovation Acceleration

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Overview

In the 21st century, the development of communications networks and the drop in the price of communications and sensors has enabled the creation of database technologies for big data as well as machine learning based on this data, not only in the information and communications industries but also in primary and secondary industrial sectors such as agriculture and manufacturing. As a result, it is becoming possible to automate and optimize industries in a way that was not previously possible. In the future, innovative artificial intelligence (AI) core technologies such as deep learning, reinforcement learning and other types of machine learning, which make maximal use of the information that has seen such explosive growth in terms of both quantity and variety, will come into widespread use, and this is expected to result in a society in which it will be possible to use information effectively in various fields. The use of data will create a need for new services and innovations in society that will change the structure of all industries.

The goal of this research area is to establish AI core technologies for gathering, processing, learning and controlling the enormous quantities of data in the real world in an intelligent, integrated and secure manner, and technologies that combine the results to help create innovations that will help to achieve the resolution of social issues and the automation and optimization of industry.

Specifically, the following types of research and development will be pursued:

1) Development of technologies to combine and analyze enormous quantities of various types of information to contribute to economy and society,
2) Development of technologies for systems that are optimized in accordance with circumstances, based on enormous quantities of various types of information, and
3) Development of security technologies that can be adapted to complex systems made up of diverse elements.

Based on the prospect of a future society in which the use of enormous quantities of information will be even more widespread and advanced, the aim of this research area is to pursue the advancement of sensor

technologies, database technologies that handle real-time big data, system security technologies, system optimization technologies based on machine learning and so on, with a view to application in various fields in the real world. Research and development of integration technologies that will enable these technologies to be combined in order to build information processing systems that can comprehensively process and understand real-world data in real time will also be pursued.

The research achievements from this research area will form the core of innovation creation to promote automation and optimization in various fields such as mobility, robotics, medicine, healthcare, nursing care, disaster prevention and mitigation, agriculture, manufacturing and so on.

To pursue these activities, an effective industry-academic collaboration will be established, and research and development will be conducted so as to enable progress through mutual sharing of issues and achievements in both fundamental research and integration research, in order to resolve actual problems facing society. In this way, research and development efforts will consider both the need to develop the AI core technologies that constitute fundamental technologies and the need for integration that actually combines these technologies to create innovation.

This research area will operate as part of the Advanced Integrated Intelligence Platform project (AIP project) of the Ministry of Education, Culture, Sports, Science and Technology.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

○ Background and basic policy

In order to achieve the goal of becoming the world's first "super smart society," as stated in the 5th Science and Technology Basic Plan (approved by the Cabinet in January 2016), it will be essential to integrate cyberspace and physical space (the real world). Increasingly, various types of big data are being generated and accumulated in various settings in society as data that link these two worlds, such as cohort data relating to medical and healthcare, data relating to materials and physical properties, and data relating to urban infrastructure and the global environment.

These various types of data must be analyzed, processed and controlled in an intelligent and integrated manner in real time, in accordance with various circumstances and needs. At present, however, the integration technologies needed to accomplish this have not yet been established. Moreover, to ensure that society is able to make maximal use of these fundamental technologies in the future, secure information technologies designed for future expansion must also be quickly developed and implemented.

Research and development such as the following will be conducted in this research area to respond to the needs of the times and make a positive contribution to society.

Examples of research and development projects are,

- Technologies to autonomously organize and combine various types of analysis data, in order to develop and provide appropriate services for constantly changing environments and needs,
- Technologies to enable intelligent and autonomous optimal data acquisition in response to individual circumstances and environments,
- Technologies that use state-of-the-art machine learning algorithms to perform ultra-high speed analysis of large quantities of various types of information and perform optimized control,
- Abnormality detection technologies based on database technologies that use real-time big data,
- Technologies that distribute data processing to peripherals of systems and cloud servers to ensure system stability and prevent data processing delays etc.,
- Heterogeneous data integration technologies that combine ontology technology (which is capable of advanced understanding of the meaning of various types of data and which enables integrated data analysis) in various ways,
- Secure data processing technologies that can conduct analysis while maintaining the confidentiality of personal data,
- Prediction type security technologies that use innovative AI technologies, and
- Integration technologies for constructing information processing systems that can combine the aforementioned technologies and process and understand real-world data comprehensively in real time.

In these types of research and development projects, we are looking for researchers who engage in the actual research with envisioning a specific path to implementation in society, and we anticipate that the achievements of the research will be deployed widely both at home and abroad. In this research area, two types of research and development methods such as the following are assumed. Researchers will receive assistance from Research Area Advisors beginning with promotion of the research and extending through various efforts aimed at launching new start-ups. The research area will actively provide support that includes surveys of fundamental technologies, design of business models, integration using the cloud, and international deployment.

- Innovative integration of AI core technologies
  - Based on a thorough understanding of the resolution of a social issue or the needs of industry, an integration system that combines business model design and "best practice" cutting-edge technologies is constructed. The proposal in which specific detail of the issue to be resolved, the solution, superiority of proposed solution and the value proposition are identified.

- Advanced development of AI core technologies
  - Unlike the innovative integration in which the social or industry issue to be resolved is identified in specific detail, in advanced development of AI core technologies, versatile functions that will lead to

broader issue resolution are provided. An example might be the integration of video image recognition, natural language processing, deep learning, IoT data analysis, abnormality prediction, security and other fundamental technologies with real-time databases, large-scale data synchronization, integrated data processing, cloud technologies and so on, in order to construct an advanced AI infrastructure that will lead to the creation of innovation.

In research proposal, it is necessary to provide a clear picture of the future society that will be the end goal, and to indicate the distinguishing characteristics of the research and development that will resolve the issue and achieve that end goal, as well as an integration plan to build the system that will lead to implementation in society. For the both innovative integration　and advanced development, the distinguishing characteristics of the research and development will be evaluated in terms of magnitude of the value being proposed, as well as the innovativeness of the integration and the novelty of the fundamental technology that are superior to other proposals.

We are seeking research and development projects that create an industry-academic collaboration that is essential for resolution of the issue, in order to enable issues and achievements to be shared during the process of introducing existing or developing new fundamental technologies and integrating these technologies. In the case of the advanced development of AI core technologies, it will not be sufficient to conduct conventional fundamental technology research in pursuit of new breakthroughs; integration that will lead to implementation in society will also be required. In the case of the innovative integration, we welcome research proposals with the novelty of integrating "design thinking" with research plans, spanning both the identification of issues to the value proposition, and/or research proposals for creative research, development and innovation (R&D&I), without regard to the novelty of the individual technologies used. With regard to data usage, we recommend that effective use be made of the data collected and developed in other projects, including the JST Center of Innovation (COI) Program.

○ Examples of research topics

In this research area, we are hoping for research proposals that demonstrate an understanding of the issue to be resolved and the necessary fundamental technologies with a view to future implementation of the research achievements in society. Specific research topics will be presented as examples, but topics will by no means be limited to the ones shown here. We welcome original and challenging proposals.

- ■ Generic AI core technologies for industrial applications
  - Real-time natural language understanding and speech interactive core technologies
  - Video image recognition core technologies for use in automatic learning in robotics
  - Environmental recognition technologies integrating various types of sensors
  - Online deep learning technologies with highly versatile performance

- Abnormality detection technologies using time-series data
- Moving-image production from natural language description
- Multimodal media recognition using voice and image

■ Mobility and robotics
- Autonomous traveling robots that integrate video image recognition and various types of sensor recognition
- High-performance wheelchairs that can travel autonomously
- Drones that can fly autonomously and automatically distinguish dangerous locations in structures
- Technologies that can detect cyberattacks while running autonomously and provide an optimal response
- Robot artificial legs that enable their wearers to play sports with able-bodied persons

■ Food, agriculture, fisheries, manufacturing, transport and construction
- "Smart" manufacturer operations for industries in which use of information and communications technologies has lagged up to now
- Robot control technologies that can provide food tray service
- Robot control technologies for livestock barn maintenance
- Optimized control technologies for irrigation that monitor the drought status of farmlands
- Analysis of data acquired from industrial equipment, optimization of equipment running status and failure prediction

■ Disaster prevention and mitigation
- Technologies to predict disasters and abnormal weather conditions and automatically devise the most appropriate response
- Systems that use data gathered for other purposes at non-emergency times to provide optimal evacuation guidance

■ Financial technology, marketing automation
- Analysis and scoring of potential customers' (leads') activity history, including web access and opening of e-mails, and identification of senders, in order to analyze potential needs and visualize purchase motivation
- Analysis of customer patterns from Twitter feed, posts, reviews, scoring, comments and other public data
- Sending of personalized messages to each customer and sending of information on sales campaigns
- Automated matching system of human resources

■ Health, medicine and nursing care
- Technologies supporting disease diagnostics using medical questionnaire
- High-speed medical imaging technology for early detection of patient diseases

- Optimization of medical treatment planning through precision processing of electronic medical charts that incorporate medical data
- Data processing technologies with a sophisticated balance between remote-monitoring nursing care for senior citizens and privacy protection

- **Security and authentication**
  - Automatic detection of cyberattacks on the system
  - Analysis of network traffic and response to attacks by unknown malware, etc.
  - Biometrics and other Multi-Factor Authentication features

○ Research and development period, and research costs

   To ensure speedy application development of research achievements in the field of information and communication technology with its rapidly changing technology cycle, a new method has been adopted for this research area. For this fiscal year, proposals will be solicited for small teams that participate in the small phase research period of two years and six months (from October 2017 through March 20209). We welcome proposals that include collaboration with companies and local governments both at home and abroad, and proposals by budding entrepreneurs. Research costs will be up to a total of 75 million yen for the period of two years and six months. During the small phase research, additional support of approximately 10 million yen for an application feasibility study will be provided depending on the progress of research. The application feasibility study will focus on preparation for application development such as prototyping in anticipation of implementation in society and a study of intellectual property strategies and business models. At this stage, applicants should focus in particular on a proactive study of collaboration with companies and other entities both at home and abroad. Support for these endeavors will also be provided. Approximately two years after the start of research by small teams, applicants will resubmit a proposed research plan based on the achievements of research, and part of the small team (we envision 1/3 to 1/2) will be able to go on to the acceleration phase which comprises an additional three years of research. During the acceleration phase, applicants will shift to an emphasis on integration research in preparation for implementation in society. Even for small teams that are outstanding in terms of the development of fundamental technologies, proposals whose development in preparation for application is weak may not be able to go on to the acceleration phase. Moreover, applicants should pursue research and development so as to enable mutual sharing of issues and achievements between both fundamental research and integration research, in order to develop solutions to actual problems facing society. The research costs for the acceleration phase will be up to 300 million yen for a period of three years.
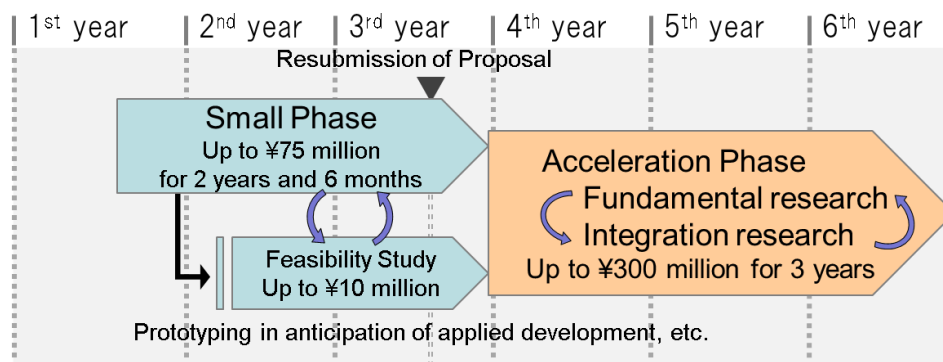
○ Considerations when submitting applications

In research proposal, the following must be specified:

- Specific objective and social impact to be achieved in five years and six months (including the acceleration phase)
- Specific objective and social impact to be achieved in the two years and six months of the small phase

The objectives and social impact of the proposals are evaluated by considering the social issues that would be solved, the scenario for implementation in society, appropriate time planning and goal setting, and the feasibility of research proposal (e.g. whether data is prepared in the case of proposals that plan to use machine learning).

The budget plan should specify the budget only for the 75 million yen during the small phase period of two years and six months.

The proposal should also include a proactive study of collaboration with companies, local governments and so on as well as a plan to launch startup companies. Even in the case of a proposal that does not include collaboration with companies or local governments, the proposal should be premised on an endeavor of seeking an innovative collaboration with companies and local government, and even more, nurturing startup companies during the small phase period of two years and six months. The acceleration phase is expected to be premised on collaboration with companies, local governments etc. and company start-up. With regard to the content of the research, applicants should give consideration to finding research topics among the actual problems facing society, with a view to eventual implementation in society. On the Research Proposal Form 3 Attachment, please note the value provided to society in the event that the proposed research content is implemented in society in the future or becomes the basis for a company start-up.

In addition, please proactively study the idea of allowing junior researchers to be involved in the research team. From the standpoint of junior researcher training, we hope that involvement will not be limited to

university researchers but instead that company researchers, outstanding students in continuing education doctoral programs will be able to join the research team as well.

Moreover, based on national policy and international trends relating to research data management and sharing, we hope that active sharing and use of data will effectively lead to the creation of research achievements and the development of new products and services (markets). In this research area, researchers will be asked to prepare a data management plan after approval of their proposals. Researchers should preserve, manage and (within the allowable scope) make their data available based on this data management plan.

The framework of this research area differs in some respects from the other CREST research areas, but we have high hopes for the participation of free-thinking and highly motivated researchers who want to help create a society of the future in which innovative AI core technologies will be in wide use.

This research area will also contribute in the integrated administration of the AIP project - which integrates artificial intelligence, big data, IoT and cyber security - by working on research tasks in cooperation with related research institutions such as the RIKEN Center for Advanced Integrated Intelligence Research. This is one of the research areas included in the "AIP Network Laboratory", which is part of the AIP project.

* The research proposal form for applying for this research area is different from that of other research areas, so to apply, download the correct form from e-Rad or the JST website for Invitation of Research Proposals.
* The briefing sessions for the call for proposals in this research area will be held on the following dates at the following locations. The briefing will be held in Japanese. We hope that many interested parties will attend.

	Date & Time	Venue
Tokyo	April 19 (Wed) 9:30 - 11:30	JST Tokyo Headquarters Annex 1st Floor Hall (K's Gobancho, Gobancho 7, Chiyoda-ku, Tokyo)

For more information, please visit the following site: http://www.senryaku.jst.go.jp/teian-en.html

Research Proposal Form 3 (Project Description) - Attachment   (CREST-Form 3 – Attachment)

Please envision the value to be provided to society in the event that the proposed research content is implemented in society in the future or becomes the basis for a company start-up, and provide responses to each of the following items.
Please make your responses clear and concise.
Note: Please limit your responses **to a single page in total**. Ultimately, the text boxes with the explanatory text **should be deleted** by the research proposal applicant.

Problem	Solution	Unique value proposition	Unfair advantage	Users
Please specify the problem affecting society and users that will be resolved by the research.	Please specify the functions that will be provided to resolve the problem and create value. New technologies, new services created by combining technologies, etc.	Please describe the value to be provided to society and users. (Please give reasons explaining why users should select the proposed solution)	Please describe the advantage of the products or services that will be difficult for other entities to imitate in the event that the research achievements are implemented in society or become the basis for company start-up.	Please specify the users (the persons who will pay compensation) to whom the research achievements will provide value. Please narrow down the combination of user attributes (industry, profession, region etc.)