Research area in Strategic Objective *"Innovation in measurement and analysis processes aimed at solving social issues*"

Establishing the Solid Foundation for Innovative Measurement and Analysis Process

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Overview

In this research area, we aim to conduct world-class research by pioneering knowledge extraction technology based on the latest information science, as well as deepening experiments and computer simulations that lead to innovative measurement technology. There are many examples of new measurement and analysis that have triggered dramatic developments in science and technology and have had a major impact on society.

The development of science and technology requires continuous innovation in measurement and analysis processes. To make this possible, it is essential to build a solid base technology.

If we can achieve this, it will be a major advantage in Japan's research environment for the next 10 to 20 years, and it is expected to lead to the realization of 2050 carbon neutrality and the resolution of global social issues such as the SDGs.

The research area in CREST has already been set under the strategic goal of FY2022, "Innovation in measurement and analysis processes aimed at solving social issues," and research activities have been underway to solve various difficult real-world problems using measurement and analysis technology. In the research area in PRESTO, we aim at basic research, which is the preliminary stage, especially as (1) Deepening and innovation of measurement principles and methods ("seeing") and (2) Creation of innovative knowledge extraction technology through data analysis using informatics (“noticing” and “understanding”). And in collaboration with the research area in CREST, we aim to form a foundation for a series of research and development processes of "seeing", "noticing" and "understanding". Furthermore, in the forum for cross-disciplinary exchange, we will promote the development of research personnel who will be responsible for future measurement and analysis technology.

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

1. Basic Objectives

(1) Deepening and innovation of experiments and computer simulations leading to innovative measurement technology

Based on solid principles, we acquire measurement data (experiments and calculations) that could not be achieved in the past, and greatly improve efficiency and accuracy by delving deeply into existing measurement methods.

(2) Development of knowledge extraction technology through data analysis using information science and technology

By applying information science and technology, which has been developing remarkably in recent years, we efficiently and highly accurately process large amounts of time-series data, spatial data, structural data, etc. obtained from experiments and calculations to extract knowledge, and aim to construct a technology to accurately understand the origin of phenomena and characteristics.

(3) Execution of multi-scale, multi-modal research

We will connect new measurement methods and knowledge extraction technology from large amounts of data using informatics as a series of processes to explore multi-scale, multi-modal research and development and use cases. The developed method will help solve various practical problems such as the development of new materials, and we aim to implement it in society as a technology that can lead to the solution of social issues in the future.

(4) Utilization of measurement and analysis technology across fields

We aim not only to sharpen measurement and analysis technology in a specific field, but also to spread it as a technology that can be used in other fields.

(5) Building R&D infrastructure that contributes to international competition and development of research personnel.

The results of this area are world-class, and we expect that they will contribute to international competitiveness in terms of elemental technology. In addition, by bundling these technologies, we aim to become the foundation of Japan's measurement and analysis technology fields, and at the same time, we will work to develop research personnel who will support these foundations in the future.

2. Specific Examples of Research

To achieve the above aims, in this area, "innovative measurement" and " informatics utilization " are positioned as the main research elements. Individual research examples are shown below, but it is extremely important for these to work closely together for truly useful innovation in measurement and analysis. In addition, followings are examples, and the proposal is not limited to them.

(1) Innovative measurement

This is research to challenge the measurement of things that cannot be measured at present. We aim to build innovative measurement technology by developing new measurement principles, measurement equipment, and computer simulation technology. These should include the active use of informatics, or at least have a clear vision of it.

As examples of measurement, firstly precise measurement of physical and chemical states and shape changes at electronic and atomic scales inside materials, lattice defects, surfaces and interfaces, and in the meso-region, dramatic improvement in spatial/temporal resolution, trace component measurement/tracking, measurement reproducibility, etc. are expected. Secondly, the challenge of elucidating phenomena that occur in conjunction at different scales in real materials with complex structures (multi-scale measurement) and solving problems in which the relationships between different properties are unknown (multi-modal simultaneous measurement). In either case, the measurement data may be acquired by computer simulation.

(2) Informatics utilization

Even if innovative measurement is realized, we will not be able to contribute to solving social issues unless the origin of phenomena and characteristics are accurately understood based on such data, and we extract knowledge that contributes to material design and process design related to structures, physical property correlation and regularity.

By applying information science and technology, which have developed remarkably in recent years, we aim to construct technology for accurately analyzing complex and large amounts of data obtained as a result of experiments and calculations and extracting knowledge.

The analysis technology to be developed should be versatile and stable regardless of the field, and the ultimate goal is to construct a series of processes from measurement to analysis. We are also envisioning the development of a system that feeds back analysis results to measurements, and a system that utilizes them in material design and process design.

In addition, information technology also includes signal processing technology as part of measurement principles and measurement equipment, including noise removal required for (1) innovative measurement, in this research area, this is organized as part of (1).

3. Research Area Management

(1) Advisor Team

This research area requires knowledge of various measurement technologies, on-site knowledge in the development of various actual materials, and a broad understanding of informatics.

Since this is a highly challenging interdisciplinary field, we will manage the field as a team by forming a portfolio of advisors from experimental measurement, computer simulation, and information science in various fields such as materials science, physics, and chemistry.

(2) Promoting Interdisciplinary Exchange

In order to innovate measurement and analysis that are not specialized in a specific field, we will establish many opportunities for interaction between researchers with different measurement and analysis technologies, different materials, and application fields. We will create innovative measurement methods and develop use cases through exchanges in different fields. In particular, we will promote cooperation with other related strategic projects.

4. Research Period and Funding

The research period shall be limited to no more than three and a half years. Research funding (direct costs) submitted include the costs required to achieve the proposal content, with an upper limit of ¥40 million. Please describe a rational basis if it exceeds the standard amount of ¥30 million.

5. Selection Policy

(1) The proposal must describe a clear strategy, such as what kind of actual measurement and analysis problems will be solved, and whether it can be expected to contribute to international competitiveness in terms of elemental technology. (During the research and development period of this project, we expect world-class research results, but we do not expect specific solutions to social issues.)

(2) The proposal must be a novel and original proposal through innovation in measurement and analysis processes.

(3) The proposal should not be a mere extension of conventional research.

6. Points to note in 2023 for Applications

(1) About application themes

In this area, by closely linking "innovative measurement" and "informatics utilization", it is possible to realize innovation in measurement and analysis and confirmation of effectiveness in actual application environments. Basically, it should be carried out under the supervision of a single researcher.

On the other hand, we believe that we should avoid losing originality and challengingness by placing too much emphasis on the linkage of these two elements.

Therefore, in PRESTO, which is an individual research project, we would like to actively adopt either of these two proposals if they satisfy "5. Selection Policy".

In any case, please be aware that collaboration between multiple elements is important in this research area, and please include or refer to collaboration in your proposals.

If the proposal is adopted, in the second half of the research period, the research supervisor may request collaboration and cooperation with other research projects or CREST projects in this area.

(2) Items to be included in proposals

In accordance with the aims and selection policy of this research area, each of the following items should be clearly indicated in proposals:

a) What kind of problems in measurement and analysis will be solved, and what kind of breakthroughs will be aimed at based on the current state of the world's top level?

b) Can it be expected to contribute to international competitiveness in terms of elemental technology? Also, how can it be expected to be useful in the future at research and development sites and practical technology development sites in Japan?

c) Concrete examples and grounds on which the proposed measurement/analysis method can be expected to be used not only in specific fields (e.g. specific materials/substances) but also in other fields.