2022

SUMMARY

2022 JST-MIRAI PROGRAM

Japan Science and Technology Agency

未来社会創造事業

Japan Science and Technology Agency

JST-Mirai Program

About JST-MIRAI

The JST-Mirai Program (hereinafter, Program) aims to promote high-risk but high-return research and development (R&D) that leads to social and economic impact. For that purpose, this program helps develop proof-of-concept (POC), so that investors and industry may judge practical application feasibility. In this program, the project sets technologically challenging goals based on basic research results and turns innovative ideas into commercial and social values for the future society.

|| Two Project Approaches

The JST-Mirai program consists of two different project approaches:"Small-start Type" and "Large-scale Type."

“Small-start Type”

In this type, project begins with feasibility study at a relatively low budget (small start) and then is scaled up to full R&D project through the stage-gate evaluation. Projects are called for based on the “prioritized theme” set by JST according to R&D mission areas set by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). During the feasibility study, the project explores the social and economic potential of the ideas toward a full R&D project. Then, stage-gate evaluations are conducted Note) to determine the transition from feasibility study to full R&D project.

Feasibility Studies	R&D period: 2.5～4.5 years R&D costs (direct costs): 35～60 million JPY/project
Full-scale R&D	R&D period: Up to 5 years R&D costs (direct costs): 380～570 million JPY/project

●Needs of Industry and Society
●S&T Trends investigated by JST

MEXT
Mission Areas based on the S&T Innovation Basic Plan

JST
Prioritized Themes
Call for proposal research projects(FS)

Feasibility Studies

Full-scale R&D Project

“Large-scale Type”

For the “Large-scale Type”, MEXT identifies “technology theme” based on various analysis of science, technology and innovation policies. R&D project is seleced according to the “technology theme” that may change existing technology systems and become platform technologies for the future.

R&D Project	R&D period: Up to 10 years R&D costs (direct costs): 2.7 billion JPY/project

MEXT
Technology Themes
to change current technology system and to be future basic technology

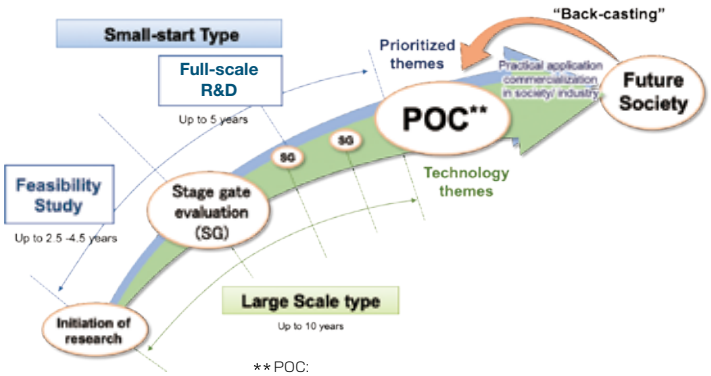
JST
Call for Proposals

R&D Projects

|| Scheme of the Program

●Maximizing the results

In the JST-Mirai program, the R&D project may conduct basic research to solve issues raised during the project period, revise the teams (e.g. adding new R&D institutions), incorporate new technologies and findings, respond to changes of social and economic needs, spin out the results of some R&D, collaborate with other organizations and take ELSI (Ethical, Legal and Social Issues) into consideration. PO reviews progresses in detail for maximizing the results of the R&D projects.

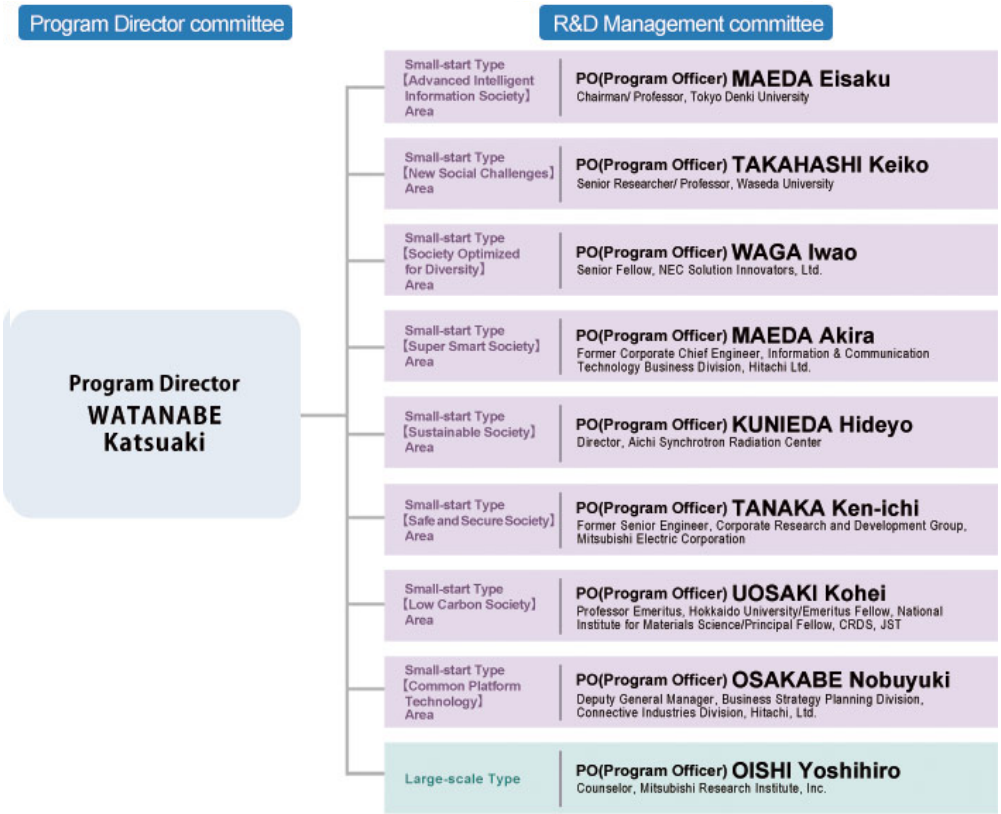


**POC:
Proof of concept where practical application feasibility may be properly judged by investors and industry

●Conducting stage-gate evaluation

The JST-Mirai program conducts a "stage-gate evaluation" during the R&D period to determine whether the R&D project could continue or not based on the viability of reaching the POC. Research papers and patents are considered as parts of evidence for verification at the stage-gate evaluation.

|| Management System



◆"Advanced Intelligent Information Society" mission area

MAEDA Eisaku
R&D Supervisor (Program Officer)
(Chairman/ Professor, Tokyo Denki University)

Overview

In recent years, the rapidly evolving digitalization, data coordination and its utilization has created a new reality in which people, organizations, logistics--in reality, almost everything--are constantly connected on a global level and mutually influence one another. In this mission area, we aim to realize a next-generation information society that enables creation of new values and immediate response to uncertain and discontinuous changes through collection of diverse and reliable data in the real world and connection with various things to them.

Prioritized Themes

- Human-centric Digital Twins Services Utilizing AI, Big Data and IoT(FY2022)
- Human centric digital twins services (FY2021)

◆"New Social Challenges" mission area

TAKAHASHI Keiko
R&D Supervisor (Program Officer)
(Senior Researcher/ Professor, Waseda University)

Overview

Japan faces a number of issues, including public health crises such as the new COVID-19 infection, unforeseen disasters, declining birthrate and aging population, climate change, rural-urban issues, food and resource problems, aging infrastructure, and the risk of natural disasters. Besides, there is demand for appropriate responses to the changes in Japan's security environment, and the need to increase the resilience of our land and social functions. In this mission area, we aim to solve such emerging social problems.

Prioritized Themes

- Sustainable and resilient social system for healthy nature (FY2022)
- Sustainable and resilient social system for healthy nature (FY2021)

◆"Society Optimized for Diversity" mission area

WAGA Iwao
R&D Supervisor (Program Officer)
(Senior Fellow, NEC Solution Innovators, Ltd.)

Overview

In the future, people's life is expected to be changed intrinsically. The modes of behavior and action such as transportation, business practices, and lifestyle habits will be specifically released from the constraints of physical space and time, and thus transformed. In addition, human resources that have not been able to play active parts in the past will be released from restrictions, and the social diversity will be improved. In this mission area, we aim to realize a society in which merchandises and services are optimized for various users.

Prioritized Themes

- Assistance and evaluation for enhancing human relationships(FY2022)
- Reproducible evaluation on our sequential states for social improvement (FY2021)

◆"Super Smart Society (Society 5.0)" mission area

MAEDA Akira
R&D Supervisor
(Program Officer)

(Former Corporate Chief Engineer, Information & Communication Technology Business Division, Hitachi Ltd.)

Overview

This research area is transdisciplinary, aiming to generate new value through the creation of industries and reformation of future society. Specifically, it includes spreading the utilization of networks and IoT not only to manufacturing industries but also to R&D in various other fields and strengthening base technologies (necessary for building a common platform through the effective utilization of IoT and base technologies that are a core of Japan's strength in creating new value, including advanced measurement technologies) for maintaining and strengthening the competitiveness of Japan as a super smart society. It also includes technologies related to space, such as satellite position measurement, satellite remote sensing, satellite communications, and satellite broadcasting.

Prioritized Themes

- Making full use of AI and simulation technologies across different fields for a human-centered society (FY2020)
- Innovative AI technologies for Sophisticated Integration of Cyber and Physical Services (FY2019)
- Modeling and AI that Connects the Cyber and Physical Worlds (FY2018)
- Establishment of a Service Platform that Enables Collaboration between Various Components and Creation of New Services (FY2017~)

◆"Sustainable Society" mission area

KUNIEDA Hideyo
R&D Supervisor
(Program Officer)

(Director, Aichi Synchrotron Radiation Center, Aichi Science and Technology Foundation)

Overview

This area focuses on technologically challenging targets to secure resources and food, aiming to realize a sustainable society in response to a super ageing and declining population. We aim to support a society of health and longevity by applying advanced technologies, developing social infrastructure for sustainable urban and local communities, and effectively and efficiently extending life-cycles of infrastructure. This will improve manufacturing and kotozukuri (story creation) competitiveness, preserve biodiversity, and so on. Research also includes marine technologies that contribute to the sustainable development and utilization of the ocean.

Prioritized Themes

- Breakthrough technologies to accelerate breeding and strain improvement in biological production for a sustainable society (FY2020)
- Enhancement of product durability and usability for resource-efficient society (FY2019)
- Creation of innovative food production technologies responding to future changes in climate and social demands (FY2018)
- Improving intellectual capability to enhance a "Societally Active life 2" for overcoming the reducing laborer force (FY2017)
- Innovation in manufacturing for new process of sustainable resource recycle (FY2017)

◆"Most Safe and Secure Society in the world" mission area

TANAKA Ken-ichi
R&D Supervisor
(Program Officer)

(Former Senior Engineer, Corporate Research and Development Group, Mitsubishi Electric Corporation)

Overview

This area responds to natural disasters; secures food safety, living environment, industrial health, and cyber security; and responds to national security issues.

Prioritized Themes

- Realization of wellbeing by feedback based on psychological states evaluated by objective methods (FY2020)
- Self-management of health based on the action mechanism of daily behaviors such as food, exercise and sleep (FY2019)
- Realization of a safe, secure, and comfortable town free from hazardous substances hiding in the living environment (FY2018)
- Creation of "human service" industries (FY2017)
- Development of the crisis navigator for individuals (FY2017)

Small-start Type

◆"Low Carbon Society" mission area

UOSAKI Kohei
R&D Supervisor
(Program Officer)

(Professor Emeritus, Hokkaido University/Emeritus Fellow, National Institute for Materials Science/Principal Fellow, CRDS, JST)

Overview

To realize a drastic reduction of GHG emissions by 2050, this area focuses on the stable securing of energy and on efficiency of energy use: energy saving technologies, higher efficiency of renewable energy, and stabilization of energy use through hydrogen or energy storage.

Prioritized Themes

- Realization of a low carbon society through game changing technologies (FY2017)

◆"Common Platform Technology, Facilities, and Equipment" mission area

OSAKABE Nobuyuki
R&D Supervisor
(Program Officer)

(Deputy General Manager, Business Strategy Planning Division, Connective Industries Division, Hitachi, Ltd.)

Overview

This is an area set to target common platform technology and cutting-edge research equipment that supports a wide variety of research activities. This area makes it possible to open up a new interdisciplinary field, support capabilities of basic science in Japan as a basis for generating world-leading research results, and contribute to creating sustainable science and technology innovation.

Prioritized Themes

- Realization of common platform technologies, facilities and equipment that create innovative knowledge and products (FY2018)

Large-scale Type

◆Large-scale Type

OISHI Yoshihiro
R&D Supervisor
(Program Officer)

(Counselor, Mitsubishi Research Institute, Inc.)

Overview

Technology themes are determined by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). For further details related to technology themes, please contact the Research and Development Infrastructure Division, Science and Technology Policy Bureau, MEXT.

Technology Themes

- Innovative microwave measurement techniques for a safe, secure, and smart society (FY2021)
- Innovative device technologies to achieve ultra-high level information processing in the age of trillion sensors (T Sensors) (FY2020)
- Innovative thermoelectric conversion technologies for stand-alone power supplies for sensors (FY2019)
- Ultrahigh precision time measurement technologies leading to a new time-business (FY2018)
- Development of innovative adhesion technologies for realizing Society 5.0 (FY2018)
- Innovative Hydrogen liquefaction technologies desired in future society (FY2018)
- Laser-plasma acceleration technologies leading to innovative downsizing and high energy of particle accelerators (FY2017)
- High-temperature superconducting wire joint technologies leading to innovative reduction of energy loss (FY2017)
- Quantum inertial sensor technologies leading to innovative high precision and downsizing of self-localization units (FY2017)

Programs (2022.4)

	"Small-start Type"		"Large-scale Type"
	Feasibility Studies	Full-scale R&D	
R&D period	2.5~4.5 years	Up to 5 years	Up to 10 years
R&D costs (direct costs)	35~60 million JPY/project	380~570 million JPY/project	2.7 billion JPY/ project

(Program budget of FY2022 : 9.1 billion JPY)

Number of Projects (2022.6)

R&D Mission Area		Program Officer: PO	Full-scale R&D	Feasibility Studies
"Small-start Type"	"Advanced Intelligent Information Society" mission area	MAEDA Eisaku	0	11
	"New Social Challenges" mission area	TAKAHASHI Keiko	0	11
	"Society Optimized for Diversity" mission area	WAGA Iwao	0	11
	"Super Smart Society (Society 5.0)" mission area	MAEDA Akira	2	7
	"Sustainable Society" mission area	KUNIEDA Hideyo	4	6
	"Most Safe and Secure Society in the world" mission area	TANAKA Ken-ichi	4	12
	"Low Carbon Society" mission area	UOSAKI Kohei	4	40
	"Common Platform Technology, Facilities, and Equipment" mission area	OSAKABE Nobuyuki	4	18
"Large-scale Type"		OISHI Yoshihiro	9	

Application

		Number of adoptions	Number of proposals
FY2021	"Small-start Type"	46	288
	"Large-scale Type"	1	3
	Total	47	291

Research Activities (FY2021)

Paper	1,207
Patent	155
Press release	1,424
Prize	242

Full-scale R&D Project

"Super Smart Society (Society 5.0)" mission area

Prioritized Theme Modeling and AI that Connects the Cyber and Physical Worlds

Development of Smart Robot for Revolution of Industry

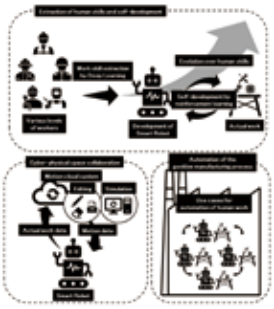
https://www.jst.go.jp/mirai/en/program/super-smart/JPMJMI21B1.html (2021.05-)

OHNISHI Kouhei
Project Leader
(Project Professor, Shin-Kawasaki Frontier Research & Education Collaborative Square, Keio University)

If the skills contained in the motion of experienced worker can be extracted and transferred to a robot, the scope of automation can be expanded to include atypical tasks (i.e., tasks that flexibly adapt to changes in the characteristics of an object) that are impossible with existing industrial robot. In order to achieve the above goals, the issues that need to be resolved are as follows.

1. The robot could acquire the skills of each experienced worker (learning skills).
2. Utilizing the expertise of experienced workers contained in the acquired skills to enable the robot to perform flexible movements adapted to the work object (using skills).
3. Evolving the robot ability to respond to all situations, including the unexpected and unknown (evolving skills).

The above issues can be solved by making robots smarter through advanced integration of real haptics and AI technologies. The project will bring some key technologies in the manufacturing process appeared in smart society.



The goal of smart robotics.

* This project is launched by integrating the following feasibility studies;
"GAN-based Robot Modeling and Its Application to Autonomous Manufacturing" (MORIMOTO Jun) , "Building a fast optimization technique for simulation based on machine learning" (YAMAZAKI Keisuke) and "Smart Robot Evolved by Learning Human Skill" (OHNISHI Kouhei)

"Super Smart Society (Society 5.0)" mission area

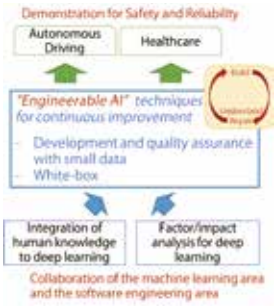
Prioritized Theme Modeling and AI that Connects the Cyber and Physical Worlds

Engineerable AI Techniques for Practical Applications of High-Quality Machine Learning-based Systems

https://www.jst.go.jp/mirai/en/program/super-smart/JPMJMI20B8.html (2021.01-)

ISHIKAWA Fuyuki
Project Leader
(Associate Professor, Information Systems Architecture Science Research Division, National Institute of Informatics)

Machine learning techniques enable to implement functionality that satisfies a fuzzy goal in an inductive way by training from data. However, this approach makes it impossible to handle rare situations or to understand and fix performance limitations over many situations. This characteristic poses an obstacle in application to safety- and reliability-critical domains.
We envision techniques for "Engineerable AI" that support development, quality assurance, and operation of AI systems, thus promoting practical applications of high-quality AI systems. We develop techniques for construction of AI by incorporating human knowledge into deep learning and for assurance and improvement by extracting and analyzing factors affecting the target quality. We promote this research by collaboration of the machine learning area and the software engineering area and demonstrate the effectiveness in autonomous driving and healthcare.



* This project is launched by integrating the following feasibility studies;
"Design of Data-driven Hierarchical Supervisor Using Formal Methods" (USHIO Toshimitsu) , "Development of a new deep-learning model that can handle both images and symbolic data and studies on its interaction with humans" (SUZUKI Kenji) and "Value Creation by Reliable Machine Learning-based Systems" (YOSHIOKA Nobukazu)

"Sustainable Society" mission area

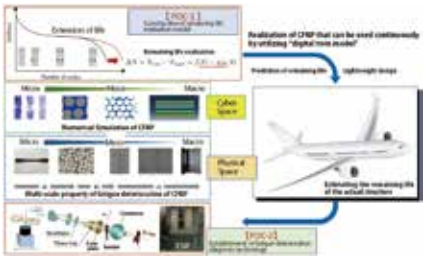
Prioritized Theme Enhancement of product durability and usability for resource-efficient society

Elucidation of fatigue deterioration mechanism and establishment of evaluation method to estimate the remaining life of CFRP laminates

https://www.jst.go.jp/mirai/en/program/sustainable/JPMJMI22C1.html (2022.04-)

ARAI Masahiro
Project Leader
(Professor, Department of Aerospace Engineering, Nagoya University)

CFRP is expected to be significantly lighter in airplanes and automobiles, and as a result, it is expected to be a material that can effectively reduce carbon dioxide emissions. To reduce CO_2 emissions by extending the service life of the aircraft, it is important to evaluate the damage and remaining life of these devices during long-term use. In this study, we will elucidate the mechanism of damage occurrence and progression of the CFRPs, and construct a model of damage and destruction. By establishing CFRP fatigue deterioration diagnosis technology and combining it with a fatigue/fracture evaluation model, highly accurate remaining life evaluation will be realized. By effectively combining the fatigue/fracture model and physical property evaluation methods such as entropy, electron spin, and thermal conductivity, the damage progress of CFRP and its remaining life are appropriately evaluated, and finally the total life of the CFRP structures is doubled in the present approach.



* This project is launched by integrating the following feasibility studies;
"Quantification of Lifetime for Thermoplastic CFRP Based on Entropy Damage" (KOYANAGI Jun) , "Realization of non-destructive observation techniques of defects & cracks triggering fatigue and degradation" (KIMURA Masao), "Evaluation of Microscale Degradation based on High Sensitivity Measurement of Thermal Wave Propagation Behavior" (NAGANO Hosei), "Operando micro-measurement analysis method for CFRP composite degradation and a model for remaining life estimation" (MARUMOTO Kazuhiro) and "Development of material design and evaluation system improving long-term reliability of CFRP laminates" (ARAI Masahiro)

"Sustainable Society" mission area

Prioritized Theme Creation of innovative food production technologies responding to future changes in climate and social demands

Development of Next Generation Sustainable Aquaculture System

https://www.jst.go.jp/mirai/en/program/sustainable/JPMJMI21C1.html (2021.06-)

NAKAYAMA Ichiro
Project Leader
(President, Japan Fisheries Research and Education Agency)

We develop a next-generation aquaculture system that integrates novel "food" "seeds" and "places" research.
We conduct researches on novel "feed", "seed", and "place" for sustainable aquaculture; fish-free feed, short-term seed development, and aquaculture system with environment adaptability. We integrate the outputs of research to a new aquaculture system applicable to various environments and fish species in Japan to support Japan's rich food culture.
The research will lead to the sustainable supply of the world's high-quality protein sources and the maintenance and conservation of marine resources.

* This project is launched by integrating the following feasibility studies;
"Development of resources-recycling aquaculture feeds inspired from features of the ecosystem" (OGAWA Jun) and "Next-generation fish breeding by combination of developmental biotechnology and genomic selection" (YOSHIZAKI Goro)

"Sustainable Society" mission area

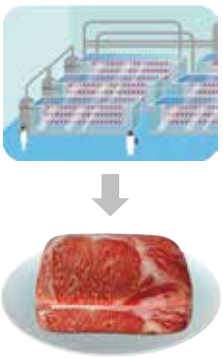
Prioritized Theme Creation of innovative food production technologies responding to future changes in climate and social demands

Development of the production technology for next generation-meat using 3D tissue engineering techniques

https://www.jst.go.jp/mirai/en/program/sustainable/JPMJMI20C1.html (2020.04-)

TAKEUCHI Shoji
Project Leader
(Professor, Graduate School of Information Science and Technology, The University of Tokyo)

This project aims to establish the technology for the industrial production of cultured steaks using bovine muscle cells.
In order to sustainably produce cultured steaks, it is necessary to establish methods for the low-cost and sustainable mass culture of bovine myoblasts, the fabrication of cm-size mature skeletal muscle tissues, and the evaluation of their safety and taste. We will solve these problems by advancing and combining the current technologies owned by the R&D team, such as algaebased culture medium technology, floating mass culture technology, 3D skeletal muscle tissue construction technology, and food evaluation technology.
For the development of cultured meat, the major focus has been on the production of minced meat, and the cultured steaks has not yet been achieved. However, since steaks has higher consumer preference and higher unit price, it is assumed that cultured steaks will have higher possibility to generate real-world impacts. The cultured steaks that solved the above problems will be the next-generation foods capable of contributing to a sustainable and healthy society.



* This project is launched by integrating the following feasibility studies;
"Innovative cultured meat production system using algae and animal cells" (SHIMIZU Tatsuya) , "Development of Automatic Production Technology for The Best Safety Cultured Meat in the World by Tissue Engineering Approach" (MATSUSAKI Michiya) and "Development of the production technology for next generation-meat using 3D tissue engineering techniques" (TAKEUCHI Shoji)

"Sustainable Society" mission area

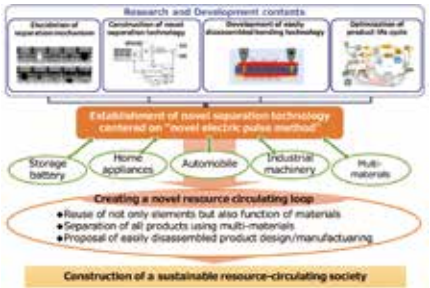
Prioritized Theme Innovation in manufacturing for a new sustainable resource recycle

Construction of integrated circular production system by product lifecycle management and innovative dismantling technology development

https://www.jst.go.jp/mirai/en/program/sustainable/JPMJMI19C7.html (2019.12-)

TOKORO Chiharu
Project Leader
(Professor, Faculty of Science and Engineering, Waseda University)

High resource efficiency and waste minimization are a big issue to realize a sustainable society. Especially in recent days, the trend of "multi-materialization" that combines different materials is growing in the automobile industry and sophisticated separation technology for them is strongly desired.
In this project, we develop the novel, high-selectivity, and high-efficient separation technology for different materials by pulsed electric discharge. To accomplish it, the separation mechanism and optimum control method are elucidated as fundamental research and development. At the same time, we promote easily disassembled design and manufacturing processes based on the above mentioned obtained knowledge. We contribute to the realization of a resource-circulating society by it coupled with the simulation tool to optimize a product life cycle based on the novel manufacturing system.



Full-scale R&D Project

"Most Safe and Secure Society in the world" mission area

Prioritized Theme Realization of a safe, secure, and comfortable town free from hazardous substances hiding in the living environment

Realization of Safe and Secured Water Cycle System Supporting Healthy Society and People

https://www.jst.go.jp/mirai/en/program/safe-secure/JPMJMI22D1.html (2022.04-)

TANAKA Hiroaki
Project Leader
(Specially Appointed Professor, Faculty of Engineering, Shinshu University/Professor Emeritus, Kyoto University)

Water is an inevitable resources in daily lives, and is recycled among human and social activities, and the water environment. Origins and whole pictures of the human health risk factors including hazardous chemicals, pathogenic bacteria and viruses, antibiotic resistance, etc. relevant to water is not disclosed well. Therefore, our present water infrastructures cannot bring human risk zero in all water applications. This project aims at identification of critical control points on such human health risk factors, risk evaluation to lower the human health risk to reasonably acceptable levels, development of high-performance and low- cost water treatment system, and development of wastewater-based epidemiology for social implementation, which is introduced to water infrastructures to realize safe and secured water application.

* This project is launched by integrating the following feasibility studies;
"Novel VUV/MBR for Production of Water with Reliable Quality " (MATSUI Yoshihiko) and "Reduction of Bio-Risk at Critical Control Points by High-Standard Water Treatment" (TANAKA Hiroaki)

"Most Safe and Secure Society in the world" mission area

Prioritized Theme Realization of a safe, secure, and comfortable town free from hazardous substances hiding in the living environment

Realization of a pandemic-free society by graphene FET sensors with quickly detectable human infectious viruses

https://www.jst.go.jp/mirai/en/program/safe-secure/JPMJMI22D2.html (2022.04-)

MATSUMOTO Kazuhiko
Project Leader
(Specially Appointed Professor, The Institute of Scientific and Industrial Research, Osaka University)

In order to quickly identify the type of human infective virus to improve the lifesaving rate, we realize a highly sensitive on site detection system that can instantly and immediately determine multiple types of viruses. Graphene field-effect transistors with ultra-sensitive characteristics are integrated and arrayed, and using a bio-inkjet printer, individual transistors are modified with multiple types of antibodies and sugar chains to which viruses selectively bind. Using these technologies, we will build an on site system that can determine the type of virus, its subtype, and human infectivity within a few tens of minutes just after collecting the virus sample. In order to dramatically improve the infection protection rate in society, we will develop a simple detection system that can detect viruses directly from saliva with high sensitivity so that anyone can easily detect viruses at home every day, and create a safe living space. Furthermore, we will develop a basic technology that can detect the presence or absence of a virus in the living space from the exhaled breath or the atmosphere.
With these results, it becomes possible to immediately measure the presence and type of human infectious virus, determine its risk as soon as possible, and prevent a pandemic due to the spread of infection.

"Most Safe and Secure Society in the world" mission area

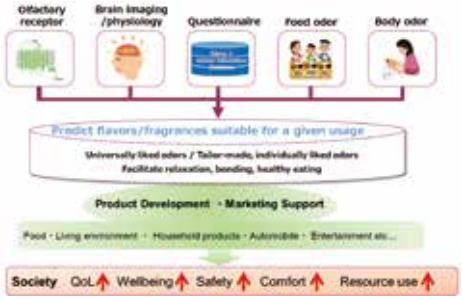
Prioritized Theme Creation of "humane service" industries

Providing humane services by expanding the function of flavor and fragrance

https://www.jst.go.jp/mirai/en/program/safe-secure/JPMJMI19D1.html (2019.04-)

TOUHARA Kazushige
Project Leader
(Professor, Department of Applied Biological Chemistry Graduate School of Agricultural and Life Sciences, The University of Tokyo)

Flavor and fragrance have great influences on our daily life such as bringing good taste in foods and good mood. Their effects, however, usually vary among individuals and the precise effects on our body and emotion have not fully been evaluated. This fact makes it difficult to utilize the beneficial functions of flavor and fragrance. In this project, we aim to develop new technologies to design and control flavor and fragrance based on the biological principle, and new methodologies to evaluate the effects on human. Finally, we will create new services to efficiently utilize previously-unappreciated benefits of flavor and fragrance.



"Most Safe and Secure Society in the world" mission area

Prioritized Theme Development of the crisis navigator for individuals

Crowd control adaptive to individual and group attributes

https://www.jst.go.jp/mirai/en/program/safe-secure/JPMJMI20D1.html (2020.04-)

NISHINARI Katsuhiro
Project Leader
(Professor, The University of Tokyo)

In the future society, it is expected that more and more opportunities of gathering people of a wide range of age groups and diverse nationalities will take place due to super aging and internationalization. Therefore, in order to prevent crowd accidents and to ensure that everyone can move with confidence, we will construct a system that provides mobility information services to individuals taking into account individual and group attributes. For this reason, we develop highly accurate crowd simulator and optimum control system of whole crowd, which contribute to safe and secure society.

"Low Carbon Society" mission area

Prioritized Theme Realization of a low carbon society through game changing technologies

Innovation of microalgal cultivation and utility systems using acidic water

https://www.jst.go.jp/mirai/en/program/lowcarbon/JPMJMI22E1.html (2022.04-)

MIYAGISHIMA Shin-ya
Project Leader
(Professor, National Institute of Genetics)

Microalgae are expected to be a new green industry that does not compete with agricultural products. However, the production cost is high due to contamination of other microorganisms and the low culture density. As a result, and their use is limited to expensive supplements. In addition, the shortage of fresh water on a global scale limits the scale of microalgal cultivation. Moreover, genetic modification has not been established in microalgal industry.
In this research and development project, by using sulfuric hot spring microalgae Cyanidiales, we will develop a procedure for outdoor microalgal cultivation in acidified seawater to a high density which leads to an reduction of production cost. The algae produced will be used as fish feed. In addition, we will establish a genome editing technology for Cyanidiales for producing biofunctional substances.
Through this development, we aim to expand the scale of use of microalgae, reduce CO_2 (32 million tons / year / world), and contribute to stable food production and improving human and animal health.

"Low Carbon Society" mission area

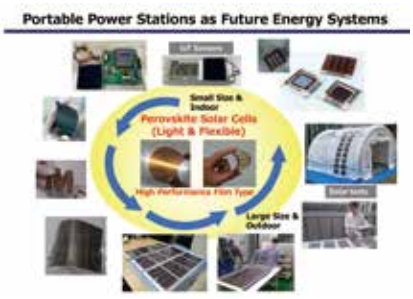
Prioritized Theme Realization of a low carbon society through game changing technologies

Pb-free Perovskite Solar Cells Consisting of Sn

https://www.jst.go.jp/mirai/en/program/lowcarbon/JPMJMI22E2.html (2022.04-)

WAKAMIYA Atsushi
Project Leader
(Professor, Institute for Chemical Research, Kyoto University)

We will develop high performance of Sn-based perovskite solar cells using environmentally friendly, Pb-free materials, which could be commercialized at large scale.
It has become clear that the efficiency of Sn-based perovskite solar cells is held back by the large density of trap sites present in the perovskite absorbers. The origin of these trap sites, which act as recombination centers for the generated charge, are impurities and lattice defects arising from the facile oxidation of Sn(II)-containing materials.
In our exploratory research on this topic, we have improved the performance of Sn-based perovskite solar cells by focusing on the fabrication of high-quality perovskite semiconductor thin films. This included developing the necessary high-quality proprietary starting materials. These efforts have led to world-leading results.



In the proposed research, based on the results and knowledge gained to date, we will pursue the development of original materials focusing on elemental hybridization (alloying) to further optimize high-quality perovskite semiconductor thin films and devices. Through these efforts, we aim to achieve Sn-based perovskite solar cells with ultra-high performance (single-layer devices with >20% efficiency, tandem devices with >30% efficiency) and high durability (>20 years).

Full-scale R&D Project

"Low Carbon Society" mission area

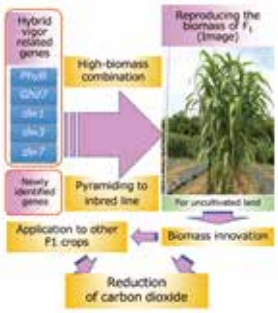
Prioritized Theme Realization of a low carbon society through game changing technologies

Biomass innovation by elucidating the principle of hybrid vigor

https://www.jst.go.jp/mirai/en/program/lowcarbon/JPMJMI21E1.html (2021.06-)

SAZUKA Takashi
Project Leader
(Professor, Biosci. and Biotech. Center, Nagoya University)

The purpose of this project is to breed the crops needed to realize the low-carbon society. From this perspective, we focus on high biomass sorghum. We utilize the five important genes that are necessary and sufficient for hybrid vigor of sorghum revealed in our previous study. By pyramiding these genes, new inbred varieties will be bred with almost the same biomass as F1 hybrids. We will also try to identify new important genes for the above purpose.
In addition, for the development of fermentation technology in biorefinery using sorghum, we will categorize by the juice ingredients of the varieties, and also evaluate the effect by microorganisms for the fermentation.



"Low Carbon Society" mission area

Prioritized Theme Realization of a low carbon society through game changing technologies

Future society opened by direct dynamic wireless power transfer to EV

https://www.jst.go.jp/mirai/en/program/lowcarbon/JPMJMI21E2.html (2021.06-)

FUJIMOTO Hiroshi
Project Leader
(Professor, Graduate School of Frontier Sciences, The University of Tokyo)

Problem of existing EV is shorter cruse-range and longer charging time.
Solved by DWPT from road coils in part of highways. Realize smart EV community without plug-in charging.
Early realization of a carbon-neutral society by DWPT EV

Demonstration test of smart EVs for the widespread of Dynamic Wireless Power Transfer.

"Common Platform Technology, Facilities, and Equipment" mission area

Prioritized Theme Realization of common platform technologies, facilities and equipment that create innovative knowledge and products

Four-Dimensional Topological Data Analysis for Future Medical Care

https://www.jst.go.jp/mirai/en/program/core/JPMJMI22G1.html (2022.04-)

SAKAJO Takashi
Project Leader
(Professor, Graduate School of Science Division of Mathematics, Kyoto University)

We shall establish a new methodology of data analysis, called "Four-dimensional topological data analysis (4d-TDA)", tracking the time evolution of geometric structures in various data with mathematically rigorously. In particular, applying 4d-TDA to issues in the fields of medicine and drug development, we shall contribute to a realization of a future society providing high-quality medical care to everyone at a lower cost.
4d-TDA consists of topological flow data analysis (TFDA) and persistent homology (PH) combined with data-driven mathematical modeling.
Our research objectives are:

- Creating a new classification for cardiovascular diseases based on blood flow structures in the heart; developing a software applicable to clinical diagnosis with echocardiography and MRI.
- Designing conditions for effective clinical trials, which reduces the time and the number of participants, for antiviral drugs against infectious disease such as COVID-19 by predicting dynamics of biomarkers.
- Establishing a common platform that provides mathematical solutions to many problems in human society.

* This project is launched by integrating the following feasibility studies;
"Quantitative approach for genome evolution dynamics based on multiscale mathematical mode" (IWAMI Shingo) and "Comprehensive R&D Platform for Topological Data Analysis" (SAKAJO Takashi)

"Common Platform Technology, Facilities, and Equipment" mission area

Prioritized Theme Realization of common platform technologies, facilities and equipment that create innovative knowledge and products

Development of Minimally Invasive High-throughput Optical Condensation System

https://www.jst.go.jp/mirai/en/program/core/JPMJMI21G1.html (2021.06-)

IIDA Takuya
Project Leader
(Professor, Graduate School of Science / Director, Research Institute for LAC-SYS, Osaka Metropolitan University)

We will develop a system accelerating biochemical reactions by "optical condensation" of a very small amount of biological samples (protein, DNA, microbe, cell, etc.) with maintaining their functions at the aimed position, and innovate the fields of preventive medicine, food inspection, and environmental measurement.
Utilizing the synergistic effect of light-induced force and light-induced convection, we clarify a principle for "optical condensation" of biological materials for the acceleration of their reactions, and develop extremely rapid and highly sensitive detection method. Particularly, we will clarify mechanisms of intermolecular interaction under optical condensation, and establish a high-throughput measurement technology for an ultra-early diagnostic method in the medical field. Furthermore, by developing a multipurpose optical condensation system, we will expand applications to the detection of microorganisms and environmentally hazardous substances, and provide innovations in food inspection and environmental measurement.

"Common Platform Technology, Facilities, and Equipment" mission area

Prioritized Theme Realization of common platform technologies, facilities and equipment that create innovative knowledge and products

Materials Exploration Platform; Expanding Search Space by high-throughput technology

https://www.jst.go.jp/mirai/en/program/core/JPMJMI21G2.html (2021.06-)

NAGATO Keisuke
Project Leader
(Associate Professor, Graduate School of Engineering, The University of Tokyo)

In order to improve efficiency of material research and development, we build a new material search method "Materials Exploration Platform", utilizing experience which is Japan's strengths.
POCs are following three for KPI of 1,000-times throughput on battery materials synthesis;
① High-throughput autonomous exploration systems;
- "Prototype": autonomous experiment system
- "Measure": automatic crystal structure analysis
- "Accumulate": properties prediction system

② Data-driven/hypothesis-driven hybrid research style;
"Understand (induce inspiration based on experience)" is connected to "P" ➡ "M" ➡ "A" by machine learning.
③ Knowledge shearing;
Knowledge obtained from data, inspirating researchers, is shared with R&D institution, R&D company, and measuring instrument manufacturers for future materials R&D ecosystem.

* This project is launched by integrating the following feasibility studies;
"Multiscale Multimodal Materials Structure Analysis System" (ONO Kanta), "Development of Materials Design Workflow and Data Library for "Materials Foundry"" (CHIKYOW Toyohiro), "Materials Robotics: A new research style for materials science" (HITOSUGI Taro) and "Data-driven Process Informatics for higher-throughput researches on powder film-formation process" (NAGATO Keisuke)

"Common Platform Technology, Facilities, and Equipment" mission area

Prioritized Theme Realization of common platform technologies, facilities and equipment that create innovative knowledge and products

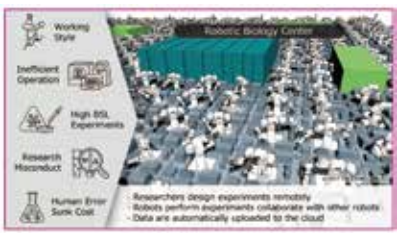
Accelerating Life Sciences by Robotic Biology

https://www.jst.go.jp/mirai/en/program/core/JPMJMI20G7.html

(2021.01-)

TAKAHASHI Koichi
Project Leader
(Team Leader, Center for Biosystems Dynamics Research, RIKEN)

Laboratory automation is a key to solving a multitude of problems that today's life sciences are facing, including poor reproducibility, inefficient operations of expensive laboratory equipment, research misconducts, and laborintensive working style. Although laboratory automation itself is not new and an increasing number of automation apparatuses are becoming commercially available, most of those products are specialized to executing some specific experimental or measurement procedures, still requiring human operators who work as 'glues' between machines, conveying samples and reagents between them, or reading and interpreting measurements. Therefore, the total efficacy of automated experiments facilities are still bound by accuracy and labor of humans.
In this project, we will develop a package of technologies including a formal experimental protocol description language, IoT systems architectures and their implementations to enable coordinated operations of various robots and machinery, and demonstrate their performance in several important applications areas including proteomics, genome editing, and stem cell culture.



JST-MIRAI PROGRAM

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