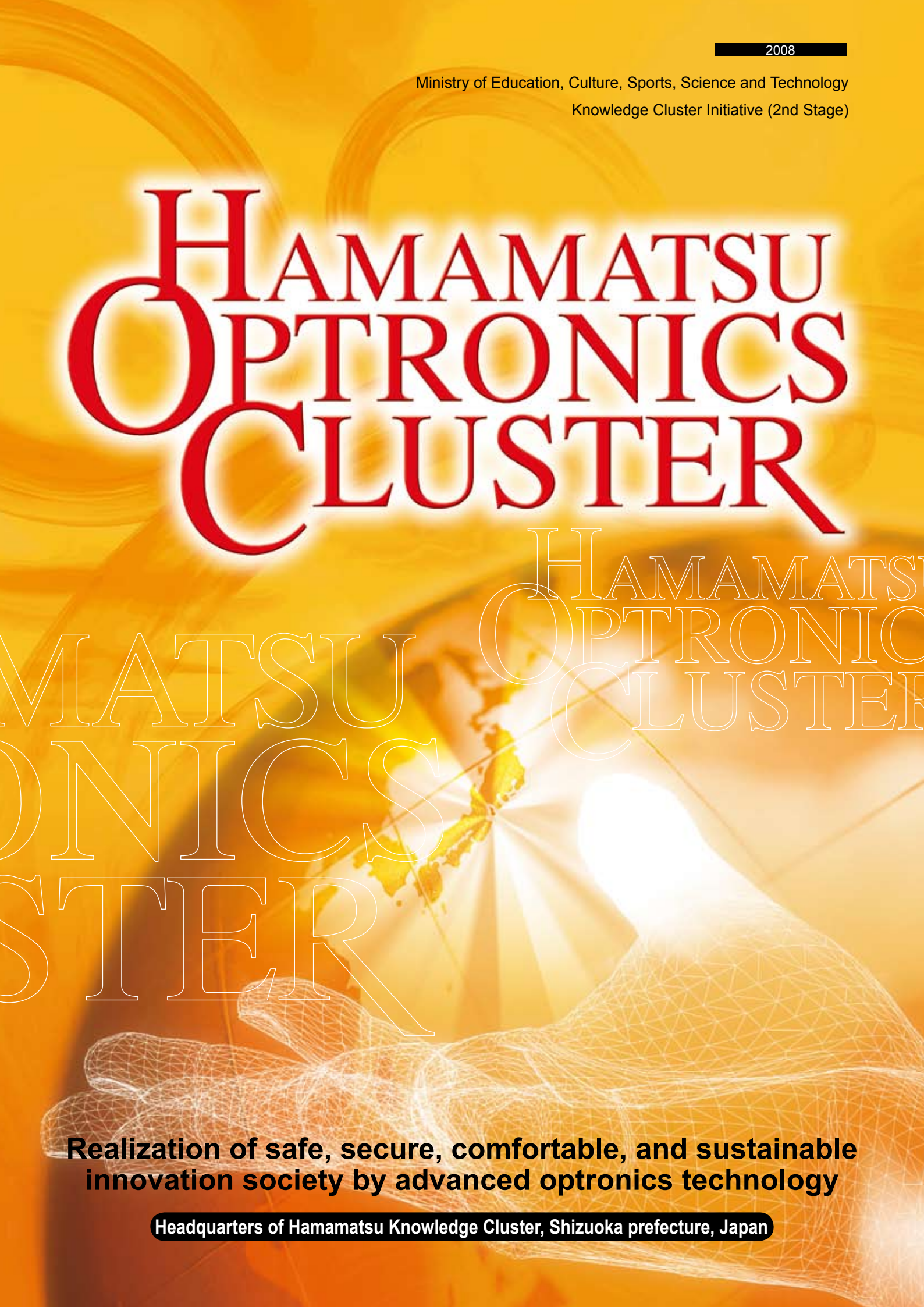
2008

Ministry of Education, Culture, Sports, Science and Technology

Knowledge Cluster Initiative (2nd Stage)

HAMAMATSU OPTRONICS CLUSTER



Realization of safe, secure, comfortable, and sustainable innovation society by advanced optronics technology

Headquarters of Hamamatsu Knowledge Cluster, Shizuoka prefecture, Japan

Hamamatsu Optronics Cluster Initiative

The Hamamatsu Optronics Cluster Initiative intends to integrate businesses, institutes, and researchers in the field of optronics. Such integration will help foster an environment conducive to the creation of new business enterprise. At its core, this large-scale repository of art and knowledge will encompass the Greater Hamamatsu Area and will incorporate the east Mikawa region extending around the City of Toyohashi in Aichi Prefecture. It will also include other advanced areas in both domestic and overseas regions.

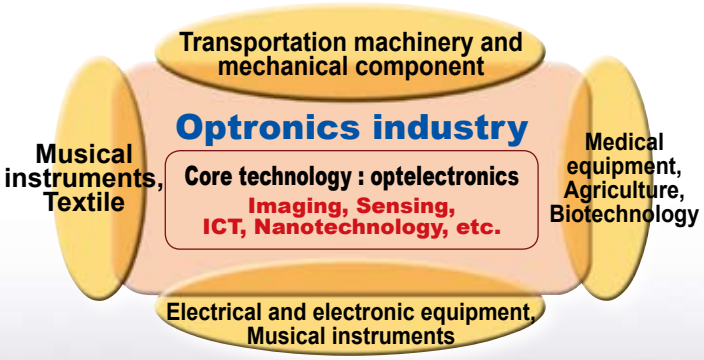
Potential of the Greater Hamamatsu Area

The Greater Hamamatsu Area is located 240km southwest of Tokyo and is blessed with a balmy climate and much natural beauty. The area has a unique local cultural spirit referred to as 'Yaramaika' in Japanese, which means 'Go for it!' or 'Just do it!' in English. This spirit encourages people to tackle all challenges and it especially thrives in the technology sector. It is evident by the number of internationally renowned companies which have roots in Greater hamamatsu Area. The most notable successes are in the fields of transportation, machinery, and musical instruments. In addition to the global companies, these fields include numerous state-of-the-art business entities and R&D enterprises. In this area, academic research institutions including Shizuoka University (Faculties of Engineering and Information, the Research Institute of Electronics), the Hamamatsu University School of Medicine, The Hamamatsu Industrial Research Institute of Shizuoka Prefecture, various R&D companies possessing advanced technologies, and other public testing and research organizations, have been working together in order to develop new technologies and products. Local industry organizations such as the Hamamatsu Chamber of Commerce and Industry and the organization for Hamamatsu Technopolis are closely tied together to provide substantial support and increase cooperation between industry, universities and local government.

Toyohashi City is in the east Mikawa region of Aichi Prefecture and the University of Toyohashi serves as a core institute in this area. It is geographically close to the greater Hamamatsu area. Hamamatsu and Toyohashi are jointly promoting the Industrial Cluster Project.

Vision

The Hamamatsu Optronics Cluster is the driving force behind promoting research and development in the field of optoelectronics and supporting the creation of new industry. Our aim is to create more value within a chain of innovative technologies and products with a focus on medical technologies, agribusiness, biotechnology, transportation, machinery, musical instruments, and textile industries.



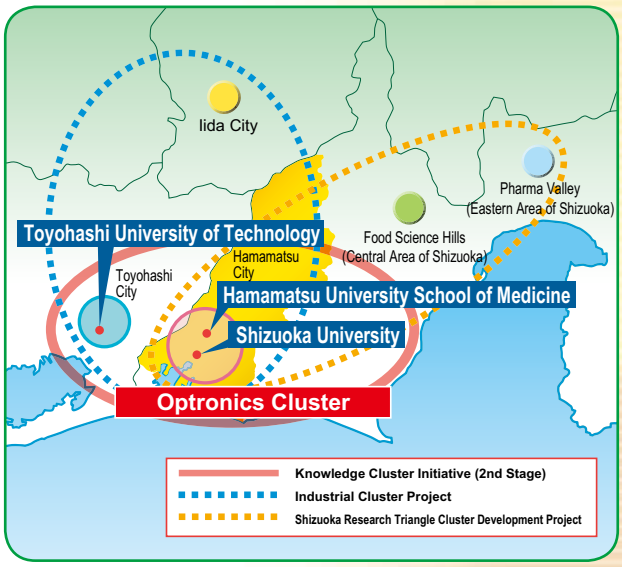
■ Overview of Hamamatsu Area Knowledge Cluster Initiative

“Realization of safe, secure, comfortable, and sustainable innovation society by advanced optronics technology”

To further extend from the above basic concepts, this project will push the base technology fostered in the first stage to a more advanced level, help achieve technical innovations in this new field while spreading overseas and domestically, and develop to a powerful R&D resource respected all over the world.

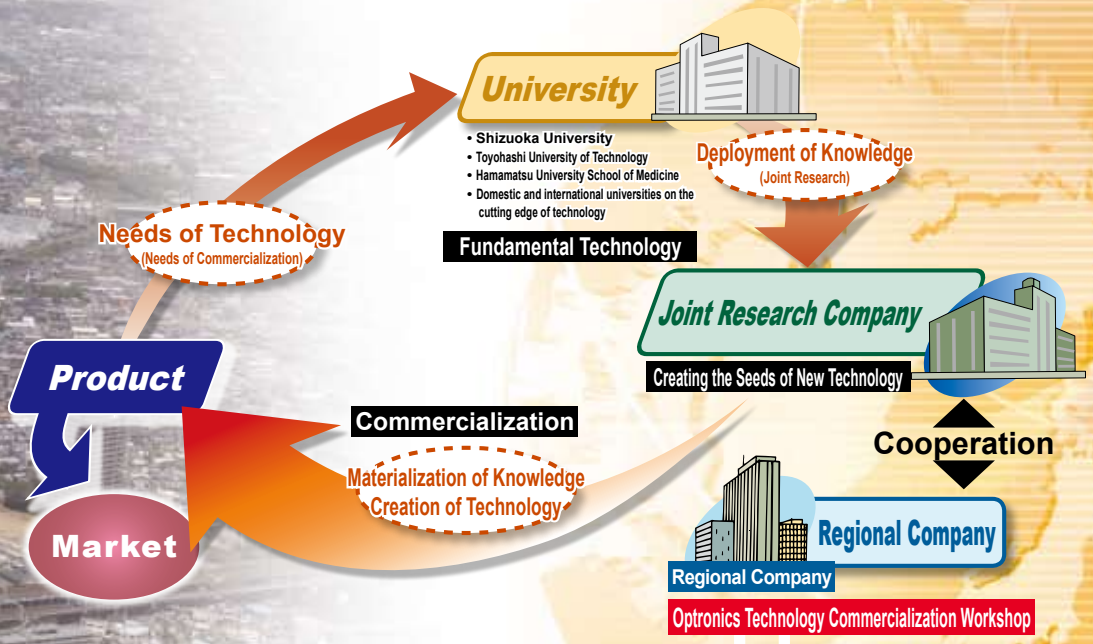
- **Development of high functional imaging devices and intellectual information process**
- **Construction of support environment for human activities**
- **Development of observation and fabrication support system for ultra fine object**

Broadly grouped into the above 3 themes, this project will make maximum use of domestic and international research and development institutions based on a nucleus formed by Shizuoka University, Toyohashi University of Technology, and Hamamatsu University School of Medicine.



■ Structure of Project

Our joint R&D effort will focus the developmental power of regional and outside companies on the seeds of new technology at universities to create the beginnings of a new technology with commercial applications.
In order to rapidly commercialize new technology seeds, we will actively take advantage of projects being undertaken by relevant ministries and governmental offices, including industry cluster projects, as well as grant programs for the results of research awarded by local governments.



■ Research and Development in the Second Stage

This project incorporates the following 16 themes for covering 3 fields with 15 themes involving devices, measurement equipment, and systems, and the single theme of innovation management to create an optronics cluster in the region.

1 Development of High Functional Imaging Devices and Intellectual Information Process

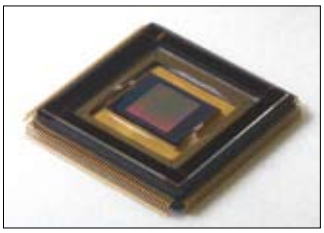
Along with imaging, measuring, and communication devices for traffic handling, industrial, medical, and information processing, work is also underway on developing device applications as support technology to build a safe, secure, and comfortable world around us.

1-1 Highly Sensitive Uncooled CMOS Image Sensor

◆Project Leader: Professor Shoji Kawahito, Research Institute of Electronics, Shizuoka University 《URL》 http://www.idl.rie.shizuoka.ac.jp/

Professor Shoji Kawahito

A super-low brightness image-capturing CMOS image sensor using noise-reduction, wide dynamic range (wide DR), and signal processing technology is under development as a high-sensitive light detector capable of capturing images over a wide brightness range even down to a single electron at room temperatures.
The sensor is for a compact high-sensitivity wide DR camera needing no cooler device. It offers great possibilities in a wide range of applications such as bioimaging and scientific measuring camera for capturing ultra-weak light, night-vision cameras mounted in vehicles for finding pedestrians under the glow of oncoming vehicle headlights, and security cameras used for night-time surveillance of poorly illuminated areas, etc.

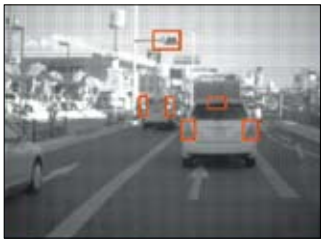


Highly Functional CMOS Image Sensor

1-2 Image Sensor for Optical Information Communication

◆Project Leader: Professor Shoji Kawahito, Research Institute of Electronics, Shizuoka University 《URL》 http://www.idl.rie.shizuoka.ac.jp/

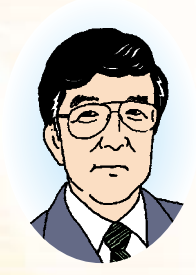
LED (light emitting diodes) are now used in signaling devices and vehicle taillights. New CMOS image sensor developed in the project is for new traffic system in which LED lights are utilized to send and receive data of car-to-road or car-to-car by overlapping traffic information onto the light. The sensor has new function to trace the light and communicate with the light of traffic signals or taillights.
The sensor also shows great potential for use in short distance communication systems besides contributing to safe vehicle driving.



1-3 Development and Application of Time Correlation Image Sensor

◆Project Leader: Professor Shoji Kawahito, Research Institute of Electronics, Shizuoka University 《URL》 http://www.idl.rie.shizuoka.ac.jp/

Professor Shigeru Ando, Graduate School of Information Science and Technology, The University of Tokyo 《URL》 http://www.alab.t.u-tokyo.ac.jp/~ando/index-j.html

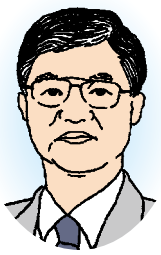


Professor Shigeru Ando

The time correlation image sensor was conceived by Prof. Ando as a sensor for irradiating a moving light pattern onto an object to acquire the image intensity signal distribution of the light the same as for an ordinary image, while also acquiring its time-correlated information. To allow high-speed sensor operation, Prof. Kawahito developed an entirely new time-correlated image sensor that utilizes high-speed charge transfer technology.
A broad range of measurement equipment combining this newly developed sensor with Prof. Ando's signal processing technology are under development and include industrial and technological applications such as real-time 3D moiré measurement, visualization of physical quantities such as 3D shape vibration, refraction and dielectric constants, as well as high-speed 3D contour inspection and flaw detection of electronic products.

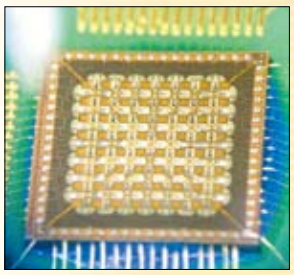
1-4 Intelligent Image Sensor using Ferroelectric Thin Film on Epitaxial Oxide Layer for IR or Ultrasonic Waves

◆Project Leader: Professor Makoto Ishida, Department of Electrical and Electronic Engineering, Toyohashi University of Technology 《URL》 http:///icg.dev.eee.tut.ac.jp/index_j.html



Professor Makoto Ishida

Imaging devices that integrate ferroelectric thin films sensors and silicon integrated circuits are under development for sending and receiving infrared and ultrasonic waves with far greater sensitivity than was possible up till now. These sensors are fabricated by epitaxially developing a strong ferroelectric material with a polarized crystal orientation enclosing an oxidized film (epitaxial alumina film) on a silicon substrate. The sensor can be used in many devices using infrared or ultrasonic waves for medical treatment, welfare, and industrial fields where safety, security, comfort, and energy-saving features are needed. It is also useful for 3D recognition of object depth contours.

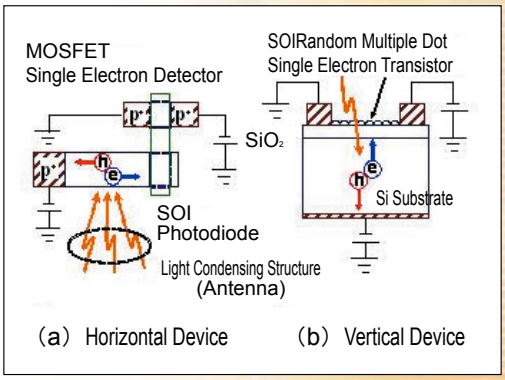


1-5 Single-Electron Device and Information Compression Circuit with Single-Photon Sensitivity

◆Project Leader: Professor Hiroshi Inokawa, Research Institute of Electronics, Shizuoka University 《URL》 http://www.rie.shizuoka.ac.jp/~nanosys/

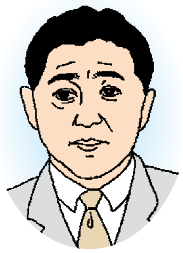
Professor Hiroshi Inokawa

Single electron devices are highly sensitive electrical charge detectors and handles minimum electrical charges. New type photon detectors (Fig. (a) or Fig. (b)) capable of directly sensing single electron emitted by photons. The detector including low-power data compression circuits using single-electron transfer does not need any electron multipliers that usually cause noise and signal jitter. It is made using SOI (silicon-on-insulation) technology for higher sensitivity, operating speed and temperature.
The detectors will remove the previous limits of measurement spectrum in the fields of medicine, physics, chemistry, physiology, and aerospace.



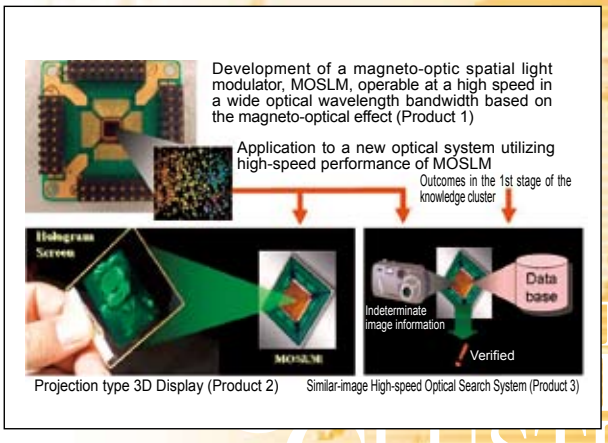
1-6 Wide-wavelength-band Super-high-speed MOSLM and Application to Optical IT System

◆Project Leader: Professor Mitsuteru Inoue, Department of Electrical and Electronic Engineering, Toyohashi University of Technology 《URL》 http://www.maglab.eee.tut.ac.jp/



Professor Mitsuteru Inoue

Current development work includes a magneto-optic spatial light modulator or MOSLM capable of high-speed operation over a wide optical wavelength band, and a high-reality projection type 3D display that combines the MOSLM with holographic screen technology. The 3D display projects directional images that can be seen from wherever the viewer is watching.
The MOSLM is also used as an information processing device to make high-speed searches for similar images. It is applied to image processing devices including trademarks, facial recognition, and airport security scanning systems, etc.



■ Research and Development in the Second Stage

2 Construction of Support Environment for Human Activity

This work focuses on developing new devices and systems for recognition and support of human behavioral intentions or noncontact inspection by sensing human movements, stances, line of vision, facial expressions for upgrading the quality of life.

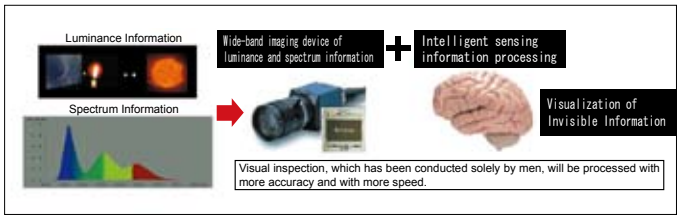
2-1 Visualization of Invisible Information by Wide Dynamic Range Measurement Concerning Luminance and Spectrum

◆Project Leader: Professor Shigeki Nakauchi, Department of Information and Computer Sciences, Toyohashi University of Technology 《URL》 http://www.bpel.ics.tut.ac.jp/jp/

Professor Shigeki Nakauchi

Human vision mechanism acts like a sensor that skillfully adjusts to a wide range of light and darkness to recognize object images and their background contrast. The new method for visualization of invisible is constructed by new algorithms and hardware studied from the human mechanism. This allows boosting the quality of images from the wide dynamic range CMOS image sensor developed in the first stage and upgrading the image of the camera to a higher level.

Another application is for near infrared imaging technology, which captures light not visible to the human eye, visualizes objects and enhances the signal from them. The technology will ensure traffic safety.



2-2 Effective Non-destructive Detection Technique using Integrated Imaging of T- and X-ray

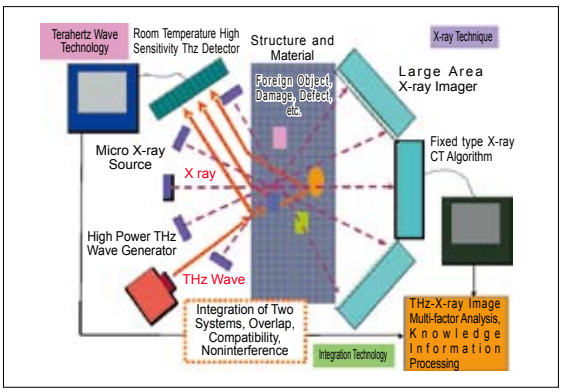
◆Project Leader: Professor Norihisa Hiromoto, Graduate School of Science and Technology, Shizuoka University 《URL》 http://www.ipc.shizuoka.ac.jp/~dnhirom/index.html

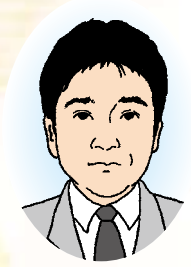
Associate Professor Toru Aoki, Research Institute of Electronics, Shizuoka University 《URL》 http://www.nvrc.rie.shizuoka.ac.jp/vision-i/

Professor Norihisa Hiromoto

Terahertz wave is electromagnetic wave with a frequency higher than used for cell phones and satellite broadcasts, yet lower than infrared ray. Terahertz wave has the unique property of resonating with molecules that make up the objects around us. The frequency of resonance is different with the object. So, terahertz wave has the ability to find materials or substances with non-destructive inspection, which is difficult for X-ray to find.

Development of imaging technology and device systems for spectroscopic imaging is done using both waves for new application.





Associate Professor Toru Aoki

2-3 Vision Sensor for Recognizing Motion Picture

◆Project Leader: Associate Professor Hironobu Fujiyoshi, College of Engineering, Chubu University 《URL》 http://www.vision.cs.chubu.ac.jp

Associate Professor Hironobu Fujiyoshi

New vision sensor under development is capable of analyzing and outputting motion picture images in real-time. It is made possible by forming a camera with a vision sensor having LSI chip that outputs video data and metadata. Feature detection techniques of “HOG” and “SIFT” are utilized to find human with a formula for finding oriented gradient histograms in localized sections within the moving image.

Visualization of Human Flow

The sensor analyzes the flow of people and vehicles. New camera incorporating the sensor, therefore, has great future prospects for many applications. They are intelligent surveillance cameras for searching video data, acquiring traffic situations from aircraft, and controlling all types of operation flows during emergencies, etc.

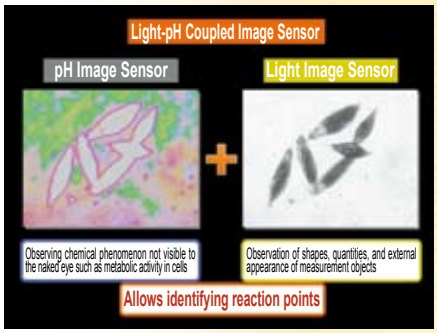
2-4 Development of Ion-light Multimodal Image Sensor and Application in Medical Field

◆Project Leader: Professor Kazuaki Sawada, Department of Electrical and Electronic Engineering, Toyohashi University of Technology 《URL》http://icg.dev.eee.tut.ac.jp/index_j.html
Professor Susumu Terakawa, Photon Medical Research Center, Hamamatsu University School of Medicine 《URL》http://www2.hama-med.ac.jp/w3a/photon/photon1/index.html

Professor Kazuaki Sawada

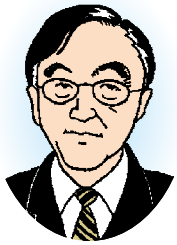
Professor Susumu Terakawa

New multimodal ion and image sensor under development is made up of arrays of numerous tiny pH sensors and arrays of optical image sensors. The pH sensor finds the amount of acid-alkaline of a substance and the image sensor takes the picture of the substance at the same time. These sensors are capable of measuring the accurate position of a substance and finding the dynamic state of the substance at that position on an acidity scale, and showing that dynamic state on a display.
This work includes utilizing these sensors in medical fields such as for judging the dynamic state of cells, investigating the causes of diseases, and measuring pharmaceutical effects.



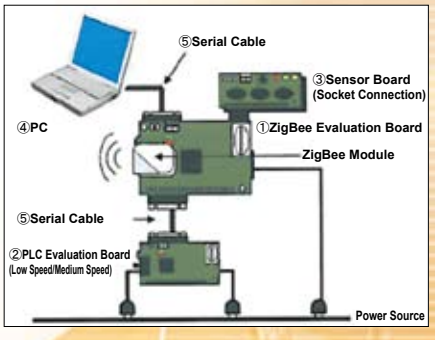
2-5 Autonomous Distributed Cooperative Ubiquitous Sensor Network

◆Project Leader: Professor Tadanori Mizuno, Graduate School of Science and Technology, Shizuoka University 《URL》http://www.mizulab.net



Professor Tadanori Mizuno

New module having some sensors is under development. It has an ability of self construction of a special network of many modules spread over the area. The modules mutually help each other to communicate by utilizing either line of wireless or power line communication to make the network that finds out what is happening in the area and allows a speedy response to those circumstances.
The installed software of the network is flexibly updated to grasp circumstances more accurately and ensure efficient operation of analyzing and mining similar items from information yielded by the sensors and provided services to assess the current status.

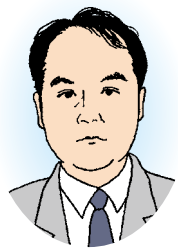


3 Development of Observation and Fabrication Support System for Ultra Fine Object

Innovative nanotechnologies for detection, machining, measurement, and production of nano-sized objects are developed for medical, agricultural, biological science, chemistry, and industry.

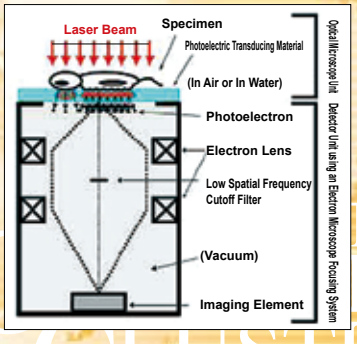
3-1 Nano Imaging Technique for Clarifying Biofunction

◆Project Leader: Professor Yoshimasa Kawata, Faculty of Engineering, Shizuoka University 《URL》http://optsci.eng.shizuoka.ac.jp



Professor Yoshimasa Kawata

New opt-electronic microscope having high resolution of smaller than 10 nanometers is under development for imaging of living biological specimens. It is built by combining the best features of optical-microscope and electro-microscopes to take the image of a biological specimen in living condition and with very high magnification provided by electron microscopes.
A laser light beam is radiated to the specimen. Electrons emitted from the photoelectric film surface according to the intensity of light penetrating through the specimen is magnified and focused to project the enlarged image on a display.



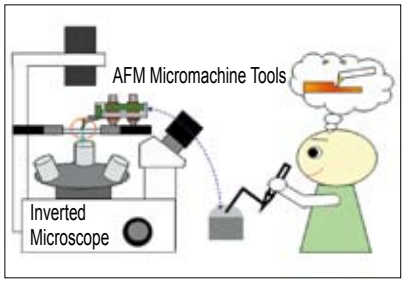
■ Research and Development in the Second Stage

3-2 Nano Machining System Coupled with Optical Manipulator

◆Project Leader: Associate Professor Futoshi Iwata, Faculty of Engineering, Shizuoka University 《URL》 http://tf2a14.eng.shizuoka.ac.jp/

Associate Professor Futoshi Iwata

Scanning probe microscopes (SPM) and atomic force microscopes (AFM) have a function as a knife in nano-scale machining. They can process nano-scale machining. A laser manipulator has a function as tweezers for nano-scale objects. They can pick and handle ultra small objects.
The developed device is a new integrated machine of new scanning probe microscope systems with machining and manipulator functions. The device is used for an inspection and processing machine for nano-sized objects. The great possibility of using the device is expected for many applications in industry and bio-fields.



3-3 Detection and 3D Imaging of Ultra Small Object using Superconducting Magnetic Sensor

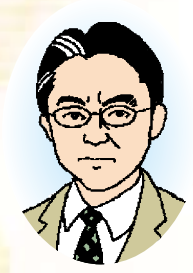
◆Project Leader: Professor Saburo Tanaka, Department of Ecological Engineering, Toyohashi University of Technology, 《URL》 http://www.eco.tut.ac.jp/%7Etanakas/tanakas.html

Professor Saburo Tanaka

New device is currently under development to detect extremely tiny metal substances that is not detected by conventional technology. The device is the SQUID (super-conducting quantum interference device) having extremely high sensitivity of 1 billionth of the magnetism of earth. This high sensitivity, for example, allows detecting tiny metallic contaminants in lithium batteries used in PC, cell phones, and cars that cause operating failures and sparks, etc.
The technology of the high sensitive SQUID also helps reduce the size of NMR (Nuclear Magnetic Resonance) equipment.

3-4 Nanostructure Embedded Phosphor Particles and Ultra-High-Output UV Source

◆Project Leader: Professor Kazuhiko Hara, Research Institute of Electronics, Shizuoka University 《URL》 http://ny7084.rie.shizuoka.ac.jp/active-display/



Professor Kazuhiko Hara

New flat panels of ultraviolet high-output source are currently under development, using electron beam excitation of UV phosphor particle of sub-micrometer diameter. Each particle has numerous atomic sized dots such as GaN (gallium nitride) inlaid in the particle.
This ultraviolet light source will serve as a safe substitute for the currently used mercury lamps needed in many applications in industrial and medical treatment fields, etc.

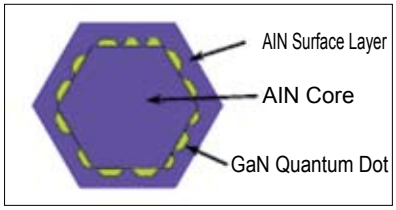
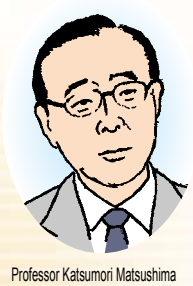


FIG. 1: Nanostructure with Embedded Phosphor Particles

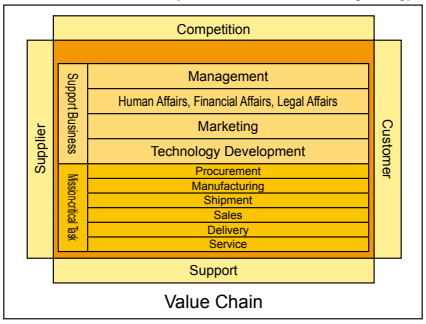
4 Development of Hamamatsu Innovation Management Model

◆Project Leader: Professor Katsumori Matsushima, Department of Meta-Technica Engineering, Institute of Engineering Innovation, School of Engineering, The University of Tokyo
《URL》 http://metatechnica.t.u-tokyo.ac.jp/



Professor Katsumori Matsushima

To make the core of the opt-electronics cluster formation in the Hamamatsu area at the world level, we will construct value chains making use of the potential in the infrastructure, or the Hamamatsu model. This management model enables to establish sustainable innovation system in the area.



Achievements in the First Stage (2002-2006)

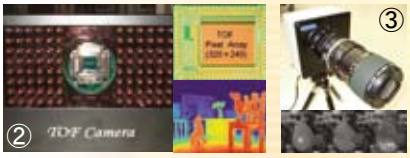
By fixing our sights on "Research and Development for Super-Visual Imaging Technology to Support Next-Generation Industries and Medical Treatment," we focused on sophisticated technologic capabilities of regional companies and the cutting edge technology at universities to promote research and development work in 3 areas with the "smart imaging and display technology" concept for sustaining a pleasant society of the future. Results from these efforts include the startup of 20 project operations and 254 patent applications (72 of them overseas), etc. Regional companies are currently making rapid progress in commercializing and creating products.

Multi-Function Integrated Imaging Device

A new type next-generation multi-function imaging device is successfully developed that acquires critical image information such as a wide dynamic range, high-speed image capture, and distance imaging, etc.

① Wide Dynamic Range CMOS Image Sensor and Camera

[Adopted for Regional New Consortium Projects (Manufacturing Innovation Division) in 2006 by the Ministry of Economy, Trade and Industry]



② TOF (Time Of Flight) Range Image Sensor and Camera

③ High-speed Image Sensor and Camera

④ Surround Vision System

⑤ Vehicle Sleepiness Detector

Optical Imaging System for Medical Use

Highly functional microscope systems and operation navigation systems have been developed for observation of cells and for surgical operations that will help support future advanced medical treatments and diagnostic techniques. In addition, imaging systems are developed that can faithfully reproduce colors. Those systems have functions that are indispensable in medical diagnoses.

⑥ Operation Navigation System

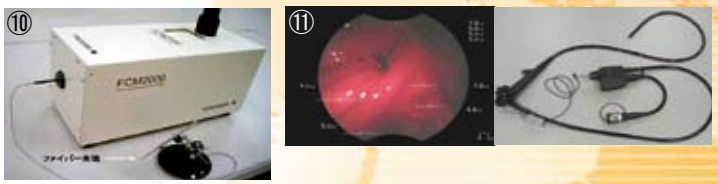
[Adopted for Regional New Consortium Projects (the division correlated with other ministries) in 2007 by the Ministry of Economy, Trade and Industry]

⑦ High-fidelity Color and Ultra-high Resolution 1-CCD Still Camera

[Adopted for Regional New Consortium Projects(the division correlated with other ministries)in 2007 by the Ministry of Economy, Trade and Industry]

⑧ Wide Range High-fidelity Color Acquisition Camera

⑨ High-fidelity Color Reproduction Projector for Colors within Color Range



⑩ Fiber Bonding Type Confocal Microscope

⑪ Endoscope with Measurement Scale

Solid-state Imaging Device for X-rays and Gamma-rays

We developed camera devices and so forth which correspond to high energy radiation for non-destructive inspection and X-ray CT.

⑫ Radiation Line Sensor

■ Regional Efforts to Create the Hamamatsu Optronics Cluster

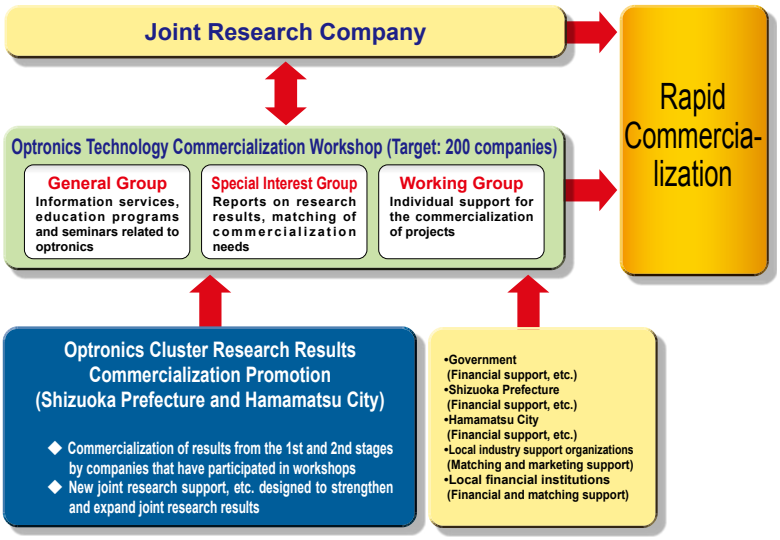
A wide range of efforts has been undertaken in order to establish an optronics cluster. Aiming at commercialization of the achievements in the 1st and 2nd stages of the Knowledge Cluster Initiative, in addition to joint research in industrial fields, many other unique projects are ongoing mainly in cooperation with local enterprises and researchers.

Optronics Technology Commercialization Workshop

Results from first stage research and second stage research and development themes are used to create new projects by individual and jointly participating companies. To assist in this effort to expand projects in the optronics field, the "Imaging Technology Commercialization Workshop" is expanded and the "Optronics Technology Commercialization Workshop" formed on a larger scale (goal of 200 companies) to further expand the optronics project field.

There are already some projects that have made possible applications based on research results. Such projects are expected to result in the early realization of products. In this workshop, we intend to organize small-scale working groups according to the characteristics and advantages of participating companies, and allow each group to establish research and development consortiums as well as product development projects. In this way, we will provide technical support for commercialization and product development. Continued support will also be provided for the establishment of new enterprises and the creation of new products utilizing research results obtained in the first stage.

In addition, we intend to implement educational programs and to invite the participation of advanced researchers in optronics technology fields from around the world. Our seminars and technological discussions will include professional skill workshops and demonstrations. In our education programs, hands-on practice will be provided in the fields of image processing technology, programming skills and optical design technology, etc.



Special-Interest Group Activities

The following special interest groups involving first and second stage research were established to spread results and accelerate commercialization of projects via technical descriptions, seminars, and specification evaluations, etc. The coordinator provides full cooperation in terms of planning with the joint research companies and commercialization project promotion.

Second Stage

① Image Measurement Group
- Time Correlation Image Sensor • Visualization of Invisible Information • Superconducting SQUID Magnetic Sensor

② NanoBio / Nanoelectronics Group
- Nano Imaging •Optical Manipulator

③ Optical Information Processing Group
- Vision Sensor for Recognizing Motion Picture • Spatial Light Modulator • Ubiquitous Sensor Network

④ Image Sensing Group
- Ferroelectric Thin Film Sensor • Ion-light Multimodal Image Sensor

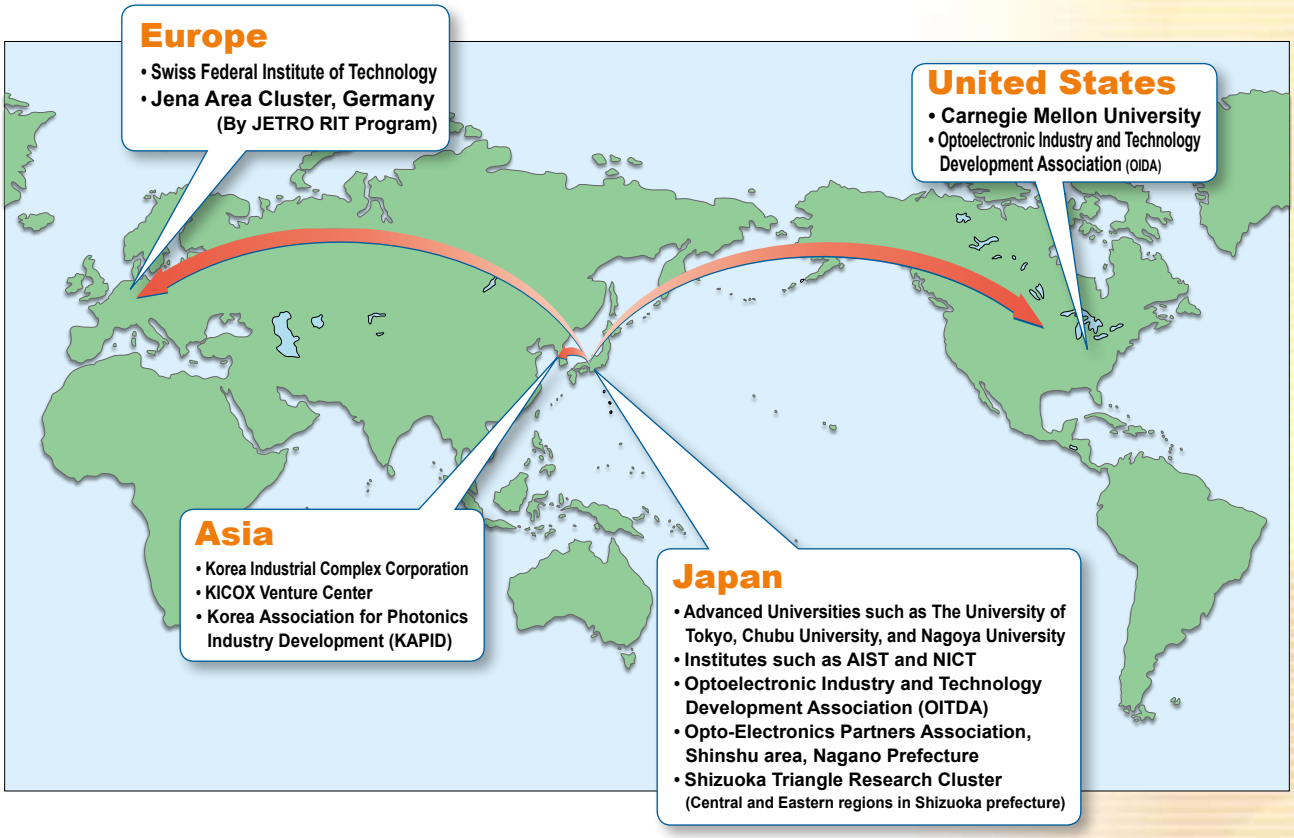
First Stage

① First Special Interest Group
- Wide Dynamic Range Image Sensor • High-Speed Sensor
- Range Image Sensor •Pupil Detection Technology • High-Fidelity Color Reproduction Imaging System

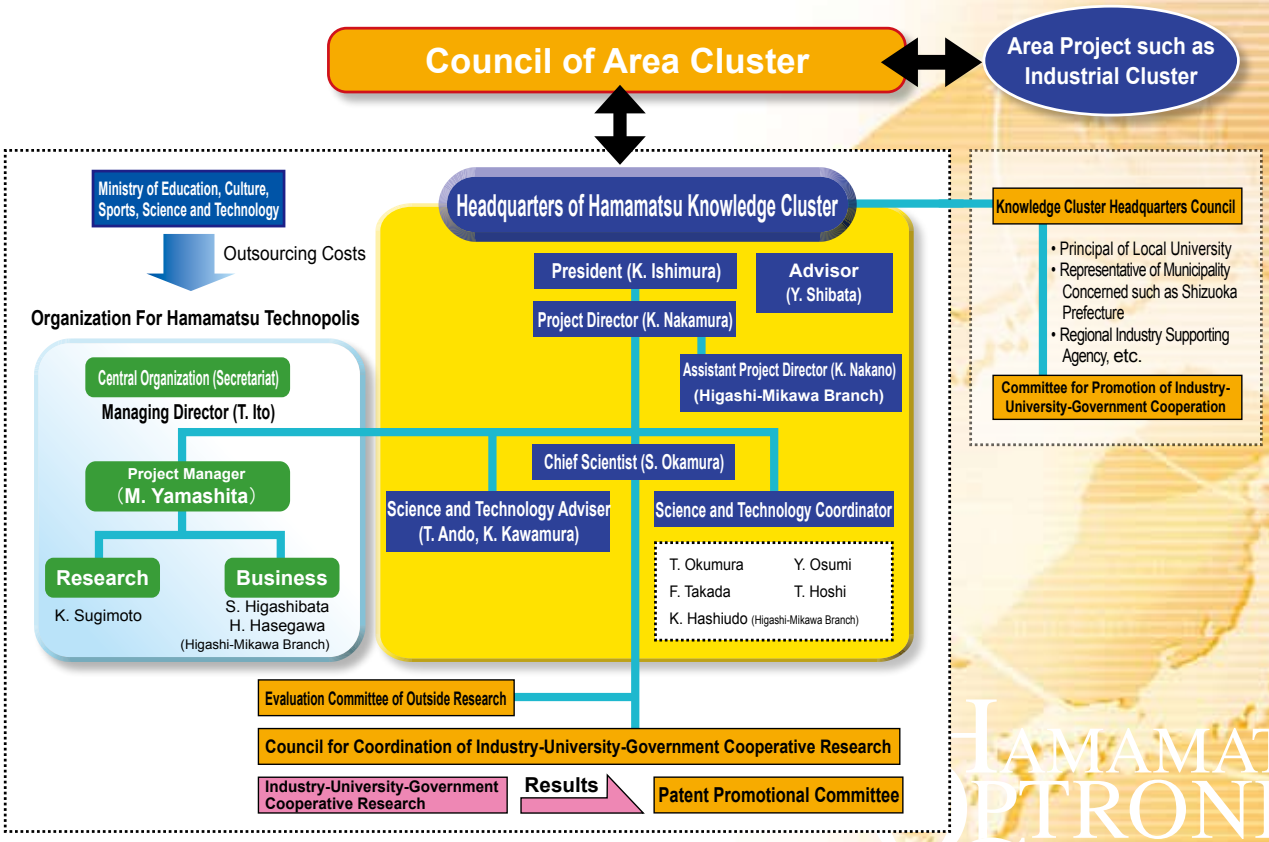
② Second Special Interest Group
- Scanning Microscope System with Confocal Method • High-Performance Endoscope
- X-ray and Gamma-ray Solid-State Imaging Device

■ Globalization

In order to create a world class Optronics Cluster in Hamamatsu, we have been intensifying linkages with wide area industry-university-government cooperation. And focusing on the world, we intend to undertake a wide range of challenges not only in research and development, but also in the integration of mutual technologies.



Project Organization

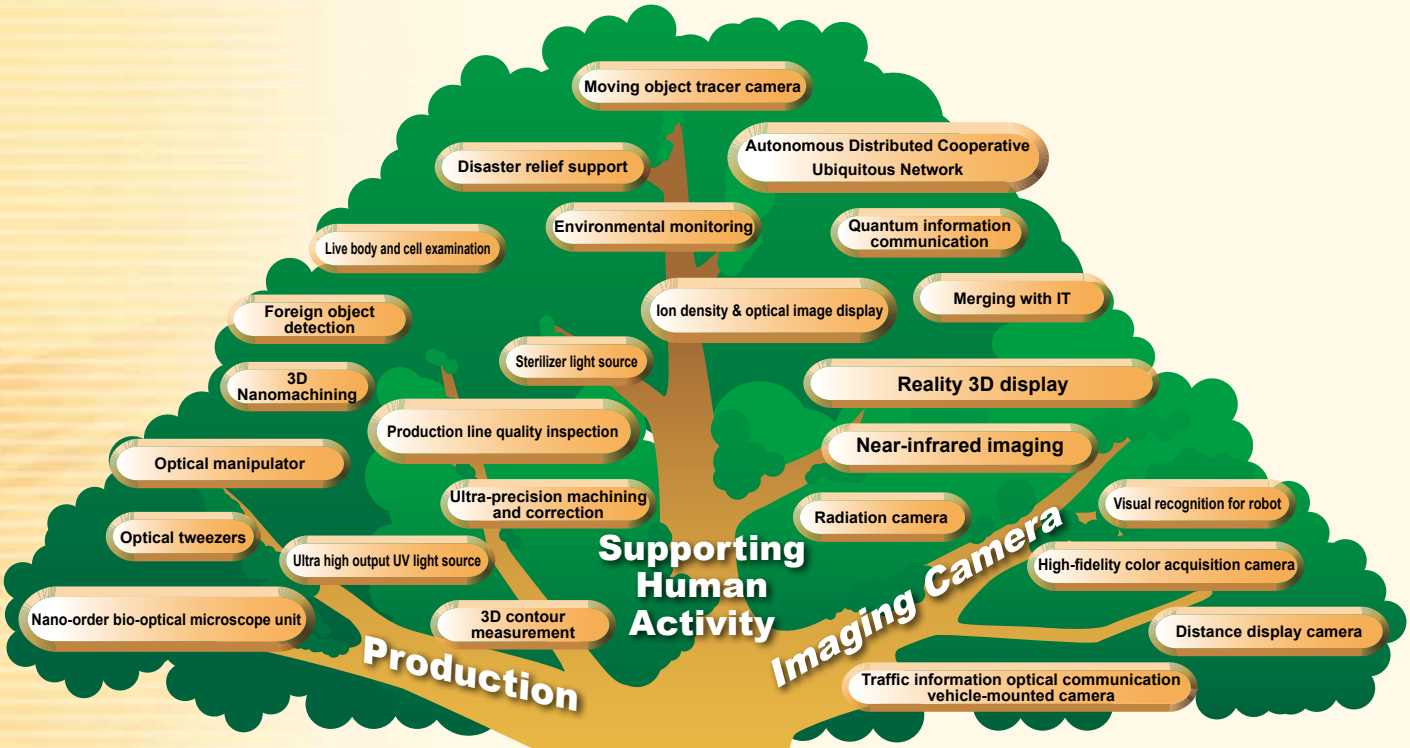


OPTRONICS CLUSTER

Ministry of Education, Culture, Sports, Science and Technology

Knowledge Cluster Initiative (2nd Stage)

Based on results gained from the knowledge cluster initiative and cooperation from METI and related agencies, a world class optronics cluster is created that form "knowledge" and "technology" into a technical spearhead for the future.



Development of high functional imaging devices and intellectual information process

Construction of support environment for human activities

Development of observation and fabrication support system for ultra fine object

《University》 14 Universities

•Shizuoka University •Toyohashi University of Technology •Hamamatsu University School of Medicine •The University of Tokyo •Chubu University •The University of Electro-Communications Osaka •Electro-Communication University •Tokai University •Nagoya University •Nagoya institute of Technology •Niigata University •Future University-Hakodate •Swiss Federal Institute of Technology •Carnegie Mellon University

《Public Research Institute》 3 Organizations

- National Institute of Advanced Industrial Science and Technology (AIST)
- National Institute of Information and Communications Technology (NICT)
- International Superconductivity Technology Center

《Industry》 30 Companies

•Adtech Sensing Research Inc. •Advance Food Tech Co., Ltd. •Aisin Seiki Co., Ltd. •Altech Co., Ltd. •Arrow 7 Co., Ltd. •ASTY Corporation •Brookman Lab Inc. •Commercial Resource, Ltd. •Denso Corporation •FDK Corporation •Hamamatsu Photonics K.K. •Hioki E.E. Corporation •Holy-mine Inc. •Honda Electronics Co., Ltd. •IHI Corporation •Juki Corporation •Kyoeisha Chemical Co., Ltd. •Mitsubishi Chemical Group Science and Technology Research Center Inc. •Nippon Chemi-Con Corporation •Papa-Lab Inc. •Roland DG Corporation •Sanei Hytechs Co., Ltd. •Senjo Seiki, Inc. •Stanley Electric Co., Ltd. •Sumitomo Electric Industries Ltd. •Techno System Inc. •Toyota Central R&D Labs Inc. •Uniopt Corporation Ltd. •UT Research Institute •Yamaha Corporation

■Headquarters of Hamamatsu Knowledge Cluster

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