PM Yagi: Innovative visualization technology to lead to creation of a new growth industry

Takayuki Yagi — Program Manager

1983 Received master's degree from Graduate School of Interdisciplinary Science and Engineering, Tokyo Institute of Technology
1983 Joined Canon Inc.
2005 Became Senior General Manager of Canon Research Center.
2008 Became Senior General Manager, Medical Imaging Project, Corporate R & D
2014 ImPACT Program Manager (temporarily transferred to JST from Canon)

Profile
Introduced MEMS technology to Canon and has a wealth of experience in practical application of the technology in inkjet printer etc. Has a wealth of experience in industry-academia collaboration, including representing Canon in joint development of Kyoto University and Canon in the MEXT program, "Innovative Techno-hub for Integrated Medical Bio-imaging".

The Challenges for the PM and the Impact of Success

✓ Overview and background.

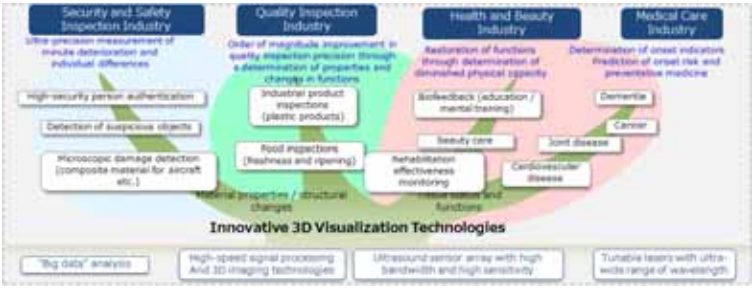
With the arrival of the super-aging society, there has been a rapid increase in morbidity and the number of persons requiring nursing care, and there is widespread concern in the general public regarding illness and nursing care. In this situation, there is a need to enable people to continue working while preserving their health and beauty.

There is also heightened concern about food safety, product quality and other issues, and achieving safety and security in people's lives is an important issue facing society.

The objective is to develop a new visualization technology that can image the state of the human body and objects whose insides are not visible, non-invasively and non-destructively, to enable early diagnosis of disease and maintenance of health, as well as quality examinations of changes of substance in order to contribute to safety and security.

✓Impact on industry and society in the event of achievement.

A new noninvasive modality for very early diagnosis is created. Early detection of underlying damage to skin aging, joint disease and lifestyle related diseases becomes possible. The technology will create a new medical imaging industry, comparable to CT scanner and MRI, new beauty industry and healthcare industry due to noninvasive. The technology also conducts new quality inspection method to enhance international competitiveness of material industry and food industry.



Disruptive Innovation

Integrating state-of-the-art laser and ultrasound technologies perform real-time 3D visualization of changes in properties and functions (workings) inside the human body and substances, non-invasively and non-destructively.
The new visualization technology brings out non-invasive 3D imaging of vessel network and blood condition to enable early diagnosis and estimation of physical depression and will also enable non-destructive inspection of the internal structure and changes in the properties of objects.

Scenario for Success and Achievement Targets

✓ Methods of resolution leading to achievement (approach) .

• The base technologies will be completed.
(1) Visualization technology, using photoacoustic technology, to illuminate laser light to objects and detect emitted ultrasound at high resolution.
(2) Tunable lasers with ultra-wide range of wavelength adapted to absorption spectrum of human body and substances.
(3) Ultrasound sensor array with high bandwidth and high sensitivity to detect various frequencies of ultrasound in real time.
• Visualization system, installed with laser and ultrasound sensor, for real-time 3D imaging will be developed.
• Its availability in the medical field and quality examination field will be verified.
(1) Many clinical research trials will be performed at a number of diagnosis departments in order to achieve proof of availability of blood vessel imaging. Risk prediction model of disease will be constructed by analyzing blood vessel images and healthcare information.
(2) Application development will be performed with researchers from different fields, such as non-destructive fields, with a view to expansion in various fields.

✓Management strategies.

• For the ultrasonic sensor, competition among detection methods will be encouraged in order to select the best one.
• For visualization system development, participant system companies will share their technologies to accelerate development.
• In clinical research trials, a cooperative organization including medical research institutions will be established in order to verify the usefulness of blood vessel imaging in clinical settings.

✓Achievement Targets .

(1) Completion of tunable lasers with ultra-wide range and ultrasound sensor array .
(2) Completion of a real-time 3D visualization system at sub millimeter resolution.
(3) Verification of its availability of diagnosis of vascular disease, cancer, joint disease and so on.
(4) Verification of its availability of evaluation of physical depression (underlying damage, skin aging and so on).
(5) Showing its availability in the measurement industry.

✓Risks.

• The domestic production of lasers for medical use will be achieved.
• There are no verification of clinical value for its blood vessel imaging, and this requires comparative studies of existing diagnostic methods.

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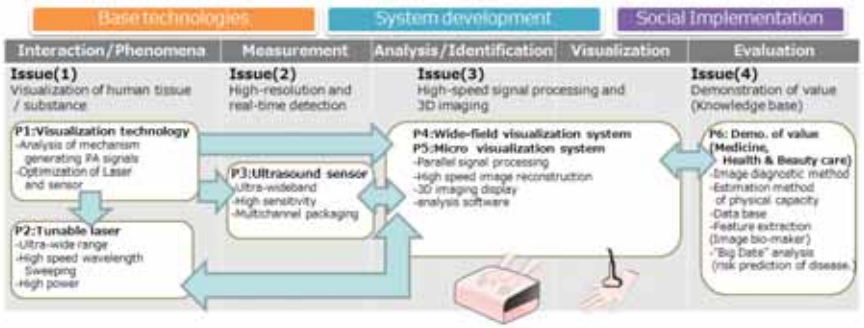
Overall R&D Program Structure Created by the PM

The program will consist of the development of three base technologies, development of real-time visualization system, and demonstration of value in order to verify usefulness. The real-time visualization systems to be developed will comprise a wide-field visualization system and a micro-visualization system with high resolution approaching that of a microscope. These systems will perform real-time 3D imaging in the range from micrometer-size to millimeter-size.

- **Visualization technology**: High resolution imaging will be researched, analyzing the generating mechanism of photoacoustic signals and making a database of properties in order to optimize laser wavelength and sensor configuration.
- **Tunable laser technology**: Electronically tunable lasers with ultra-wide range of wavelength, infrared tunable laser for human body and a range of mid-infrared tunable laser for substances, will be developed and achieved with high durability and compact.
- **Ultrasound sensor technology**: A sensor that can achieve more than double the broadband capacity of conventional sensors will be developed through competition between a piezoelectric ultrasound sensor and a capacitive ultrasound sensor (CMUT). Following selection, a 2D ultrasonic sensor array designed for real-time detection will be achieved.
- **Wide-field visualization system** : High-speed signal processing and 3D imaging technologies will be completed and a visualization system, installed with laser and ultrasound sensor, for real-time 3D imaging will be developed.
- **Micro-visualization system**: A basic system will be designed based on high-frequency ultrasound technology and a micro visualization system will be developed in addition to technologies developed for wide-field visualization. The system can image capillary vessels in the skin.
- **Demonstration of value**: The visualization systems will be provided to multiple medical research institutions to develop diagnostic methods and skin function evaluation methods. Diagnostic and evaluation indexes will be shown through image analysis, and a risk prediction model of disease will be proposed through “big data” analysis.



Total R&D Program Cost

JPY2.97 billion

* May increase/decrease depending on development progress

* Expenses required for PM activities and support will be provided as a separate allowance.

Implementation Structure as Assembled by the

✓Key points for implementing organization.

•In order to put the technology to the first practical use in the world, a cooperative implementing organization made up of research institutions that possess global top-level technologies and companies that can develop commercial applications will be established.

✓Approach to institution selection.

- **Visualization technology:** Kyoto Univ., which has produced Japan’s top research achievements in the field of photoacoustic imaging and conducts state-of-the-art ultrasonic simulations, has been selected. For quality measurement applications, an open offering process will be used to select an institution with the measurement technologies.
- **Tunable laser technology**: RIKEN, which possesses electrically tunable laser technology and owns patents for these technologies, has been selected. An open offering process will be used to select a Japanese laser company to work with RIKEN to develop a laser to commercial use.
- **Ultrasound sensor technology**: For a piezoelectric ultrasound sensor, Ueda Japan Radio Co., Japan’s top company in the industry in terms of ultrasound transducers, has been selected. For a capacitive ultrasound sensor, Canon, which has MEMS manufacturing technologies and can design custom IC of CMUT and has successfully developed a 2D ultrasound sensor array, has been selected.
- **Wide-field visualization system**: The company will be selected from among those companies with a track record of research in the field of photo-acoustic waves. Canon, which has developed a global top-level high-resolution photoacoustic mammography system and owns more patents than any other company in the world, and Hitachi-Aloka Medical, which possesses state-of-the-art ultrasound imaging technology, have been selected and will conduct joint development.
- **Micro-visualization system**: Tohoku Univ., which has high-frequency ultrasound imaging technology and has research achievements in the field of photoacoustic microscopy, and Shiseido, which possesses technologies for analysis of skin blood vessel structure and skin data, have been selected, and will work to quickly devise a basic system. An open offering process will be used to select a Japanese company to work with these institutions to develop micro-visualization system.
- **Demonstration of value**: Kyoto Univ. Graduate School of Medicine and Hospital, which has conducted a clinical research trials of photoacoustic mammography (the only hospital in Japan to do so, and the first in the world to publish a medical paper on the subject) and has knowledge in this field, has been selected. An open offering process will be used to select multiple medical research institutions. In addition, the National Institute of Informatics, which has state-of-the-art “big data” analysis and image analysis technologies, has been selected to conduct a risk prediction model of disease.