THE CANON FRONTIER 2022/2023

Focus on Technology and R&D

Building the Future by Fusing Imaging Technology and Cutting-edge Technology

Canon's technology, with its origins in camera development, is now expanding its possibilities and being applied to wide-ranging fields from security to commercial printing, medical treatment and industrial equipment.
All in order to solve diverse social challenges and enrich lives.
By joining imaging technology with AI, cloud and other IT, Canon is unlocking the next stage of the future.

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Office multifunction devices


Toner cartridges


Angiography systems


Professional inkjet printers


Laser printers


OLED panel manufacturing equipment


Inkjet printers


Components

Core Competency Technologies

Technologies that are most important for creating competitive, strong products

Image processing
Optical materials and elements
Optical design and measurement
CMOS sensor
OLED materials and devices
Bio measurement
Image recognition
Big data utilization

Value Creation Technologies

Technologies that support products and core competencies

● Framework / ● Platform

Color management
Electrophotographic process
Inkjet processes
Paper handling
Recording materials
Functional materials
Product development
Virtual prototyping
Smart design
Data analysis
Support for intellectual property rights
Quality value creation
Automatic control
Bio materials
Radiant energy measurement
Image reconstruction
Driving and control
Alignment control and measurement
Microstructure mold release and imprinting
Manufacturing process
Processing and molding
Environment-responsive
Cloud services
Support for standards
Communications

Fundamental Technologies

Technologies that form the base for accumulating core competency technologies

Analysis of image and signal
Electronic device and sensor
AI algorithm
Cell engineering
Image processing
New functional materials
Applied optics
Drive and control

PRINTING
IMAGING
MEDICAL
INDUSTRIAL

Executive Vice President & CTO, Canon Inc. Toshio Homma

Building the Future through Innovation

Amidst the 'new normal' forced upon us by the COVID-19 pandemic,
and during a time of tumultuous change around the world,
how will Canon develop technologies and contribute to mankind and society?
Toshio Honma, Executive Vice President and CTO (Chief Technical Officer),
talks about research and development at Canon.

A Period of Change for Canon and the World

Canon's Current State of R&D: Recognizing Changes in Society

As society changes dramatically due to the digital transformation (DX), which is itself accelerating in terms of the shift to a new normal, Canon is also approaching a major turning point. Alongside the continued contraction of markets for cameras and other products that once constituted our core businesses, significant changes are affecting the office multifunction device and printer markets as well. We are taking on the challenge of great transformation in order to reach the next stage of growth.

With technology at the heart of global transformation, research and development, which has thus far been invention-focused, now also becomes innovation-focused so that it may help solve social challenges, thus experiencing a paradigm shift.

R&D in ages of industrial society and information society has involved finding the seeds of technology and bringing forth a proliferation of carefully-nurtured inventions. Groundbreaking products have been launched one after the other, enriching our lives, improving convenience and changing the world. Yet now, the march of globalization is seeing the emergence of numerous social issues and the rise of technologies to address them. Indeed, we live in an age when social issues are necessitating technologies, one when efficient R&D requires more than just cultivating seeds through "invention-focused" R&D. For its part, Canon is engaging in M&A and other endeavors to create innovations with immediate effectiveness and speeding up innovation-focused R&D which rapidly addresses social problems.

Seizing this opportunity, Canon is pivoting towards open innovation through industry-academia partnerships in our invention-focused R&D, while, in our innovation-focused R&D, we are refining our own technologies and incorporating additions gained through such means as alliances with other companies and M&A. In this way, we are accelerating R&D that generates innovation capable of precisely meeting social needs.

Support for Creating Businesses with Core Competency Management and Trend Research

The Basic Concept Behind Canon's R&D

Since Canon's foundation, we have been promoting diversification of our business through development of Core Competency Management, which combines Core Competency Technologies (Core Technologies), which create industry-leading core products, with Fundamental Technologies that form the basis of our technology accumulation, and Value Creation Technologies that form the basis of our product commercialization technologies. Cameras, office multifunction devices, inkjet printers, laser printers, and semiconductor lithography equipment — is no exception. In addition, medical systems, network cameras, commercial printing, and industrial equipment, we have been strengthening competitiveness by incorporating our long-held Fundamental Technologies into the Core Technologies that have recently become part of the Canon group.

We have transformed several of these Core Technologies into Fundamental Technologies through repeated R&D efforts. Toners, drum and other advanced materials, for example, were once Core Technologies used in copying machines. Now they are Fundamental Technologies such as organic synthesis technologies, which are proving useful in developing competitive products for other businesses. In our imaging businesses, one of Canon's major strengths, our image processing and our lens, image sensor, and other imaging device technologies — our overwhelmingly superior Core Technologies — are making Canon cameras more competitive. These technologies are used in other businesses as Fundamental Technologies for our optical, electronic device/sensor and image processing technologies. The Core Technology behind camera people detection has been further developed as a Fundamental Technology for detection AI/Statistics analysis and is now being incorporated into healthcare IT systems helping to enhance our business unit.

The features of Canon's R&D are not limited to this alone. The technology and know-how that Canon has accumulated during its growth supports the quality, cost, and on-time delivery of our brand. We are incorporating this as Value Creation Technology supports the launch of new products and businesses. Robust Value Creation Technologies, which focus on analysis simulation, intellectual property, quality, design, value engineering, field engineering and the environmental technology, are one of Canon's greatest strengths for quickly growing business.

Now more diverse than ever, Canon pursues product development following plans unique to each product division. At the same time, the head office's development division engages in advanced trend research and advance technology development. We are strengthening existing businesses and developing new ones by having divisions and the head office simultaneously engage in multi-layered R&D while still staying very closely coordinated.

Aspiring to Innovate Using a Combination of Cyber and Physical Technologies

How will Canon's R&D Change?

A variety of social challenges have become clear as we strive to achieve innovative life styles and work styles in this 'new normal' society. Adapting to these historical changes, Canon embarks in 2021 on Phase VI of our Excellent Global Corporation Plan. Following this plan, we will strengthen R&D along three trajectories.

First, we will further strengthen our Fundamental Technologies and Value Creation Technologies. This will strongly support the key strategy of our Excellent Global Corporation Plan Phase VI: to thoroughly strengthen the business competitiveness of each industry group – Printing, Imaging, Medical and Industrial.

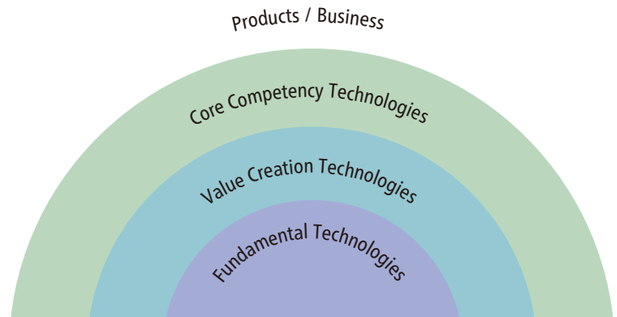
Second, we will generate the seeds of our next ventures based on robust Core Technologies and Fundamental Technologies. For example, in physical research and development, we will develop new functional materials leveraging material technology based on ink and toner materials, while also developing devices leveraging other specialized materials, then we will foster next-generation technologies as the seeds of new business. Through technological diversification, we will blaze a trail into new business domains.

Third, we will strengthen innovation-focused technology development that meets the needs of this era. While recognizing trends such as DX and carbon-neutral solutions, we will continue driving technology development that leads to higher corporate value. In particular, Canon is focusing on cyberspace, which allows us to merge myriad services, physical space where people connect with one another and a cyber-physical system that effectively integrates both. We are developing cyber and physical business models and products that are one step ahead by incorporating advanced cyber technology gained through our partnerships into our world-class Core Technologies in physical domains.

Supporting the Growth of Technicians through Core Competency Management

Human Resources to Support Future R&D

People are the key to these new approaches. Through Core Competency Management, Canon has created a database of what technologies we possess, in which departments, and how many personnel are involved as well as the professional backgrounds of our engineers. We have established a system that enables our talented staff to develop world-class Core Technologies in product development and cutting-edge Fundamental Technologies at the head office's development division, all from a company-wide perspective. In addition, we provide training opportunities to cultivate talent in order to acquire technologies in new domains we believe should be strengthened. Thus, we can continue to update our R&D structure to in response to the changing times. In particular, through Core Competency Management, we will provide opportunities for young people to demonstrate their capabilities in both product development divisions and the head office's development division, thereby cultivating the kind of talent that will lead the next generation by being able to identify both the business and technology domains deemed essential for innovation, and to undertake challenges in unexplored fields.

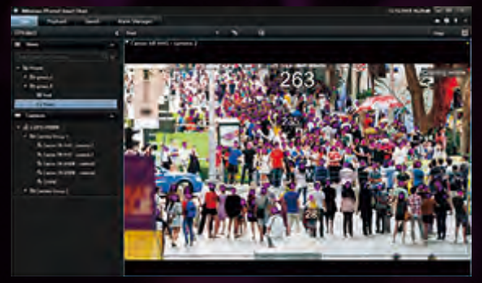


CHAPTER 1 Fundamental Technologies

Video Content Analytics Technology (Network Camera)

Network Cameras and AI Create Value for the New Era

Appropriate guidance and reliable security are essential in public facilities and event venues where many people gather.
AI-powered Crowd People Counter technology significantly contributes to the efforts to ensure the safety of visitors.



Understands the number of people in the crowd in real time

Counting Thousands of People in Real Time

When it comes to assessing the number of people present at such crowded locations as event venues and how that number changes over time, manual counting has its limitations. In 2019, Canon released Crowd People Counter for Milestone XProtect, a software that uses video content analytics technology to count thousands of people in a congestion in real time. In a proof-of-concept test, the software was able to count approximately 6000 people in a few seconds. When the results were compared with the number obtained by the manual count of people in the video, the software successfully provided a count of the crowd almost in real time with a margin of error below 5%.

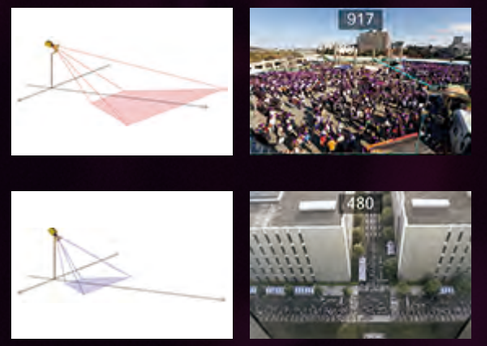
Displays the changes in the number of people in chronological order

Aiming to Achieve High Accuracy Counting Through Deep Learning

What characterizes Canon's Crowd People Counter technology is that it counts the "heads" of people using AI. It used to be difficult to count people in crowded locations by body or face because of people overlapping and facing different directions. To overcome these problems, Canon has developed the AI technology that distinguishes a person's head to make it possible to count the number of people in a crowd in real time.

At the initial stage of the study, in order to increase accuracy, the developers put markings on each human head to train the AI through repetition. By training its AI technology with image samples from a variety of angles, the system has become able to detect people from videos captured within an angle of depression (angle looking downward from horizontal) between 10 to 65 degrees. Supporting such a wide range of angle of depression allows for cameras to be installed in a greater variety of locations.

To further enhance usability, Canon developed a lightweight AI model. This contributes to lower operational costs and power consumption. The deterioration of counting accuracy under low light conditions has been solved by Canon's analysis method which takes into account the noise component of the camera body. Canon will continue to offer unique cutting-edge solutions supported by technologies of both high-quality, high-performance cameras refined over many years and software powered by constantly evolving AI.



Possible to count across a wide range of angle of depression (from 10 to 65 degrees)

Network Cameras with AI Generating New Value

Network cameras create new values with Crowd People Counter technology. For instance, by chronologically recording the number of visitors to a store, trends in crowd flow can be analyzed by time of day or day of the week. This makes it possible to adjust the inventory or plan an optimal allocation of security personnel to the anticipated number of customers. The changes in the number of people can be obtained close to real time, which also helps the decision making to restrict admission and avoid overcrowding. At the same time, it is also possible to count people within a designated area on the screen, which is useful for obtaining information on the number of people at a specific booth at an event or in a specific area inside a station or airport.

Canon's Crowd People Counter technology enables more effective use of videos from network cameras and is now being increasingly deployed in a wide variety of fields.

For more information about Video Content Analytics Technology

CHAPTER 1 Fundamental Technologies

Latest Image Sensor (SPAD sensor)

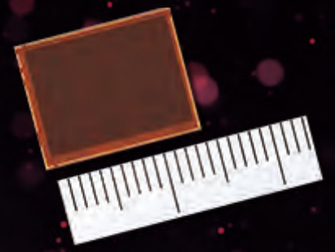
Canon Successfully Develops Key Devices for Future Society

One of the key components that will change society as we know it is the sensor, a device that changes light into electronic signals.
Canon has successfully developed an ultra-small 13.2mm x 9.9mm SPAD sensor capable of capturing the world's highest* resolution of 3.2-megapixel images – a higher resolution than Full HD (approximately 2.07 megapixels), even in low-light environments.

*Among SPAD sensors. As of December 14, 2021. Based on Canon research.

For more information about SPAD sensor

Color images at a resolution of 3.2 megapixels greater than Full HD



The 13.2mm x 9.9mm 3.2 megapixel SPAD sensor
* Size of effective pixel portion shown

Measuring the Value of Light – not the Amount

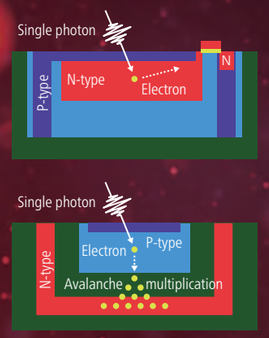
SPAD (Single Photon Avalanche Diode) sensors are a type of image sensor. The term "image sensor" probably brings to mind the CMOS sensors found in digital cameras, but SPAD sensors operate on different principles.

Both SPAD and CMOS sensors make use of the fact that light is made up of particles. However, with CMOS sensors, each pixel measures the amount of light that reaches the pixel within a given time, whereas SPAD sensors measure each individual light particle (i.e., photon) that reaches the pixel. Each photon that enters the pixel immediately gets converted into an electric charge, and the electrons that result are eventually multiplied like an avalanche until they form a large signal charge that can be extracted.

CMOS sensors read light as electric signals by measuring the volume of light that accumulates in a pixel within a certain time frame, which makes it possible for noise to enter the pixel along with the light particles (photons), hence contaminating the information received. Meanwhile, SPAD sensors digitally count individual photon particles, making it hard for electronic noise to enter. This makes it possible to obtain a clear image.

Low-light Environments can be Viewed as if It Were Recorded in Bright Areas

The SPAD sensor newly developed by Canon employs a proprietary pixel architecture that reflects photons inside the pixel in order to effectively detect photons across the entire range of effective pixels. Under equivalent light, this SPAD sensor can capture the same images as a conventional CMOS sensor while requiring only 1/10 of imaging area. This makes possible an ultra-small design that can be installed even in small devices and greatly increases sensitivity. By equipping cameras designed for low-light and monitoring applications with this new SPAD sensor, even video footage of low-light environments can be viewed as if it were recorded in bright areas, enabling identification of subject movement as though viewing with the naked eye in well-lit environments.



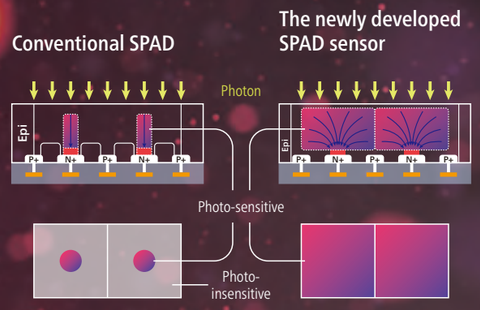
CMOS sensor
approx.
1x multiplication
Possibility of noise causing inability to correctly detect photon entry, resulting in reduced accuracy.

SPAD sensor
approx.
1000000x multiplication
Correctly detects photon entry. More accurate information received per photon due to multiplication.

Comparison of CMOS sensor and SPAD sensor

Achieving High Pixel and High-sensitivity

In conventional backlit SPAD sensors, only photons within the space covered by an electrical field (sensitivity field) can be detected, creating a challenge requiring pixel size to be shrunk and as a result, sensitivity to be lowered. With the proprietary voltage accumulation architecture of this new SPAD sensor, the space within the sensitivity field covers the entire pixel area, increasing the amount of photons that reach the light-receiving pixels. This makes possible a photon use efficiency of 100%, including within the near-infrared range, with a pixel pitch of 6.39 µm, realizing both miniaturization and high sensitivity. As a result, clear images with the world's highest resolution of 3.2 megapixels can be captured under environments equivalent to starless night skies.



Cross-sectional views and top-view layouts of conventional BSI SPAD array (left) and BSI charge focusing SPAD array (right).

Unprecedented High-speed and High-precision Distance Measurements

The SPAD sensor that Canon developed has a time resolution as precise as 100 picoseconds, which enables extremely fast information processing. This makes possible capture of the movement of objects that move extremely quickly, such as light particles. In addition to high-resolution and high-sensitivity, it is also capable of capturing light trails moving at a speed of approximately 300,000 kilometers per second (7.5 times the Earth's circumference). Taking advantage of its high-speed response, it is expected to be used as a sensor for driverless vehicles, medical diagnostic imaging equipment, scientific measurement equipment, etc.

For example, thanks to temporal resolution and high sensitivity, there are expectations that this technology may be used in the process of obtaining high-speed, high-precision 3D special information for such applications as distance measurement for automated vehicles, Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR). What's more, in the field of medicine, this sensor holds the potential for use in camera components of medical diagnostic imaging devices, microscopes and other equipment. Such devices may be used to determine the behavior and position of fluorescent substances in patient bodies that emit faint light in extremely brief time spans, thereby potentially helping to identify early-stage cancer cells or other illnesses or localized afflictions in their initial stages.

Canon's research and development efforts increase the possibility that yet-unknown services and products that many people would have never dreamt of, yet hold the potential for great impact, may someday become reality.

CHAPTER 1 Fundamental Technologies

Volumetric Video System

Offering a Brand-new Viewing Experience

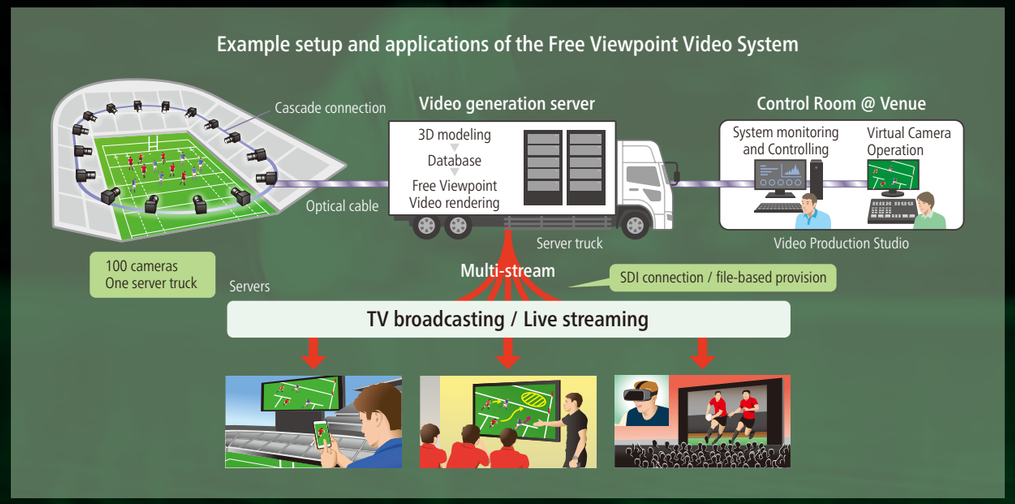
Making it possible to enjoy an immersive field-level viewing experience, Canon's imaging technology offers a cutting-edge way to watch sports and experience the entertainment.

A Revolutionary Technology which Dramatically Changes How Sports are Viewed

Conventional stadium systems use broadcast cameras and cable camera systems which provide video feeds from limited viewpoints. Meanwhile, Canon's Volumetric Video System allows the viewer to see the action on the field from any position or any angle in the stadium. You can view the same scene from various angles, changing to the perspective of an athlete on the field or any number of alternate viewpoints. Additionally, viewers can control both viewpoint and game time at will. For example, viewpoint can be changed while watching the scene in slow motion. This revolutionary technology dramatically changes how sports are viewed, and it has become reality.

The means by which video is generated may very well be considered the future of video capture. Visual data is captured by high-resolution cameras installed around the stadium, then converted into 3D data and stored on servers. When the user sets or moves the position of the virtual camera, the video they see is generated from the 3D data to show video from the desired camera angle. This video data can then be output for viewing.

In addition to optical and visual technologies consistently developed since its founding, the Canon group develops cutting-edge technologies in such fields as network transmission and user interface. Such technologies have the power to take the workflows of video production and broadcasting to a new level. Canon's project to develop its Volumetric Video System involved selecting developers from various divisions to work together and combine their specialized engineering skills.



Maintaining Innovative Spirit for a Greater Height Ushering in a New Era

Canon provides Volumetric Video Systems for rugby, basketball, and other kinds of sports. For overseas professional sports matches, video from viewpoints and angles not possible with actual camera positions has been shown on large displays in stadiums and even broadcast on TV stations. Volumetric Video Systems are pioneering a new way to watch sports, such as a bird's-eye view of a game from the sky and immersive experiences that feel like being right on the field with the players.

Accurate 3D data from fast-moving sports scenes, every camera must start shooting at the exact same time. If the timing is off for even one camera, the data cannot be generated correctly. Developers were aware of this issue from the design phase, and accordingly developed algorithms to control and completely synchronize the start of shooting for multiple cameras. An additional challenge is the need to process enormous amount of data instantaneously in order to generate Free Viewpoint Video data. Efforts are underway to generate high-definition images at faster speeds through such means as parallel distributed processing.

In addition to sports, Volumetric Video Systems are enabling the creation of completely new content in the field of entertainment. Since it was originally researched and developed for sports, it can produce video even for performances where multiple subjects are present in a wide area. The absence of an actual camera or photographer on stage allows for free camera work without the camera showing up in various cuts.

Canon launched Volumetric Video Studio - Kawasaki, that makes possible a fully supported workflow, including capturing and editing of 3D content in 2020. Using 4K cameras and Canon's proprietary image processing technology, high-detail video and 3D data can be generated almost simultaneously with capturing, enabling live streaming of video and shortening the time required for content production. Canon will continue to develop technologies that break down the barriers of location and time, leading to the creation of unprecedented value.

Volumetric Video Studio -Kawasaki filming area-

For more information about Volumetric Video Studio

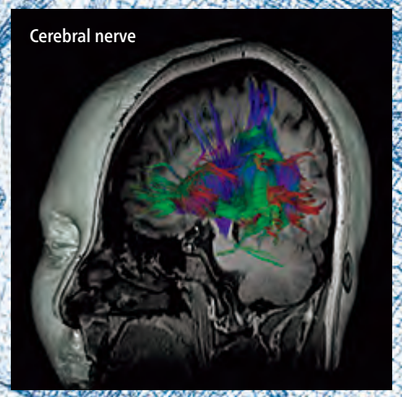
CHAPTER 1 Fundamental Technologies

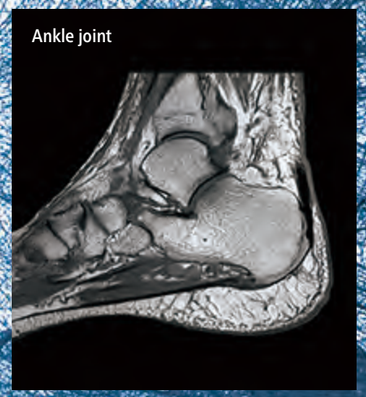
Medical AI

Deep Learning-powered Equipment will Overhaul Healthcare

The MRI is becoming more widely used.
At Canon, we have succeeded in employing imaging technology that makes use of deep learning to enhance image quality while shortening examination time, thereby reducing the burden on patients and medical professionals.

The MRI system to be equipped with a deep learning-based noise suppressing reconstruction system





MRI scans various areas by changing the direction of the magnetic field and the radio wave frequency

MRI Examination Times Prevent Growing Needs from Being Met

As a diagnostic imaging device for use in medicine, MRI equipment is proficient at helping users detect lesions in parts of the body where X-rays are less likely to produce differences in brightness, such as the brain, spinal cord, muscles in the arms and legs, and organs in the pelvic region. Because it does not subject patients to radioactive exposure, there is increasing demand for its use in a wide array of fields, including diagnosis, treatment, and research. An examination generally takes 20 to 30 minutes, but may sometimes require more than an hour. Not only does this cause inconvenience to patients, but the limited number of scans that can be done in a day prevents medical institutions from performing as many examinations as they would like.

The water and fat content in the human body contains hydrogen nuclei known as protons. MRI collects and images the differences in proton movement in a strong magnetic field as echo signals. Differences appear in the image in the form of different levels of contrast where the tissue is normal or abnormal. This contrast is an important feature of diagnostic imaging. MRI can acquire various contrasts and acquires multiple contrast information necessary for diagnosis, resulting in prolongation of examination time, Canon Medical has been developing technology to overcome this obstacle.

Efforts to Realize a 3T Device Capable of Producing Images at 7T Quality

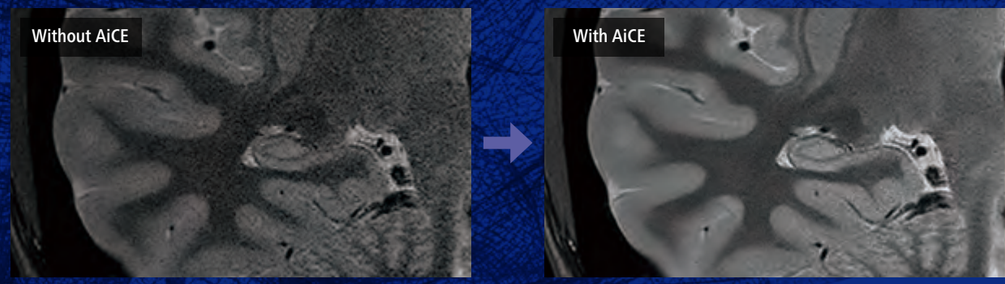
To both shorten MRI examinations and improve image quality, it is typical to strengthen the magnetic field. Some MRI systems currently employed for clinical examinations offer a maximum field strength of 7 Tesla (a unit of measurement of magnetic field strength). However, because the systems are larger and require a stronger, more robust scanning room and enhanced magnetic shielding capabilities, they can be installed at only a limited number of medical facilities. As it is mainstream for most medical facilities to install a 1.5T to 3T MRI, Canon Medical has been devoting its efforts to developing a 3T MRI that is capable of producing images of 7T MRI quality. First, they worked on developing the gradient coil. A gradient magnetic field works with the main static magnetic field to produce the magnetic field necessary to get a cross-sectional image. Canon Medical succeeded in strengthening the gradient field to enable capturing of images at a higher resolution than before. In addition, Canon Medical applied a high-speed imaging technique that involves capturing images at some instead of all data points, an approach that is also used in astronomical observation. At the same time, to minimize deterioration in image quality caused by reducing the number of data points captured, Canon Medical also created a unique algorithm to enhance both scanning speed and image quality.

Reconstruction Technology to Harness Deep Learning for Noise Suppression

Yet another new development is the Advanced intelligent Clear-IQ Engine (AiCE), a reconstruction technology developed for MRI makes use of deep learning to suppress noise. This development was made by training the neural network, the basis of deep learning, so that it suppresses only noise and retains structural details that should be captured in the image. This training required a vast amount of image data with very little noise, and members of the development team went through MRI images acquisition to capture around 30,000 images.

Reducing the Burden Placed on Patients and Medical Institutions

The 3 Tesla MRI system incorporates these technologies. Following the introduction of two new models, in April 2020, Canon Medical also launched a 1.5 Tesla MRI system that can incorporate the AiCE. Canon Medical aims to shorten the examination time, thereby reducing the burden on the patient, as well as enhance the diagnostic performance with higher image quality and improve work efficiency at medical institutions. Most importantly, it allows patients to receive more appropriate diagnoses and treatment.



Improvement of Image Quality of Brain Images by AiCE
AI technology is used in the design stage of image reconstruction processing, the system itself does not have a self-learning function.

KIOXIA Corporation / Canon's nanoimprint semiconductor-manufacturing system is currently being studied mass production at KIOXIA's Yokkaichi plant

CHAPTER 2 Core Competency Technologies

Nanoimprint Lithography

The Ultimate Microfabrication Technology Revolutionize Semiconductor Industry

Semiconductor lithography equipment is used to transfer circuit patterns onto a semiconductor chip. By overcoming the limits of miniaturization with lower power consumption and cost, Canon's Nanoimprint Lithography technology is about to trigger a revolution in semiconductor manufacturing.

Nanoimprint Lithography The Ultimate Microfabrication Technology

The evolution of semiconductor chips correlates directly to the history of circuit miniaturization. The key to this miniaturization has been the shortening of light-source wavelengths and advances in lithography technologies. In the early 1990s, 350 nm patterns (nm: nanometer = one-billionth of a meter) were realized with i-line lithography systems, followed by KrF/ArF lithography systems. Recently, there has been an ongoing trend toward shorter wavelengths with EUV lithography systems. Canon sought alternatives to shorter wavelengths, establishing a new approach to circuit miniaturization. That approach was nanoimprint lithography (NIL), which exceeds conventional lithographic limitations and does so at lower cost and lower power consumption. NIL is a simpler process, resulting in reduced costs compared to existing technologies. In addition, power consumption can also be significantly reduced. By enabling inexpensive production of patterns of 15 nm or smaller, NIL is poised to revolutionize the semiconductor industry.

Overcoming Numerous Technological Challenges

Unlike conventional lithography technology that uses light to expose circuit patterns, nanoimprint lithography fabricates nanometer-scale patterns by pressing the nano-pattern mask(mold) onto the coated resin on the wafer surface to form circuits. Because the process involves no projection lens, it enables the faithful reproduction of the mask's minute circuit patterns on the surface of the wafer. However, because the circuit patterns are formed using direct transfer, the process requires nanometer-level control technologies for accurately positioning the mask and wafer, eliminating particle contaminants and other cutting-edge technology. Through the comprehensive development of hardware, software and materials technologies, along with environmental control technologies to keep microscopic particles in check, Canon successfully overcame these numerous obstacles.

One of the technologies Canon developed for nanoimprint lithography controls the amount and positioning of the resin that is applied to the wafer surface. This technology precisely controls how much and where the resin is applied to prevent it from being squeezed out when the mask is pressed into the resin, while also ensuring the formation of a resin layer with a uniform thickness. Likewise, when the mask is removed from the wafer, their relative positions must be optimally controlled to prevent the deformation of the convex circuit patterns formed in the resin.

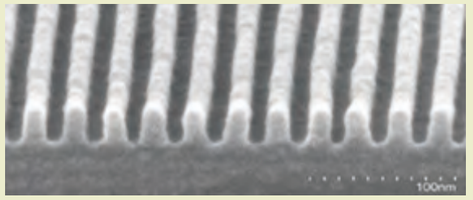
Generating Synergies from Different Cultures

With the aim of mass-producing nanoimprint lithography systems, Canon is collaborating with U.S.-based Canon Nanotechnologies, Inc. (CNT), which boasts some of the world's most advanced and unique technologies for microfabrication devices in the field of nanoimprint lithography. In addition to lithography system control and measuring technologies achieved through Canon's development of semiconductor lithography systems, Canon's service and support know-how will be merged with CNT's cutting-edge nanoimprint lithography technologies, thereby paving the way to further miniaturization.

The key performance of FPA-1200NZ2C nanoimprint semiconductor lithography equipment has reached a level suitable for mass production of memory, and we are now working with device manufacturers to usability in real-world mass production. In addition, NIL technology has been selected for a project subsidized by Japan's New Energy and Industrial Technology Development Organization (NEDO), and development is underway for applications in advanced logic manufacturing processes.

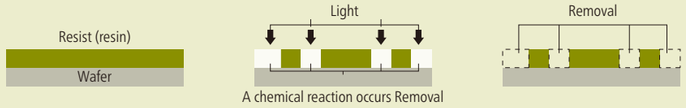
Going forward, we will continue to contribute to society through the addition of new technologies generated through synergies with existing technologies developed in-house.

For more information about Nanoimprint Lithography



The line-and-space pattern of 14 nm line widths formed with nanoimprint lithography technology
Source: KIOXIA Corporation

Photolithography



1 The resist (resin) for light exposure is coated to the wafer surface

2 A projection lens is used to reduce and project circuit patterns drawn on the reticle onto the silicon wafer, causing a chemical reaction in the resist

3 After development, the resist that was exposed to light is removed to create a circuit pattern

Nanoimprint lithography

1 Inkjet technology is used to dispense droplets of liquid resin to the wafer surface in accordance with the circuit pattern

2 A mold, called a mask, has the circuit patterns, is pressed like a stamp onto the resin that has been applied to the wafer surface

3 Ultraviolet light is used to solidify the resin and form the circuit patterns, after which the mask is removed from the resin

Canon's Nanoimprint Lithography technology leverages a simple approach of physically pressing patterns on a mask onto the resin. The simplified manufacturing process has the potential to significantly lower costs.
Also, because this approach produces extremely sharp circuit patterns, it is expected to contribute to lower chip-defect rates.

Streamlining Work and Enabling More Flexible Working Styles

Creating new workflows with high-end, high-speed scanning and printing.
Data sharing and cloud integration that can accommodate varied working styles.
Our multifunction devices (MFDs) are making work more efficient and furthering the adoption of flexible working styles.

Driving Digital Transformation in the Office by Integrating Multifunction Devices with Stronger Core Features with Cloud Services

Currently, the rapid development of "digital transformation (DX)" accompanying ICT (Information and Communication Technology) technological innovation and the spread of cloud services is accelerating work style reform through such means as increased adoption of remote working. Among such reforms, we have received various requests from customers regarding digitalizing paper documents in offices.

Canon swiftly responded to this trend with the 2021 launch of the imageRUNNER ADVANCE DX (iR-ADV DX) series, which supports the promotion of DX in offices through such functions as filing assist, which makes possible automated and efficient electronic filing of paper documents, and in cooperation with cloud services. In addition to improving aspects of core performance such as energy saving and quiet operation, the seamless integration with cloud services contribute to the promoting DX and improving productivity.

Pursuing Core Performance, Including Reduced Power Consumption and Operating Noise

Customers are more aware than ever of products' eco-friendliness, and office MFDs are no exception. The iR-ADV DX series pursues greater energy savings. For toner, the equivalent of ink in the electrophotographic method, using low-melting-point toner lowers the fixing temperature and achieves industry-leading standard power consumption (TEC_{2018}).

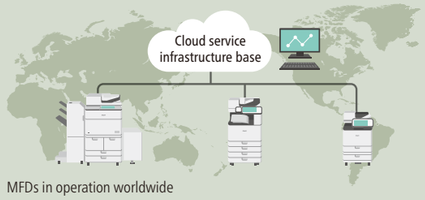
In addition, real-time control technology for the motor current reduces operational noise, and with the reduction of noises that happen when paper hits parts during paper feeding, quiet operation suitable for office environments is achieved.

Cross-section of low-melting-point toner

Developing an IoT Platform to Manage Operating Information on MFDs Installed in Offices around the World

We have developed global cloud service infrastructure to manage operating information on millions of office MFDs in operation around the world. This provides us with a foundation for creating value in both development and sales.

A vast amount of information about MFDs operation are collected and analyzed. This information is provided to servicing departments, helping them to reduce MFDs downtime and provide more efficient maintenance services. Furthermore, the collected device information is analyzed by device model and region, and is used not only to determine the number of sheets printed, but also to improve MFDs quality, business division management and business strategy planning.



MFDs in operation worldwide

MFDs for the Digital Transformation Era that Boost Efficiency in Office Operations through Flexible Combinations of Hardware and Cloud Services

In response to drastic changes in the office environment, Canon is offering hardware that has been refined to provide environmental performance like improved quietness and low power consumption, core printer performance such as higher security, and of course, the high speed and high image quality users have come to expect. In addition, we offer cloud services that flexibly add functions required for office operations as needed. By combining these services and promoting the digital transformation that will integrate MFDs and cloud services, Canon is realizing more efficient office operations while responding to customer needs.

CHAPTER 2 Core Competency Technologies

Digital Printing Technology is Ushering in a New Era of Expanded Choices for Printing

Achieving unprecedented high image quality for a wide range of print media.
Digital printing enables a variety of output that can only be achieved digitally to meet diversifying commercial printing needs.

Commercial Printing is Undergoing a Shift to Accommodate Short-run Production for a Broad Range of Applications

Offset printing has been the mainstay of commercial printing to date and, while it is advantageous for printing large volumes, it employs thin aluminum printing plates which makes it cumbersome and not very cost effective for small runs.

Digital printing has risen to the fore to address such concerns. Digital printing does not require printing plates, and it enables on-demand printing, in which only the amount needed is printed, and variable data printing, in which the content of each page is different.

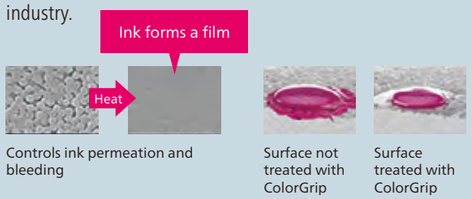
For example, direct mail typically involves sending the same message to many customers, but with digital printing, messages can be customized to fit the interests of each individual customer, resulting in improved effect.

Realizing High Image Quality on Various Types of Paper through Advanced Ink Control and Proprietary High-precision Image Processing

Canon Production Printing has expanded its product lineup to provide products that meet the needs of printing businesses for on-demand printing. One such product is the ProStream 1000 series, a continuous feed press developed to realize high image quality printing of materials such as high-quality catalogs and premium direct mail advertisements.

The ProStream 1000 series enables printing onto a wide variety of media with ColorGrip, the latest media-pretreatment used to prepare the paper surface to prevent the ink from bleeding. It also improves the durability of printed goods through polymer-based pigment ink (an ink containing a polymer component that forms a durable film).

An inline sensor placed in the body of the printer detects banding and areas of unevenness with high precision and then optimizes the ink landing position for large and small droplets accordingly. This proprietary image processing enables Canon to realize high level of image quality in the industry.



Controls ink permeation and bleeding

Surface not treated with ColorGrip

Surface treated with ColorGrip

Delivering High-value-added Large-format Printing with Fluorescent Ink

The imagePROGRAF GP Series large-format printers, equipped with pink fluorescent ink, use Canon's unique "radiant infusion" processing technology, in which other inks are layered on the paper surface during printing, which improves the brightness and saturation of the entire print, thereby resulting in vividly colored poster printing.

Color reproduction with ordinary processing and radiant infusion processing (conceptual image)

Fluorescent ink luminescence enhances brightness together with saturation

Canon's Printers for Commercial Printing Satisfy a Wide Range of Needs Thanks to Advanced Technologies

Alongside the ProStream 1000 series, Canon is continuing to meet a broad range of printing needs with a varied lineup of commercial printers, including digital continuous feed presses and sheet-fed presses that can print books, manuals, and forms at high speeds, and large-format inkjet printers for producing drawings, signage, and the like.

CHAPTER 2 Core Competency Technologies

EOS R5

Unlocking New Possibilities for Visual Expression

Such vastly improved specifications are
usually achieved only after lengthy development periods.
However, by continuing to make breakthroughs,
Canon has managed to produce
a game-changing camera ahead of its time.

EOS R5

Autofocus on a bird's eye Photo taken in cooperation with Kakegawa Kachouen

EOS R5: Conceptualized Years Ago, in Anticipation of Future Imaging Needs

High-resolution cameras for landscape photography, cameras capable of high-speed continuous shooting for sports, and cinema cameras for movie production – until recently, it was only natural for professional and advanced amateur photographers to decide which camera to purchase based on their specific photographic subject and use cases. However, photographers longed for a camera model that could handle any scenario, including landscapes, sports and video production, all in one camera body.

Fulfilling that desire is the EOS R5, an all-rounder camera released as one of Canon's second-generation full-frame mirrorless cameras. With its high pixel count of 45 megapixels*1 and support for 8K video recording, it also boasts a high-speed, high-precision autofocus (AF) system, up to 8.0 stops*2 of In-Body Image Stabilizer and high-speed continuous shooting.

Developing the camera required the union of advanced optical, electrical and mechanical technologies, and achieving a significant improvement in specifications requires time. Anticipating current and future imaging needs, Canon develops products years ahead of their time. The EOS R5 is one such product, achieved through a series of technological breakthroughs that would make the camera a reality.

Delivering State-of-the-art- Video Continuing The "5" Development Spirit to Realize 8K Video

The EOS 5D Mark II, released in 2008, was the first DSLR camera in the world to feature Full HD video capabilities. This sparked a new trend that could be considered a DSLR videography boom. The EOS R5, which also bears the significant number "5" in its name, was developed in the same spirit. Canon has spent more than 10 years developing 8K video cameras, and Canon 8K cameras are already being used in such applications as professional video production, academic research and the documentation of important cultural assets and natural heritage.

Recording in the 8K DCI 30p format supported on the EOS R5 requires processing a tremendous volume of data equivalent to 35-megapixel still images per second. From developing a new 45-megapixel CMOS sensor and DIGIC X Image Processor capable of high-resolution, high-speed readout, to addressing issues specific to 8K shooting such as the CFexpress card writing speed, the EOS R5's 8K recording capabilities were made possible by leveraging Canon's front-line experience in movie production, including playback environments.

Image captured with IS off (left) versus IS on (right)

It Can Even Recognize Birds' Eyes The Latest Autofocus Developed Using Deep Learning

Focusing exactly where the photographer wants, as though it can read the photographer's mind. This was achieved by incorporating deep learning technology into the camera's subject detection algorithm.

To enable subject tracking even during high-speed continuous shooting at up to 20 frames-per-second (fps), the EOS iTR AF X (Intelligent tracking and recognition) subject recognition capabilities of the EOS R5 were enhanced using deep learning, rendering the camera capable of detecting human heads as well as animal (dog, cat and bird) eyes, faces, bodies, and vehicles*3 (cars and motorcycles for racing). Ensuring high subject recognition accuracy through deep learning requires a massive volume of image data to "train" the system. For human head detection, a collection of sports-related images were used to train the system to reliably and accurately track the complex movements of athletes. Bird detection, however, posed a different set of challenges. There are many different species of birds, and even within the same species, the shape of a bird is drastically different when its wings are folded compared to when its wings are spread, which makes recognizing birds far more difficult than recognizing dogs and cats. From collecting training images from academic texts, to using their off time to test the bird detection capabilities by photographing birds. Canon's engineers personally strive to improve the technology, finally achieving high subject detection accuracy.

Go here for the EOS R5 introduction video

Hand-held shooting of Nightscapes and Waterfalls: Revolutionizing Handheld Shooting with up to 8.0 Stops of In-Body Image Stabilizer

Starting from the EOS R5, the second-generation EOS R system, cameras became the company's first camera to be equipped with an image sensor-shift type In-Body Image Stabilizer. This makes it possible to take slow shutter-speed shots of such scenes as nightscapes, or rivers and waterfall that harness motion blur effects, without the need for a tripod.

In order to make possible 8-stop image stabilization, Canon not only used high-precision gyro sensors, but also revamped the entire system to include a sensor unit that could accurately move the full-frame image sensor as well as an image processor and algorithms that could calculate sensor information from the camera body and lens in real time.

One scenario in which the camera's 8-stop maximum IS capability has proved invaluable is during long exposures, where even the slight movement that occurs due to the Earth's rotation tends to result in blurring in images. Due to the camera's high precision, this becomes a serious issue. In order to resolve it, Canon utilized an algorithm that detects the movement resulting from the Earth's rotation and factored it into the image stabilization function, thus ensuring proper stabilization. This results in ultra-high-precision IS that ensures the rotational movement of the Earth does not affect the sharpness of images.

An image stabilization system as precise as 8.0 stops is not something that can be achieved simply by putting together high-spec parts. The high quality and level of precision that makes it good enough to be a Canon product is the result of know-how cultivated by many years of developing, testing and manufacturing cameras.

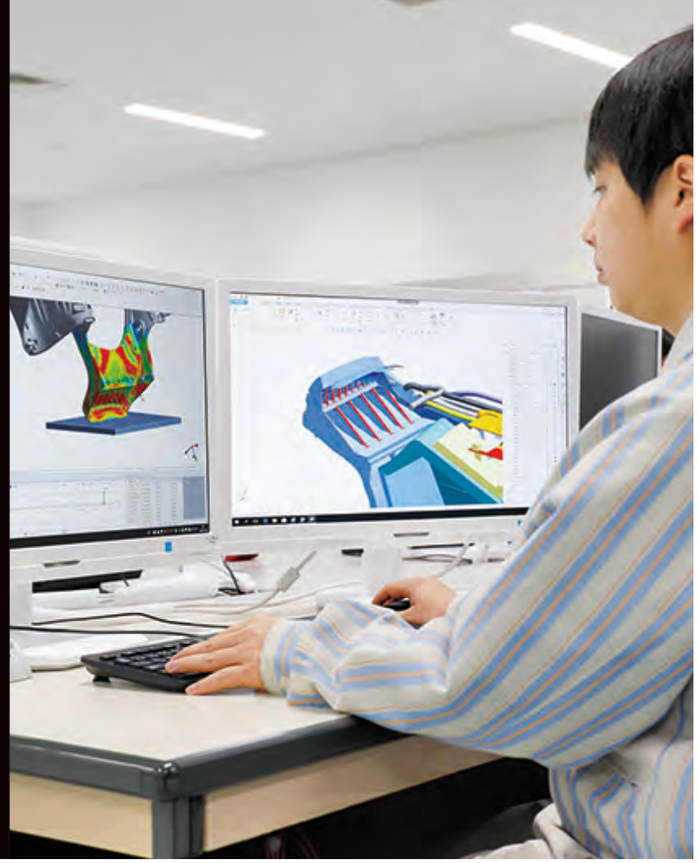
Canon has created a camera that can capture images that were previously thought impossible, thereby expanding the range of imaging possibilities. Canon will continue to improve on the EOS R system's technologies as it aims to support the expansion of creative possibilities for photographers.

*1 45 effective megapixels. Actual pixel count: 47.1 megapixels.
*2 When using RF24-105mm F4 L IS USM at a focal length of 105mm. According to CIPA standards.
*3 You may need to update the latest firmware version.

CHAPTER 3 Value Creation Technologies
Manufacturing

Efforts to Further Advanced Manufacturing Technology

Canon continues to produce high-quality products through analysis and production engineering technology, including virtual prototyping that supports advanced designs.



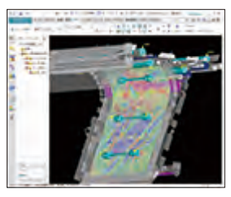
Support for Advanced Design Upstream of Development Virtual Prototyping Technology

Canon has been working to better understand the mechanisms of phenomena that cause problems in product development, and to incorporate them into simulation models and product design rules. Based on these achievements, we have developed proprietary Computer Aided Engineering (CAE) and Computer Aided Design (CAD) tools, and accumulated expertise needed to utilize them in higher-level operations. This has been systematized within Canon as "virtual prototyping technology" and is effectively used at design sites to drastically reduce reworking time and costs while continuing to produce high-quality products that support our brand.

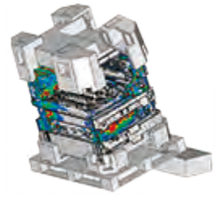
For example, in printer development, there are a variety of issues that occur during paper feeding which must be solved. Canon has developed a proprietary simulator that can check for problems such as paper jams, paper wrinkles, and diagonal movement and even study solutions, enabling design work that doesn't require physical prototype models.

In the past, damage to parts caused by dropping or impact was tested only after completing a prototype model. This meant that once a problem occurred, the design had to be revised during the final stages, which caused delays in the development process. By simulating problems such as deformation, breakage, and dislocation that occur when a product is dropped, Canon can determine such problems early on in the design stage and help shorten development periods.

However, performing these high-level simulations requires very large-scale calculations, which are not feasible with typical computer environments. Canon solved this problem in 2021, when it became one of the first private companies to introduce a commercial machine based on Fugaku, the world's fastest supercomputer at the time. Virtual prototyping technology is being used more frequently in each of our businesses, as it creates an environment in which large-scale simulation calculations can be performed faster and more often.



Paper feeding simulation



Drop impact simulation

Manufacturing technology supporting Canon Quality

In concurrent engineering, development and production processes run simultaneously in order to greatly reduce time and cost while still creating high-quality products that support Canon brand. At the first stage of the product cycle, which connects product development and manufacturing floor, Canon uses advanced analysis technology to figure out the mechanisms of phenomena that cause problems at the development and manufacturing floor, and replaces them with simulation models and product design rules.

At the same time, on the production process, the second stage of the product cycle, we are realizing optimal production system tailored to meet demand and are striving to achieve high quality at low cost. Meanwhile, we are also pursuing automation and in-house manufacturing processes. The expertise and knowledge accumulated through this approach is being also applied to production technology of our businesses.

Analysis Technology

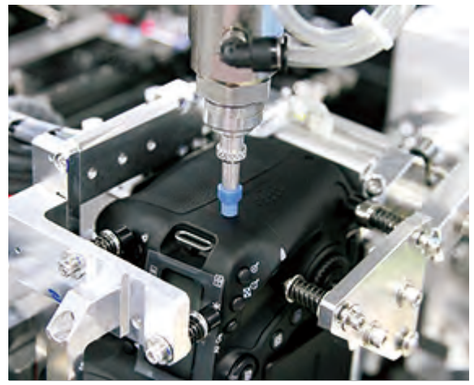
Many design issues concern phenomena with theoretical mechanisms that are difficult to determine, and it is impossible to reproduce all of them in physical simulations. Canon solves these issues by visualizing the phenomena with high-precision analysis equipment and creating a database of characteristic values to be entered into the simulator.

In the example of paper feed simulation mentioned earlier, the actual paper feeding speed varies depending on such factors as the tension acting on the paper, the amount of toner applied, and the presence or absence of paper dust. Since it is difficult to measure these characteristics with high precision using commercially available analysis equipment, we have developed our own analysis equipment and technology.

Canon possesses analysis equipment to create databases of various characteristics, such as changes over time in the friction coefficient of paper and rubber, flow characteristics of high-viscosity ink, cooling system characteristics, and acoustic characteristics. Through the use of these databases, we are able to clarify the mechanisms behind the occurrence of defects occur and incorporate this knowledge in product design, significantly contributing to improvements in product quality.

Analysis equipment developed in-house

Production Technology



Automated assembly lines

From the development stage, Canon carries out product design considering assembly automation. We have also built proprietary automated production systems for toner cartridges used by laser printers and office multifunction devices. These systems cover parts processing, product assembly, inspections, packaging and recycling. We are expanding the area of these automation systems to other products including DSLR cameras, mirrorless cameras, and interchangeable lenses, which we expect will lead to further cost reductions and improvements to quality.

Through in-house production of key components that are crucial for product performance, Canon is working to ensure our products truly stand out and increase our competitive strength. For example, our glass mold technology is used to produce lenses by directly pressing a mold that has undergone ultra-precision machining onto glass at high temperatures, thus transferring the shape of the mold to the glass. The ability to easily change molds is one characteristic that makes glass molding a highly productive machining method—one which Canon uses to manufacture a variety of lenses.

For more information about Manufacturing

CHAPTER 3 Value Creation Technologies

Intellectual Property Activities

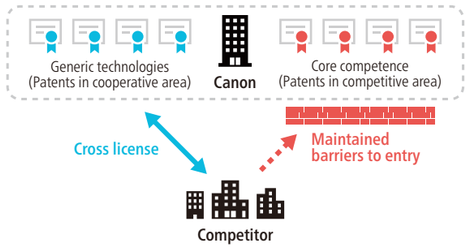
Supports Tomorrow's Business

Canon has formulated its intellectual property strategy to support business development in line with its corporate vision for the next ten years, and even twenty years while also anticipating future global trends.

Patent Acquisition for New Value Creation

Canon's intellectual property activities began with the acquisition of a utility model for developing cameras in order to avoid patents held by Leica of Germany. In the 1960s, in order to breakthrough the airtight patent wall which U.S.-based Xerox built around its copying machines, Canon succeeded in developing the NP method, an all-new electrophotographic technology that did not infringe Xerox's patents. This experience is the foundation of Canon's intellectual property strategy, which has been passed down to date.

Canon Basic IP Policy



- Cross-licensing for generic technologies for telecommunications, GUI, and other cooperative areas ensures the freedom of R&D and business activities while leading to the provision of attractive products and services
- Licenses are not granted for patents for core competency technologies, in order to protect Canon businesses and to ensure Canon's superior position in competitive areas
- Respect the IP rights of other companies. Stand firm on dealing with infringements of Canon's own IP rights
- Inventions that other companies will not easily discover themselves and are difficult to validate will be kept secret and protected to prevent emulation and ensure Canon's superior position

In recent years, alongside the acquisition of patents relating to core technologies in its businesses, Canon has also been focusing on acquiring patents for AI, IoT, standardization technologies and other fields in preparation for litigation and negotiation with IT companies and others that are do not directly compete with Canon but may be competitors in the realm of IP. Canon also actively acquires patents that contribute to realization of SDGs and the resolution of other social issues, maintaining a robust patent portfolio. This strong portfolio ensures Canon's superior position and freedom to engage in businesses.

Among the Top 5 U.S. Patent Recipients for 36 Consecutive Years and the Top Japanese Company for 17 Years

Canon focuses on patent acquisition both in Japan and globally, pursuing patents based on region-specific business strategies as well as technological and product trends. Given that the United States is such a large market and home to many of the world's most technologically advanced companies, Canon has also focused on both expanding its business and technological partnerships there, and has been among the top 5 U.S. patent recipients for 36 consecutive years.

Number of Canon's U.S. registered patents figures

	Rank overall	Ranking among Japanese companies	No. of patents
2021	3	1	3,022
2020	3	1	3,225
2019	3	1	3,548
2018	3	1	3,051
2017	3	1	3,284
2016	3	1	3,662
2015	3	1	4,127
2014	3	1	4,048
2013	3	1	3,820
2012	3	1	3,173

- Figures for patents received in 2021 are based on numbers announced by IFI CLAIMS Patent Services. (As of January 11, 2022)
- Figures for 2012 to 2020 are based on information publicly disclosed by the United States Patent and Trademark Office.

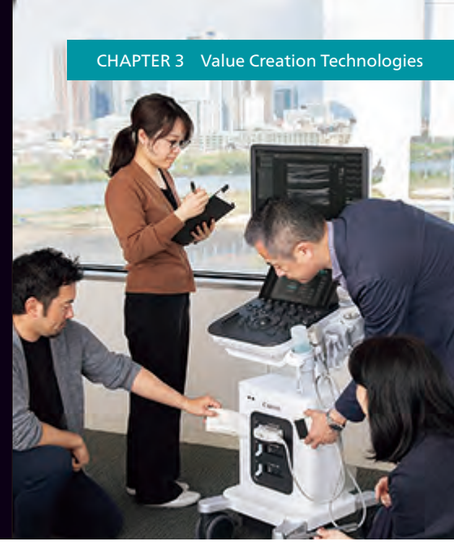
For more information about Canon's Intellectual Property Activities

CHAPTER 3 Value Creation Technologies

Canon Design

Designing Ease of Use

High-quality design and new value with corporate activities. Increase brand value through a customer-centered approach to design.



User-focused Design

As Canon's business expands from cameras and printers to highly specialized fields such as healthcare and industrial equipment, we need to incorporate a deep understanding of these fields when designing. However, even with such major changes taking place both in the scope of our business and the roles therein, we have maintained the same design philosophy we have held since our inception – design for the people who actually use our products.

The user experience – when a customer engages with a company's products or services – links directly to the company's brand image. As the technology used in our products and their capabilities continue to evolve, design plays an important role in ensuring these products remain easy to understand and use.

Organizing issues through a workshop

A Customer-oriented Design Approach

Canon's design process starts by gaining a deep understanding of the customer through various methods, such as interviews and behavior observation, so we can uncover any issues. Designers and developers work together to resolve issues, gathering ideas from many different perspectives. They create sketches and product prototypes to give these ideas a tangible shape, and then verify if it can resolve the customer's issue. By repeating this series of steps, they get closer and closer to producing the ideal user experience for the customer.

Canon will continue to enhance brand value through the pursuit of design that combines aesthetic beauty with ease of use.

Using sketches to give an idea a tangible shape

For more information about Canon Design

CHAPTER 4　Development of new businesses

SARS-CoV-2 Rapid Antigen Test

Facilitate Emergency Medical Services for the COVID-19 patients in emergency rooms

We have developed a new dedicated test kit for the coronavirus disease 2019 (COVID-19).
It takes just 15 minutes for detecting antigens of SARS-CoV-2*.
The test results help medical staffs and improve their working environments in medical institutions.

*Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causes COVID-19 after transmitting to people.

A Higher Sensitivity and Specificity Antigen Test Kit

COVID-19 pandemic has made hospitals keep guarding against SARS-CoV-2 carriers slipping into their green areas. Rapid tests are helpful for screening SARS-CoV-2 carriers from outpatients. The test kits alarm medical staffs in early stage and they prepare risks and prevent COVID-19 in-hospital infections by isolating the carriers/patients in COVID-19 care units.

The antigen tests for SARS-CoV-2 are designed to diagnose COVID-19 patients with such symptoms as fever (within nine days following onset of symptoms), using a nasal swab (mucus specimen collected from a depth of approximately 2cm) or a nasopharyngeal swab (mucus specimen collected from the back of the nose). These tests make use of immunochemical reaction "antigen-antibody reaction," an innate immunological mechanism of the human body, to detect target proteins present in the virus (antigens). The combination of high-sensitive optical detection technology of Canon and high-specific antibody of the Microbiology Lab at the Yokohama City University achieved higher sensitive and specific test kit for detecting SARS-CoV-2. This test system delivers well-balanced performance that satisfies the three key elements in screening of SARS-CoV-2 "higher sensitivity, shorter turnaround time and higher specificity (lower risk of false-positivity due to cross-reaction to other viruses or bacteria)."

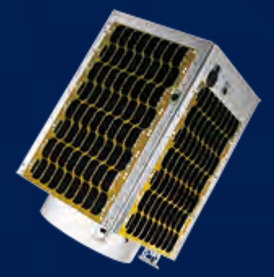
Rapid Test Relieves Stress of Medical Staffs in the Hospital

There are some variabilities in users' interpretation of visual test line of immunochromatographic antigen test. For example, some users interpret a faint line as negative, others do the line as positive. Canon's Rapiim antigen test system shows the interpreted result as "+ (positive)" or "– (negative)," which would make the medical staffs less stressful in interpretation of test results. Rapiim SARS-CoV-2-N detects SARS-CoV-2 proteins and achieves 5 times higher sensitivity compared with conventional lateral flow test devices (immunochromatographic assays). Additionally, its turn-around time is minimum 4 minutes in case of high density of viral antigens, and 15 minutes in case of no or very tiny density of the antigens. Using the combination of less cross-reactional antibodies in the test kit reduces risks of false positive rate. Canon will continue to develop products and services in order to promptly provide test solutions that would benefit both patients and medical staffs.

CHAPTER 4　Development of new businesses

Satellite Development

Exploring the Final Frontier: Outer space



Canon group is fully mobilizing its technologies
with Canon Electronics Inc.'s entry into the micro-satellite industry.
We are steadily hitting milestones towards exploring the final frontier : outer space.

Towards the Next Frontier

From satellite development, production, and launching to communications, satellite imagery, and location information services, the space business is a field that is expected to see tremendous growth in the future. Canon Electronics already had the technological foundations essential needed to develop a micro-satellite - the motor technologies for attitude control of the satellite, lens technology ranging from macro to zoom and miniaturization technologies for eliminating wasted space. In addition, Canon Electronics could leverage the electronic, mechanical, optical, materials and other technologies of Canon Group to make the satellite development possible.

Space: A Different Environment

Micro-satellite development involves challenges such as the risk of system shutdowns and malfunctions due to radiation and the heat generated in a vacuum environment. This is because the operating environment is in space, which is very different from that on the ground. Canon Electronics has already succeeded in launching two satellites by solving problems through the use of consumer components that are resistant to radiation and the idea of a radiative cooling method using metal. Equipped with a Canon camera and an ultra-high-sensitivity camera, the satellites are transmitting various image data to Earth on a daily basis. These include wide-area images of 760 km by 571 km from an orbit 500 km above the ground, high-resolution images that can even recognize cars, and nighttime images with a light source as faint as moonlight.

In addition, four companies including Canon Electronics established Space One, a rocket launch business firm. Japan's first private rocket launch site was built in Kushimoto Town, Wakayama Prefecture, with the aim of becoming a comprehensive space business that handles everything from satellite development and production to launches.

For more information about Satellite Development

CHAPTER 4. Development of new businesses

Visual SLAM Technology

Video Analysis Technology that Functions as the Eyes of Mobile Robots

The progress in information technologies has resulted in significant evolution in robotics. However, despite advancements in the robot brain and motion control technologies, it is impossible to utilize the full potential of a robot if the performance of its eyes, or its ability to perceive the state of the target object or surrounding environment, is less than satisfactory. By leveraging the optical and imaging technologies developed thus far, Canon has successfully made a huge leap forward in the functionality of robot eyes.

SLAM Technology Essential for Autonomous Mobile Robots

In recent years, there has been growing demand for mobile robots such as AGVs (Automated Guided Vehicles) as a means of saving manpower and enhancing work efficiency in logistics operations, such as transportation of parts and materials at plants or sorting goods in warehouses and transporting them to delivery trucks. Conventional AGVs are mainly guided using a track that is built by attaching magnetic tapes to the ground, and implementation of such a system is costly and time-consuming.

SLAM technology eliminates the need for such work and enables easy changing of routes.

Visual SLAM technology, developed by Canon, makes use of cameras as sensors to lower cost while enabling high-precision measurement at the same time. Operations at plants and logistics warehouses involve the movement of different types of goods. Because an AGV's surroundings change dynamically, it is necessary to detect such changes and update the environment map accordingly.

The sophisticated analytical power and software design of Canon's Visual SLAM technology allows a vast amount of information to be processed within a short time, even on low-end computers, ensuring that the environment map is optimally updated. This includes real-time updates of information on the environment map, which enable AGVs to navigate autonomously even in areas that are subject to rapid changes in the surrounding environment.

Drastically lower cost than existing systems

Conventional guide systems using magnetic tapes require attachment of these tapes to the track of the AGV. Tapes must also be replaced regularly, which can increase running costs by several million yen every year at large-scale factories.

In contrast, the Visual SLAM system doesn't require magnetic tape installation, and the robot can create the first environmental map within one trip, resulting in a substantial reduction in costs. Canon will further expand the possibilities of automation through robots, thereby contributing to the safety, comfort and convenience of society and everyday life.

For more information about Visual SLAM Technology

CHAPTER 4 Development of new businesses

Ultra-high-sensitivity Multi-purpose Cameras

The Challenge of Deep Sea Exploration with the Shinkai 6500

As a manned research submersible, the Shinkai 6500 boasts world-leading deep submergence capabilities. Since 2018, Canon's ultra-high-sensitivity multi-purpose camera, ME20F-SH has been equipped to the Shinkai 6500 as its primary camera, used in many researches.

Verification of underwater ultra-sensitive multi-purpose cameras at Nippon Marine Enterprises, Ltd.

The Shinkai 6500: Playing a Crucial Role in Global Deep Sea Research

It would be no exaggeration to say that the deep sea is like another universe. "Deep sea" generally refers to the part of the ocean below the depth of 200 meters, which constitutes 98% of all the ocean in the world. It is also a treasure trove of crucial information for unravelling geoscientific mysteries. However, extremely harsh conditions such as high water pressure, low temperatures and the presence of hydrothermal vents that spew out burning hot sea water make deep sea research a challenging endeavor.

One vehicle that is playing a core role to deep sea research efforts is the Shinkai 6500, which is owned by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). Capable of diving as deep as 6,500 meters.

A Camera Handpicked by Deep Sea Survey Specialists (Nippon Marine Enterprises, Ltd.)

The deep sea is pitch black. In the deep sea, subjects must be illuminated in order to be photographed. However, capturing bright and clear images is not as simple as shining strong light through the darkness: the stronger the light, the more it will be reflected by particles floating in the water (such as marine snow), which frequently leads to image whiteout. The reflected light also prevents the colors and forms of deep sea organisms from being captured accurately.

Photo: Japan Agency for Marine-Earth Science and Technology

In 2018, the Shinkai 6500 was equipped with the ME20F-SH to solve this problem. The conventional high vision cameras installed in the underwater equipment can operate at a minimum subject illuminance of about 1 to 0.1 lux, which was limiting in terms of capturing deep-sea footage. Canon developed a 35 mm full-frame sensor consisting of large pixels measuring 19 micrometers per side, 7.5 times larger than that of the EOS-1D X. In addition, Canon has designed a circuit structure for an efficient circuitry readout even from a large pixel, and also equipped a unique noise reduction technology. These achieve a minimum subject illumination of no more than 0.0005 lux (ISO 4000000 equivalent).

Now, it's possible to capture the scenes outside the submersible vehicle with faint light from the cockpit that leaks from the viewports of the Shinkai 6500, reproducing places clearly that were previously not visible due to lack of illumination. Deep sea research is critical for discovering to understand earth environments and creating a more sustainable society.

For more information about ultra-high-sensitivity multi-purpose cameras

R&D of New Technologies Around the World

The Canon group conducts business around the world. Today, sales outside of Japan account for approximately 80% of Canon's consolidated net sales.
To ensure that the research work from Canon's global R&D locations expands into businesses, Canon's developers activity collaborate and engage in exchanges with research institutes.

1 Canon Medical Research Europe Ltd.

Edinburgh, U.K.
R&D of clinical decision support systems AI automation.

2 Canon Research Centre France S.A.S.

Rennes, France
R&D of network and communication technologies for transmission and connectivity to high-quality, high-volume video date processing; and security camera systems and technologies.

3 Canon Production Printing Netherlands B.V.

Venlo, Netherlands
R&D of commercial and industrial printers, consumables, etc.

4 NT-ware Systemprogrammierungs GmbH

Bad Iburg, Germany
R&D, sales, and support of print and scan management solutions and document process management systems.

5 Milestone Systems A/S

Copenhagen, Denmark
R&D of video management solutions.

6 AXIS Communications AB

Lund, Sweden
R&D for network video and analytics, access control, intercom and audio systems.

7 BriefCam Ltd.

Modi'in, Israel
Development and sales of video analytics solutions.

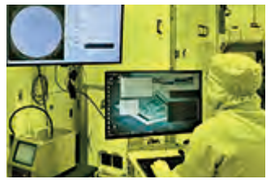
8 Canon Medical Systems Corporation

Otawara (Tochigi), Japan
R&D of medical devices and systems.

9 Redlen Technologies Inc.

British Columbia, Canada
R&D and manufacturing of semiconductor detectors modules used in Photon Counting CT and other advanced imaging applications.

10 Canon Nanotechnologies, Inc.



Texas, USA
R&D of nanoimprint lithography systems.

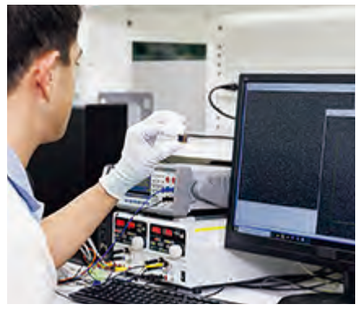
11 Canon Medical Research USA, Inc.

Illinois, USA
R&D of core system physics, data acquisition, and image reconstruction hardware and software for medical devices and systems.

12 Quality Electrodynamics, LLC

Ohio, USA
R&D, manufacturing and service for innovative, high-performance RF-coils used to obtain detailed MRI images of the human body.

Canon Inc.



Headquarters (Shimomaruko) ..... R&D areas, development of digital cameras, etc.
Yako Office ..... Development of inkjet printers, large-format printers, inkjet chemical products.
Kawasaki Office ..... R&D areas, R&D of production equipment and dies, R&D of semiconductor devices, etc., and R&D of network cameras.
Tamagawa Office ..... Development of quality management technologies.
Kosugi Office ..... Development of medical devices.
Hiratsuka Plant ..... Development of displays and next-generation devices.
Ayase Plant ..... Development of semiconductor devices.
Fuji-Susono Research Park ..... R&D of electrophotographic technologies.
Utsunomiya Office
Utsunomiya Optical Products Plant ..... R&D of semiconductor lithography equipment and FPD lithography equipment.
Optics R&D center ..... R&D of optical technologies.
Toride Plant ..... R&D of electrophotographic technologies, etc.

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CANON TECHNOLOGY

The site presents a wide range of
Canon technologies from various angles,
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https://global.canon/en/technology/

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