Overview

Measurement Technologies and Digital Solutions for Resolving Societal Challenges

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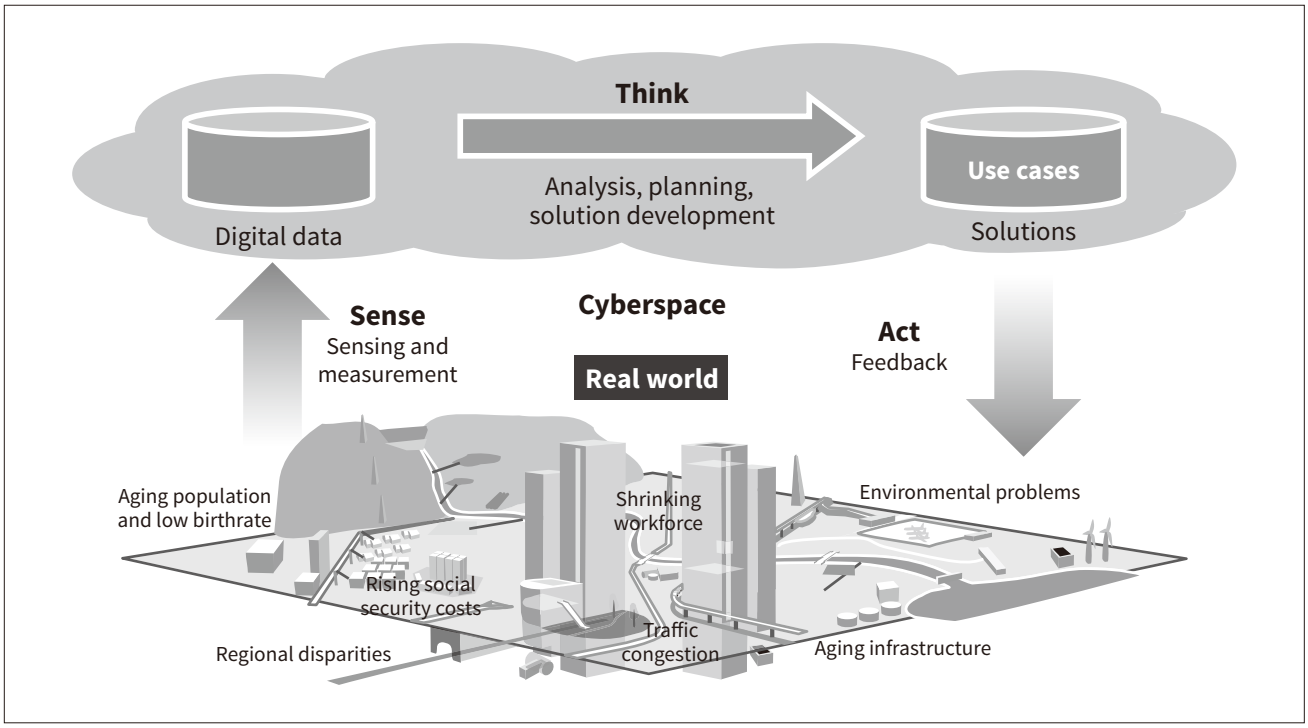
1. Introduction

More and more effort has been made globally to solve societal challenges, as represented by Sustainable Development Goals (SDGs)[1] adopted by the United Nations in September 2015 and the Society 5.0 concept[2] promoted by the Japanese government. In these efforts, more and more companies are relating their activities to solving societal challenges proposed by SDGs etc. Hitachi also has shown its contribution to the realization of the SDGs in its Hitachi SDGs Report[3]. One concrete example of such efforts is providing digital solutions using Lumada as a core. Hitachi has established an Internet of Things (IoT) platform as part of Lumada and pursued "digital transformations" that utilize digital technology to create new value.

As shown in **Figure 1**, Society 5.0 aims to balance the resolution of societal challenges and economic

Figure 1 — CPSs to Balance Economic Growth and Resolve Societal Challenges

Society 5.0 aims to balance economic growth and the resolution of societal challenges by using cyber-physical systems (CPSs) that highly combine the real world and cyberspace.



growth via cyber-physical systems (CPSs) that involve a high-level combination of the real world and cyberspace. To realize solutions established on the basis of digital data, it is important to collect (Sense) the elements of the real world and physical conditions of issues such as people, things, and environments, as digital data using sensing and measurement technologies; to understand their conditions and derive solutions by analyzing the above collected data by artificial intelligence (AI), etc. (Think); to give feedback to the real world with solutions (Act); and to accumulate and reuse use cases.

This article describes the measurement technologies for people, things, and environments that underpin use cases, primarily in Hitachi's four focus business domains (power and energy; industry, distribution, and water; urban; and finance, social, and healthcare).

2. Measurement Technologies that Underpin Digital Solutions

This section describes approaches to solving societal challenges via digital solutions, measurement technologies for things such as devices, people, and environments, and digital solutions using these technologies.

2. 1
Measurement of Things and Digital Solutions

The maintenance of infrastructure as well as equipment and devices used in factories is necessary to ensure the safety of social systems and to shorten the non-operational time of devices due to faults, etc. The higher and older the infrastructure is, the more important it is. Meanwhile, in terms of societal challenges, countries with their working population falling require efficient maintenance work. This section introduces examples that realize more efficient maintenance of infrastructure as well as equipment and devices in plants and that innovate the efficiency of material development.

In the railway industry, the routine inspection of railway facilities such as track and overhead wires is essential for ensuring safe and trouble-free railway transportation. Conventionally, track warping and other conditions have been measured by means of regular inspections by dedicated vehicles. This requires inspection vehicles and inspection workers for the vehicle's operation. As an alternative to this, inspection by track inspection systems that can be mounted on operational vehicles has already started on railway companies' operating lines. This allows more efficient maintenance work and, in the future, a service to assist the creation of optimal maintenance plans based on daily accumulated measurement data has been targeted[4].

Next, examples in the energy field are presented. Photovoltaic power generation, a form of renewable energy, requires optimal operation of tens of thousands of photovoltaic power generation (PV) panels. Conventionally, PV panels had difficulty detecting errors since their output varies depending on the sunshine conditions. To overcome this, Hitachi has developed a cloud-based technique for detecting faults or deterioration that works based on a fault diagnosis model on the basis of semiconductor device physics and information such as the output current and voltage of the panel, the level of sunlight, and the temperature. This enables remote fault diagnosis that monitors PV panel faults and deterioration online, thereby maintaining the performance of power plants and making maintenance more efficient[5].

In the field of materials development, measurement and analysis techniques play an important role in elucidating the mechanisms of material functions. An approach that has attracted attention in recent years as an efficient way to search for materials is materials informatics, which makes use of digital technologies such as big data of material parameters systematically accumulated and AI. For this, Hitachi has developed technologies to extract material parameters from images of electronic microscope images that support advances in materials informatics. This accelerates the development of new materials that realize low power consumption and low energy, thereby contributing to solving energy and environmental issues.

2. 2
Measuring People and Digital Solutions

As of 2018, Japan is a super-aging society with a rate of aging (population ratio of 65 years or older) of 28.1%. Also in China, rapid aging due to its One Child Policy from 1979 to 2015 is a societal problem. In these aging societies, maintaining the health of elderly

people is an issue of reducing social security costs such as medical and care costs. In response to these healthcare challenges, Hitachi plans to offer a solution to the elderly in China that utilizes advanced measurement technology. The plan is intended to extend healthy lifespans by estimating health condition using health condition monitoring data and activity data and using them in care service. Technologies and equipment that measure and analyze daily health condition and activity status are represented by portable brain activity measuring devices that use optical topography, finger tapping devices with magnetic sensors that are expected to establish a simple inspection method to detect Alzheimer's disease at an early stage, and stereo cameras to analyze walking ability. The health of the elderly is improved by giving appropriate feedback on their daily activities based on the data collected by the above devices. In the future, Hitachi intends to contribute to solving China's elderly problem by rapidly bringing its solutions to market.

2. 3

Measuring the Environment and Associated Digital Solutions

Also available are solutions that make use of information not only on things and people, but also environments. As environmental information, in addition to physical conditions such as the temperature and humidity at a particular location, there is location information about spaces.

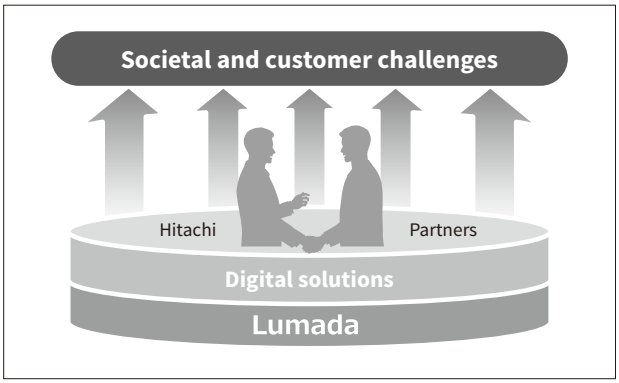
To stabilize social systems, steady and long operation of social infrastructure facilities such as electricity, plants, and factories, and traffic is required. Unfortunately, these facilities are often installed under harsh environments such as low or high temperatures, high humidity, and particular gases, resulting in operational faults due to corrosion etc. In response, Hitachi has developed electrical resistance corrosion sensors that can predict equipment corrosion. The sensor can quantify the effects on equipment due to corrosive gases in the surrounding environment, enabling remote monitoring of corrosion risks. In the future, Hitachi will realize corrosion environmental diagnosis solutions for social infrastructure facilities located in emerging countries or in places that humans have difficulty inspecting.

Next, an example involving the distribution field is presented. In the "cold chain" for transportation products such as food or medicine that require temperature control, it is expected to record the temperature history during transportation. For this purpose, Hitachi has developed temperature-sensing ink that changes color based on the temperature in the surrounding environment. Since this ink changes its color irreversibly if the temperature outside in the surrounding environment exceeds the controlled temperature band, it can capture the existence of deviations from the controlled temperatures during transportation. This offers safe cold chain solutions for cargo such as food and medicine that needs temperature control. Through testing with customers, Hitachi intends in the future to provide comprehensive item-by-item temperature control that extends from production to consumption.

Also, more and more automatic guided robots have been introduced in order to achieve more efficient transportation work in warehouses in manufacturing and distribution industries. These automatic guided vehicles require a positioning system. However, since magnetic tapes and markers were conventionally used in operation sites, costs for installing and maintaining the above guides were an issue. Hitachi, in response, has developed ICHIDAS, a positioning component that uses spatial information acquired by laser scanner and matches it to a map of the area. By incorporating this component into an automatic guided vehicle, guideless operation becomes possible, resulting in less labour effort and more efficiency for transportation work in warehouses. For outdoor location information, more and more precise satellite positioning technologies have been used. In Australia, demonstration experiments with quasi-zenith satellites and Global Positioning System (GPS) satellites have been undertaken for the sake of demonstrating autonomous driving of agricultural machinery. In the future, Hitachi intends to continue creating solutions that make use of high-precision measurement technologies for outdoor positioning in a variety of fields such as construction machinery, infrastructure inspection, and disaster prevention and mitigation, as well as in mobility, such as autonomous driving.

Figure 2 — Overcoming Societal Challenges with Digital Solutions Developed through Collaborative Creation with Customers

Establish digital solutions using measurement technologies on Lumada to overcome societal challenges and customer issues through collaborative creation with customers and other partners.



3. Conclusions

This article described Hitachi's efforts in sensing and measurement technologies as well as digital solutions in its four focus business domains. More information about these initiatives is provided in the individual articles in this issue. As shown in **Figure 2**, Hitachi will continue to establish digital solutions with measurement technologies as a core on Lumada, accumulating and making use of use cases to solve societal challenges through collaborative creation with customers.

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