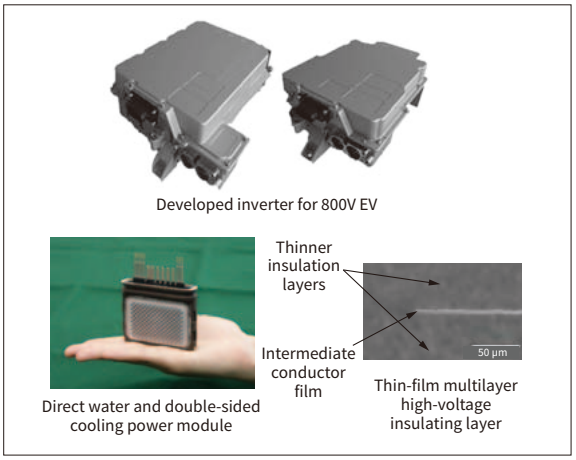
Technology Innovation:
Smart Life

1 Inverter Technology for Shorter Charging Times to Improve Driver QoL

A low-carbon society calls for the provision of optimal systems and key devices for the many different ways in which energy is consumed, and also for the efficient use of electrical energy as its consumption continues to rise. In particular, if the emission of carbon dioxide (CO_2) in the transportation of people and goods is to be reduced, there is a need for drive systems and charging infrastructure that are capable of providing the longer vehicle ranges, shorter charging times, miniaturization, and efficiency gains essential to the wider adoption of electric vehicles (EVs). One of the issues when seeking to combine rapid charging with small size and high output is how to raise the voltage of EV systems from the current 400 V to 800 V so that more energy can be transferred in a given period of time.

To this end, Hitachi has led the world by developing an inverter for 800 V EVs that shortens charging time by 50% while achieving a high power density of 94.3 kVA/L.

The developed inverter uses multiple layers of thinner insulation and runs intermediate conductor film between the insulation layers to achieve a doubling of insulation performance together with lower thermal resistance. Specifically, each insulation layer is reliably exposed to only half as much voltage and areas where the electric field is concentrated also experience only half the voltage. This improves insulation reliability while also increasing heat dissipation due to the thinness of the insulation layers.



1 Developed inverter and power module

The developed technology has been supplied to vehicle manufacturers around the world since 2019 and Hitachi plans to deploy it more widely in mobility, smart life, and other sectors to help advance the decarbonization of society.

2 Release of DS3000 Compact CE Sequencer

Hitachi developed the DS3000 Compact CE Sequencer to expand its business in deoxyribonucleic acid (DNA) sequencers for personal use. The new model makes good use of space and is easy to use. It is manufactured by Hitachi High-Tech Corporation and went on sale on September 1, 2020. The sequencer has an installation footprint roughly half that of the previous model (60% by width and 80% by depth), with the following three features added to facilitate release under Hitachi's own brand.

(1) Polymer injection mechanism that supplies highly viscous polymer directly from the container to the capillaries, with no waste

(2) Base calling technique that uses acoustic signal processing

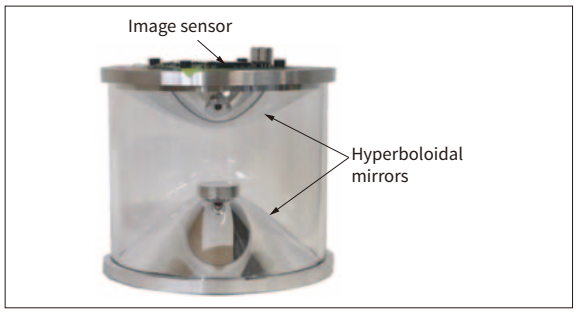
(3) Error rate prediction using machine learning

The new sequencer is differentiated from its competitors by use of direct polymer injection to make it maintenance-free and by use of a laser diode light source to ensure a long product life. Also available is a remote monitoring system utilizing web service technology for

2 DS3000 Compact CE Sequencer

sequencer condition monitoring and settings. Hitachi plans to expand its DNA sequencer business in the future by marketing the sequencer more widely, both within and outside Japan.

3 Omnidirectional Stereo Camera



3 Omnidirectional stereo camera

Technology for autonomous driving is accelerating the spread of level-two and level-three advanced driver assistance systems (ADASs). Omnidirectional sensing in particular will be a prerequisite for the future realization of fully autonomous operation (levels four and five).

Hitachi has developed technology for compact, low-cost stereo cameras capable of omnidirectional, three-dimensional (3D) sensing in a single optics system. This is achieved by using opposing upper and lower hyperboloidal mirrors to acquire stereoscopic images using a single image sensor. Beyond autonomous driving, the technology also has a wide range of potential uses in other applications with a need for spatial information in three dimensions, such as smart factories or smart cities. Through 3D sensing, Hitachi intends to contribute to creating a safe and secure society with a high quality of life (QoL).

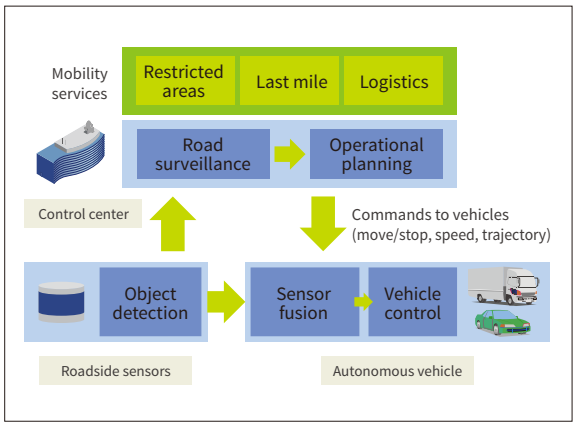
4 Autonomous Driving Technology by Government-funded Projects HumanDrive and DENSE

Autonomous vehicles are expected to bring benefits to society by enhancing mobility and increasing safety. To accelerate the realization of autonomous vehicles, Hitachi Europe Ltd. participated in the HumanDrive and Adverse Weather Environmental Sensing System (DENSE) projects and developed pioneering artificial intelligence (AI) technology to fuse and exploit the plethora of data generated from modern cars to improve the comfortability and safety of future autonomous vehicles in all weather conditions.

A key innovation of the technology was the creation of an intelligent data management tool that was used to prepare and learn from terabytes of human driving data. This enabled the company to remove any bias from the AI models used to interpret the road environment and generate a safe path for the vehicle as humans would naturally do. Further, Hitachi Europe designed a prototype AI-electronic control unit (ECU) that was used by DENSE partners to run AI functions. This approach, successfully tested on private tracks, with zero human interventions from the safety driver, delivered a driving experience that was acknowledged by passengers, to be substantially smoother and more natural than purely robotic control approaches.
(Hitachi Europe Ltd.)

4 Overview of DENSE and HumanDrive projects

5 Joint Research with Tsinghua University to Demonstrate Autonomous Driving Technology



5 Solution for cooperative autonomous driving

Hitachi (China) Research & Development Corporation has been undertaking joint research into mobility with Tsinghua University based on Future-oriented Collaborative Innovation Scheme agreed between the university and Hitachi in November 2018. The joint research is drawing on the respective experience of Hitachi and Tsinghua University in autonomous driving to engage in the development and testing of technology for cooperative autonomous driving in China. This is based on a vision for achieving safe and low-cost self-driving transportation that features cooperative interoperation with roadside infrastructure.

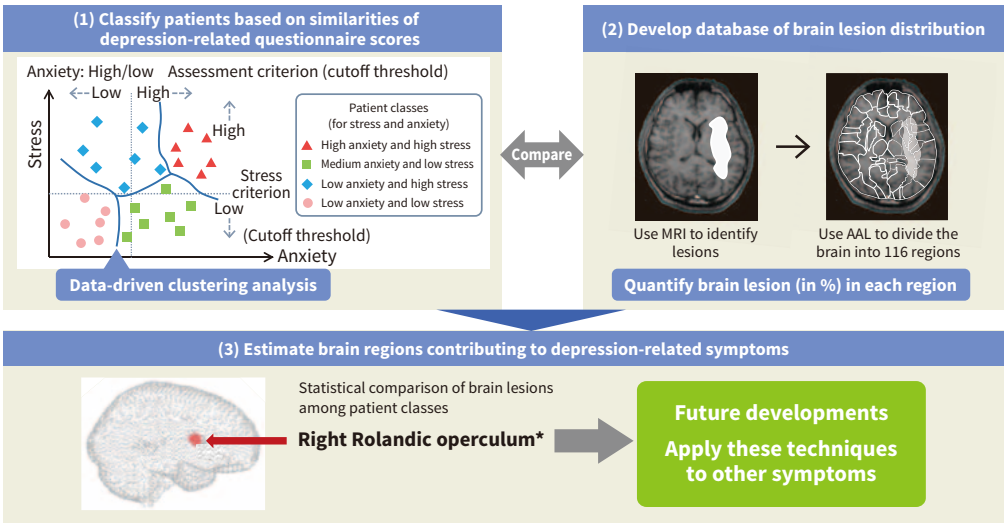
The system for cooperative autonomous driving improves safety through the coordinated operation of roadside sensors, the vehicles themselves, and a control center. It works by judging areas in which vehicles can be safely operated (taking account of blind spots) and then regulating the speed and trajectory of the vehicle by means of commands issued from the control center. This is intended to prevent collisions at intersections and other such locations and to reduce the cost of achieving level-four autonomous driving.

The objective of these trials is to speed up the introduction in China of safe mobility services provided by autonomous and self-driving vehicles.

6 Technique for Analyzing Depression-related Symptoms to Improve QoL of Stroke Patients

Stroke is the second highest cause of elderly nursing care, and early recovery from stroke has important implications for improving elderly QoL. However, 20% to 40% of stroke patients (1.12 million per year in Japan) simultaneously experience depression-related symptoms, making rehabilitation difficult and delaying recovery.

In collaboration with Hiroshima University and Hibino Hospital (located in Hiroshima Prefecture), Hitachi developed a technique to identify cerebral infarction (70% of total stroke incidents) patients and classify them into four groups based on a data-driven analysis of multiple depression-related questionnaire scores. In addition, a technique for estimating brain regions was developed by matching the database with the percentage of lesions in each brain region.



AAL: automated anatomical labeling MRI: magnetic resonance imaging
* A region associated with self-awareness and interoception

6 Details of brain lesion estimation technique related to depression-related symptoms

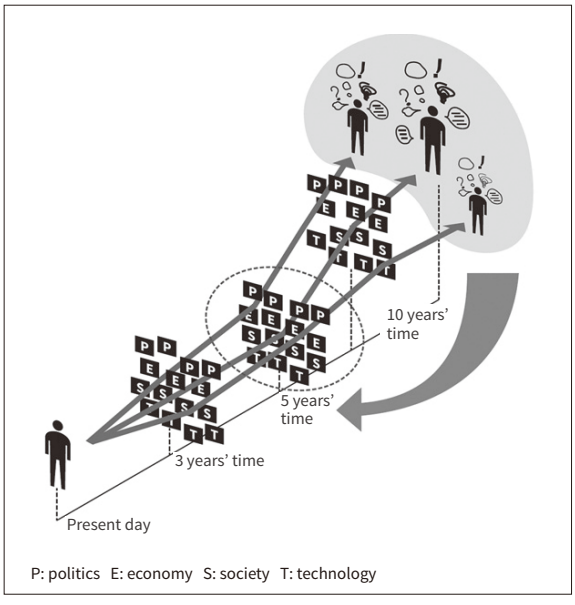
The technique may accommodate the early recovery for patients by predicting depression-related symptoms from brain lesions and recommending appropriate care. Further development and its deployment to rehabilitation facilities will contribute to early recovery of patients with cerebral infarction and improve elderly QoL.

7 Vision-driven Solution Development Strategy

Given the major changes taking place in lifestyles and the social environment, it is far from easy to come up with products and services that will win over consumers by means of incremental improvement or by forecasting based on an assessment of current conditions. This has led to the adoption of vision-driven development processes that consider what new needs will arise out of changes in people's values and then use "backcasting" from these hypothesized needs to come up with specifications and technologies for future products and services.

Hitachi has initially targeted the lifestyle services sector, focusing on future changes in people's values to envision scenarios for the future. These are used as a basis for devising solutions that will deliver the sort of lifestyles that people will want in a decade's time. Hitachi has also been factoring in the impact of the current COVID-19 pandemic to look at what sort of products, services, and design concepts will be applicable to life under the new normal that has arisen in its wake.

Through these measures, Hitachi Global Life Solutions, Inc. aims to become a people-focused solutions company that delivers inclusive solutions that generate value. (Hitachi Global Life Solutions, Inc.)

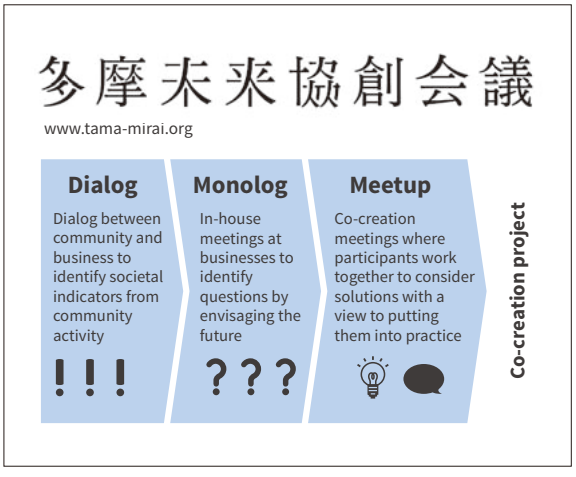


7 Backcasting-based product development

8 Future Living Lab Pursuing Value in Post-COVID World: From Use to Engagement

In the summer of 2020, amid the COVID-19 pandemic, Hitachi Kyoto University Laboratory published "BEYOND SMART LIFE: *Kokishin-ga Kudosuru Shakai* (Society Driven on Sense of Wonder)" (Nikkei Publishing, Inc.). The book made the case that the pursuit of excitement unconstrained by considerations of immediate convenience brings about new perceptions of value and enriches society. The Future Living Lab (FLL) is an initiative for putting this idea into practice.

Along with specific work with urban residents on the collaborative creation (co-creation) of new ways of running neighborhoods, this is intended to build communities that share common objectives. One example is the Tama Future Co-creation Conference, a community for fostering new activities in the Tama region of Tokyo that is bringing companies and other groups into contact with one another through three forms of interaction, dubbed "dialog," "monolog," and "meetup." In Miura City, Kanagawa Prefecture, it has also participated in establishing the "koyart" community, which is using agriculture and art to explore the future of the local region and convey this to the public. Having set "from use to participation" as its theme, the FLL is seeking to expand the functions provided by infrastructure in a way that shifts focus away from making the lives of individuals more convenient and toward fostering engagement alongside people and the community.



8 Process of Tama Future Co-creation Conference