

Automotive Systems

1 360° Stereo Vision

To realize autonomous driving on city roads, Hitachi Astemo developed a 360° stereo vision prototype with multiple cameras that can sense the entire area around a vehicle in three dimensions (3D).

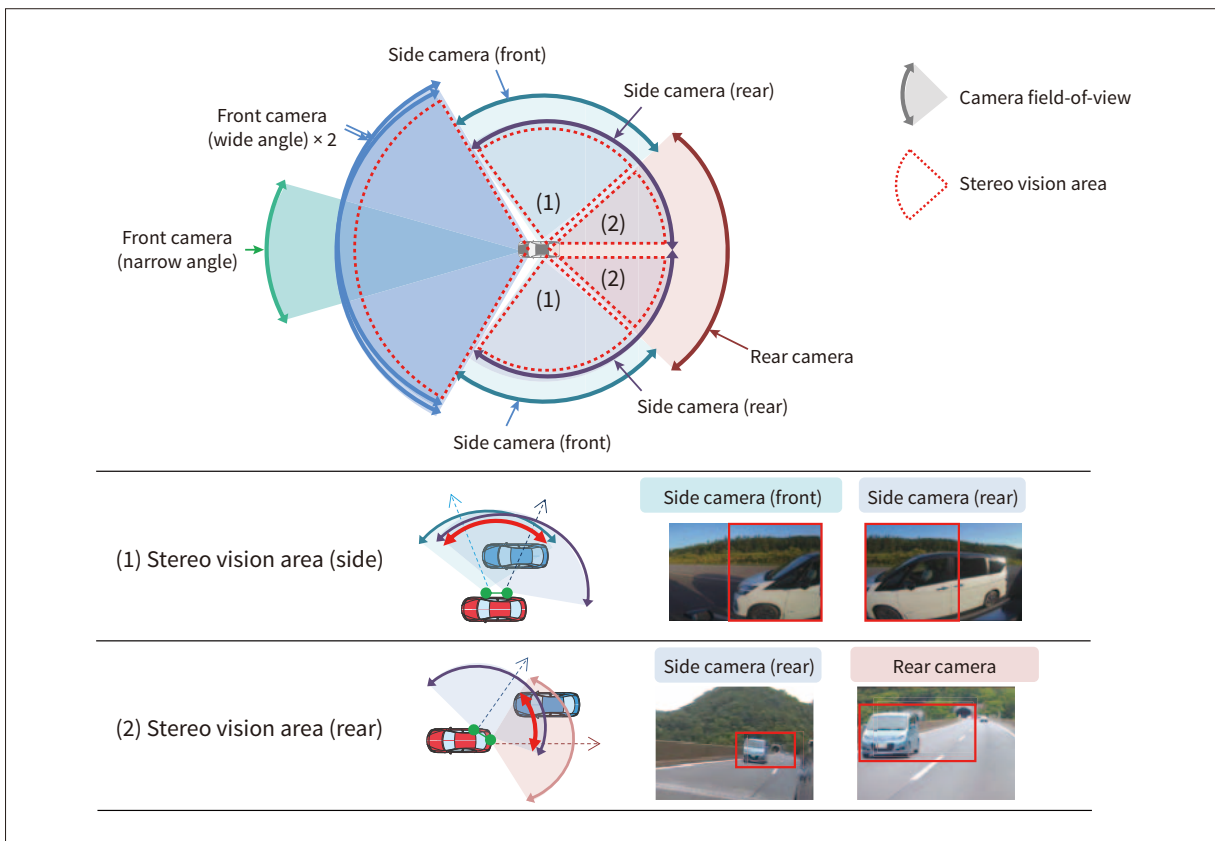
Conventional stereo vision uses an integrated structure composed of two cameras in parallel with the same field-of-view. The newly developed stereo vision technology combines different field-of-view and non-parallel monocular camera pairs. It uses multiple cameras placed around the vehicle to enable 3D sensing along the entire periphery. Allowing for freedom in camera placement makes it possible to use existing cameras, which keeps system costs down and realizes stereo vision with high precision and high-resolution 3D sensing. The goal is to realize autonomous driving on city roads by accurately measuring the distance to objects such as

a vehicle traveling side-by-side in the lane adjacent to the vehicle, a two-wheeled vehicle pulling out of a line of cars to the rear during a traffic jam, and pedestrians or bicycles when turning right or left at an intersection, and applying it to applications for avoiding a collision, for example.

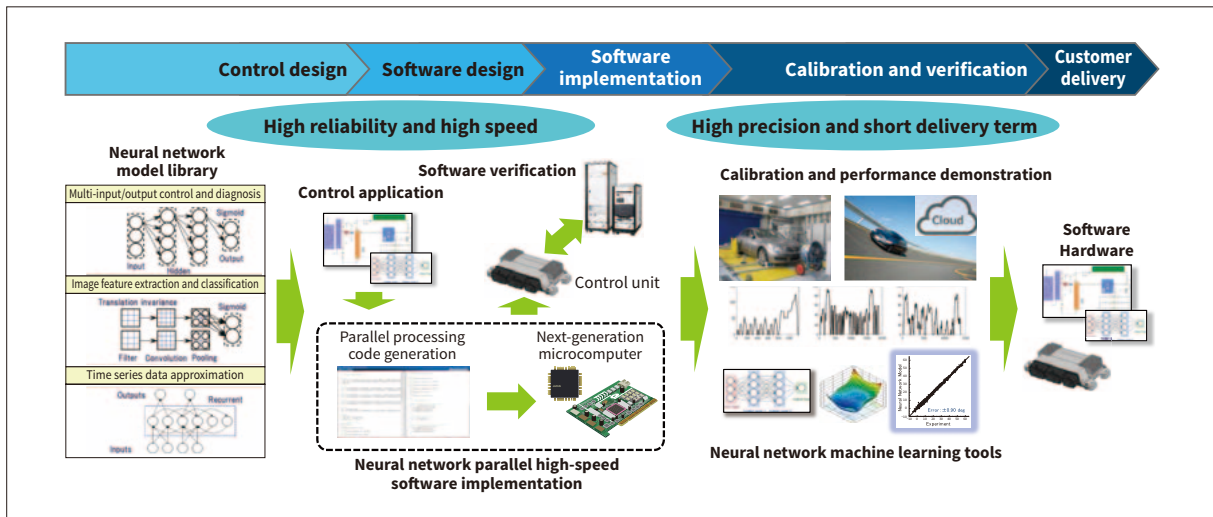
(Hitachi Astemo, Ltd.)

2 Neural Network Control Technology for Automobile Powertrain Systems

With the strengthening of environmental regulations on automobiles, powertrain control systems are becoming more complex, and the calibration (control parameter tuning) workload is increasing in size. Although model-based methods and automation of experimental measurements are advancing toward calibration efficiency, it is effective to adopt control algorithms with few calibration



1 360° stereo vision



2 Neural network control implementation technology realizing calibration efficiency and high-speed arithmetic operations

elements in the control software itself or that can be automated for calibration.

Therefore, Hitachi developed a powertrain control and software implementation technology that utilizes a neural network (NN), which is one type of mathematical model. This technology is composed of various NN control libraries and learning tools according to the target such as steady state, transient, and multi-inputs and outputs, etc. Using experimental data acquired under various conditions such as acceleration and deceleration as supervised data, the NN parameters are optimized through machine learning. Utilizing the parallel processing features of next-generation microcomputers, high-speed arithmetic operation is realized through implementation software optimized according to the NN structure.

Going forward, the company will utilize this technology to apply NN control applications to the reduction of engine exhaust gas and the thermal management of electric powertrains.

(Hitachi Astemo, Ltd.)

3 Development of Bioplastic Material Applied to Resin Gear of Deceleration Mechanism for Electric Power Steering

Hitachi has developed a resin gear that uses bioplastic aimed at achieving carbon neutrality throughout the entire value chain, and it was incorporated into the worm wheel for dual-pinion electric power steering for the first time in the world.

By adopting the biomass material polyamide 410, which comes from plant-derived raw materials, in place of the conventional polyamide 66 material, which is based on raw materials derived from 100% fossil fuels, the company reduced the carbon footprint [greenhouse gas emissions emitted throughout the entire lifecycle converted to carbon dioxide (CO₂)] by 71% and the CO₂ per kilogram of resin by 4.6 kg. Moreover it satisfies the durability, oil resistance, and other component requirement characteristics and increases the resin gear strength by 30% with a product design that applies the high toughness characteristics of this material. As a result, Hitachi achieved a



3 Dual-pinion electric power steering

size and weight reduction of the deceleration mechanism including the worm wheel.

Going forward, the company will contribute to the realization of a carbon-neutral society in 2050 by providing a variety of sustainable products.

(Hitachi Astemo, Ltd.)

* According to a survey by Hitachi Astemo, Ltd.

a power density of 94 kVA/L (maximum rated/capacity) that is 2.7 times greater than conventional products.

These inverters have been well received and were awarded the 68th Okochi Memorial Prize in FY2022. Going forward, Hitachi will contribute to the evolution of EVs and the realization of a carbon-neutral society.

(Hitachi Astemo, Ltd.)

4 Compact, High Output Inverter with Direct Water-cooled Double-sided Cooling Power Module for EVs/PHEVs

The miniaturization and weight reduction of drive systems continues to be pursued in the rapidly advancing electrification of automobiles aimed at decarbonization. Under such circumstances, in order to reduce the thermal resistance of power modules (PMs) which integrate power semiconductor elements that generate a lot of heat, Hitachi eliminated heat-dissipating grease and developed a double-sided direct cooling PM for electric vehicles (EVs) and plug-in hybrid EVs (PHEVs) with a structure that cools both sides of the semiconductor instead of just one side, and commercialized the third-generation inverter in 2013.

In addition to reducing the size by 15% and adding 400 V support to the fourth-generation PMs, 800 V support PMs were added to the lineup, and an 800-V fourth-generation inverter was commercialized in 2019. For the 800-V fourth-generation inverter, PM parallel drive technology was developed, the insulation design was revised, and the components were adapted for higher voltages to achieve a smaller size and a higher output with

5 High-performance Dual-pinion Assist EPS Utilizing High-precision MBD Technology

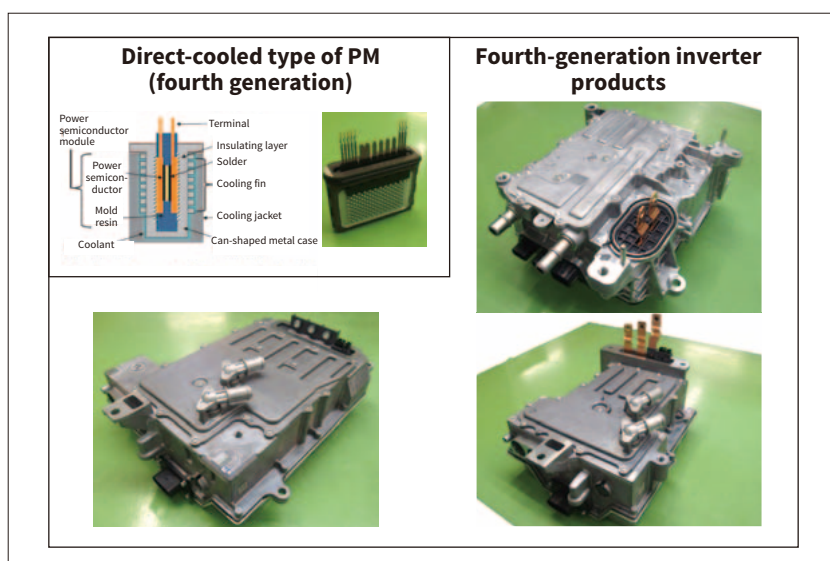
As a supplier of electric power steering (EPS), Hitachi has improved development efficiency by improving the precision of initial design studies. In addition, it has completed high-precision model-based development (MBD) technology with the goal of contributing to the realization of efficient customer vehicle development. The features of this technology are as follows.

(1) Achieves computer-aided engineering (CAE) analysis on a full EPS system with a one-dimensional (1D) control model + 3D mechanical component model

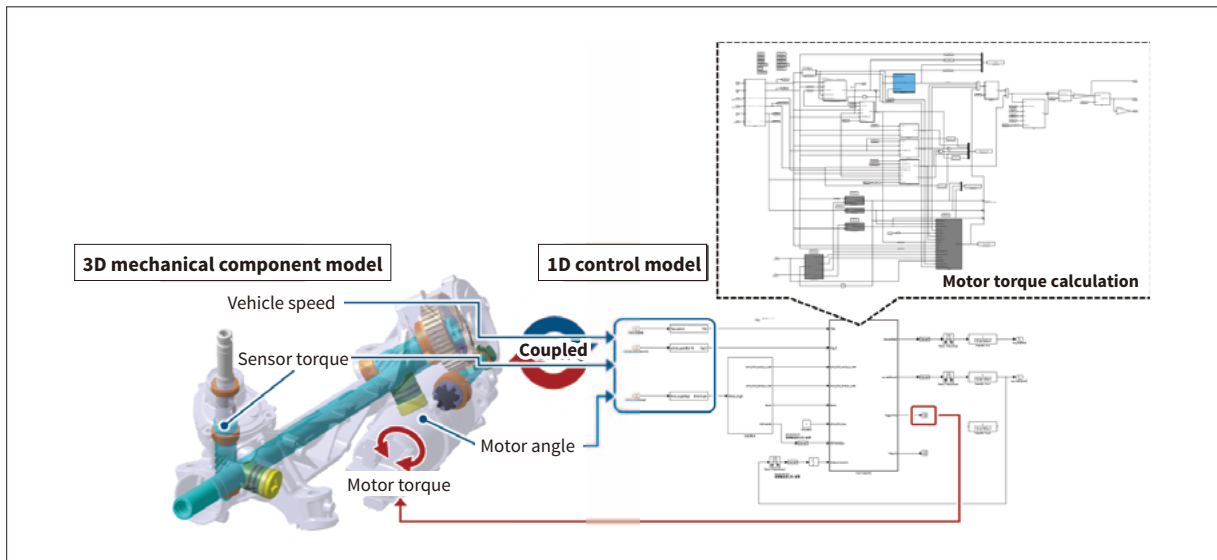
An environment that enables optimal design without performing actual sample verification, making it possible to verify system performance evaluations and abnormal noise evaluations with CAE.

(2) Realizes auto-tuning through a 1D control model + 1D mechanical component model and automatic optimal parameter tuning logic construction

By automating the current control map setting process, which determines the steering feel, Hitachi has reduced the work time by approximately 80% and, together with improved accuracy of initial map settings, has significantly



4 Fourth-generation inverter



5 Electric power steering mechanical component model + control model

shortened the delivery time. The company started gradually applying these technologies to EPS products being mass-produced from 2021.

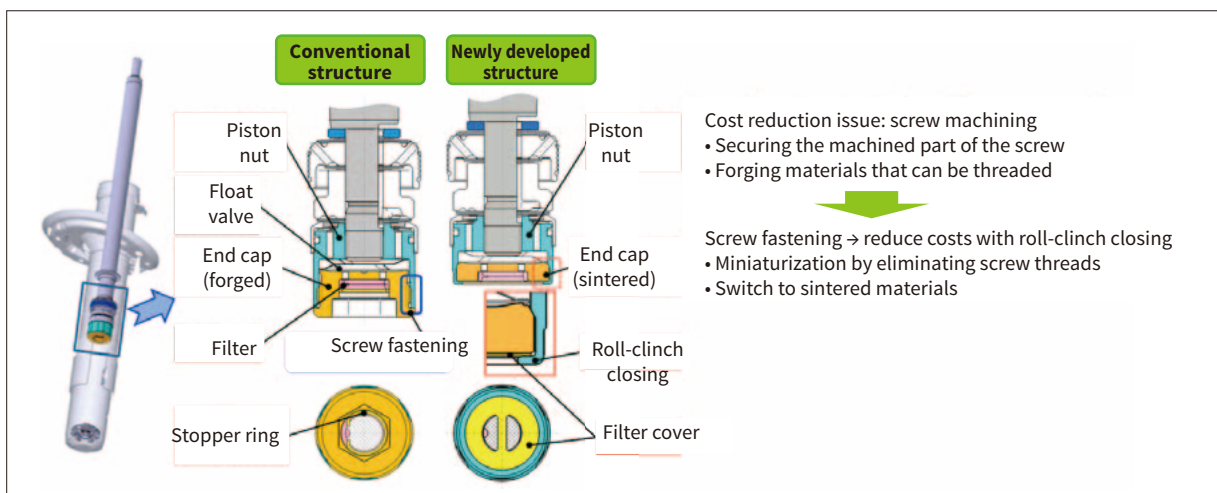
Going forward, Hitachi will steadily expand the applicable areas of CAE to shorten the prototype evaluation period and contribute to the effective utilization of resources. (Hitachi Astemo, Ltd.)

for ride comfort and quietness, while cost reductions are being sought for existing products, including suspension products, as vehicle development costs increase in the automotive industry. Amid such circumstances, Hitachi developed a high value-added product featuring excellent cost competitiveness and performance with a mechanical variable damping force piston structure that is positioned between semi-active and conventional control.

In this development, the company changed the fixing method of components from the conventional screw fastening to roll-clinch closing, eliminating screw machining, and changed the component material to achieve a more compact size and lighter weight in addition to significant cost reduction. Moreover, the product maintains the same level of performance as the current product without loss, resulting in a highly competitive, high-value-added product that achieves both performance and cost at a high level. (Hitachi Astemo, Ltd.)

6 Sensitive Frequency Response Damper (Generation 2.5)

The sensitive frequency response damper (SFRD) improves ride comfort without sacrificing handling stability by changing the oil flow channel according to road conditions and mechanically adjusting the damping force. In recent years, the rapid expansion of electrification and automation in vehicles has increased the demand



6 SFRD (Generation 2.5)



7 Kawasaki Ninja ZX-25R

7 Electronically Controlled Throttle Body for 250-cc Parallel Four-cylinder Engines

Electronically controlled throttle bodies (drive-by-wire), which separate the accelerator from the throttle controlling the engine output and increase the degree of control freedom are becoming more prevalent.

Under such circumstances, Hitachi started mass production of the world's first* electronically controlled throttle body for 250-cc parallel four-cylinder engines.

It has been adopted for use in the Kawasaki Ninja ZX-25R super sports model where it helps improve riding enjoyment by making it possible to switch the throttle control mode.

Target vehicles are equipped with a mechanism that mechanically maintains the throttle at a constant opening even when the throttle drive motor of the electronically controlled throttle body experiences an electrical fault, which enables the vehicle to limp home at a constant speed even during a breakdown. It adopts a structure that places the drive motor and opening retention mechanism in the center of the throttle body to consolidate the features of the opening retention mechanism composed of multiple components, achieving a more compact layout through a reduction in the number of components.

The downsizing of the entire throttle body contributes to a slimmer frame.

(Hitachi Astemo, Ltd.)

*According to a survey by Hitachi Astemo, Ltd.

8 Development and Mass Production of Suspension for Side-by-Side Vehicles

Hitachi has developed a side-by-side vehicle (multi-purpose offroad vehicle) suspension and started production in the USA.

The market for this category is expanding in North America for outdoor leisure use due to the impact of COVID-19, and original equipment manufacturers (OEMs) have begun full-scale entry into the market, with all of them announcing new models in recent years.

In response, Hitachi has applied its motocross suspension technology, which is specialized for off-road driving with features such as anti-dust performance, and has optimized the piston size. Moreover, the company has achieved a balance between road handling, toughness, and durability in a wide range of driving zones from race use to leisure use by applying a position-dependent mechanism for greater wear and dust resistance with the goal of improved bottom toughness. As a result, Hitachi has won orders for many models that have been well-received by customers.

(Hitachi Astemo, Ltd.)



8 Rear cushion for side-by-side vehicles