

Measurement and Control Systems

Measurement and Control Systems for Future Infrastructure Development
IMURA Kazuhisa**Trends in Measurement and Control Systems and Toshiba's Approach**
MIMURA Akihiro / HARA Hideyuki / KUSAKABE Hiroyuki

Measurement and control systems are widely used in various fields including industrial systems, public facilities, and other facilities. Demand has been growing in recent years for improvement of energy efficiency, enhancement of reliability and productivity, establishment of safer and more secure systems, and inheritance of plant operation technologies in such fields as building management systems, factory automation systems in steel plants, petrochemical plants, paper mills, and so on, as well as in the field of social infrastructure systems such as water and sewage monitoring and control systems. In response to this broad range of market needs, Toshiba has been developing major components of measurement and control systems incorporating the latest technologies.

Functional Safety and Plant Data Management Solutions for Steel Plants
SAKAMOTO Tadashi / YOSHIDA Akihiko / DOJO Koji

Toshiba Mitsubishi-Electric Industrial Systems Corporation has launched its two latest control and monitoring technologies for steel plants. The first technology is the safety PLC, a safety programmable logic controller in the TMACS_{TM} (Toshiba Mitsubishi-Electric Advanced Control Solutions) series. This provides a control system with functional safety in response to requirements for enhancing system safety if problems occur. The other technology is called the TM-PDS, comprising various plant data management solutions with scalability based on our steel plant database (uDB) such as remaining life assessment of mass induction-heating equipment. These solutions are realized by collecting and utilizing a variety of time-series data via the TC-net_{TM} 100 and TC-net_{TM} 1G control networks as well as product data.

Realization of Advanced Plant Monitoring and Control System Focusing on Alarm Management
NAKANO Hiroshi / SUGIMORI Hisayoshi / TATENO Genki

In recent years, distributed control systems (DCSs) have been playing a leading role in manufacturing systems. From the standpoint of plant safety management, it is necessary to set up an appropriate alarm system and establish an alarm management system for the life cycle of the plant. With these trends as a background, TOSDIC_{TM}-CIE DS/nv, a DCS developed by Toshiba, supports a new alarm system that promptly informs operators of significant changes taking place in the plant through alarms on the display to assist them in making judgments and taking the necessary actions. Furthermore, TOSDIC_{TM}-CIE DS/nv not only offers monitoring and evaluation of the existing alarm system for highly efficient plant operations, but also supports redesign of the alarm system for alarm management throughout the plant's life cycle.

Industrial Controllers Meeting Sophisticated User Requirements
SHIBAMIYA Toru / HIROTA Tatsuo / SHIBATA Koji

Industrial controllers are used in control systems in manufacturing facilities and environment-monitoring equipment in a variety of fields including general industry, social infrastructure systems, and electric power plants. In order to meet the growing demand in recent years for control systems offering greater safety through enhanced functional safety, environmental harmony by means of energy saving, and more efficient operation, there is an ongoing need for the application of the latest technologies as well as the effective utilization and inheritance of existing technologies for industrial controllers. To satisfy these increasingly sophisticated user requirements, Toshiba has been expanding its lineup of the Unified Controller nv series_{TM} with further strengthened functions.

Latest Industrial Computers Supporting Social Infrastructure Systems
ANAN Kazuhiro / AZUMA Takao / IZAKI Kosuke

Industrial computers are widely applied to social infrastructure systems including various types of monitoring and control systems. With the expansion of the scale of social infrastructure systems and the progress of networking and hierarchization of information in recent years, industrial computers are required to provide increasingly high processing performance as well as high reliability, robustness, and maintainability exceeding those of general PCs. Toshiba has developed the FR2100SS series industrial computers as its latest models in this field. Equipped with the third-generation Intel[®] Core[™] i7 processor, the FR2100SS series achieve the performance and functionality required to meet the demands of today's social infrastructure systems. These models offer not only high reliability, secured by the use of selected parts, shipment tests, and the application of our original redundant array of independent (inexpensive) disks (RAID) system, but also easy setting due to their 2U form factor and easy maintenance achieved by a design that allows components such as fans and hard disk drives (HDDs) to be replaced from the front. Furthermore, the stable operation of social infrastructure systems is sustained by long-term product support and the offer of compatible models.

LQ520 Microwave Density Meter to Meet Requirements of Chinese Market
WATANABE Kazuhiro / SAKATA Shinichiro / KIMURA Makoto

The rising proportion of the Chinese population living in urban areas has led to the construction of sewage treatment plants to accommodate the increasing amounts of sewage and sludge. In Japan and various other countries, the concentrations of sewage and sludge are generally measured continuously using microwave density meters in the sewage treatment process at sewage treatment plants and in the pulp and paper, food, and other industries, to achieve stabilization of both optimal chemical dosing and the concentration of dehydrated sludge. In China, on the other hand, sewage treatment plants employ intermittent concentration measurement without the use of microwave density meters. Hence, in order to reduce the processing cost per unit amount of sewage and sludge in China, it is necessary to accelerate the dissemination of microwave density meters there. In response to this situation, Toshiba has developed the LQ520, a new type of microwave density meter with appropriate performance and functionality for the Chinese market. We achieved reductions in the size, weight, and cost of the LQ520 by reducing the detector weight and the number of circuit boards.

TOSGAGE_{TM}-C2710BPS-A Width Gauge System with Hole Detection Function Applying High-Speed Cameras for Steel Rolling Lines
TAKEMURA Shota / NAKAO Tsutomu / KAJIWARA Tatsuya

Rolling line measuring instruments are widely used to measure the thickness, width, shape, and surface defects of the product at all stages of production in steel rolling mills, from upstream processes such as the hot rolling line to downstream processes such as the surface inspection line. Toshiba has been developing and supplying these instruments for a broad range of applications utilizing its proprietary radiation detection and optical sensing technologies. In the field of optical measuring instruments, measuring accuracy and detection resolution depend on the performance of the optical sensor employed in the instrument.

We have now developed the TOSGAGE_{TM}-C2710BPS-A, a new width gauge system with a hole detection function that realizes hole detection at higher resolution compared with conventional instruments. This has been achieved both by the use of high-speed cameras compliant with the CoaXPress high-speed image data transmission standard mainly for machine vision applications, and improvement of the image processing performance. Moreover, lower power consumption and reduction of environmentally harmful substances have also been realized.

Time-Interleaved SAR ADC Achieving Balance between High-Speed Sampling and Low Power Consumption
FURUTA Masanori / MATSUNO Junya / ITAKURA Tetsuro

In the field of ultrahigh-speed wireless communication systems, demand has recently been growing for high-speed and high-resolution analog-to-digital converters (ADCs). A time-interleaved ADC using multiple successive approximation register (SAR) ADCs as sub-ADCs is a solution for the realization of high-speed sampling. However, it is necessary to reduce the power consumption of the sub-ADCs in the development of a time-interleaved ADC. Furthermore, the power consumption becomes larger because of the conventional impedance transformer (IT) circuit at the front of each sub-ADC to suppress interference between sub-ADCs that increases distortion. Toshiba has developed a technology to reduce the power consumption of the source-follower circuits that make up an IT circuit, and fabricated a 7-bit, 1.5-gigasamples per second (GS/s) time-interleaved ADC with eight SAR ADCs for ultrahigh-speed wireless communication integrated circuits (ICs). As the current flowing into a source-follower circuit is dynamically changed with the introduction of dynamic operation, the bias current is reduced to about one-half compared with that of conventional source-follower circuits achieving high-speed sampling. Experiments on a prototype ADC confirmed that it achieves the world's top-class figure of merit (FOM) of 300 fJ/conversion-step.

Technologies for Disaster Recovery Support Robots
TERAI Fujio / UEHARA Takuya / NAKAJIMA Toru

At the Fukushima Daiichi Nuclear Power Station, which was damaged by the Great East Japan Earthquake of March 11, 2011, it was important to immediately confirm the situation of the nuclear reactors and the radiation levels after the accident. However, it was extremely difficult for workers to gather information in the area around the accident site due to the risk of radiation exposure. Robots and observation equipment remotely controlled from safe areas with a low level of radiation were found to be essential to improve the ability to collect information on behalf of workers. To make it possible to immediately resolve such situations, Toshiba has developed technologies for the following disaster recovery robots: (1) a remote-controlled gamma-ray measurement robot consisting of a crawler vehicle using our existing technologies and a gamma-ray camera that can visualize the levels of radioactive materials in different colors, which was used to measure radiation levels near the No. 1 nuclear reactor in May 2011; (2) a six-axis articulated mobile robot that can ascend and descend stairs and clear away rubble; and (3) a remote-controlled underwater camera that can monitor the inside of a nuclear reactor spent fuel pool, which assisted in investigation of the rubble in the No. 3 nuclear reactor spent fuel pool.

Large-Scale Integrated SCADA System Applying Private Cloud Computing
MIYAZAWA Kazuyuki / IWAHASHI Hirotaka / IJIMA Yoshikazu

Supervisory control and data acquisition (SCADA) systems for electric power systems have conventionally been installed in each facility covering a specific area of the electric power system. In the event of a disaster occurring in some area of the electric power system, however, serious damage might be caused in that area due to loss of the functions of the SCADA system. With this as a background, electric power providers have recently been paying increasing attention not only to business continuation by strengthening the functions of SCADA systems in the event of a disaster but also to the effective operation of facilities in electric power systems. Toshiba has developed a large-scale integrated SCADA system for electric power systems to integrate distributed platforms connected to a wide-area network and achieve flexible operation of the electric power system by applying private cloud computing. This system has been implemented in the SCADA systems of Hokkaido Electric Power Co., Inc. to upgrade the regional SCADA system configuration.

Space-Saving DC Switchgear for Overseas Railway Systems
HASEGAWA Tetsuya / KANDA Koji / FUKUDA Yasuyuki

DC switchgears, which consist of a DC circuit breaker, disconnecting switch, measurement and protection equipment, and other devices, are used to supply power to DC electric trains on urban railway lines. Toshiba has been developing and manufacturing DC switchgears mainly for the Japanese railway system since the 1970s, and has now developed a DC switchgear applicable to overseas railway systems. This product applying a newly developed control circuit, circuit breaker, and main circuit compartment achieves a 57.5 % reduction in installation area per feeder panel compared with conventional DC switchgears in the Japanese market. Furthermore, the control circuit compartment is equipped with a DC protection relay incorporating protection, control, and measurement functions as well as network functions compliant with international standards in a single unit, reducing the need for separate installation of conventional protection and control panels. This also contributes to space saving for the entire substation. We have delivered 21 panels of our new DC switchgear for three substations of the Directorate General of Railways of the Ministry of Transportation, Indonesia, and are promoting this product in other emerging markets that are planning to construct urban railway lines.

High-Performance 50 kW Smart Battery Capable of Utilizing Various Batteries and Operating with PV Systems
ENDO Tamotsu / TOHARA Masahiro / INABA Yuki

In recent years, demand has arisen for the stabilization of electricity distribution systems accompanying the expansion of renewable energy systems such as photovoltaic (PV) power generation and wind turbine systems, the reinforcement of disaster-prevention measures including the securing of electricity supplies during wide-area blackouts, and the need to suppress power fluctuations caused by the dissemination of electric vehicles (EVs) and EV rapid charging stations. Another emerging trend is the development of battery reuse as an environmental measure accompanying the increasing number of used EVs on the market.

In response to these diverse requirements, Toshiba has developed a high-performance 50 kW smart battery as one of its stationary battery systems. This smart battery, incorporating our proprietary technologies for controlling multiple DC/DC converters, can be connected with a variety of batteries and operate in conjunction with PV power generation systems.

Battery Inspection Technology Employing Charging Curve Analysis for Long-Term Use of Lithium-Ion Batteries and Its Applicability
HOSHINO Masayuki / ONO Shuji / HONDA Keizoh

A charging curve analysis technology developed by Toshiba is a battery inspection technology to calculate the cell performance of lithium-ion batteries installed in electric vehicles (EVs), plug-in hybrid vehicles (PHEVs), and stationary battery energy storage systems. This technology makes it possible to easily visualize the health of batteries actually used in EVs and other products and to improve the reliability of batteries in long-term use. It is expected to accelerate the dissemination of products for long-term use including EVs, PHEVs, and stationary battery energy storage systems, as well as the creation of used EV and PHEV markets and the development of rental and reuse businesses for lithium-ion batteries.

Charging Curve Analysis Method to Visualize State of Health of Lithium-Ion Batteries through Internal State Estimation
MORITA Tomokazu / MONDEN Yukitaka / HONDA Keizoh

Lithium-ion batteries are now widely used in electric vehicles (EVs) due to their long operating life exceeding 10 years, although the rate of performance degradation depends on the actual conditions of use. It is therefore necessary to evaluate the remaining value of the battery to ensure battery health when purchasing a used EV and reusing the battery itself. To facilitate estimation of the remaining value of lithium-ion batteries, Toshiba has developed a charging curve analysis method for such batteries comprising a simple method of evaluating battery cell performance in actual use. This charging curve analysis evaluates the current battery cell performance, including its capacity and internal resistance, at the time of charging based on changes in the internal state due to degradation of the active materials in the battery cathode and anode. Experiments on SCiB_{TM} batteries have confirmed that the performance of a newly developed battery state calculation algorithm using our charging curve analysis method is sufficient for practical application.