

Data Analysis Technologies Improving Security and Efficiency

Putting Big Data Innovation to Work

UCHIHARA Naoshi

Growing Importance of Data Analysis Technologies in Era of Big Data

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Data analysis technologies to extract useful information from large volumes of data, as well as parallel computing platforms to handle such data, have become increasingly important as key technologies in the new era of big data. With the continuous increase in the volumes, categories, and expansion ratios of stored data, data analysis technologies are expected to offer new insights in fields that have remained unanalyzed up to now by making full use of newly constructed databases.

In response to this situation, Toshiba has been engaged in the development of various technologies to collect data from its business activities in a diverse array of fields, ranging from social infrastructure systems to consumer products, and to analyze and utilize such big data efficiently. We are also developing highly sophisticated analysis methods and databases to process combinations of various types of data for the effective utilization of big data.

Failure Prognosis Technology for HDDs in Notebook PCs Using Data Mining

NISHIKAWA Takeichiro / NAKATSUGAWA Minoru

Toshiba has developed the Toshiba PC Health Monitor, which monitors various sensor data in its notebook PCs via the Internet with users' approval and alerts the users to significant system conditions including battery degradation and system cooling information prior to the possible occurrence of problems. We have already collected a broad range of operating logs from more than 2.2 million notebook PCs around the world.

We have now developed a failure prognosis engine for hard disk drives (HDDs) to diagnose HDDs in notebook PCs using collected sensor data, based on a failure prognosis model established by analyzing the relationships between these logs and failure data to predict the peculiarities of a failing HDD. We conducted evaluation experiments and confirmed that the group of HDD users alerted by this engine had a 67 times higher failure probability compared with the non-alerted HDD users group. This engine allows users to take adequate measures to prevent data loss once they become aware of a sign of a failing HDD.

Technology for Modeling Power Generation Performance of Large-Scale Grid-Connected Photovoltaic Plants

NAGASAKA Mari / SATO Makoto / NAKAMURA Hiroshi

A number of large-scale grid-connected photovoltaic (PV) plants have been constructed throughout Japan in recent years. In order to predict their power generation performance, which is affected by meteorological conditions, many PV plants have functions to visualize data from weather sensors and PV power generation sensors. With the upscaling of PV plants, however, it has become difficult to correctly grasp states of system abnormality by means of such visualization functions.

As a solution to this issue, Toshiba has developed a technology for modeling the power generation performance of large-scale grid-connected PV plants taking weather conditions into consideration. Applying a multivariate polynomial regression model, this technology can predict PV power generation output taking into account such factors as losses caused by various devices without being affected by the characteristic parameters of an individual plant, and is expected to contribute to more accurate predictions in this field. We have confirmed its effectiveness using actual PV plant data, and are now conducting verification tests of a PV power generation performance analysis system using this technology at several large-scale grid-connected PV plants.

Lifetime Analysis Technology for Elevator Components Using Data Mining

SATO Makoto / YANO Toru / KINOSHITA Eiji

For the continuous safe and secure operation of facilities and equipment, it is essential to perform appropriate maintenance according to their method of use and operating environment. With the wide dissemination of computer-based maintenance management systems (CMMSs) to collect and manage maintenance logs using electronic data, demand has recently been growing for the application of large volumes of accumulated maintenance history data.

Toshiba and Toshiba Elevator and Building Systems Corporation have developed a maintenance planning simulator for elevators that improves the quality of maintenance services by integrating a data mining technology, a statistical modeling technology, and a simulation technology, based on maintenance history data accumulated over a period of almost 10 years. The maintenance planning simulator can analyze the lifetime of elevator components and determine component replacement standards according to the usage conditions of the elevator. Applying this simulator, we have constructed lifetime models for approximately 2,000 types of components for elevators.

Technology for Real-Time Information Extraction from Social Sensors

NAGANO Shinichi

With the wide dissemination of smartphones in recent years, the posting of messages to social media in various situations while out of the office or away from home has become popular.

Toshiba has been researching a novel technology to extract information related to social infrastructure systems from the text contents of social media by handling them as social sensors. As part of this research, we have developed a method of extracting train status information from Twitter^(†) data to show suspensions or delays in train services. Through verification tests applying this method to commuter train lines in the Tokyo metropolitan area, we have confirmed its effectiveness in terms of high accuracy and real-time characteristics and are now working toward its application to the social infrastructure field.

GridStore™/NoSQL Scale-Out Database Supporting M2M Businesses in Social Infrastructure Field

HATTORI Masakazu / IDE Shunichi / KURITA Masayoshi

With the unpredictable future growth in the volume of sensor data in the social infrastructure field, databases with high scalability are essential for the management of machine-to-machine (M2M) data. In particular, scale-out technologies are important to enhance the efficiency and effectiveness of overall systems.

Toshiba Solutions Corporation has developed the GridStore™/NoSQL scale-out database, which forms the core of the Integrated Big Data Platform. This system offers high performance in the accumulation of large volumes of various data from sensors in real time by applying a unique approach adjusted to the characteristics of such sensor data, while also improving services and reducing costs by means of a nonstop scale-out feature.

All-Digital Calibration Technology for Time-Interleaved ADCs to Achieve Balance between High Speed and Downsizing

MATSUNO Junya / FURUTA Masanori / ITAKURA Tetsuro

There is a strong requirement to increase the speed of operation of analog-to-digital converters (ADCs) in large-scale integrations (LSIs) for wireless communication systems to respond to the improvements achieved in system transmission speeds and data rates. A time-interleaved ADC (TI-ADC) using multiple sub-ADCs that operate in parallel has been attracting attention as a solution for the realization of faster conversion. However, the higher manufacturing cost of conventional TI-ADCs, due to the need for large-scale digital calibration circuits to rectify differences in the performance of individual sub-ADCs that occur as a result of the manufacturing process, is a serious issue.

Toshiba has developed a compact all-digital calibration technology to drastically reduce the area occupied by conventional calibration circuits while maintaining the calibration accuracy of TI-ADCs, by subtracting harmonic signals caused by differences in the performance of sub-ADCs from the digital output signals. We have conducted simulation experiments using a model of a 10-bit TI-ADC with four sub-ADCs for next-generation wireless communication systems, and verified that this technology reduces the amount of digital calibration circuits required by about 80%.

Verification of Direct Correlation between Hydrogen and Reliability of Silicon Oxide Film Using Nuclear Reaction Analysis

SUZUKI Masamichi / HIGASHI Yusuke / TAKAISHI Riichiro / FUKUTANI Katsuyuki

Silicon oxide (SiO₂) film is employed in many devices, including as a gate oxide film in metal-oxide-semiconductor field-effect transistors (MOSFETs) and as a tunnel oxide film in NAND flash memory cells. Although a model has been reported attributing reliability degradation of these devices to the migration of hydrogen incorporated into the SiO₂ film during the semiconductor manufacturing process to the SiO₂/Si interface, this has not been experimentally verified so far.

Toshiba has now quantitatively verified a direct correlation between hydrogen at the interface and reliability degradation of SiO₂ film for the first time in the world, through demonstration experiments using nuclear reaction analysis (NRA) based on the comparison of MOSFET characteristics and hydrogen depth profiles estimated by NRA.

Determination of Effective Nitrogen Species in Silicon Nitridation Plasma Process

KURIHARA Kazuaki / SASAKI Koichi

There is a growing need for advanced processing technologies to achieve fine processing with nanometer-order accuracy by semiconductor processing devices. Although a plasma process has been widely used for etching and surface modification due to its high reactivity in thermal nonequilibrium conditions, the improvement of process controllability has become increasingly important. However, the plasma process is usually controlled by changing the device parameters through trial and error because it is difficult to quantitatively measure several important reactive species.

Toshiba, in cooperation with Hokkaido University, has developed systems to measure multiple reactive nitrogen species for plasma nitridation processes, which are widely used in industrial applications, in the same chamber for the first time in the world. From the results of experiments using these systems, we have confirmed that both excited nitrogen molecules and their ions are major precursors of the silicon nitridation process. These quantitative measurement technologies for reactive species in process plasma are expected to improve the process capability and the controllability of plasma process equipment.

Practical Application of Line Current Differential Relay Utilizing Communication Networks for General Use

NISHIDA Tomonori / MORI Takahiro / YAMADA Junichi / KOHIGA Seiichi

Line current differential relays contribute to the stable operation of electric power systems by detecting faults, such as lightning faults, and issuing a trip command to circuit breakers in order to isolate faulted network components. This system is capable of detecting whether a fault is an internal or external accident in the area covered by protection through differential calculations using current data from all of the terminals on the transmission line collected via a pulse code modulation (PCM) communication system. Conventional systems of this type therefore require a dedicated communication system, leading to increased costs.

Toshiba and Tokyo Electric Power Company, Inc. have developed a new line differential protection system utilizing a native Ethernet^(†) communication system without dedicated facilities for the first time in the world. We have put this system into practical use, resulting in cost reductions for communication facilities and the overall system.

FA3100SS Model 1000 Desktop Type Industrial Computer

HAYANO Toru / AZUMA Takao / ANAN Kazuhiro

Industrial computers are widely applied to social infrastructure systems including various types of monitoring and control systems.

Toshiba has developed the FA3100SS model 1000 as its flagship desktop type industrial computer lineup, which achieves high-speed processing of large volumes of data with its third-generation Intel^(†) Core^(†) i7 processor and high-speed serial interfaces including universal serial bus (USB) 3.0, PCI Express^(†) 3.0, and Gigabit Ethernet^(†). This model will contribute to the safe and secure operation of social infrastructure systems due to its features of long-term product supply and maintenance with the same chassis dimensions in products of the same series.

72/84 kV-Class Solid-Insulated Switchgear

TAKEI Yoshihiro / TAGAYA Osamu / SATO Junichi

Cubicle type gas-insulated switchgears (C-GISs) using sulfur hexafluoride (SF₆) as a gaseous dielectric medium have been widely applied as 72/84 kV-class switchgears for electric power transmission systems. However, as SF₆ is listed as one of the quantified emission limitation and reduction objectives in the Kyoto Protocol adopted at the Third Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP3) in December 1997, demand has been growing for 72/84 kV-class switchgears that do not use SF₆.

With this as a background, Toshiba has developed and released an SF₆-free 72/84 kV-class solid-insulated switchgear (SIS), following its previous launching of a 24/36 kV-class model for power distribution systems. The newly developed SIS is an environment-conscious product that offers not only easier maintenance without the need to exchange SF₆ or other insulation gases, but also greater compactness taking the renewal of substations into consideration.

Metadata Complementer Technology to Improve Accuracy of TV Program Recommendations

OGAWA Shuta / NISHIMOTO Yoshinori / OHMORI Yoshihiro

With the increase in the number of TV channels accompanying the shift to digital broadcasting, it has become difficult for viewers to find TV programs that they particularly wish to see from among the large number of programs available. Demand has therefore been growing in recent years for the development of TV program recommendation technologies. However, the shortage of program metadata necessary to find programs according to the preferences of each viewer has lowered the accuracy of TV program recommendation.

As a solution to this issue, Toshiba has developed a metadata complementation technology for TV program recommendation. This technology makes it possible to complement missing metadata by comparing program titles to determine, for example, whether a program is part of a series that is broadcast weekly. We have conducted evaluation experiments and confirmed that the metadata complementation technology can complement missing metadata due to improvement of the F-measure of detection accuracy of series type programs from the conventional level of 0.20 to a practicable level of 0.95, thereby improving recommendation accuracy. We have applied this technology to the automatic recording function of TV products for the European market since the spring of 2014.

Technology to Improve Real-Time Performance of Linux^(†) for Multicore CPUs

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