Towards harmonized power system control based on PV power prediction

*Junichi Imura[1,2]

1.Tokyo Institute of Technology, 2.JST, CREST

This paper presents the outline of the research project ''System Theory for Harmonized Power System Control Based on Photovoltaic Power Prediction (HARPS)," (PI: Jun-ichi Imura), supported by the EMS CREST research program of JST, which has started in April, 2015 for five years. According to “Long-term Energy Supply and Demand Outlook” proposed in July 2015 by METI, a roadmap to photovoltaic (PV) generation dissemination, 7% of the total electric energy and about 30% of the total electric power in Japan, which equals to 64GW of PV power generation, will be covered by a large penetration of PV in 2030. This makes an approach to install a large amount of PV generation to reduce CO2 emission gaining momentum. Therefore, developing a new structure of control technologies to achieve a stable electric power supply using PV generation forecasts is urgent. In addition, there are needs to fundamentally review frameworks of the entire system to achieve the supply and demand balance. Electric power supply systems will be renewed after the separation of electrical power production from power distribution and transmission, and the deregulation of electricity. Developments of new mechanisms, such as demand response, from advancements in information infrastructures and home battery technologies also cause the necessity to review the frameworks. The goal of this research project is to develop a system theory for the more advanced generation electric power system control by fully exploiting demand/PV predictions and focusing on properties and functions of a middle layer. The middle layer is expected to take many different forms such as demand-side energy management systems (BEMS, CEMS, etc.), cooperative power conditioners, demand response aggregators, and balancing groups of suppliers. In particular, as a basic theory and technology to be the core of harmonized electric power systems control to enable PV introduction of 102GW, and further towards PV introduction of 330GW, we aim to develop the following fundamental theories and technologies: (i) Electric Power System Design: a system design theory composed of supply layer, middle layer, and consumer layer, (ii) Prediction Technology: a PV generation prediction technology adapted to power system control techniques that achieves a stable power supply, (iii) Control Technology: a power system control theory and technology to realize a harmonized stable power supply from the perspectives of fairness and comfort as well as the economics and environmental friendliness, by fully exploiting PV generation predictions. This research is performed from the following five viewpoints: PV power prediction, supply and demand control, consumer-side control, control of power transmission and distribution systems, and basic systems theory. The number of researchers including students is 112 (36 students). This research is performed from the following five viewpoints: PV power prediction, supply and demand control, consumer-side control, control of power transmission and distribution systems, and basic systems theory. See http://www.cyb.mei.titech.ac.jp/crest/ for the details on this project.

Keywords: Photovoltaic Power Generation, Power System, Suppy and Balanace Control

Application of the JMA data for a renewable energy management field -AIST efforts and future initiatives-

*Hideaki Ohtake[1], Fumichika Uno[1]

1.National Institute of advanced industrial and technology

Recently, many photovoltaic (PV) power systems have been installed in the Japan islands from an introduction of feed-in-tariff in 2012. In the current situation, over 20 GW of PV systems has been penetrated. However, renewable energy such as PV power production and wind power production has significant large temporal and spatial variations due to cloud moving and wind speed over complex topography. In order to control a total electric power system in an electric power service area, electric power service companies has to adjust other power outputs (thermal power plants (oil, coal, natural gas), hydraulic power, water pumping etc.) not only renewable energy resources. For a safety control of energy management system (EMS) using renewable energy resources, forecast and monitoring data of renewable power outputs will be necessary more and more.

National Institute of Advanced Industrial Science and Technology (AIST) develop a PV power forecast technology based on machine learning algorism (support vector machine, SVM). In this system, grid point values (GPV) of a mesoscale model (MSM) of the Japan Meteorological Agency (JMA) are used as an input data. In the current situation, solar irradiance forecast data are not included in the GPV datasets of the JMA. Therefore, we must forecast solar irradiance and/or PV power output based on a numerical prediction model. In order to forecast of PV power output, we use the SVM with both MSM GPV and solar irradiance data as an input data. To perform a bias correction, the SVM are also used in our forecast system.

Research center for photovoltaics of AIST also collaborated with the Meteorological Research Institute (MRI) of JMA and has been validated the solar irradiance forecast data from the MSM and a local forecast model (LFM). Each horizontal resolution is 5km and 2km, respectively. MSM performed 39 hours forecasts every 3 hours and LFM performed the 9 hours forecasts every 1 hour. Therefore, MSM was used day-ahead forecast and LFM are expected for short-term forecast in the EMS. From our validation of solar irradiance forecast, negative bias in summer and positive bias in winter are remained in the MSM. Actually, bias correction using the SVM is performed to reduce systematic forecast errors in AIST. Furthermore, validation results would be useful information to improve solar irradiance forecasts of the Numerical Weather Prediction[u1] (NWP). In previous study, our research group investigated the relationship between solar irradiance forecasts and cloud types in cases of large forecast errors. In PV forecasts, forecast errors are included in the model outputs because of both uncertainties of model schemes of NWP and meteorological observations when initializing models. Therefore, confidence intervals of solar irradiance forecasts are also required for users of PV power outputs (or electrical system operators). A usability of ensemble forecasts using different dataset from overseas NWP centers[u2] has been also examined.

Recently, users of PV power outputs have paid attention to aerosol optical depth and/or volcanic ash not only clouds distribution because of the decrease of PV power outputs due largely to the reduction of direct normal irradiance (see a related presentation by Dr. Uno (AIST) in the section “Dynamics of eruption cloud and cumulonimbus; modelling and remote sensing” of JpGU 2016).

AIST has taken part in the Japan Science and Technology Agency (JST) Core Research for Evolutional Science and Technology (CREST) project of “Creation of Fundamental Theory and Technology to establish a Cooperative Distributed Energy Management System and Integration of Technologies Across Broad Disciplines Toward Social Application” (EMS). In this presentation, we will show our effort in the JST CREST EMS project.

Keywords: Forecast of PV power generation, Numerical Prediction Model, JMA data

Real-time distribution of Himawari 8 observational data

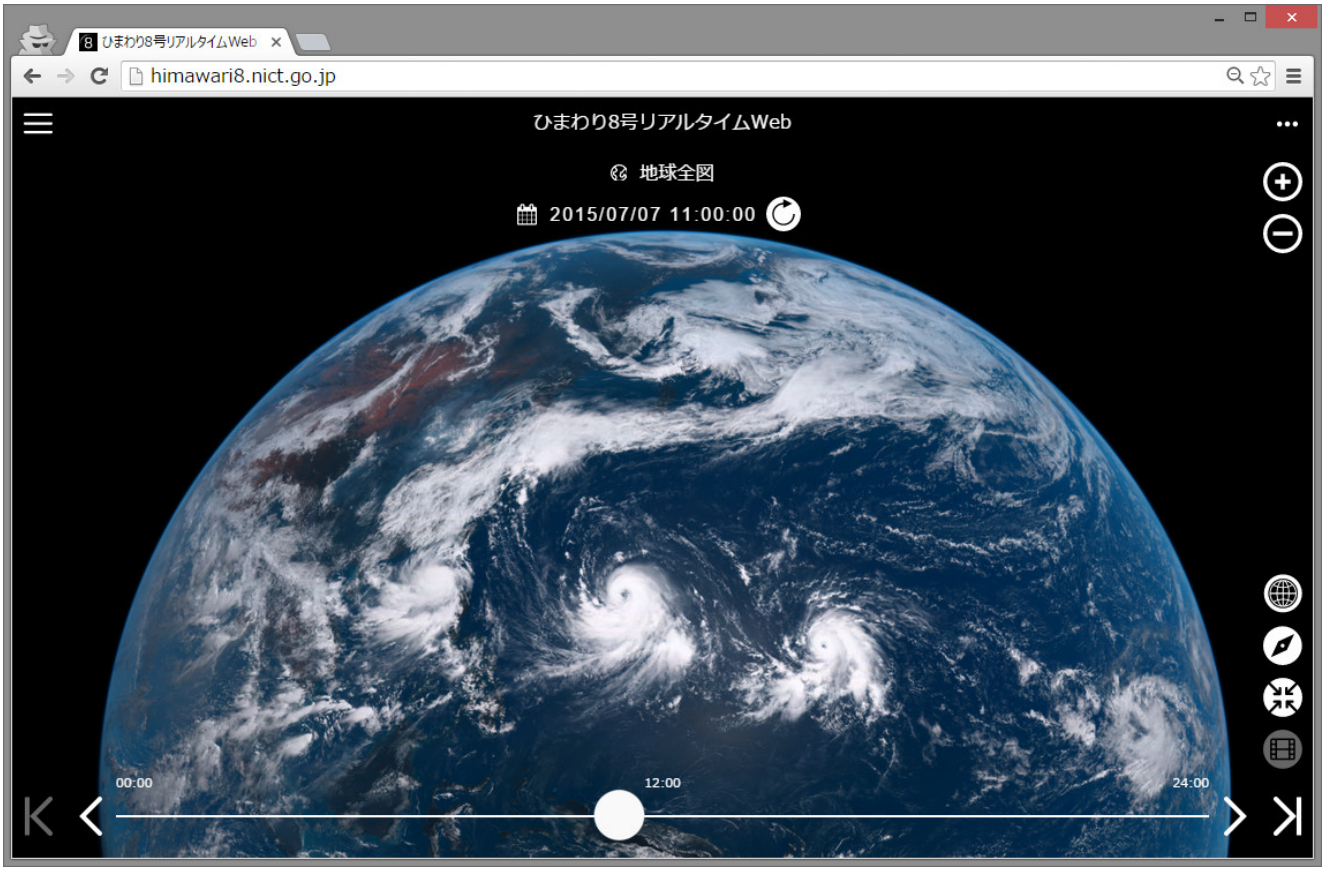
*Yoshiaki Nagaya[1], Ken T. Murata[1], Atsushi Higuchi[2], Koichi Toyoshima[2], Rie Honda[3], Kotaro Bessho[4], Katsuhiro Mouri[5], Kentaro Ukawa[6], Kazuya Muranaga[6], Yutaka Suzuki[6], Jun'ichi Murayama[6]

1.National Institute of Information and Communications Technology, 2.Center for Environmental Remote Sensing (CEReS), Chiba University, Japan, 3.Department of Information Science, Kochi University, 4.Meteorological Satellite Center, Japan Meteorological Agency, 5.Nagoya City Science Museum, 6.Systems Engineering Consultants Co.,LTD.

On July 7, 2015, the next-generation meteorological satellite "Himawari 8" of Japan Meteorological Agency (JMA) started formal operation. Corresponding to a request from the Japan Meteorological Agency, Science Cloud project of National Institute of Information and Communications Technology (NICT) cooperates in preservation and distribution of observational data of Himawari 8, and Science Cloud unveiled the Himawari 8 Real-time Web on the same day.
Himawari 8 observes a full-disk in every 10 minutes, and a Japanese region and a target region in every 2.5 minutes. A sensor in Himawari 8 has 16 observation bands between visible light to infrared rays, and spatial resolution of 500m (band 3) at under the satellite's orbit. The data size after converted into physical values turns into about 50 times in Himawari 7, and about 400GB per day with large improvement in time and spatial resolution of the Himawari 8 sensor.
Moreover, those data is transferred from the satellite in every 10 minutes. It takes about 10 minutes after the observation to be put on the storage of JMA and converted into physical values. The data is acquired by Science Cloud in an instant mostly through SINET by National Institute of Informatics and JGN by NICT. After adjusting a color tone to improve appearance, the website has distributed observational data by HTML.
This website is developed for accesses of not only PCs but also smart phones and tablets. In addition, control by finger touch is also activated for user experience and practical use at school education. In addition, time, data, place, and zoom ratio of display are acquired in the format of URL, and a characteristic observational data is sharable through a social network etc. is also implemented.
In order to respond to many requests for a night observation, infrared rays are added as the observation result of 24 hours, although only visible light is available on July 7, 2015.
International use of observational data should be in target because Himawari 8 covers East Asia and Oceania. Therefore, the website also supports the display by eight languages with cooperation of overseas researchers.
Close to 30,000 per day users visited to the website when this website opening to the public and it has settled down on about 2,000 accesses / day after one month. However, when a typhoon approached and landed at Japan, the number of accesses reached to 5,000 /day. In addition, in the eruption of Mt. Aso on September 14, 2015, the number of accesses increased. From these things, when a certain weather event occurs, it is assumed that usage in which users check actual data by this website is created.
According to users by countries, there is much use from the People's Republic of China and the Republic of China. Since this increase is coincide with the release in Chinese, it is assumed that not only specialists but general users are interested in this service. Moreover, the program code which collects images automatically from this website was registered into the open source program share site "GitHub", and, as a result, access from the United States of America and Russian Federation increased rapidly on February 4, 2016.
The users of Himawari 8 observational data are not only specialists or researchers, but general

users all over the world across the border have interest. It is assumed that the Himawari 8 Real-time Web has an important result in which science data restricted to use of only researchers and specialists until now is made familiar for general users.
As this background, it is assumed that the time and spatial resolution of observational data which is advanced by Himawari 8 are overlapped to the ordinary personnel life. It is concluded that this is a good feasible study for expanding use of science data like education sector as a result of advancement of observation technology and development of information and communications technology.

Keywords: Big data, Real-time processing, Satellite, Himawari



Land surface temperature retrieval from Himawari-8

*Yuhei Yamamoto[1], Hirohiko Ishikawa[1], Yuichiro Oku[2]

1.Disaster Prevention Research Institute, Kyoto University , 2.University of Hyogo

1 .Introduction

Land surface temperature (LST) is one of the key parameters in land-atmosphere interaction of various scale. Therefore, understanding the variation characteristics of LST has a crucial role to solve environmental issues of desertification or urban heat island. Oku et al. [1],[2],[3] proposed a retrieval method of LST over the Tibetan Plateau using GMS-5 and calculated land surface energy fluxes by their proposed method. The newly launched Japanese Geostationary Satellite, Himawari-8 supplies data of improved horizontal, temporal and spectral resolution. Using these data, it is expected that Himawari-8 can observe the smaller scales such as urban area in Japan, and can resolve various phenomena in urban area concretely. In this study, a new retrieval method of LST using Himawari-8 data was developed for applicable to smaller scales such as urban area in Japan.

2. Calculation algorithm of LST

Estimation of LST from a geostationary weather satellite requires information of thermal infrared radiation from the land surface. Because thermal infrared radiation cannot transmit clouds, we need to exclude clouds from satellite data as preprocessing. Therefore, we firstly constructed the clouds detection algorithm using 7 Himawari-8 spectral bands and made cloud mask products. Next, we simulated various land surface and atmospheric conditions using the radiative transfer model Rstar6b for determining best calculating LST equation and best combination of thermal infrared Himawari-8 bands. Furthermore, we developed LST equation fitted with satellite zenith angle by simulating some viewing zenith angle situations. And also, thermal infrared radiation observed by the sensor is influenced not only by land surface temperature but also by land surface emissivity and water vapor. Therefore, Estimation of LST requires information of land surface emissivity and water vapor. So, we constructed estimation method of land surface emissivity and water vapor. Accordingly, a new retrieval method of LST using only Himawari-8 data was developed.

3. Results

To evaluate accuracy of LST calculated by our method, comparisons were made around Japan between retrieved LST by our method and MODerate resolution Imaging Spectrometer (MODIS) LST product (Collection-5) provided by NASA. Consequently, retrieved LST reasonably overestimated with MODIS LST product (Collection-5) which has a feature of underestimating with observed LST in hot and humid environment. Furthermore, cloud detection method constructed in this study was also evaluated by comparison with MODIS cloud mask product and AMeDAS actual sunshine duration data. Consequently, our cloud detection method was confirmed in urban regions that is difficult to detect clouds. Construction of retrieval method of LST using Himawari-8 geostationary satellite data enables high temporal resolution and global scale observations of LST compared to the polar orbit satellite data.

Acknowledgements

Himawari-8 data processing is carried out on the NICT Science Cloud. GPS precipitable water is supported by Japan Meteorological Agency.

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Keywords: Satellite metorology, Remote sensing, Land surface temperature

Database of Weather Charts for Hundred Years: Construction of long-term data archives on weather charts created by Japan Meteorological Agency

*Asanobu Kitamoto[1]

1.National Institute of Informatics

Weather charts are valuable resources to represent the history of meteorological observations in Japan because of their importance on understanding and prediction of weather based on the integration and visualization of meteorological observations on the ground and in the upper atmosphere. We started the construction of a long-term data archives for weather charts that have been created by Japan Meteorological Agency (JMA) and its predecessors since March 1, 1883 for about 134 years, and released a website called “Database of Weather Maps for Hundred Years” (http://agora.ex.nii.ac.jp/digital-typhoon/weather-chart/).

The core part of this database is weather charts purchased from Japan Meteorological Business Support Center. Weather charts were uniformly extracted and converted so that they can be searched by date. Continuous from the beginning is the surface weather chart around Japan or Asia Pacific, and the type of weather charts has been gradually increasing to reach eight at the latest. In general it can be considered as continuous time series, but weather charts are significantly missing for twenty days in September 1923, which seems to be the result of fire at the Central Meteorological Observatory in Tokyo after Great Kanto Earthquake on September 1. The website was publicly released on November 2015, after an experimental release on January 2014 with a credit stating that this database is based on the usage of data from JMA according to the data policy of JMA.

The original plan was to construct the database of weather charts that are geometrically corrected (georeferenced). The manual geometric correction of weather charts is infeasible for more than 100,000 weather charts, so the key is the development of an automated process for the geometric correction. As a result, weather charts after August 1958 could be processed to a satisfactory level, so we took advantage of geo-browsers such as Google Earth, Google Maps and Cesium to show the overlay of georeferenced weather charts.

The next challenge is to improve the usability of the database. Search by date was the first search method being implemented, but more advanced search methods were missing due to the lack of metadata. Hence we implemented four methods to improve the findability of weather charts. First, we added search for the description of “daily weather charts” from JMA to enable keyword search on relevant weather phenomena. Second, we integrated with other databases of “Digital Typhoon,” to provide a variety of access methods such as weather charts of the day of typhoon landfalls, or weather charts of the day of disasters that satisfy a set of criteria. Third, we created short narratives on relevant weather charts with the help of NPO Weather Caster Network to access weather charts of historical events and extreme observations (29 cases) or major typhoons (19 cases) through the narrative of weather charts. Fourth, we used an image browser with synchronized timelines called “SyncReel,” to offer efficient access to past weather charts by scrolling horizontal timelines.

A challenge for the future is the mining of information embedded within weather charts. Automatic extraction by software does not work for weather charts on which lines are written multiple times. Instead, we should rely on the power of human through the activity of crowd-sourcing or citizen science, where scientists and citizens can take part in the activity of information extraction from weather charts after considering the following issues. First, we need training for the proper interpretation of data such as different unit of pressure. Second, we need to clarify contribution

to science about how historical weather charts can contribute to scientific discovery, because this is where citizens are motivated to contribute to the activity.

Keywords: weather chart, database, geometric correction, georeference, historical resource, citizen science

Investigating long-term trends of climate change and their spatial interactions with local environments through data mining techniques

*Yichun Xie[1], Anbing Zhang[2]

1.Eastern Michigan University, 2.Hebei University of Engineering

Climate change is a global phenomenon but is also modified by regional and local environmental conditions. Climate change displays apparent regional variations. For instance, mountainous regions are usually more sensitive to climate change than flat and low elevation regions. Unique landscape structures of land masses, oceans or water bodies, dominant air flows, topographies and elevations can have significant impacts on local meteorological conditions and thus lead to distinct regional patterns of climate change. Moreover, climate change exhibits remarkable cyclical oscillations and disturbances, which often mask and distort the long-term trends of climate change we would like to identify. Traditional analytical methods based on the comparisons between minimum, average and maximum values of temperature and precipitation are not capable of separating long-term trends from cyclical fluctuations and abrupt changes or capturing temporal dynamics or regional patterns of climate change. As a result, it is almost impossible to study long-term interactions between meteorological conditions and underneath landscape, vegetation and topography by simply analyzing the records of temperature and precipitation. Therefore it is desirable to apply an effective data analysis method to break down the climate variations into individual processes, i.e., cyclical, long-term and abrupt components. Only with this type of data mining and pre-processing is it feasible to investigate spatial patterns and interactions between climate change and regional environmental factors.
In this paper, we attempted to apply computational data mining approaches that were developed in recent years. In particular, we synthesized advanced signal processing and denoising techniques to extract long-term trends of climate change. In specifics, we experimented with the empirical mode decomposition (EMD) technique to extract long-term change trends from climate data that contained significant cyclical oscillations. We then applied 2.5D surfaces, 2.0D contours, and cross-station similarity plots to examine and visualize spatial variations of the extracted change trends over regions, biomes and weather-stations to reveal modifications of climate change at regional and local scales. We conducted a case study to investigate the climate change in Inner Mongolia, China based on the daily records of precipitation and temperature at 45 meteorological stations from 1959 to 2010. The EMD curves effectively illustrated the long-term trends of climate change. The 2.5D surfaces, 2.0D contours and cross-station similarity plots revealed that the change trends of temperature were significantly different from those of precipitation. Noticeable regional patterns and local disturbances of the changes in both temperature and precipitation were identified. These regional patterns and local disturbances were also confirmed by the similarity statistics. In brief, no simple statements could be made concerning either increasing or declining trends of temperature and precipitation over Inner Mongolia. The trends of change were modified by regional and local vegetation covers and topographical characteristics. Our findings provide very convincing evidences to support the IPCC predictions that the climate change varies significantly by location and through time. The data-mining based statistical-cum-visual method is very effective in revealing spatial patterns of regional and local climate changes. The methods developed in this study are also suitable for investigating long-term trends and spatial patterns of other ecological processes that are noted with cyclical or seasonable fluctuations.

Keywords: climate change, regional variation, trend analysis, data mining

Development of three-dimensional dynamic object extraction and tracking method and its application to the analysis of localized heavy rain system

Manami Matsuoka[1], Tomoya Matsunaga[1], *Rie Honda[1], Ken T. Murata[2], Shinsuke Sato[2], Koji Sassa[1], Fumie Murata[1], Yoshiaki Nagaya[2], Kentaro Ukawa[3]

1.Department of Information Science, Kochi University, 2.National Institute of Information and Communications Technology, 3.Systems Engineering Consultants Co., LTD.

The development of the ground-based radar observation instrument such as phased-array meteorological radar has enabled the acquisition of the data on three-dimensional structure of the raincloud system. In particular, the phased-array is able to sample the data at the time interval as short as 30 Sec, and thus it helps to understand the whole process of development of localized heavy rainfall systems starting from precursor (the first echo) to the main rainfall event.
We extended a method of 2D dynamic object extraction and tracking for time-series images (e.g., Honda et al. 2002) to that of 3D objects, and applied it to the phased array meteorological radar data. As a result of modeling of the object points sampled from the data after the threading at the value of 30dBZ, we observed the first echoes of heavy rainfall events are extracted the independent components at each event, and extracted the development of clouds in complex shape as the increase of the number of components.
In addition, we considered the hierarchical data model that is composed of “snapshot object”, “real object”, “object family”, and currently constructing the interactive query and visualization system that will be utilized in exploring the collection of object information to find spatio-temporal patterns of clouds related to heavy rainfall.

Keywords: spatio-temporal, data mining, object extraction, meteorological radar, modeling

Real-time Data Processing via Gfarm/Pwrake and Applications on the NICT Science Cloud

*Kazuya Muranaga[1], Ken T. Murata[2], Kazunori Yamamoto[2], Yoshiaki Nagaya[2], Kentaro Ukawa[1], Junichi Murayama[1], Yutaka Suzuki[1], Osamu Tatebe[3], Masahiro Tanaka[3], Eizen Kimura[4]

1.Systems Engineering Consultants Co., LTD., 2.National Institute of Information and Communications Technology, 3.University of Tsukuba, 4.Department of Medical Informatics Ehime Univ.

This paper is to present a technology to perform parallel data processing on parallel storage system, which has been developed at NICT (National Institute of Information and Communications Technology), Japan. The NICT science cloud is an open cloud system for scientists who are going to carry out their informatics studies for their own science. The NICT science cloud is not for simple uses. Many functions are expected to the science cloud; such as data standardization, data collection and crawling, large and distributed data storage system, security and reliability, database and meta-database, data stewardship, long-term data preservation, data rescue and preservation, data mining, parallel processing, data publication and provision, semantic web, 3D and 4D visualization, out-reach and in-reach, and capacity buildings.
In the present study, Gfarm/Pwrake is used for the big-data processing. The Gfarm is one of the parallel storages system developed in Tsukuba University. The Pwrake is a task scheduler designed for the Gfarm. With combination of two technologies, real-time data processing is easily constructed on the NICT Science Cloud. Several examples to use this Gfarm/Pwrake real-time data processing are discussed for meteorological satellite data processing, weather radar data processing, and other real-time data processing's.

Overview of ionospheric total electron content (TEC) monitoring system using dense GNSS receiver networks

*Michi Nishioka[1], Takuya Tsugawa[1], Hidekatsu Jin[1], Mamoru Ishii[1]

1.National Institute of Information and Communications Technology

We are operating an ionospheric total electron content (TEC) monitoring system using dense GNSS receiver networks on the NICT Science Cloud system. We have automatically collected more than 7000 ground-based GNSS receivers' data in the world, and converted into two-dimensional TEC maps. High-resolution TEC maps are available in Japan, North America, and Europe, where GNSS receivers are densely deployed. These TEC maps and global TEC maps are available through the web site, http://seg-web.nict.go.jp/GPS/DRAWING-TEC. These high-resolution TEC maps make it possible to get a full view of 100-1000 km scale ionospheric disturbances. Recently, we developed a real-time TEC monitoring system by processing streaming data of GEONET, which is a ground-based GNSS receiver network in Japan provided by Geospatial Information Authority of Japan. TEC are calculated within a delay of several minutes.

Keywords: TEC monitoring system, dense GNSS receiver network, GEONET real-time data

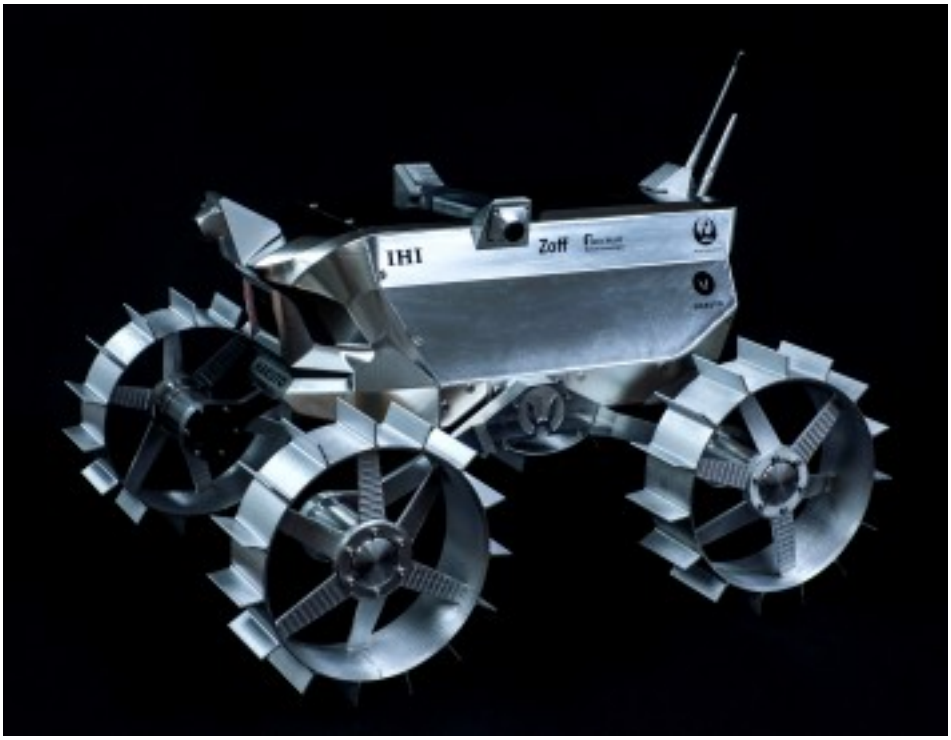
The Systems Design and Project Status of the HAKUTO Micro Lunar Rover for Possible Skylight Exploration

*Toshiro SHIMIZU[1], Kazuya Yoshida[2,1], Nathan John Britton[1], John David Walker[2], Toshiki Tanaka[1], Daisuke Furutomo[1]

1.ispace technologies, inc., 2.Tohoku University

This paper describes the project status of HAKUTO rovers, its systems and the results of the field experiment. HAKUTO is the Japanese team participating in the Google Lunar XPRIZE. This team is consisted of a venture company, Tohoku university and pro bono members.
The Google Lunar XPRIZE is an unprecedented competition, challenging privately funded teams to accomplish three main goals: successfully land a spacecraft on the lunar surface, run the rover on the lunar surface at least 500 meters, and transmit high-definition video and image back to earth. HAKUTO has developed a small and lightweight dual rover system to fulfill the above Google Lunar XPRIZE requirement. Demonstration of rovers' performance in space environment is verified by conducting thermal vacuum testing, vibration testing, and field testing at Nakatajima sand dune. Furthermore, HAKUTO plans to explore caves beneath the lunar surface for potential lunar habitation. Currently, HAKUTO is preparing the Flight Model rovers which are supposed to be launched in 2017.

Keywords: Moon, Rover, HpFP, Skylight Exploration, UDP, TCP/IP



HpFP: A new protocol for LFNs with packet-loss based on UDP -A basic concept and detailed design of the protocol

*Takamichi Mizuhara[1], Ayahiro Takaki[1], Keisuke Fukushima[1], Ken T. Murata[2], Kazunori Yamamoto[2], Yoshiaki Nagaya[2], Kazuya Muranaga[3], Eizen Kimura[4]

1.CLEALINKTECHNOLOGY Co.,Ltd., 2.National Institute of Information and Communications Technology, 3.Systems Engineering Consultants Co., LTD., 4.Department of Medical Informatics Ehime Univ.

For LFNs (Long-Fat Networks) with 10 Gbps or more and satellite networks with large latency, a variety of TCP-based protocols have been proposed which show high performance on large latency network conditions. However, such TCP protocols are essentially unable to archive large bandwidth on high latency networks accompanied with packet-losses that are inevitable on practical LFNs or satellite networks. To overcome this issue, we designed a new data transfer protocol on TCP/IP transport layer built on top of UDP: High-performance and Flexible Protocol (HpFP). It constantly monitors latency (RTT) and packet losses, and conducts rate control and retransmission control based on them to enable higher bandwidth data transfer than 10 Gbps even on packet-loss conditions over LFNs. The basic concepts are addressed and protocol design of the HpFP are discussed. An applications to tansfer many data files in small size (e.g., 1MB x 10000 files) with almost wire-rate bandwidth (10 Gbps) is also addressed.

Current Status and Future Challenges of the Japan Data Exchange Network JDXnet

*Kiyoshi Takano[1], Hiroshi Tsuruoka[2], Shigeki Nakagawa[2]

1.Interfaculty Initiative in Information Studies / Earthquake Research Institute, the University of Tokyo, 2.Earthquake Research Institute, the University of Tokyo

In Japan, about 1200 high-sensitivity seismic observation stations and about 120 broadband seismic observation stations are installed , and by using these stations the quick detection and determination of the location and magnitude of the small and large earthquakes which occured in and around Japan . These broadband and high sensitivity seismic observation have been carried out by 9 National Universities, JMA , NIED , JAMSTEC, AIST etc. JDXnet (Japan Data eXchange network) is the nationwide real-time data exchange and distribution network of these seismic stations. Currently, JDXnet is constructed by using wide-area L2 network of SINET4 and JGN-X as a backbone network, and connect many agency and university and exchange real-time data that each agency has collected from each observation stations. We will introduce the current status and future challenges that should be addressed future of this JDXnet.

Keywords: seismic data exchange, seismic observation network

3D modeling and Web3D display of near-surface geophysical survey results

*Tomio INAZAKI[1], Kaoru KITAO[2], Kunio AOIKE[3], Takanori OGAHARA[4]

1.Public Works Research Institute, Tsukuba Central Institute, 2.CubeWorks Ltd., 3.OYO Corporation, 4. formaerly Public Works Research Institute, Tsukuba Central Institute

Near-surface, mainly composed of man-made strata, weathered layers, and Holocene soft sediments, inherently implies small-scaled irregular or various structures. Accordingly conventional geotechnical boring information is inadequate to reconstruct surface 2D geology of the region of interest because of their sporadic distribution, rough log description, and insensitiveness of SPT N-values to lithofacies. In contrast, near-surface geophysics can provide high-resolution, quantitative, and reliable information to the near surface as continuous 2D or 3D profiles. The authors have been developing near-surface geophysical investigation techniques for delineating internal detailed structure in man-made strata up to 3 m, and have demonstrated the usefulness of Web3D rendering of 3D geophysical models reconstructed by integrating various types of surface data. The surface data incorporated in our 3D model consisted of GPR aided by high-precision VRS-GNSS positioning system, non-contact type high-frequency surface wave measurement, ultra-shallow seismic reflection survey, and high-resolution DC resistivity survey. Surface DSM of the site was generated from MMS (Mobile Mapping System) data. We also built a surface orthophotograph with Agisoft Photoscan. Surfer and Voxler provided by Golden Software were utilized to make a 3D surface model. In addition, we developed a Web3D system which can render combined 3D models without any plug-ins based on WebGL. The Web3D system was quite helpful to understand spatial orientation for a near-surface heterogeneous structure.

Keywords: Geophysics, Near surfaces, 3D modeling, Web3D

Scatter Plot-Based Color Map for Multivariate Data Visualization and its Application to Geofluid Simulation Data

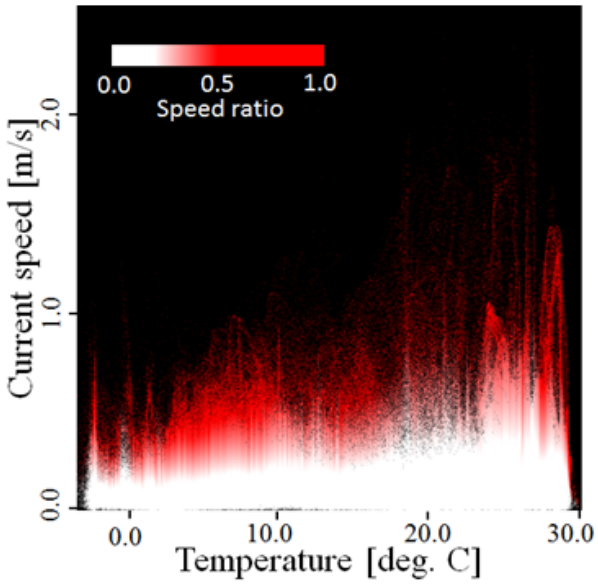
*Daisuke Matsuoka[1], Fumiaki Araki[1], Yumi Inoue[1]

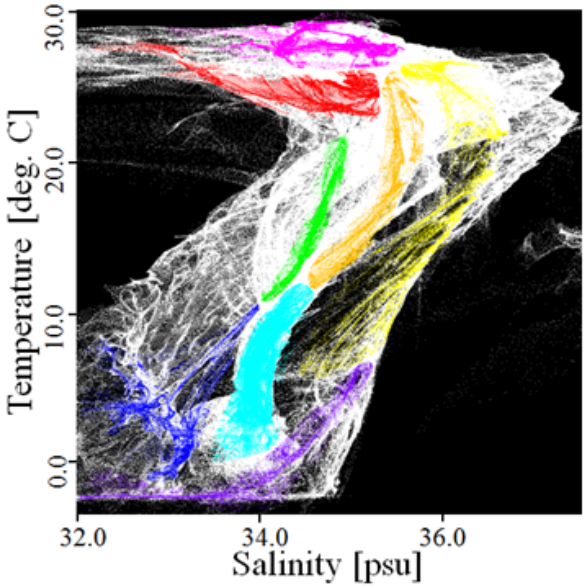
1.Japan Agency for Marine-Earth Science and Technology

To understand simulation data from the perspective of multivariable is important in numerical simulation study. This study proposes a new multi-dimensional color map which enables users to extract and visualize characteristic feature with their empirical and intuitive judgment. In the proposed method, data points which represent characteristic feature are selected in a couple of 2-dimensional scatter plots. Extracted data in each 2-variable space are assigned to different color components such as hue, saturation and/or brightness, respectively, in order to classify and specify the characteristic features from multivariate data. We applied the method to high-resolution geofluids simulation data with advices of domain specialists. As a result of case studies, characteristic structures such as ocean currents, eddies and clouds are intuitively extracted and clearly represented with their physical properties. In this presentation, we explain the proposed method in detail and demonstrate the way to use for actual application.

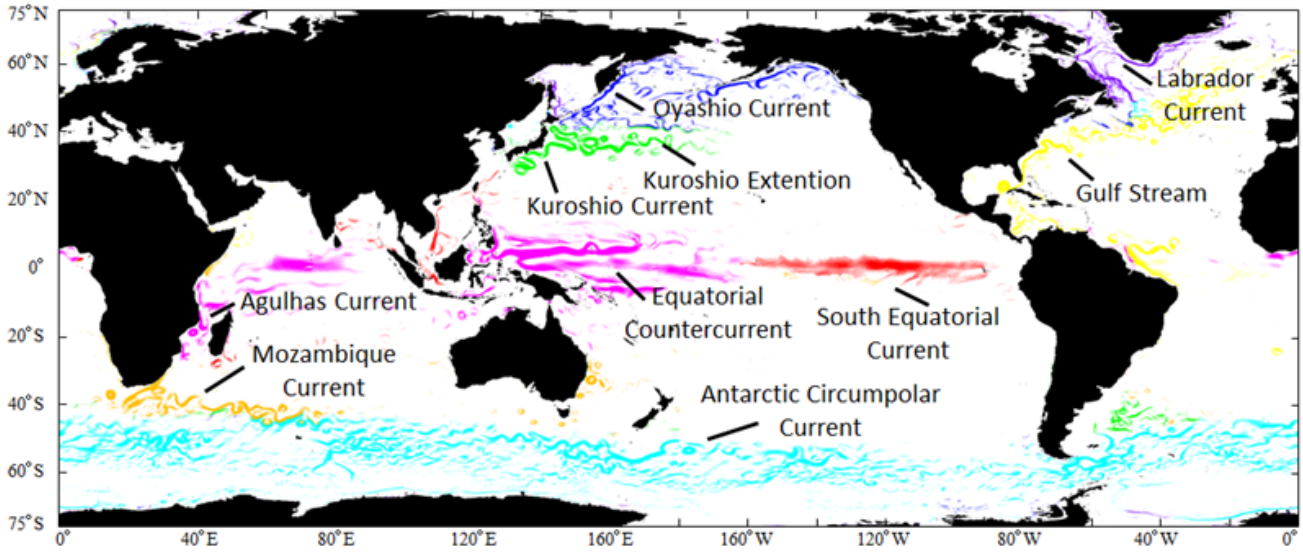
Keywords: Feature extraction, Visualization

Color map





Visualization result



Open simulation data system for Jovian magnetospheric research

*Keiichiro Fukazawa[1], Tomoki Kimura[2], Fuminori Tsuchiya[3], Go Murakami[4], Chihiro Tao[5], Hajime Kita[3], Ken T. Murata[6]

1.Academic Center for Computing and Media Studies, Kyoto University, 2.Nishina Center for Accelerator-Based Science, RIKEN, 3.PPARC, Tohoku University, 4.ISAS, JAXA, 5.Applied Electromagnetic Research Institute, NICT, 6.Integrated Science Data System Research Laboratory, NICT

Recently there are a lot of good Jovian observation data by HIASAKI. On the other hand, thanks to the development of computer system, we can perform the parameter survey simulation of Jovian magnetosphere (which is not so high spatial resolution). Thus it is good time to collaborate the simulation with observation in Jovian magnetospheric research and we have started to create the simulation database of Jovian magnetosphere. In this simulation database we store the basic configuration of magnetosphere under the several constant solar wind dynamic pressures and IMFs, and realistic solar wind conditions from the modeling and observation. Additionally, we will also run the simulation with the specific solar wind condition for the experimental data. Now the simulation data is stored in our own server system. The basic simulation data size is 3 GB and the variation of solar wind condition is a few hundred then it is expected that the total data size will be ~100 TB including the calculation of quasi-steady state of magnetosphere. We also plan to add the high spatial resolution simulation to the database, then the total data size will become around 1 PB. It is important to create the environment of analyzing these data. We now plan to use the NICT Science Cloud or cloud (hosting) computer resources of supercomputer center of university. In this presentation we will show the simulation database of Jovian magnetosphere and discuss how to create and maintain it.

Keywords: Jovian magnetosphere, Numerical simulation, big data

Data archive and integrated data analysis tools developed by ERG Science Center

*Tomoaki Hori[1], Yoshizumi Miyoshi[1], Yukinaga Miyashita[1], Kunihiro Keika[1], Masafumi Shoji[1], Tomonori Segawa[1], Norio Umemura[1], Kanako Seki[2], Yoshimasa Tanaka[3], Iku Shinohara[4]

1.Institute for Space-Earth Environmental Research, Nagoya Univ., 2.Univ. of Tokyo, 3.National Institute of Polar Research, 4.JAXA/ISAS

The ERG (Exploration of energization and Radiation in Geospace) is a Japanese geospace exploration project. Its core component is the ERG satellite, an inner magnetosphere satellite with the full set of particle and field instruments currently scheduled to be launched in FY2016. The ERG project consists of the satellite observation team, the ground-based network observation team, and the integrated data analysis/simulation team. Besides these research teams, ERG Science Center (ERG-SC) has been organized to play an essential role in managing the data center for all kinds of scientific data as well as promoting close collaborations of the three teams and other research projects. Thus the goal of ERG-SC is to maximize scientific output from the ERG project. For studies of geospace, where different plasma populations are interacted with each other via cross-energy and cross-regional coupling processes, the integrated data analysis combining various kinds of data sets is key to comprehensive understanding of multi-scale dynamical processes. A standard data format and integrated data analysis tools are essential to realize the seamless data analysis environment for the science community. The ERG satellite data of Level-2 (calibrated, in physical unit) and higher levels and the ground observation network data are archived in the NASA CDF format and basically open freely to the international science community. Together with scientific data, the data files in CDF carry a set of metadata. The metadata set is designed to provide data users with the concise description on the data themselves as well as some useful information used by data analysis software visualizing/analyzing the data. The integrated data analysis tool is developed on the basis of the Space Physics Environment Data Analysis Software (SPEDAS) in collaboration with the THEMIS and IUGONET teams. It should be noted that other satellite project data for geospace, such as THEMIS, Van Allen Probes, and MMS can be easily combined with SPEDAS if the ERG data are also converted to the CDF format. Thus the integrated data analysis using many kinds of data is truly realized through SPEDAS with the standardized data archive in CDF. Other useful tools, such as the ERG Web Analysis Tool (ERGWAT), Conjunction Event Finder (CEF), and the numerical solver tool of the dispersion relation for plasma waves in geospace have also been developed by ERG-SC to contribute to scientific researches related to the ERG project.

Open Science using Big Data obtained by Japanese Antarctic Research

*Masaki Okada[1], Masaki Kanao[1], Akira Kadokura[1]

1.National Institute of Polar Research

Syowa Station, Antarctica, can now be reached via Intelsat satellite link , whose band withd is 3Mbps for 24hs. Most observation systems are controlled from Japan and summary data can be viewed in real time. Although hi-resolution raw data has to be shipped from the station using Shirase and we have to wait for the precise analysis by the investigators. Satellite link can carry more than 10TB every year. Thus huge amount of data can be transfered and open not only for research community but also for public.
National Institute of Polar Research is now preparing for servicing DOI indexing for the antarctic observation data. This will archiving more widely opened data accessibility of the Antarctic observation data and will accelerate science opportunity.
Current status of our data policy and provision will be presented in this talk.

Keywords: Antarctic Research, Database, Open Science

“Big-data” and “Open-data”: Two key words to support future science

*Ken T. Murata[1]

1.National Institute of Information and Communications Technology

A pioneering computer scientist Jim Gray proosed “the Fourth Paradigm: Data-Intensive Scientific Discovery” in 2008. Increasingly, scientific breakthroughs will be powered by advanced computing capabilities that help researchers manipulate and explore massive datasets. The speed at which any given scientific discipline advances will depend on how well its researchers collaborate with one another, and with technologists, in areas of eScience such as databases, workflow management, visualization, and cloud computing technologies.
The data intensive science, which is often called “data driven science”, is a methodology to start science at data, not to data; Data is a starting point. This idea implies that all of the necessary information are included in the data. In these days, this kind of concepts have been presented and discussed in books, papers, web and other media. This means that the "Opinion for All" is correct unexpectedly as James Surowiecki mentions. This is a concept recently denoted as “collective intelligence”.
To the author, “big data”, “data oriented science”, “data driven science”, “collective intelligence” and “information commons” in science seem to be directed to a certain objective. What is required to order to move in this direction is “open data”; all of the scientific data should be open and accessible to any researchers. Data scientists who have any technologies for big data would be motivated to analyze these open data, even if they are not specialist of the domain fields. Nobody knows what will be derived, or nothing new will be exracted. To examine this, anyway, data must be open.

