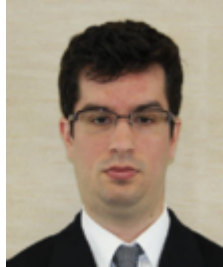


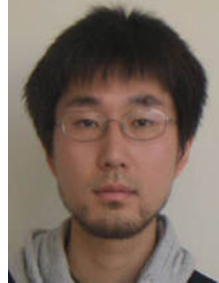
Computer Graphics Laboratory



Shigeo Takahashi
Professor



Pierre-Alain Fayolle
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Yohei Nishidate
Associate Professor

Refereed academic journal

- [fayolle-305-013-01:2016] Pierre-Alain Fayolle and Alexander Pasko. An evolutionary approach to the extraction of object construction trees from 3D point clouds. *Computer-Aided Design*, 74:1–17, 2016.

In order to extract a construction tree from a finite set of points sampled on the surface of an object, we present an evolutionary algorithm that evolves set-theoretic expressions made of primitives fitted to the input point-set and modeling operations. To keep relatively simple trees, we use a penalty term in the objective function optimized by the evolutionary algorithm. We show with experiments successes but also limitations of this approach.

- [nisdiate-305-013-01:2016] Y. Nishidate, I. Khmyrova, J. Kholopova, E. Polushkin, B. Shevchenko, and S. Shapoval. Numerical Study of Light-Emitting Diode with Injected Current Modulated by Designed Electrode. *Optical Review*, 23(5):798–805, 2016.

Numerical model and procedure are developed to study the output optical performance of light-emitting diode (LED) in which injected current is spatially modulated by mesh-like top metal electrode. The mesh strips have rectangular cross-section as in realistic LEDs. The finite element method is applied to obtain three-dimensional distributions of electric potential which are incorporated in the equations for total output power. The numerical procedure is applied to evaluate LED's total output optical power at different geometric parameters of the electrode: the mesh pitch, the width, and the height of the top meshlike electrodes. Modeling results demonstrate the effect of mesh pitch variation on the output optical power. In particular, at a certain value of the mesh pitch maximum total output optical power is revealed. The presented approach can be used in the optimization of the LEDs with designed metal electrodes

- [nisdiate-305-013-02:2016] Yu. Kholopova, I. Khmyrova, S. Larkin, V. Zemlyakov, V. Egorkin, A. Tsatsul'nikov, Y. Nishidate, and S. Shapoval. Blue-green InGa_N/Ga_N light-emitting diode with mesh-like top metal electrode. *Microelectronic Engineering*, 174:80–84, 2017.

Light-emitting diodes (LEDs) with blue-green dual-wavelength emission and top metal electrode patterned as a mesh were fabricated using InGa_N/Ga_N material system and tested. In pulsed voltage supply mode an increase in injected current resulted in electroluminescence (EL) with equal peak in-

tensities of blue and green emission lines and shallow trough between them. These features of the LED EL-spectrum can be attributed to the effect of the mesh-like patterning of the top electrode. Meshed electrode promotes the injection of current spatially nonuniform along the planes of the quantum well (QWs) which results not only in spatial nonuniformity of the intensity of generated light but also may contribute to position-dependent compensation of Quantum-confined Stark effect (QCSE) resulting in blue shift of EL in the QWs. The observed phenomenon can be used to control or engineer the EL spectra of dual-wavelength LEDs by electrode patterning

[shigeo-305-013-01:2016] Hiroko Nakamura Miyamura Satoshi Ohzahata Hsiang-Yun Wu, Shigeo Takahashi and Akihiro Nakao. Inferring Partial Orders of Nodes for Hierarchical Network Layout. *Journal of Imaging Science and Technology*, 60(6):60407–1–60407–13, 2016.

Extracting hierarchical structures from networks provides us with an effective means of visualizing them, especially when they contain complicated node connectivities such as those in traffic and distributed networks. Although many techniques have been developed for such purposes, they often deterministically break unwanted cycles that may arise from inconsistencies in the network hierarchies, and thus never seek the best compromise among possible partial orders of nodes inherent in the cycle. This article presents an algorithm for inferring such partial orders by optimizing the network hierarchies along flow paths that are given as input. Our idea is to extract network hierarchies from round-trip paths as well as one-way ones by deriving reasonably consistent multi-layered structures even from possibly inconsistent flow data over the networks. This problem is formulated as mixed-integer programming where we incorporate additional constraints into fundamental layout criteria according to the type and/or expected use of the network. For better visual readability of the network layout, the nodes in individual layers are clustered and reordered for minimizing edge crossings, which is followed by fine adjustment of intervals between neighboring nodes. We study several network examples to demonstrate the feasibility of the proposed approach including course dependency charts, railway networks, and peer-to-peer (P2P) networks.

[shigeo-305-013-02:2016] Longyin Xu Masanori Nakayama Hsiang-Yun Wu Kazuho Watanabe Shigeo Takahashi Makoto Uemura, Ryosuke Itoh and Issei Fujishiro. TimeTubes: Visualization of Polarization Variations in Blazars. *Galaxies*, 4(3):23, 2016.

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Optical polarization provides important clues to the magnetic field in blazar jets. It is easy to find noteworthy patterns in the time-series data of the polarization degree (PD) and position angle (PA). On the other hand, we need to see the trajectory of the object in the Stokes QU plane when the object has multiple polarized components. In this case, ironically, the more data we have, the more difficult it is to gain any knowledge from it. Here, we introduce TimeTubes, a new visualization scheme to explore the time-series data of polarization observed in blazars. In TimeTubes, the data is represented by tubes in 3D (Q, U, and time) space. The measurement errors of Q and U, color, and total flux of objects are expressed as the size, color, and brightness of the tubes. As a result, TimeTubes allows us to see the behavior of six variables in one view. We used TimeTubes for our data taken by the Kanata telescope between 2008 and 2014. We found that this tool facilitates the recognition of the patterns in blazar variations; for example, favored PA of flares and PA rotations associated with a series of flares.

[shigeo-305-013-03:2016] Shigeo Takahashi Kazuho Watanabe, Hsiang-Yun Wu and Issei Fujishiro. Asymmetric Biclustering with Constrained von Mises-Fisher Models. *Journal of Physics: Conference Series*, 699, 2016.

As a probability distribution on the high-dimensional sphere, the von Mises-Fisher (vMF) distribution is widely used for directional statistics and data analysis methods based on correlation. We consider a constrained vMF distribution for block modeling, which provides a probabilistic model of an asymmetric biclustering method that uses correlation as the similarity measure of data features. We derive the variational Bayesian inference algorithm for the mixture of the constrained vMF distributions. It is applied to a multivariate data visualization method implemented with enhanced parallel coordinate plots.

[shigeo-305-013-04:2016] Shiro Ikeda Keiichi Maeda-Hsiang-Yun Wu Kazuho Watanabe Shigeo Takahashi Makoto Uemura, Koji S. Kawabata and Issei Fujishiro. Data-Driven Approach to Type Ia Supernovae: Variable Selection on the Peak Luminosity and Clustering in Visual Analytics. *Journal of Physics: Conference Series*, 699, 2016.

Type Ia supernovae (SNIa) have an almost uniform peak luminosity, so that they are used as “standard candle” to estimate distances to galaxies in cosmology. In this article, we introduce our two recent works on SNIa based on data-driven approach. The diversity in the peak luminosity of SNIa can be

reduced by corrections in several variables. The color and decay rate have been used as the explanatory variables of the peak luminosity in past studies. However, it is proposed that their spectral data could give a better model of the peak luminosity. We use cross-validation in order to control the generalization error and a LASSO-type estimator in order to choose the set of variables. Using 78 samples and 276 candidates of variables, we confirm that the peak luminosity depends on the color and decay rate. Our analysis does not support adding any other variables in order to have a better generalization error. On the other hand, this analysis is based on the assumption that SNIa originate in a single population, while it is not trivial. Indeed, several sub-types possibly having different nature have been proposed. We used a visual analytics tool for the asymmetric biclustering method to find both a good set of variables and samples at the same time. Using 14 variables and 132 samples, we found that SNIa can be divided into two categories by the expansion velocity of ejecta. Those examples demonstrate that the data-driven approach is useful for high-dimensional large-volume data which becomes common in modern astronomy.

Refereed proceedings of an academic conference

[fayolle-305-013-02:2016] Mathieu Sanchez, Oleg Fryazinov, Pierre-Alain Fayolle, and Alexander Pasko. Convolution filtering of continuous signed distance fields for polygonal meshes. In *Eurographics 2016*, 2016.

Signed distance fields obtained from polygonal meshes are commonly used in various applications. However, they can have C1 discontinuities causing creases to appear when applying operations such as blending or metamorphosis. The focus of this work is to efficiently evaluate the signed distance function and to apply a smoothing filter to it while preserving the shape of the initial mesh. The resulting function is smooth almost everywhere, while preserving the exact shape of the polygonal mesh. Due to its low complexity, the proposed filtering technique remains fast compared to its main alternatives providing C1-continuous distance field approximation. Several applications are presented such as blending, metamorphosis and heterogeneous modelling with polygonal meshes.

[nisidate-305-013-03:2016] Y. Nishidate, J. Kholopova, A. Kovalchuk, B. Shevchenko, I. Khmyrova, and S. Shapoval. Modeling of Light-Emitting Diode with Nonuniform Current Injection. In *16th Interna-*

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tional Conference on Numerical Simulation of Optoelectronic Devices (NUSOD2016), pages 171–172, Sydney, Australia, Jul. 11–15 2016. IEEE.

Light-emitting diode (LED) with nonuniform current injection caused by the mesh-like design of top metal electrode is studied numerically. Three-dimensional Laplace equation for electric potential is solved by finite element method. The numerical model incorporates mapped infinite element to account for potential decay far away from the LED structure and finite element model developed for boundary condition at semiconductor-air interface in the mesh opening. Simulation results demonstrate the effect of the mesh geometrical parameters on the total output power.

[nisidate-305-013-04:2016] Y. Kholopova, Y. Nishidate, I. Khmyrova, E. Polushkin, V. Zemlyakov, B. Shevchenko, and S. Shapoval. Light-emitting diodes with designed top metal electrode. In *42th International Conference on Micro and Nano Engineering (MNE2016)*, pages D5–1–4, Vienna, Austria, Sep. 19–23 2016.

Light-emitting diodes with top metal electrode designed as a mesh were proposed to enhance light extraction. Paper deals with computer modeling of the effect of the electrode designed as a mesh with strips of square crosssection on the LED's output optical performance.

[nisidate-305-013-05:2016] Y. Nishidate, J. Kholopova, A. Kovalchuk, E. Polushkin, B. Shevchenko, I. Khmyrova, and S. Shapoval. Effect of Designed Top p-electrode on Output Performance of LED by Numerical Modeling. In *2016 IEEE Photonics Conference (IPC2016)*, pages 714–715, Waikoloa, Hawaii, USA, Oct. 2–6 2016. IEEE.

Impact of mesh-like top metal electrode on output performance of light-emitting diode (LED) is studied using developed numerical model. Three-dimensional Laplace equation is solved by FEM method. Modeling results demonstrate that effect of mesh pitch variation dominates over strip height variation.

[shigeo-305-013-05:2016] Hsiang-Yun Wu Yuki Ohtaka, Shigeo Takahashi and Naoya Ohta. Using Mutual Information for Exploring Optimal Light Source Placements. In *Proceedings of Smart Graphics 2015 (SG2015)*, volume 9317 of *Springer Lecture Notes in Computer Science*, pages 155–166. Springer, March 2017.

Exploring optimal light sources for effectively rendering 3D scenes has been an important research theme especially in the application to computer graphics and visualization problems. Although conventional techniques provide visually plausible solutions to this problem, they did not seek meaningful correlations between proper light sources and their related attribute values. This paper presents an approach to exploring optimal light source placements by taking into account its correlations with such attribute values. Our idea lies in the novel combination of existing formulations by taking advantage of information theory. We first employ the quantized intensity level as the first attribute value together with the conventional illumination entropy so as to find the best light placement as that having the maximum mutual information. Meaningful relationships with viewpoints as the second attribute value are then studied by constructing a joint histogram of the rendered scenes, which is the quantized version of a 3D volume composed by the screen space and intensity levels. The feasibility of the proposed formulation is demonstrated through several experimental results together with simulation of illumination environments in a virtual spacecraft mission.

[shigeo-305-013-06:2016] Shigeo Takahashi Fumiya Sato, Hsiang-Yun Wu and Masatoshi Arikawa. Extracting Important Routes from Illustration Maps Using Kernel Density Estimation. In *Proceedings of Smart Graphics 2015 (SG2015)*, volume 9317 of *Springer Lecture Notes in Computer Science*, pages 167–174. Springer, March 2017.

Illustration maps often direct our visual attention to the specific route with geographic symbols and annotation labels associated with important landmarks. This inspires us to evaluate the quality of such maps by analyzing the spatial distribution of visual attention over the map domain. In this paper, we introduce kernel density estimation in order to identify important routes that are implicitly designated by the map designers. Our algorithm begins by composing the density field as a combination of Gaussian kernels centered on the landmarks. The algorithm then allows us to extract an important route on the map as the trajectory of a ball running along the valley of the density field. We conducted a user study where we compared the routes reconstructed from the sequence of landmarks specified by the participants and their originally intended routes, and report some insight into possible aesthetic criteria in illustrating such maps.

[shigeo-305-013-07:2016] Shigeo Takahashi Kouhei Yasuda and Hsiang-Yun Wu. Enhancing Infographics Based on Symmetry Saliency. In *Proceedings*

Summary of Achievement

of the 9th International Symposium on Visual Information Communication and Interaction (VINCI2016), pages 35–42. ACM, September 2016.

Consistently placing annotation labels across map scales often poses a problem due to the restriction of the screen space. This problem becomes further exacerbated when we navigate by arbitrarily zooming in and out of digital maps on mobile devices. In this paper, we introduce leader lines to conventional techniques for scale-aware consistent labeling to accommodate more annotation labels on the map domain while retaining their plausible arrangement. The overall visibility of annotation labels is optimized using genetic algorithms while avoiding their unwanted popping effects and sudden leaps regardless of the change in the map scale. The feasibility of the proposed approach is demonstrated by experimental results including comparison with relevant techniques.

[shigeo-305-013-08:2016] Hsiang-Yun Wu Kazuho Watanabe Shigeo Takahashi Makoto Uemura Longyin Xu, Masanori Nakayama and Issei Fujishiro. TimeTubes: Design of a Visualization Tool for Time-Dependent, Multivariate Blazar Datasets. In *Proceedings of the 2016 Nicograph International*, pages 15–20. IEEE, July 2016.

Blazars are active galactic nuclei whose relativistic jets ejected from the central black hole are pointing toward the Earth. Astronomers have attempted to classify blazars, but analyzing the time-dependent multivariate datasets with conventional visualization methods, such as scatter plot matrices, is difficult. This paper presents TimeTubes, a new visualization scheme that allows astronomers to analyze dynamic changes in and feature causality among the multiple time-varying variables. We target six representative time-varying variables from the originals, including two polarization-related parameters and their corresponding errors, intensity, and color. The four polarization parameters with a common time stamp are transformed to an ellipse, and a series of such ellipses are aligned in parallel along the time line to form a volumetric tube in 3D space. The resulting tube is then colorized by the observed intensities and colors of the blazar. We designed a designated interface with nine functions to control the view of the tube interactively. The usability of TimeTubes is discussed with feedback from astronomers.

[shigeo-305-013-09:2016] Shigeo Takahashi Rie Ishida and Hsiang-Yun Wu. Adaptive Blending of Multiple Network Layouts for Overlap-Free Labeling. In *Proceedings of the 20th International Conference on Information Visualisation 2016 (IV2016)*, pages 15–20. IEEE, July 2016.

Conventional force-directed algorithms are known as a common approach to aesthetically drawing networks while they still suffer from self-overlaps especially when the network nodes are annotated with text labels. Incorporating space partitioning techniques including Voronoi tessellation are often effective to spare enough space around each node while this may incur different artifacts such as unexpectedly long edges and edge overlaps. This paper presents an approach to resolving overlaps among node labels by adaptively blending multiple layout forces applied to the respective network nodes. This is accomplished by extending our previous approach for transforming the force-directed layout into that obtained through the centroidal Voronoi tessellation. Our technical contribution lies in a novel algorithm for smoothing blending ratios associated with the network nodes so that we can adaptively explore the reasonable balance between the two layouts independently for each node. Experimental results will present that our new approach can produce well-balanced distribution of node labels while maximally avoiding the aforementioned unwanted visual artifacts.

Unrefereed proceedings of an academic conference

[fayolle-305-013-03:2016] Pierre-Alain Fayolle and Alexander Pasko. Surface Discretization of Multi-material Heterogeneous Volume Objects. In *Second international workshop on software solutions for integrated computational materials engineering (ICME 2016)*, 2016.

Heterogeneous volume objects are characterized by non-uniform internal structures with multi-material distributions and microstructures [1]. These objects can be represented by real vector functions of point coordinates [2,3]. We present an algorithm for meshing implicit surfaces based on the Delaunay triangulation of a point-set adaptively sampled on an implicit surface. To improve the quality of the resulting triangular mesh, we use at each iteration a mesh optimization algorithm with the following objectives: optimizing the connectivity, retrieving the sharp features, regularizing the triangles shapes and minimizing the approximation error. Then, we extend this algorithm in order to handle functionally defined multi-material heterogeneous object surfaces, while maintaining a good quality for the triangles' shapes and the mesh features (geometrical sharp features and boundaries between different materials) [4].

[nisdade-305-013-06:2016] I. Khmyrova, J. Kholopova, E. Polushkin, Y. Nishidate, A. Tsatsulnikov, and S. Shapoval. Electroluminescence spectra of GaN/InGaN multi-QW systems under spatially nonuniform current

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injection. In *Recent Developments in 2D systems (RD2DS)*, Okinawa, Japan, Apr. 4–8 2016.

Writing a part of textbook or technical book

[shigeo-305-013-10:2016] Shigeo Takahashi. *Visual Information Processing - Computer Graphics and Image Processing [Revised edition]*, chapter Chapter 2: Modeling, pages 48–72. CG-ARTS Society, 2017.

Research grants from scientific research funds and public organizations

[shigeo-305-013-11:2016] Shigeo Takahashi (as the Principal Investigator). Dynamic layout optimization for annotated information visualization, 2016–2018.

[shigeo-305-013-12:2016] Shigeo Takahashi (as the Principal Investigator). Information Visualization based on Cartographic Design Principles, 2015–2016.

[shigeo-305-013-13:2016] Shigeo Takahashi (as a Co-Investigator). Consolidation of Visualization Platform Toward Facilitating Sparse Modeling, 2013–2017.

Academic society activities

[fayolle-305-013-04:2016] Pierre-Alain Fayolle, 2016.
Program committee - GRAPP

[fayolle-305-013-05:2016] Pierre-Alain Fayolle, 2016.
Reviewer - Computer Aided Design

[fayolle-305-013-06:2016] Pierre-Alain Fayolle, 2016.
Reviewer - Computer & Graphics

[fayolle-305-013-07:2016] Pierre-Alain Fayolle, 2016.
Reviewer - Journal of Visualization

[fayolle-305-013-08:2016] Pierre-Alain Fayolle, 2016.

Reviewer - International Journal of Image and Graphics

[fayolle-305-013-09:2016] Pierre-Alain Fayolle, 2016.

Reviewer - IEEE Transactions on Visualization and Computer Graphics

[nishidate-305-013-07:2016] Y. Nishidate, Sep. 2016.

Reviewer, Optical and Quantum Electronics

[shigeo-305-013-14:2016] Shigeo Takahashi, 2016-2018.

Associate Editor

[shigeo-305-013-15:2016] Shigeo Takahashi, 2015-.

Associate Editor

[shigeo-305-013-16:2016] Shigeo Takahashi, March 2017.

Conference Co-Chair

Advisor for undergraduate research and graduate research

[fayolle-305-013-10:2016] Junichi Kuwata. Hand motion controlled 3D object transformation, University of Aizu, 2016.

[fayolle-305-013-11:2016] Kichi Homma. Surface reconstruction from 2D images and application in volumetric pixel art, University of Aizu, 2016.

[nishidate-305-013-08:2016] Kazuya Akutsu. Graduation thesis, University of Aizu, 2017.

Thesis Advisor: Y. Nishidate

[nishidate-305-013-09:2016] Ryota Kanai. Graduation thesis, University of Aizu, 2017.

Thesis Advisor: Y. Nishidate

[nishidate-305-013-10:2016] Masato Yabe. Graduation thesis, University of Aizu, 2017.

Thesis Advisor: Y. Nishidate

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[shigeo-305-013-17:2016] Asaichiro Kazawa. Graduation Thesis: Network Community Analysis with Set-diagram Metaphors, University of Aizu, 2017.

Thesis Advisor: Shigeo Takahashi

[shigeo-305-013-18:2016] Takamasa Kawagoe. Graduation Thesis: Fractal Dimension based Visual Analysis for Medical Image Sets, University of Aizu, 2017.

Thesis Advisor: Shigeo Takahashi

[shigeo-305-013-19:2016] Yasuto Murakami. Graduation Thesis: Constrained Optimization for Generating Tag Cloud Maps, University of Aizu, 2017.

Thesis Advisor: Shigeo Takahashi

Contributions related to syllabus preparation

[nisidate-305-013-11:2016] Numerical Analysis (role: Course Coordinator)

[nisidate-305-013-12:2016] Finite Element Modeling and Visualization (role: Master course instructor)

Contribution related to the building or operation of the university computer system

[nisidate-305-013-13:2016] Computer System 2 Replace Working Group (role: Committee Member)

Contribution related to educational planning management

[nisidate-305-013-14:2016] Honors Program Working Group (role: Committee Member)

[shigeo-305-013-20:2016] Member of the University of Aizu Employment Duty Related Invention Deliberation Council

[shigeo-305-013-21:2016] Member of the University of Aizu Cooperative Research, Etc. Acceptance Deliberation Committee

Summary of Achievement

[shigeo-305-013-22:2016] Member of the University of Aizu Mid-Term Plan Working Group

[shigeo-305-013-23:2016] CAIST Advisory Board Member

[shigeo-305-013-24:2016] Coordinatory of IT Field for Undergraduate Courses

Other significant contribution toward university planning, management, or administration

[nisidate-305-013-15:2016] PC-Koshien Programming Section (role: Problem Preparation Committee)

[nisidate-305-013-16:2016] PC-Koshien Programming Section, Preliminary and Final Contests (role: Judge)

[nisidate-305-013-17:2016] Entrance Exam (role: Problem Proposals, Problem Creation, and Marking)

[nisidate-305-013-18:2016] Entrance Exam by Commendation (role: Problem Proposals, Problem Creation, and Marking)

Contributions related to regional education

[nisidate-305-013-19:2016] Computer Science Summer Camp (role: Executive Committee)

[nisidate-305-013-20:2016] Computer Science Summer Camp (role: Computer Graphics Course Coordinator)

Did you participate in Public Lectures, and/or Open Campus? (Yes or No) If yes, please describe what you did.

[nisidate-305-013-21:2016] organized place to exhibit, recruited students to explain, provided materials to exhibit.

[shigeo-305-013-25:2016] Participation in Open Lab activities (Summer and Autumn)