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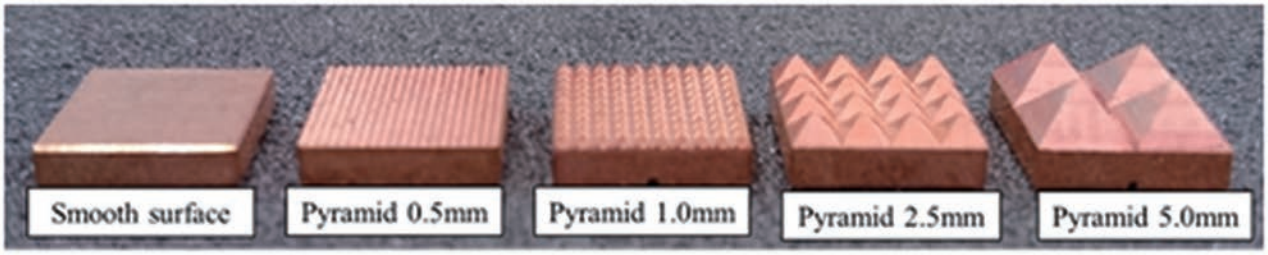
Professor, Department of Mechanical Engineering

Hitoshi Matsushima is a professor at the Department of Mechanical Engineering, College of Industrial Technology, Nihon University. He received his bachelor's, master's and doctoral degrees in engineering all from Keio University. Dr. Matsushima joined Nihon University in 2008. Before that, he was a senior researcher at the Mechanical Engineering Laboratory of Hitachi, Ltd., where he actively developed new technology for electronic equipment. Also, he was a visiting scholar at Purdue University from 1987 to 1988, and Duke University in 2017. His area of interest in research is heat transfer, especially cooling of electronics. Dr. Matsushima's current research is focused on enhancement of phase change heat transfer, such as boiling and thermosiphons.

Research Achievements

1) Evolutionary design of conducting layers with fins and freedom, International Journal of Heat and Mass Transfer, 126, 2018, pp. 926–934.
2) Improvement of heat transfer in saturated pool boiling under low pressure condition using masking plate, Thermal Science and Engineering, Vol. 26, No. 2, 2018, pp. 51–54.
3) Heat transfer characteristics of pool boiling under low pressure condition, Thermal Science and Engineering, Vol. 26, No. 1, 2018, pp. 39–50.
4) Thermal Performance of Loop-Thermosiphon for Electronic Cooling (Extraction and verification of effective factors), Thermal Science and Engineering, Vol. 25, No. 4, 2017, pp. 75–78.
5) Heat Transfer Characteristics of Thermosiphon Type Heat Pipe (Effect of tube diameter and inclination), Thermal Science and Engineering, Vol. 25, No. 3, 2017, pp. 45–56.



Pyramid Type Heat Transfer Surfaces

Published Paper

Heat Transfer Characteristics of Pool Boiling under Low Pressure Condition

Hitoshi MATSUSHIMA and Takuya SAITOU

We experimentally examined the possibility of enhancement of boiling heat transfer under sub-atmospheric pressure. The range of pressure tested was between atmospheric pressure to 5 kPa. The heat transfer coefficient under low pressure condition decreased dramatically at the pressure of 5 kPa. This tendency was seen for all types of heat transfer surfaces and working fluids, and differences in heat transfer between smooth surface and extended surfaces almost diminished. Heat transfer performance of pyramid 2.5 mm and copper sintering surfaces was rather good at the pressure of 5 kPa, and the performance of both was almost similar except at atmospheric pressure. Sodium myristate is a promising surfactant that showed stable performance under low pressure condition. The heat transfer coefficient of a smooth surface using pure water increased with the decrease in liquid height. However, reduction in liquid height showed a tendency to change from nucleate boiling to film boiling at an early stage.

Keywords: Sub-atmospheric Pressure, Nucleate Pool Boiling, Heat Transfer, Enhancement, Experiment

低圧下でのプール沸騰における熱伝達特性

本研究では，大気圧から 5kPa までの低圧下におけるプール沸騰実験を行い，低圧下での沸騰熱伝達の促進の可能性について，実験的に検討した．伝熱面や作動液の種類によらず，圧力が 5kPa まで下がると熱伝達率が急激に低下し，各種の拡大伝熱面や界面活性剤使用時と純水・平滑面使用時との差異が大幅に縮小した．低圧下では，ピラミッド型 2.5mm と銅繊維焼結面での伝熱性能が特に良好であり，両者は大気圧下を除きほぼ同等の伝熱性能を示した．なお，圧力の低下とともにピラミッド型伝熱面の最適なピッチは小さいものから大きいもの（2.5mm）へ次第にシフトした．沸騰開始温度についてはピラミッド型，銅繊維焼結面ともに，平滑面に比べて大きく低下した．このことは，電子機器冷却の観点から考えて重要である．今回測定した作動液の中ではミリスチン酸水溶液（100ppm）が最も良好であり，低圧下でも気泡径が小さく安定した伝熱性能を示した．低圧下では，純水・平滑面での伝熱性能は作動液水位が減少するとともに単調に増加する傾向を示した．ただし，作動液水位は小さくなると膜沸騰に遷移しやすくなる傾向を示した．

キーワード : 低圧 , 核沸騰 , 熱伝達 , 促進 , 実験

Journal（掲載誌）
Thermal Science and Engineering, Vol. 26, No. 1, 2018, pp. 39-50.

Susumu TAKAHASHI

Professor, Department of Mechanical Engineering

Susumu Takahashi is a professor at the Department of Mechanical Engineering and director of the Center for Automotive Research (NU-CAR), College of Industrial Technology, Nihon University. He received his master's degree from Shibaura Institute of Technology in 1981 and his Ph. D. from the Council for National Academic Awards in the U.K. in 1986. He worked for Nissan Motor Company from 1981 to 2007, where he developed numerical forming simulation technologies in the field of production engineering, such as sheet metal forming, forging, injection molding, casting and assembly. He has worked for Nihon University since 2007.

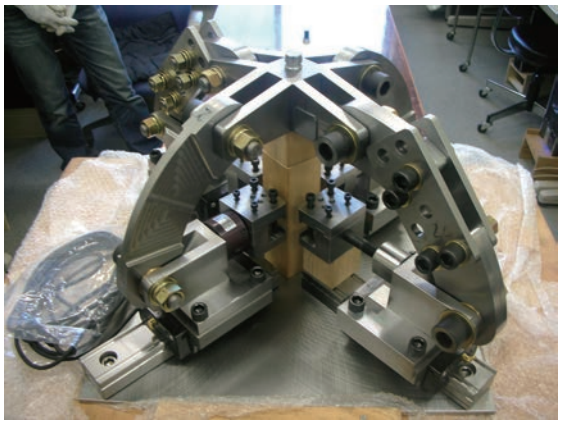
Dr. Takahashi's research interests are as follows.

1) Measurement methods of material characterization
   - Biaxial tensile test for metals and rubbers
   - High speed tensile and friction test for metals
   - Residual stress measurement using neutron
2) Forming technologies
   - Composite material using plant-derived materials
   - Recycled plastics

He is a fellow of the Japan Society of Plastic Plasticity. Additionally he is a member of the Japan Society of Mechanical Engineers, the Japan Society of Polymer Processing, the Japan Society for Design Engineering, Japan Foundry Engineering Society, the Japan Society for Computational Engineering and Science and the Society of Chemical Engineers, Japan. He is a director of the Japan Metal Stamping Association and a Japanese delegate of ISO/TC164/SC2 (ductility testing).

Research Achievements

1) Thinning of Shell Layer and Metal Mold on Shell Back Metal Process for Small Cast Iron Parts, Journal of Japan Foundry Engineering Society, (in Press)
2) Examination of Weld-line with Compound Polypropylene on Injection Molding, Asian Workshop on Polymer Processing 2019, pp.28-29, 2019.
3) Effect of Strain Rate on Tensile Properties of Dual Phase Sheet Steel, Journal of Japan Society for Experimental Mechanics, Vol.18, No.3, pp.169-175, 2018.
4) Study on effect of strain rate on elongation in advanced high strength steel, The 12th International Conference on Technology of Plasticity, Vol. 207, pp.1988-1993, 2017.



Biaxial tensile test apparatus

Particle board using peanut husks and PVA

Published Paper

Effect of Strain Rate on Tensile Properties of Dual Phase Sheet Steel

Tomohiro KAMIURA and Susumu TAKAHASHI

High tensile steel sheets are widely used to reduce the weight of automobiles. Dual phase steel sheet is a kind of high tensile steel sheet. Tensile tests of dual phase steel sheets at high strain rates were performed to investigate the relationship between strain rate, elongation and temperature. The strain did not change much at uniform elongation at the strain rate up to 5/s, and decreased in local elongation. In quasi-static tensile tests, the n value did not change when the temperature was 373K or less, but increased when over 473K. Softening of the sheet did not occur at slow strain rates. Similarly, at the strain rate of 100/s, strain did not change in uniform elongation, but increased in local elongation. The temperature during uniform elongation was about 300K, but exceeded 473K at the end of local elongation. At the high strain rate, strain increased in both uniform elongation and local elongation. The conclusions obtained for the elongation are as follows. At strain rates less than 5/s, stress concentration due to temperature difference causes local elongation to decrease as the strain rate becomes faster. At strain rates above 100/s, local elongation increased due to softening of the steel sheet caused by plastic heat generation, as well as increased n value.

Keywords: Tensile test, Temperature measurement, High tensile steel, Mechanical properties

Dual Phase 鋼板の引張特性におよぼすひずみ速度の影響

自動車の軽量化では，高張力鋼板が多く使用されている．Dual Phase 鋼板は，高張力鋼板の一種である．本論文では，Dual Phase 鋼板の高速変形時の温度上昇と延性の変化に関して検討した結果を述べている．ひずみ速度が 5/s までは，一様伸び部のひずみはあまり変化しなかった．一方，局所伸び部のひずみは減少した．準静的引張試験における n 値は温度が 373K 以下では変化しなかったが，473K 以上になると増加した．低ひずみ速度では，軟化は発生しなかった．ひずみ速度 100/s でも一様伸び部のひずみ量は変化しなかった．局所伸び部のひずみ増加した一様伸び変形時の温度は約 300K だった．局所伸び変形中に温度は 473K 以上となった．高いひずみ速度の場合，一様伸びの時のひずみも局部伸び部のひずみも増加した．Dual Phase 鋼の延性特性について以下の結論を得た．ひずみ速度 5/s 以下では温度差による応力集中により，速度が速いほど局所伸びが減少する．ひずみ速度 100/s 以上では，塑性発熱による軟化および n 値の増加により，局所伸びは増加したことが分かった．

キーワード：引張試験，温度計測，高張力鋼板，機械的特性

Journal（掲載誌）
Journal of Japan Society for Experimental Mechanics, Vol.18, No.3, pp.169-175, 2018

Yusuke KUDO

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Yusuke Kudo was born in Miyagi, Japan, in 1977. He received his B.E., M.E., and Dr. Eng. degrees from the Department of Electrical Engineering, Yamagata University, Yonezawa, Japan, in 2000, 2002, and 2005, respectively. He is currently an Associate Professor at the Department of Electrical and Electronic Engineering, College of Industrial Technology, Nihon University. He researches photocatalyst and environmental engineering along with electrostatic discharge.
Dr. Kudo is a member of the Institute of Electrostatics Japan, the Institute of Electrical Engineering of Japan and The Japan Society of Applied Physics.

Research Achievements

1) Relationship Between Power Generation Performance and Drying Temperature of Catalyst Layer for DMFC by Electrostatic Spray, *Journal of the Institute of Electrostatic Japan*, Vol.42, No.1, Page.34-39 (2018)
2) Photocatalytic Activity of Titanium Oxide Thin Film Deposited on Transparent PET Film, *Journal of the Institute of Electrostatic Japan*, Vol.42, No.1, Page.21-26 (2018)
3) High Performance Visible-light-responsive $TiO_2/Cu_xO/Cu$ Photocatalyst, *IEEJ Transactions on Fundamentals and Materials*, Vol.136, No.8, Page.551-552 (2016)
4) Experimental study of the visible-light photocatalytic activity of oxygen-deficient TiO_2 prepared with Ar/H_2 plasma surface treatment, *Japanese Journal of Applied Physics*, Vol.54, p.01AE04 (2015)
5) Visible-light-responsive photocatalyst prepared by sintering a TiO_2/Cu plate, *Japanese Journal of Applied Physics*, Vol.53, p.098001 (2014)

Published Paper

Fabrication of the Slightly Reduced TiO_2 Photocatalyst Reacted Visible Light by the Microwave-H_2-plasma Processing

Shota YAZAWA, Yusuke KUDO, Tetsuya NAKANISHI, Tomohiko TAKEUCHI, Shota ARAKI, Noboru KATAYAMA and Sumio KOGOSHI

A photocatalyst is attracting widespread attention because it works semipermanently under light irradiation. A photocatalyst has useful characteristics such as an oxidative decomposition and a super-hydrophilicity. However, TiO_2 photocatalysts which are often used can be activated only by ultraviolet rays. The ultraviolet rays for photoactivation of TiO_2 are included nearly zero in indoor lights. If a photocatalyst can be activated with visible light as well as ultraviolet light, a photocatalyst can be used not only outdoors but also indoors. A slightly reduced TiO_2 is one of visible light responsible photocatalysts. A slightly reduced TiO_2 can be produced with H_2-plasma surface processing. However, it is not so clear that the dependence of the performance on the processing parameters. In this study, we have focused on a H_2-plasma processing time. The performance of a slightly reduced TiO_2 under visible light irradiation is estimated from a decomposition rate of formaldehyde. It is found that the performance of the slightly reduced TiO_2 improves as the plasma processing time become shorter although the amount of the visible light absorption becomes smaller. The performance of a slightly reduced TiO_2 under visible light irradiation is also compared with that of a N-doped TiO_2, which is the most popular visible light responsible photocatalyst. The result shows that the decomposition rate of formaldehyde by the slightly reduced TiO_2 is three times or more than that by the N-doped TiO_2.

Keywords: Visible-light-responsible photocatalyst, Microwave-H_2-plasma, TiO_2

水素マイクロ波プラズマ処理による可視光応答化酸素欠損型光触媒の製作

光の照射下で半永久的に使用することができ，酸化分解作用と超親水性作用を発揮する光触媒は広く注目を集めている。よく使用される光触媒として酸化チタン (TiO_2) があるが，酸化チタンはそのままでは紫外線によってのみ活性化されるため，太陽光などの紫外線を含む光源がある場所では有効に働くのに対し，屋内など紫外光を含まない光源しかない場所では有効に働かないという問題がある。本研究では酸化チタンに水素マイクロ波プラズマ処理を行うことで酸素欠損型光触媒とし，可視光で活性化させることに成功した。また，ホルムアルデヒド分解試験を用いて光触媒の性能を評価することで，水素プラズマ処理の条件と可視光下での光触媒の性能の関係について詳細に調べた。実験結果より水素マイクロ波プラズマ処理により可視光応答化した酸化チタン光触媒は従来法である窒素ドープ型酸化チタン光触媒の 3 倍以上の性能を示すことがわかった。

キーワード : 可視光応答型光触媒，水素マイクロ波プラズマ

Journal（掲載誌）
Journal of the Institute of Electrostatics Japan, Vol.37, No.3, Page.138-143 (2016)
http://www.iesj.org/content/files/pdf/papers/37/37-3-138.pdf

Masayuki EGASHIRA

Research Assistant, Department of Electrical and Electronic Engineering

Masayuki Egashira was born in Japan in 1990. He received his B.E., M.E., and Dr. Eng. degrees from the Department of Electrical and Electronic Engineering, College of Industrial Technology, Nihon University in 2013, 2015 and 2018, respectively. Since 2018 he has been a Research Assistant at the Department of Electrical and Electronic Engineering, College of Industrial Technology, Nihon University. He researches fuel cells and electrostatic discharge. Dr. Egashira is a member of the Institute of Electrostatic Japan and the Institute of Electrical Engineers of Japan.

Research Achievements

1) Relationship between Power Generation Performance and Drying Temperature of Catalyst Layer for DMFC by Electrostatic Spray, Journal of Institute of Electrostatics Japan, Vol.42, No.1, pp.34-39 (2018)
2) The Optimization of Electrostatics Spray Condition to Fabricated MEA for DMFC, International Conference on Electrical Engineering 2016 (2016)
3) Fabrication MEA for Direct Methanol Fuel Cell Using Electrostatic Spray, International Conference on Electrical Engineering 2015 (2015)

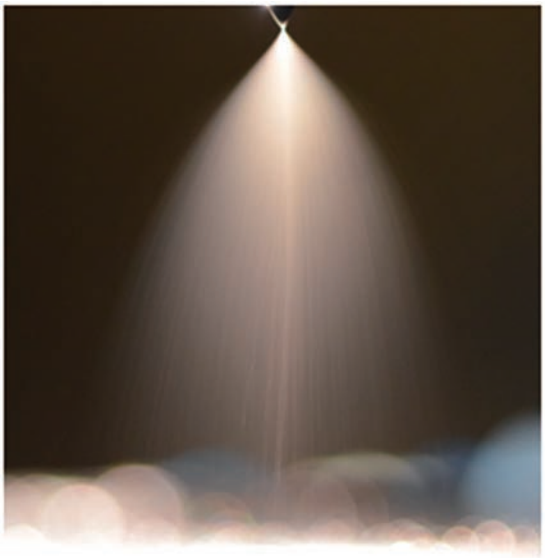

Fig.1 Magnified photo of electrostatic spray

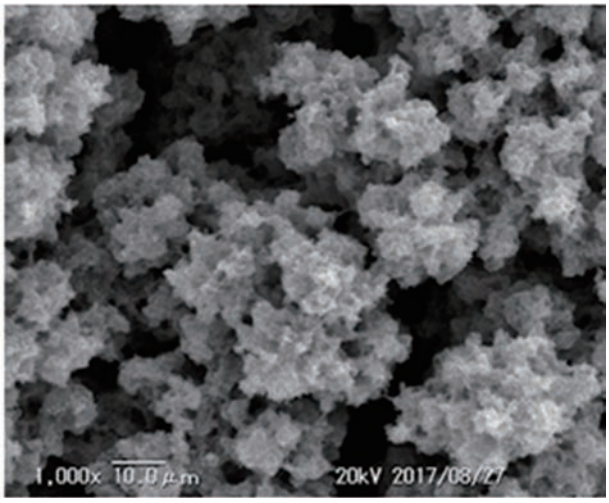

Fig.2 SEM image of catalyst layer

Published Paper

Relationship between Power Generation Performance and Drying Temperatur of Catalyst Layer for DMFC by Electrostatic Spray

Masayuki Egashira, Kazuki KOBAYASHI, Naruhiro KITAOKA,
Shota YAZAWA Yusuke KUDO and Tetsuya NAKANISHI

Progress of power generation performance of DMFC can be expected by increasing surface area of catalyst layer. In this study, catalyst layer for DMFC was fabricated by electrostatic spray. And the power generation performance of DMFC was investigated when the drying temperature was changed from 40℃ to 120℃ during electrostatic spray. From the results, the power generation performance of DMFC improved when the drying temperature was increased in the range 40℃ to 100℃ . It is thought that the surface area of catalyst layer was increased as drying temperature increased. However, the power generation performance of DMFC was not progressed when drying temperature was 120℃. It is thought that the electrolyte in catalyst layer was deteriorated by heat. From the above, it was found that the optimal drying temperature was 100℃.

Keywords: Electrostatic Spray, Direct Methanol Fuel Cell, Catalyst Layer, Surface Area

静電噴霧法を用いた DMFC 用触媒層の乾燥温度と発電性能の関係

直接メタノール形燃料電池 (Direct Methanol Fuel Cell: DMFC) の発電性能は化学反応を起こす部品で極の表面積を増加させることで増加することが知られている。本研究では液体に対して高電圧を印加するある電ことで微粒子状に放出する静電噴霧法と呼ばれる技術を用いて、触媒電極薄膜の作製を行った。その際、作製時の乾燥温度に着目し 40℃～ 120℃の範囲でそれぞれ作製し、DMFC としての発電性能や交流インピーダンス法によるインピーダンス解析を行った。発電性能測定の結果、100℃までは発電性能が向上したが 120℃で作製した触媒電極薄膜を用いた DMFC の発電性能は著しく低下した。インピーダンス解析の結果、100℃までは電極の活性化損失が減少したため発電性能が向上したが、120℃からは活性化損失が増加したため発電性能が低下したと考えられる。乾燥温度 120℃で作製した触媒電極薄膜の活性化損失が増加した要因として電極内の電解質材料が劣化したためだと考えられる。

キーワード：静電噴霧法，直接メタノール形燃料電池，触媒層，表面積

Journal（掲載誌）
Journal of the Institute of Electrostatics Japan, Vol.42, No.1, pp.34-39 (2018)

Toshiro SUGIMURA

Professor, Department of Civil Engineering

Toshiro Sugimura is a professor at the Department of Civil Engineering, College of Industrial Technology, Nihon University. He received his Ph.D. from the Research Institute of Science and Technology, Nihon University in 1993. Dr. Sugimura worked for the Remote Sensing Technology Center of Japan (RESTEC) from 1980 to 2014. While at the research and development department of RESTEC, his major research topics were image processing and application study using high resolution satellite images. He is a member of the Japan Society of Civil Engineers, the Remote Sensing Society of Japan, the Japan Society of Photogrammetry and Remote Sensing, the Heat Island Institute International, and the Japanese Society of Coastal Forest.

Research Achievements

1) Multi-Frame Image Processing of Himawari-8/AHI Data, Transactions of the Japan Society for Aeronautical and Space Sciences, Aerospace Technology Japan, Vol.16, No.3, 224-229, 2018.

2) Thermal Environment in Urban Areas by Hiamawari-8 Images, JSCE Earth Environment Symposium on Civil Engineering Society, Vol. 74, No. 5, pp. I_157- I_165, 2018.

3) Thermal Environment of Tokyo by Geostationary Meteorological Satellite, JSCE Earth Environment Symposium on Civil Engineering Society, Vol. 71, No. 5, pp. I_319- I_324, 2015.

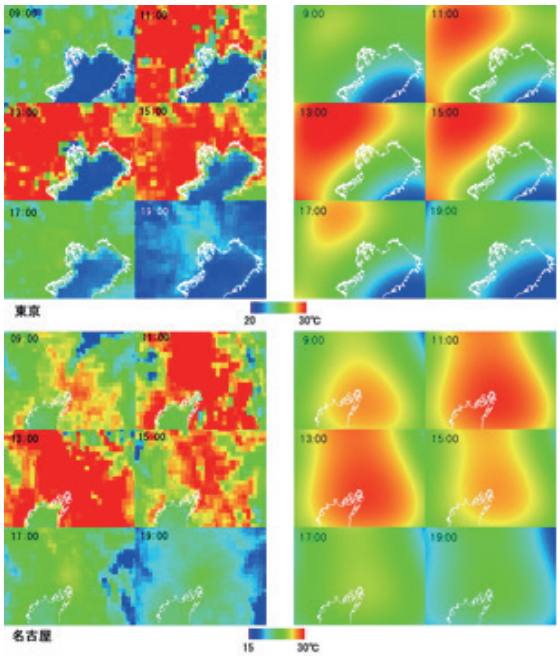

Fig.1 Spatio-temporal trend surface analysis

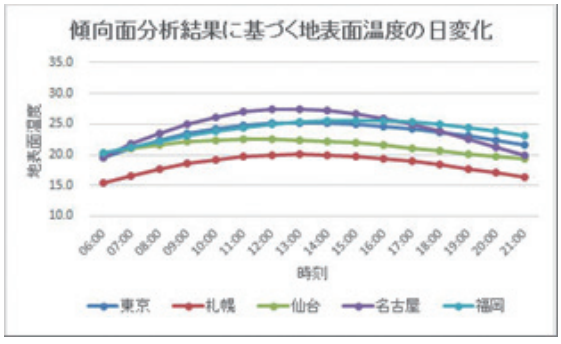

Fig.2 Comparison of surface temperature change

Published Paper

Multi-Frame Image Processing of Himawari-8/AHI Data

Toshiro SUGIMURA, Yuuki UCHIDA, Sadayoshi AOYAMA, Tomohito ASAKA and Keishi IWASHITA

Himawari-8 is Japan's next-generation geostationary meteorological satellite using a highly improved sensor, Advanced Himawari Imager (AHI). The satellite observes all of the Earth's surface (within visual range) every 10 min and all of Japan every 2.5 min. Therefore, 24 images of Japan can be observed sequentially in an hour.

Tasks performed by Himawari-8, operated by Japan Meteorological Agency (JMA), include weather monitoring by collecting information about cloud coverage and movement. Clouds appear, move, and dissipate slowly, and this process can be observed using Himawari-8/AHI sequential images. On the other hand, because many objects on the ground are fixed, Hiamawari-8 also provides multi-frame images of immovable objects on the ground.

The authors apply high-resolution image reconstruction using multi-frame low resolution images in this paper. This technique was developed to enhance video images. Since a set of Himawari-8/AHI sequential data is considered to be a multi-frame image, high-resolution reconstruction processing was examined as an enhancement opinion.

Comparing 24 images observed sequentially in an hour does not yield noticeable distortion among them. If the pixels in each image are divided into 10×10 subpixels, several distortions, particularly in Band 3, become apparent because the resolution in Band 3 is higher than that of other bands. If the distortion of images divided using subpixels corrected automatically, subpixels can be fixed in their positions relative to each other to produce an enhanced image.

This study examined the feasibility of multi-frame image processing using Himawari-8/AHI data observed sequentially over an hour. By adjusting the distortion of multi-frame images by subpixel comparison and automatic registration, it is possible to improve image quality from multi-frame image processing using mean value, median value, or a regression function to shift subpixel positions in an image. As a result, Himawari-8 data can be improved to observe more information than provided by the raw data.

Keywords: automatic registration, multi-frame image, super resolution technique, Himawari-8

ひまわり8号連続観測データを使った画質の向上について

2014 年 10 月 7 日、次世代静止気象衛星「ひまわり 8 号」が打ち上げられた。観測波長帯数、空間分解能、観測時間でそれぞれ機能が向上している。特に日本域等特定の領域は 2.5 分間隔で連続観測され、種々現象の動きが観測できる。地表面は雲と違い移動することが無いため、これら連続観測された画像は対象を複数のフレームで撮影していると言い換えることが出来る。このことから、画質の改善が可能と思われる。また、各画像間に若干の位置ずれがあるとすれば、解像度の改善も可能であると考えられる。

本研究では、連続観測された画像間の位置ずれをサブピクセルに分割して調査し、それぞれの画像間に最大 0.5 画素のずれが存在し得ることを確認した。位置ずれを自動探索し、高解像度化および高画質化について検討、調査したところ画質の向上について良好な結果が得られた。

キーワード：位置ずれ、マルチフレーム、高解像度化、ひまわり 8 号

Journal（掲載誌）
Transactions of the Japan Society for Aeronautical and Space Sciences Vol.16, No.3, 224-229, May 2018

Shuichi SHIMOMURA

Associate Professor, Department of Architecture and Architectural Engineering

Shuichi Shimomura is an associate professor at the Department of Architecture and Architectural Engineering, College of Industrial Technology, Nihon University. Dr. Shimomura received his Dr. Eng. from Nihon University in 2011. He served as a research engineer at Kajima Technical Research Institute from 2003 to 2012. Since 2012, he has been with the College of Industrial Technology, Nihon University. His main research area is geotechnical engineering, such as pile design, ground investigation, soil improvement, and liquefaction. Dr. Shimomura is a member of the Architectural Institute of Japan, the Japanese Geotechnical Society, the Japan Association for Earthquake Engineering and the Japan Society of Civil Engineers.

Research Achievements

1) A proposal of practical group pile efficiency evaluation formula, Journal of Structural Engineering, AIJ, Vol. 64B, pp.621-627, Mar. 2018

2) Soil classification method using screw point-soil fricative sound by swedish weight sounding, Journal of Structural and Construction Engineering, AIJ, Vol. 83, No. 743, pp.111-121, Jan. 2018

3) Horizontal resistance of pile evaluated by Chang's formula using coefficient of subgrade reaction calculated from shear wave velocity, Journal of Structural and Construction Engineering, AIJ, Vol. 82, No. 741, pp.1747-1757, Nov. 2017

4) Coefficient of Subgrade Reaction Estimated from Horizontal Load Test Data of Single Piles with Wide range Diameter in Cohesive Soil Deposit, AIJ Journal of Technology and Design, Vol.23, No.53, pp.93-98, Feb. 2017

5) Coefficient of Subgrade Reaction Estimated from Horizontal Load Test Data of Single Piles with Wide range Diameter in Sand Deposit, AIJ Journal of Technology and Design, Vol.22, No.52, pp.919-924, Oct. 2016

Published Paper

Horizontal Resistance of Pile Evaluated by Chang's Formula Using Coefficient of Subgrade Reaction Calculated from Shear Wave Velocity

Shuichi SHIMOMURA and Yasutsugu SUZUKI

In seismic design of pile foundation by static stress analysis, a model in which a pile is a beam and the beam and the ground are connected by multiple springs (coefficient of subgrade reaction k_h) is used as a practical design. The stress and horizontal displacement of the piles obtained from this method strongly depends on the evaluation accuracy of the coefficient of subgrade reaction k_h as well as the specification section of the pile body. In this study, we propose a method to evaluate coefficient of subgrade reaction kh based on shear wave velocity. We also propose a method to evaluate k_h from inverse analyses based on the Chang's formula using past several horizontal loading test data including large diameter piles performed at in situ. Using the proposed k_h, simulation analyses by Chang's formula are carried out and the validity of the coefficient is verified.

Keywords: Single pile, Coefficient of subgrade reaction, Horizontal load test, Shear wave velocity, Pressuremeter test, Chang's formula

せん断波速度に基づく地盤の変形係数を用いた Chang 式による杭の水平抵抗評価

静的応力解析による杭基礎の耐震設計では，杭を梁，この梁と地盤を複数のばね（地盤反力係数 k_h）で連結したモデルを実用的な設計として用いている。この手法から得られる杭の応力と水平変位は，杭体の断面性能だけではなく，水平地盤反力係数の評価精度に強く依存する。本研究では，水平地盤反力係数の評価に用いる地盤の変形係数算定にせん断波速度を用いる方法を提案した。さらに，杭頭自由条件の単杭の原位置水平載荷試験結果に基づき，Chang 式を用いた逆解析から逆算水平地盤反力係数を求め，大口径杭まで含めた水平地盤反力係数の設定方法を提案した。提案手法を用いた Chang 式による原位置水平載荷試験のシミュレーションにより，本提案手法の有効性を確認した。

キーワード：単杭，水平地盤反力係数，水平載荷試験，せん断波速度，孔内水平載荷試験，Chang 式

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Kenichi Shinozaki is a First Class Kenchikushi*1) and architect with extensive practical experience in architectural design and supervision. He is also a qualified landscape architect. As a researcher, he explores the existence of architectural space focusing on the concept of spatial schema, and examines new possibilities of fieldwork in remote areas and of first person research.

Shinozaki's background of study in architecture includes undergraduate and postgraduate education at Tokyo Institute of Technology (graduated in 1986 and 1989, respectively). Under the influence of design education by Kazunari Sakamoto and Kazuo Shinohara, he studied the architectural planning theory foundation under Yoshitsugu Aoki.

Another important aspect of his architectural background is studying at the Swiss Federal Institute of Technology Zurich (Eidgenössische Technische Hochschule Zürich (ETH) as a MEXT dispatched scholarship international student from 1987 to 1988) while in graduate school, and studying at the studio of Ticino architect Mario Campi under the influence of Italian rationalism and critical regionalism.

After graduating from graduate school, Shinozaki worked at Toyo Ito & Associates, Architects engaged in a large number of practical works in design and supervision as well as discussions and proposals on new architecture. Since 2001, while having his own atelier, he has designed and cooperated with Toyo Ito & A.A. and worked as a chief architect on projects both in Japan and overseas. His major works include Gallery U in Yugawara, Gavia Park in Madrid, the Relaxation Park, the Barcelona complex, the Amiens Museum of Contemporary Art (FRAC) in France, and the Koenji performance theater, etc. During this period, he has also given lectures in Spain at Logroño (Rioha) International Conference (II Foro Internacional "Territorios 21"), Universidad Politécnica de Madrid (UPM), etc., and at Alicante Architects Association. Shinozaki worked as the architect responsible for the Toyo Ito exhibition (2006 to 2008 Tokyo Opera City, Kanagawa Prefectural Museum of Modern Art, etc.).

In 2008, he joined the faculty of the Nihon University CIT Habitation Space Design Course led by Yoshifumi Nakamura as a part-time lecturer, and was mainly in charge of exterior design lectures and practical skills. After becoming an associate professor at the Faculty NUCIT in 2011, Shinozaki participated in the launch of new Architectural Design Course and worked with both architects Kosuke Izumi and Rokuro Hashimoto to create a new educational framework and curriculum. In recent years, his teaching diploma works winning third place nationwide (2017 JIA Diploma) and the first prize nationwide (2018 Akarenga Diploma) have contributed to architectural education.

All the activities and discussions throughout his career at universities and graduate schools, and at Toyo Ito & A.A. were ideal professional experiences where there was no border between research study and practical projects. Shinozaki hopes to provide the same experiences and opportunities here at NUCIT as well.

SPECIALIZATION

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Research Achievements

1) Exploring Archetypes of Spatial Schema through Spatial Experiences Involving Embodiment -Application of KJ method in Organizing "PhotoDiaries", Congnitive Studies, 22(1), pp.37-52. March 2015 (in Japanese)
2) Exploring Spatial Schema and the Characteristics of Folk House in Izena Village, Okinawa, through the Interviews to the residents A Study of Characteristics of Folk House Dwelling Spaces focusing on Ichiban-za, Niban-za, and Amahaji. The 34th Annual Meeting of the Japanese Cognitive Science Society
3) Architect & Landscape Architect, R.L.A.: AN OPEN DESIGN IN AN ENVIRONMENTALLY CONSCIOUS CITY PLAN - THE CASE STUDY OF PARQUE DE LA GAVIA, Architecture in the Fourth Dimension, Proceedings of the Joint Conference of CIB W104 and W110, November 15-17, 2011, Boston, Massachusetts, USA, pp. 272-279, Ball State University, College of Architecture and Planning, Muncie, Indiana, 47306, USA, November 2011, ISBN 0-937994-44-8

Published Paper

The Relation of Hmong Dwelling to Its Surrounding Natural Topography at Keo Patu Village in Northern Laos (LPD)

Exploring spatial schema that generates structure of the village of the Hmong, an ethnic group originated in mountain areas

Kenichi SHINOZAKI, Haruyuki FUJII, Nanako KATAOKA, Takanori ISHII and Yuta TAKAHASHI

This paper aims to reveal the spatial recognition of the Hmong through discussing the relation of 1) the main axis of Hmong dwellings which is composed of the ancestral alter and the main door located in front of it, with 2) the correlation of the dwelling to its surrounding geographical features and to the natural topography in relation with the mountains which surround the village. The Hmong is an ethnic group who believe in a variety of natural, ancestral, and supernatural spirits which live in and animate all things. Whose homelands are in the mountain areas of northern Thailand, Laos, and Vietnam. And who has no tradition of written language.

Through understanding previous studies in terms of spatial structure of their dwellings and villages made by R. Cooper and Hata, et al., the authors derive two important components that will generate Hmong's spatial recognition, 1) The main axis is an important spatial element to locate the dwelling in its environment. 2) The correlation between the dwelling and the topography is surveyed both in microscopic and macroscopic comprehension of its geographical features. The rule ‘the ancestral alter upward and the main door downward’ is a fundamental spatial notion of the Hmong, which can be shared by an ordinary boy. The survey tries to reveal how this rule applies to their recognition.

The geographical features of the village Keo Patu differs from those of the previous studies. The village is in a flatland surrounded by mountains and the spatial structure of the village is based on circler patterns. If the Hmong is divided into variants as is said in previous study, the exploration in the field Keo Patu is worthwhile.

Through the investigation of all 81 dwellings in the village, the main axis is identified for 75 dwellings, by means of recognizing the ancestral alter or the red cloth above the lintel of the main door, or of the resident's explanation. 57 dwellings are located in the geographical features according to the rule ‘the ancestral alter upward and the main door downward’ (in microscopic comprehension). On the other hand, 67 dwellings are located in the natural topography in relation with the mountains (in macroscopic comprehension).

As a result, it became clear that the Hmong's spatial notion ‘the ancestral alter upward, and the main door downward’ is preserved in two ways. One is as A) an simple order to generate the traditional spatial structure of Hmong villages situated on a mountain slope, and the other is in B) a resilient structure to keep the frame of the recognition by involving both conceptual understanding of natural topography in relation with the mountains and practical use of land surrounding their dwellings.

Keywords: The Hmong, Dwellings, Ancestral alter, Main door, Axis, Spatial Recognition

ラオス北部ゲオパトゥ村のモンの住居と地形の関係
（山岳少数民族モンの集落空間構成の基本となる空間図式の探究）

本研究は，山岳少数民族であるモンの信仰にもとづく空間構成原理を探究し，彼らの住居や集落空間を構成する空間認識の基本的枠組みを理解することを目的としている．筆者らは空間の認識を方向づける心的な構造を空間図式と呼び，これを探究している．モンの住居や集落空間は，この心的な構造によって方向づけられた認識に基づいて構成されると考え，これをラオス北部山岳地帯のモンの集落ゲオパトゥにおいて，臨地実地調査に基づいて探究する．研究の発端は，彼らの口承文化と，自然と一体となった生活，住居と集落空間の簡潔な存在の仕方を可能にするモンの空間概念への関心と，既往研究の明らかにするモンの集落空間構成秩序が，ゲオパトゥの空間構成にはそのまま当てはまらないことへの疑問にある．

数次の臨地悉皆調査を経て明らかになったのは，ゲオパトゥにおける住居と集落空間の構成の仕組みは，１）集落の輪郭の山の斜面およびその直近では，伝統的なモンの住居と集落空間の構成秩序「住居は，同じ山を背にし，斜面にスカ（信仰の札）を上コッチョンタ（住居の主扉）を下にして建ち，住居は，等高線の法線方向にスカ・コッチョンタ軸を向け同方向に並んで建つ」が成立する，一方，２）集落内部では，一見そのような伝統的実体的な空間秩序はないように見えるが，地形の微視的解釈（住居近傍の地形）と巨視的解釈（住居と山の関係）に基づいて，生活の実用的要求（集落道との関係など）も取り込み，総体としてモンの伝統的な空間認識であるスカ・シャペ，コッチョンタ・シャンダー（スカが上でコッチョンタが下）が保持されるという，抽象的でもる柔軟な空間の認識構造があると考えられるということである．

キーワード：空間図式，モン，住居，スカ，コッチョンタ，軸，空間認識

Journal（掲載誌）
Transactions of AIJ. Journal of Architecture and Planning. Vol. 82, No. 741, pp. 2827-2836, 2017. 11.

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Toshiyuki Sato is an assistant professor at the Department of Applied Molecular Chemistry, College of Industrial Technology, Nihon University. His three research themes interest include continuous reactive crystallization for metal oxide nanoparticles in hot-compressed water using micro-reactor, development of mixing device using micro-space, and development of energy-saving separation process for measurement of isobaric vapor-liquid equilibrium at low to elevated pressure.

Dr. Sato received his B.S. in Engineering in Industrial Chemistry from the Nihon University's College of Industrial Technology in 2001, and his M.S. in Engineering in Industrial Chemistry from Nihon University's Graduate School of Industrial Technology in 2003. He joined Taiatsu Techno Corporation in 2003 and was assigned to the Technology Group. Dr. Sato obtained his Ph. D. from Nihon University Advanced Research Institute for the Sciences and Humanities (ARISH) under the supervision of Prof. Dr. Tatsuaki Yashima, Prof. Dr. Hiizu Iwamura and Prof. Dr. Toshihiko Hiaki in 2008.

Research Achievements

1) Enhanced production of α-form indomethacin using antisolvent crystallization method assisted by N2 fine bubbles, Journal of Crystal Growth, Volume 469, 91-96, 2017.

2) Continuous hydrothermal synthesis of $Ca_{1-x}Sr_xTiO_3$ solid-solution nanoparticles using a T-type micromixer, The Journal of Supercritical Fluids, Volume 85, 159-164, 2014.

3) Continuous Hydrothermal Synthesis of Nickel Ferrite Nanoparticles Using a Central Collision-Type Micromixer: Effects of Temperature, Residence Time, Metal Salt Molality, and NaOH Addition on Conversion, Particle Size, and Crystal Phase, Industrial and Engineering Chemistry Research, Volume 50, 9625-9631, 2011.

4) Continuous hydrothermal synthesis of Fe_2O_3 nanoparticles using a central collision type micromixer for rapid and homogeneous nucleation at 673 K and 30 MPa, Industrial and Engineering Chemistry Research, Volume 49, 8841-8846, 2010.

5) Hydrothermal Synthesis of $CuAlO_2$ with the Delafossite Structure in Supercritical Water, The Journal of Supercritical Fluids, Volume 46, Issue 2, 173-177, 2008.

Published Paper

Rapid and Continuous Production of Ferrite Nanoparticles by Hydrothermal Synthesis at 673 K and 30 MPa

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$MeFe_2O_4$ (Me = Ni, Cu, Zn) nanoparticles synthesis from Fe $(NO_3)_3$ and Me $(NO_3)_2$ aqueous solution was carried out at 673 K and 30 MPa using a flow apparatus. A T-type micro-mixer with inner diameter of 0.33 mm was used for super-rapid heating of the starting solution to supercritical water condition. The Me/Fe molar ratio in starting solution changed less than 0.50. Residence time ranged from 0.002 to 4.000 s. Conversion, average particle size, crystal phase, lattice parameters and Me/Fe molar ratios were characterized by ICP, TEM, XRD and XRF, respectively.

For the solid-solution nanoparticles of $MeFe_2O_4$ and γ-Fe_2O_3 with a cubic spinel structure, the average particle size of under 10 nm was obtained. The particle size decreased and the conversion increased with decreasing solubility of the metal oxides in the order ZnO > CuO > NiO > Fe_2O_3 on the basis of classical nucleation theory. The results of the experiments lead to the conclusion that $MeFe_2O_4$ particles were formed by secondary nucleation of mixed oxide of Me and Fe on the primary particles, low-crystallinity γ-Fe_2O_3, through both dissolution-recrystalliation and also Ostwald ripening.

Keywords: hydrothermal synthesis, nanoparticles, supercritical water, micro-mixer, ferrite

超臨界水熱法におけるフェライトナノ粒子の連続合成

本研究は，T 型マイクロミキサを組み込んだ流通式反応装置を用いて，$Fe(NO_3)_3$ および $Me(NO_3)_2$ (Me = Ni, Cu, Zn) を原料として $MeFe_2O_4$ ナノ粒子の合成を，反応温度 673 K，反応圧力 30 MPa，滞在時間 0.002 から 4.000 で行った．T 型マイクロミキサには，流路内径 0.33 mm を用いて原料金属塩水溶液を高温高圧水との混合時に急速昇温させるために使用した．各種金属イオンの転化率，粒径，相同定，格子定数の算出および生成物中の Me/Fe モル比の分析には，ICP，TEM，XRD および XRF をそれぞれ用いた．

生成物は，$MeFe_2O_4$(または γ-Fe_2O_3) の単一相であり平均粒径は 10 nm 以下であった．また，滞在時間の増加にともない各金属イオンの転化率は，原料由来の金属酸化物の溶解度差に準じて上昇することに起因して，得られる $MeFe_2O_4$ ナノ粒子の粒径も増加する傾向を示した．実験結果より，$MeFe_2O_4$ 粒子は，まず一次粒子である低結晶性の γ-Fe_2O_3 が生成後，溶解再析出とオストワルド熟成の両方により，Me^{2+} イオンを取り込み二次核生成によって形成される生成機構を明らかにした．

キーワード：水熱合成，ナノ粒子，超臨界水，マイクロミキサ，フェライト

Journal（掲載誌）
Industrial and Engineering Chemistry Research, Volume 47, No.6, 1855-1860, 2008.

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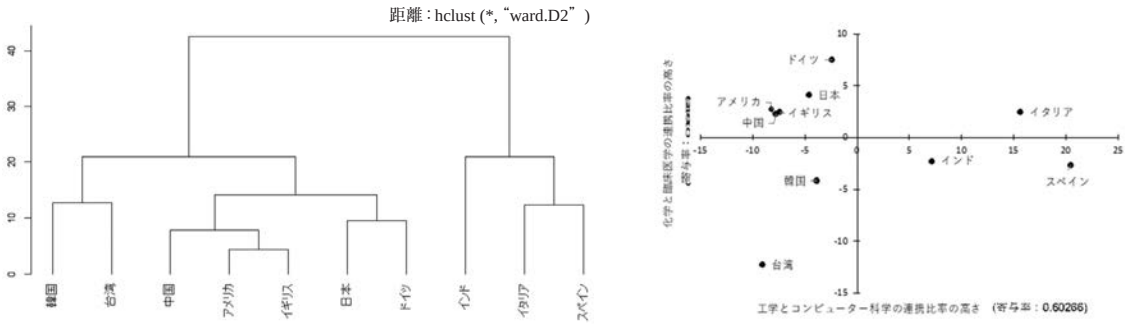
Yuji Mizukami is a professor at the Department of Industrial Engineering and Management, College of Industrial Technology, Nihon University. Dr. Mizukami is a researcher of business administration and statistics. He served as a visiting associate professor at the Institute of Statistical Mathematics (ISM) for four years, and is currently a researcher at Japan Aerospace Exploration Agency (JAXA), a role he began in 2016. Dr. Mizukami has researched new theories and methods in personnel evaluation and product development processes. Dr. Mizukami's main areas of research are knowledge creation by innovation and value-added creation by data driven organization theory. He also teaches students of the business management course about business administration, such as strategy, planning or process of assumed business models. Dr. Mizukami's main lectures include innovation management, management strategy, product planning and development, management information management, and others. He also contributes his knowledge to academic societies as the Editor in Chief of the Japan Association for Management Systems (JAMS), the Editorial Vice-Chair of the Japan Academic Society of Hospitality Management (JASH), a Standing Director of the Japan Association for Management Systems, and others. In recognition of his activities, Dr. Mizukami received an academic award from the Japan Association for Management Systems (2018), the Excellent Paper Award at the 12th International Symposium on the International Society of Management Engineers (2015), and more.

Research Achievements

1) Study on Research Trends on the Internet of Things Using Network Analysis, *International Journal of the Japan Association for Management Systems*, 10(1): 27-35 (2018)
2) Synergies between different areas in hospitality research: A network analysis of bibliographic data, *International Journal of Japan Academic Society of Hospitality Management*, 4(2):1-8 (2018)
3) Applying Integrated R&D Process in Process Innovation Research:Estimating the Impact of a Process Change in Automotive ECU Development on Organizational Flexibility and Product Quality, *International Journal of the Japan Association for Management Systems*, 9(1): 7-17 (2017)
4) An International Research Comparative Study of the Degree of Cooperation between disciplines within mathematics and mathematical sciences: proposal and application of new indices for identifying the specialized field of researchers, *Springer, Behaviormetrika*, 44(2): 385-403 (2017)
5) Co-author Information and Authors' Affiliation Information in Scientific Literature Using Centralities -The Researchers who Act as Mediators between Organizations-, *International Journal of the Japan Association for Management Systems*, 8(1): 1-8 (2016)

Research Achievements



(a) Dendrogram of similarity (b) Principal component analysis

Fig.1 Top 10 IoT papers on connections between research fields (2016)

Published Paper

Study on Research Trends on the Internet of Things Using Network Analysis

Yuji MIZUKAMI, Keisuke HONDA and Junji NAKANO

The development of the Internet of Things (IoT) is indispensable for the spread of Industry 4.0. To develop IoT research, this article analyzes the trends in IoT research from the viewpoint of the importance of IoT research in responding to the global IoT scenario. In this analysis, we perform network analysis and investigate the characteristics of researchers who are related to IoT research.

We studied the fusion of different fields, such as chemistry and engineering, in IoT research. In this article, we analyzed in three stages using the framework of "meeting different fields and measuring innovation of research power." Firstly, we identified researchers in the field of IoT research. Secondly, we identified the specialized fields of these researchers. Finally, we implemented visualization of the heterogeneous fusion of the whole IoT research field. We present the following 4 points as a proposal for extending IoT research activities in Japan: (1) establish a cooperative relationship with researchers in computer science; (2) improve direct relationships with clinical medicine; and (3) establish a direct relationship with physics; and (4) strengthen the indirect relationship with molecular biology & genetics and physics via clinical medicine.

Keywords: Research Metrix, Institute Research, Network Theory, IoT

ネットワーク分析を用いたIoT 分野の研究動向に関する研究

Internet of Things (IoT) の開発は，「Industry 4.0」の普及促進の要因として重要である．本稿では, IoT 研究の発展に向けて，現状を把握する必要があるという観点から，IoT 研究の動向をネットワーク分析にて解析して，改善のポイントを提示するものである．分析では,「異分野融合研究によるイノベーション創出」フレームワークを用いて 3 段階で展開した．まず，IoT 研究論文を収集して IoT 研究に携わる研究者を特定．次に，これら研究者の関連論文を全て収集して専門分野を特定．最後に，IoT 研究分野全体の異分野融合の形態を視覚化した．分析の結果，異分野融合研究によるイノベーション創出との観点で，日本での IoT 研究を活発化する方策として 4 点が挙げられる．まず「コンピュータサイエンスの研究者との関係構築」, 次に「臨床医学との直接的な関係強化 」，そして「物理学との直接的な関係強化」，最後に「臨床医学を介して，分子生物学および遺伝学，物理学との関係強化」である．

キーワード：Research Metrix, IR, ネットワーク分析, IoT

Journal（掲載誌）
International Journal of the Japan Association for Management Systems, 10(1): 27-35 (2018)

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Research Achievement

1) Point Cloud Analysis for the Classification of Error Proneness, The 6th IIEEJ International Conference on Image Electronics and Visual Computing (IEVC 2019) to appear, Aug. 2019.
2) Visualization and analysis of regions of monotonic curvature for interpolating segments of extended sectrices of Maclaurin, Computer Aided Geometric Design, Vol. 56, pp.35-47, Aug. 2017.
3) Quadratic Log-Aesthetic Curves, Computer-Aided Design and Applications, Volume 14, Issue 2, pp. 219-226, Mar. 2017.
4) Analytic parametric equations of log-aesthetic curves in terms of incomplete gamma functions, Computer Aided Geometric Design, Volume 29, Issue 2, pp.129-140, February 2012.
5) Interactive Aesthetic Curve Segments, The Visual Computer (Pacific Graphics), Vol. 22, No.9-11, pp.896-905, 2006.

Published Paper

Quadratic Log-Aesthetic Curves

Norimasa YOSHIDA and Takafumi SAITO

Log-aesthetic curves are curves with linear logarithmic curvature graphs. In this paper, we propose quadratic log-aesthetic curves that have quadratic logarithmic curvature graphs. In previous work, Gobithaasan et al. proposed generalized log-aesthetic curves by adding a constant to the curvature or the curvature radius of log-aesthetic curves. Quadratic log-aesthetic curves are another generalization of log-aesthetic curves by quadratic logarithmic curvature graphs. We derive the general formula of quadratic log-aesthetic curves by using the error and imaginary error functions. To compute curve points, we need to compute the inverse of the error and imaginary error functions. We propose a method for computing these inverse functions and showing that a curve segment can be generated in real time.

Keywords: Quadratic log-aesthetic curve, logarithmic curvature graph, error and imaginary error functions

2 次対数美的曲線

対数美的曲線は，曲率対数グラフが直線となる曲線である．本論文では，曲率対数グラフが 2 次曲線となる 2 次対数美的曲線を提案する．従来の研究において，Gobithaasan らは，対数美的曲線の曲率または曲率半径に定数値を加える一般化対数美的曲線を提案した．2 次対数美的曲線は，曲率対数グラフが 2 次曲線である，もう一つの一般化である．誤差関数および複素誤差関数を用いて，2 次対数美的曲線の一般式を導出する．曲線の点を計算するためには，誤差関数および複素誤差関数の逆関数を計算する必要がある．これらの逆関数を計算する手法を示し，曲線セグメントがリアルタイムに生成できることを示す.

キーワード：2 次対数美的曲線 , 曲率対数グラフ , 誤差関数と複素誤差関数

Journal（掲載誌）
Computer-Aided Design and Applications, Vol. 1 4, Issue. 2, pp.219-226, Mar. 2017

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Research Achievements

1) A Don't Care Filling Method for Low Capture Power based on Correlation of FF Transitions Using SAT, IEICE Transaction on Fundamentals, E100-A(12), 2824-2833, Dec 2017.
2) A Controller Augmentation Method to Improve Transition Fault Coverage for RTL Data-Paths, Proceedings of the 25th IEEE International Symposium on On-Line Testing and Robust System Design, 293-298, July 2019.
3) A Capture Safe Static Test Compaction Method Based on Don't Cares, Proceedings of the 24th IEEE International Symposium on On-Line Testing and Robust System Design, 195-200, July 2018.
4) A Low Capture Power Oriented X-filling Method Using Partial MaxSAT Iteratively, Proceedings of IEEE the 22nd International Symposium Defect and Fault Tolerance in VLSI and Nanotechnology Systems, S2-4 1-6, Oct 2019.
5) Strongly Secure Scan Design Using Extended Shift Registers and Evaluation of Security, IEICE on Information and Systems, Vol.J101-D (8), 1165-1175, Aug. 2018.

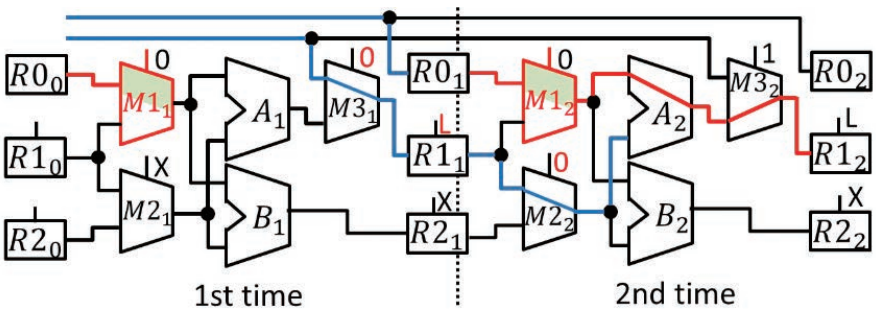

Fig.1 Loc Test Generation Model of M1

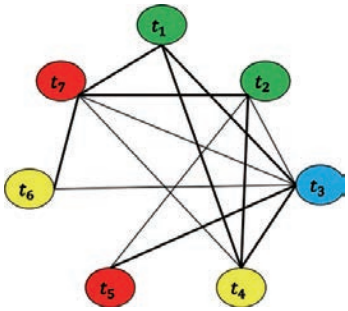

Fig.2 Low Power Test Cube Compatibility Graph

Published Paper

A Low Capture Power Test Generation Method Based on Capture Safe Test Vector Manipulation

Toshinori HOSOKAWA, Atsushi HIRAI, Yukari YAMAUCHI, and Masayuki ARAI

In at-speed scan testing, capture power is a serious problem because the high power dissipation that can occur when the response for a test vector is captured by flip-flops results in excessive voltage drops, known as IR-drops, which may cause significant capture-induced yield loss. In low capture power test generation, the test vectors that violate capture power constraints in an initial test set are defined as capture-unsafe test vectors, while faults that are detected solely by capture-unsafe test vectors are defined as unsafe faults. It is necessary to regenerate the test vectors used to detect unsafe faults in order to prevent unnecessary yield losses. In this paper, we propose a new low-capture-power test generation method for transition faults based on launch-on-capture scheme. This method mimics capture-safe test vectors which have low launch switching activity in the initial test set, and uses fault simulation. In the proposed test generation method, new test vectors to detect unsafe faults are generated using the fault propagation path information of the capture safe test vectors. This simulation-based approach reduces the test generation time, and the simplicity of the proposed algorithm facilitates simple implementation. Experimental results show that the use of this method reduces the number of unsafe faults by 94% while requiring just 18% more additional test vectors on average, and while requiring less test generation time compared with the conventional low capture power test generation method.

Keywords: low power, test generation, capture safe test vectors, test vector synthesis, unsafe faults

キャプチャセーフテストベクトル操作に基づく低キャプチャ消費電力テスト生成法

実速度スキャンテストにおいて，キャプチャ動作時の過度な電力消費は回路の熱破壊や IR ドロップによる誤テストといった深刻な問題を引き起こし，歩留り損失の原因のひとつにあげられる．したがって，キャプチャ消費電力が閾値を超えるようなテストベクトルは，不必要な歩留り損失につながるためテストに使用できない．そのため，テスト生成時にキャプチャ消費電力を考慮する必要がある．本論文では初期テスト集合中の低キャプチャ電力テストベクトルを利用した故障シミュレーションベースの低キャプチャ電力テスト生成手法を提案する．この方法は，初期テスト集合中の信号線遷移が少ないキャプチャセーフテストベクトルを模倣し，故障シミュレーションを用いたものである．提案法では、キャプチャセーフテストベクトルの故障伝搬経路情報を用いて，アンセーフ故障を検出するための新しいテストベクトルを生成する．提案手法では，シンプルなアルゴリズムで高速に低キャプチャ電力テスト集合を生成する．ISCAS’89，ITC’99 ベンチマーク回路を用いた実験では，初期テスト集合に 18% の新しいテストベクトルを追加して，従来の低キャプチャ電力テスト生成手法と比較して，アンセーフ故障数を平均 94% 削減したことを示す．

キーワード：低消費電力，テスト生成，キャプチャセーフテストベクトル，テストベクトル合成，
アンセーフ故障

Journal（掲載誌）
IEICE on Information and Systems, Vol.E100-D (9), 2118-2125, Sept 2017.

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Kazuhito Misaji is a professor at the Department of Mathematical Information Engineering, College of Industrial Technology, Nihon University. Dr. Misaji received his B.L.A. in Mathematical Engineering from Nihon University in 1981, his M.S. in Mathematical Engineering from Nihon University in 1983, and his Doctorate of Engineering from Nihon University in 1996. Dr. Misaji worked for Honda R&D Co., Ltd until 2008. While working at the Tochigi Research Center, his major research included the study of acoustic simulation for reducing vehicle interior noise. He is a senior research scientist and a chief engineer in the acoustic analysis business. Dr. Misaji moved on to Nihon University to expand his high frequency acoustic analysis using statistical energy analysis methods to acoustic analysis of not only automobiles but also automobile peripheral parts based on Biot theory. From 2010, he began to analyze the musculoskeletal mathematical model of the human body, and he received the Best Paper Award at the 7th Thai Society of Mechanical Engineers International Conference.

Research Achievements

1) Quantifying Roll Feel of a Car by Using a Musculoskeletal Mathematical Model, Journal of Computer Modeling in Engineering and Sciences, vol.118/ No.3, 493-507, 2019/03/25.
2) Using a Musculoskeletal Mathematical Model to Analyze Fatigue of the Muscles in the Lower Limbs during Different Motions, Journal of Computer Modeling in Engineering and Sciences, vol.114/ no.2, 191-207, 2019/03/25, 2018/03/01.
3) Treasuri2/FE: A Tool for the FE Simulation of Sound Package Parts Fully Integrated in Nastran, SAE 2009 International Journal of Passenger Cars Mechanical-systems, vol. 2, 1511-1527, 2009/10/01.
4) SEA Model Building of Automotive car Body-in-White Using Experiment and FEM, SAE 2003 Transactions Journal of Passenger Cars & #8211; Mechanical, 2003-01-1411, pp.1561-1568, 2003/5.
5) Prediction of the SEA Input Parameters for the Sound Package, SAE 2003 Transactions Journal of Passenger Cars & #8211; Mechanical, 2003-01-1022, pp.1175-1184, 2003/5.

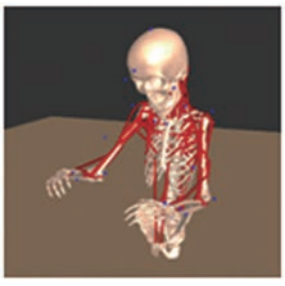

Fig. 1 Musculoskeletal model

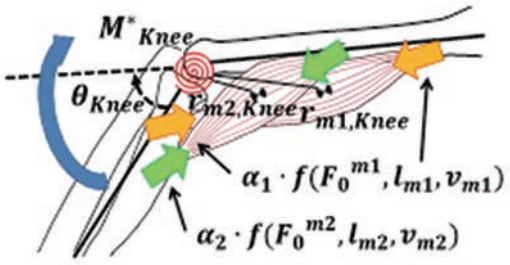

Fig. 2 Muscle torque around the knee joint

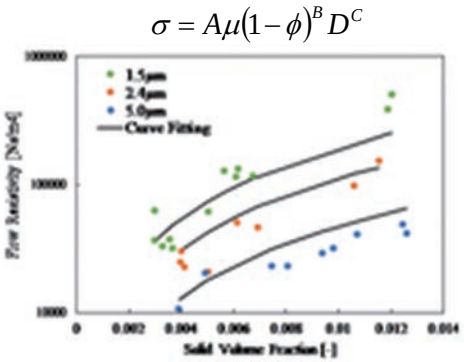

Fig. 3 Curve fitting of flow resistivity with solid volume fraction

Published Paper

Quantifying Roll Feel of a Car by Using a Musculoskeletal Mathematical Model

Masaki IZAWA, Ryota ARAKI, Tatsuro SUZUKI, Kaito WATANABE and Kazuhito MISAJI

There are different approaches to improve driving comfort. One is to reduce noise and vibration, the other is to enhance smooth ‘roll feel’ felt by the driver in corners. In terms of the roll feel evaluation, it is inequivalent in a way that roll feel is a combination of assessment on handling and reception of the roll feel (sensory evaluation) [(2016); Yoshioka, Abe, Yamakado et al. (2017)]. These researches indicate the difficulty of showing evidence of associations between biological indexes e.g. EMG/EEG and sensory evaluation of roll feel, resulting in statistical treatment upon examination of objective appraisal of roll feel involving the physical value of a car, biological indexes and sensory evaluation. Ride comfort related musculoskeletal research, however, is mainly conducted by collecting data measured in a driving simulator rather than data during driving on the road [Ogabayashi (2010)]. In this study, data of the driver’s posture was recorded while driving using motion capture cameras in creation of a three-dimensional musculoskeletal model, so that we could quantitatively analyze the load on muscles and joints by examining the changes of drive torque’s time series data and muscle activity level, which is a conventional analytical method. Load of the driver’s body while driving could be quantified by analyzing these results in order to quantitatively compare the difference in roll feel caused by the driving modes and damper variations.

Keywords: Human engineering, biomechanics, musculoskeletal mathematical model, driving torque, motion capture

筋骨格数理モデルを用いた自動車のロールフィール定量化研究

運転の快適さを改善するためのさまざまなアプローチがあります．１つは，騒音と振動を低減すること，もう１つは，コーナーでドライバーが感じる「ロールフィール」を向上させることです．ロールフィールの評価に関しては，ロールフィールがハンドリングの評価とロール感の受容（感覚評価）の組み合わせであるという点で不等価です [（2016）; 吉岡、阿部、山門ら（2017）]．これらの研究は，生物学的指標間の関連性を示すことの困難さを示しています．ロール感触の官能評価．車の物理的価値，生物学的指標，および感覚評価を含むロール感触の客観的評価の考察時には統計的処理をもたらします．ただし，乗り心地に関連する筋骨格の研究は，主に道路での運転中のデータではなく，運転シミュレータで測定されたデータを収集することによって行われます [Ogabayashi（2010）]．本研究では、3 次元筋骨格モデルを作成する際に，モーションキャプチャカメラを使用して運転中の運転者の姿勢のデータを記録したため，各関節廻りの駆動トルクの時系列データの変化を調べることで筋肉と関節の負荷を定量的に分析できます．運転中の運転者の身体への負荷は，これらの結果を分析することで定量化でき，運転モードとダンパーの変動によって生じるロールフィールの違いを定量的に比較できます．

キーワード：人間工学，バイオメカニックス，筋骨格数理モデル，駆動トルク，モーションキャプチャー

Journal（掲載誌）
CMES (Computer Modeling in Engineering & Sciences) Vol.118/ no.3, 493-507, 2019/03/25.

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Tomoe Komoriya is an associate professor at the Department of Sustainable Engineering, College of Industrial Technology, Nihon University. She obtained her B.S. in Engineering in Industrial Chemistry from the College of Industrial Technology of Nihon University in 2000, her M.S. in Engineering in Industrial Chemistry from the College of Industrial Technology of Nihon University in 2002, and her Ph.D. in Engineering from Nihon University in 2013. Dr. Komoriya is member of the Chemical Society of Japan, The Japan Society for Bioscience, Biotechnology, and Agrochemistry, the Association for the Rapid Method and Automation in Microbiology, and The Japan Society for Clinical Laboratory Automation. Her research interests include the development of high-sensitive latex agglutination test, and removal of environmental pollutants in water.

Research Achievements

1) Performance of a circulation type purification system during the treatment of sludge from Manila bay and two ports in Japan, International Journal of GEOMATE, 17, 51-56, 2019.
2) Effect of addition of bacteria on the removal of radioactive cesium from ocean sludge in a circulation type purification system, International Journal of GEOMATE, 12, 123-126, 2017.
3) Detection of Clostridium perfringens toxin genes in the gut microbiota of autistic children, Anaerobe, 45, 133-137, 2017.
4) In vitro study of the prebiotic xylooligosaccharide (XOS) on the growth of Bifidobacterium spp and Lactobacillus spp., International Journal of Food Sciences and Nutrition, 66, 919-922, 2015.
5) Use of a highly sensitive latex reagent with amino acid spacer for determination of C-reactive protein concentration in a variety of liver diseases, Journal of Bioscience and Bioengineering, 114, 560-563, 2012.

Published Paper

Use of a Highly Sensitive Latex Reagent with Amino Acid Spacer for Determination of C-reactive Protein Concentration in a Variety of Liver Diseases

Tomoe KOMORIYA, Naoko INOUE, Kazuaki YOSHIMUNE, Masahiro OGAWA, Mitsuhiko MORIYAMA, Hideki KOHNO

C-reactive protein (CRP) is a major acute-phase protein, which is extremely important in inflammatory disease diagnosis. CRP is rapidly elevated in various diseases as a result of tissue injury, infection and inflammation. Recently, many reports have shown its usefulness as a risk marker for arteriosclerosis and metabolic syndrome. However, the lack of sensitivity of existing CRP assays has hampered CRP testing in conditions associated with viral infections, where CRP levels typically elevate only marginally. In this report, we prepared a novel, ultra-sensitive latex-based CRP test using amino acid spacers with a high sensitivity and a wider assay range. Our method of conjugating latex beads enabled us to measure CRP in the range of 5e500 ng/mL in patient sera. Furthermore, we studied CRP levels in patients with various liver diseases, such as chronic hepatitis, liver cirrhosis and hepatic carcinoma, in order to examine the correlation between severity of liver dysfunction and CRP levels, and to examine the likelihood of recurrence of liver dysfunction. The reagent was simple to prepare and sensitive during clinical investigation, where it discriminated clearly between normal subjects and those with liver diseases. Therefore, we conclude that our ultra-sensitive CRP assay will contribute greatly to the clinical study of hepatic disorders.

Keywords: Latex reagent, CRP (C-reactive protein), Immunoassay, liver diseases

さまざまな肝疾患における CRP 濃度測定のための アミノ酸スペーサーを用いた高感度ラテックス試薬の利用

本研究では，高感度で広い測定範囲能を持つアミノ酸スペーサーを使用した新しい超高感度 CRP ラテックス試薬を作製し，その試薬を利用して肝機能障害の重症度と CRP 濃度の相関関係を調査することにより，高感度なラテックス試薬の必要性と有用性を報告した．

C 反応性タンパク質（CRP）は主要な急性期タンパク質であり，組織の損傷，感染，炎症などのさまざまな疾患で急激に上昇する．さらに，動脈硬化とメタボリックシンドロームのリスクマーカーとしての有用性が近年報告されている．しかし，既存の CRP 測定試薬の検出感度が低いことから，CRP 濃度がわずかにしか上昇しないウイルス感染において CRP 測定は行われていない．そのため，本研究では，高感度で広い測定範囲能を持つアミノ酸スペーサーを使用した新しい超高感度 CRP ラテックス試薬を作製し，肝機能障害の重症度と CRP 濃度の相関関係を調査した．本研究で作製されたラテックス試薬は，患者の血清中の 5-500 ng / mL の範囲で CRP 濃度を測定することができた．さらに，慢性肝炎，肝硬変，肝癌などのさまざまな肝疾患の患者の CRP レベルを作製した試薬で測定し，肝機能障害の重症度と CRP レベルの相関関係を調査した．この試薬は、測定方法が簡便であり，さらに高感度な検出能を有することにより，正常な被験者と肝疾患のある被験者を明確に区別することができた．よって，超高感度 CRP ラテックス試薬は，肝障害の臨床研究への貢献が期待できる．

キーワード：ラテックス試薬，CRP(C 反応性タンパク質)，イムノアッセイ，肝疾患

Journal（掲載誌）
JBB (Journal of Bioscience and Bioengineering) Vol. 114, No. 5, 560-563, Jun 2012

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Shinnosuke Kamei is an assistant professor at the Department of Sustainable Engineering, College of Industrial Technology of Nihon University. Dr. Kamei received his B. Engineering in Materials and Applied Chemistry from Nihon University in 2007, and his Ph.D. from Nihon University in 2011. Dr. Kamei has been working for Niigata University as a postdoctoral researcher from 2011 to 2012. While working at Graduate School of Science and Technology, his major research topic was inorganic material chemistry, especially in research on the development of new high-performance phosphors for LED lighting systems. After leaving Niigata University in 2012, he moved to Nihon University. He is a member of The Society of Inorganic Materials, Japan, The Ceramic Society of Japan, Phosphor Research Society, The Electrochemical Society of Japan, The Electrochemical Society of Japan, The Japan Society of Applied Physics, The Materials Research Society of Japan, The Rare Earth Society of Japan and The Society of Sea Water Science, Japan.

Research Achievements

1) Quantitative Determination of the Effective Mn^{4+} Concentration in a $Li_2TiO_3:Mn^{4+}$ Phosphor and Its Effect on the Photoluminescence Efficiency of Deep-red Emission, ACS Omega, **4**, 19856-19862 (2019).
2) Room-Temperature Solid State Contact Reaction Synthesis of Rare Earth Free $RbVO_3$ Phosphor and Their Photoluminescence Properties, *ECS Journal of Solid State Science and Technology*, 7(6), R88-R93 (2018).
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4) A novel synthesis of phosphorus-substituted tobermorite with calcium silicate hydrate, *Journal of the Ceramic Society of Japan*, **122**, 664-667 (2014).
5) Preparation and fluorescence properties of novel red-emitting Eu^{3+}-activated amorphous alkaline earth silicate phosphors, *Journal of Luminescence*, **130**, 2247-2250 (2010).

Published Paper

Luminescence enhancement of $LiSrPO_4:Eu^{2+}$ phosphor by Mg^{2+} ion addition

Shinnosuke KAMEI, Tomoki HATSUMORI, Takuya HASEGAWA, Tadashi ISHIGAKI, Kazuyoshi UEMATSU, Kenji TODA, Mineo SATO

This paper describes a new method of the luminescence enhancement s of blue-emitting phosphate phosphors. Mg-doped $LiSrPO_4:Eu^{2+}$ ($Li(Sr, Mg)PO_4:Eu^{2+}$) phosphors, in which some Sr^{2+} ions were replaced by Mg^{2+} ions, were prepared using a conventional solid-state reaction method. The crystal structure of the phosphors was hexagonal, which is the high-temperature phase of $LiSrPO_4$, even though synthesis was carried out at a relatively low temperature of 900 ℃. Fluorescence could be efficiently excited in the 220–400 nm ultraviolet regions, and bright blue emission was produced with a peak at 448 nm. The emission intensity was higher than that for $LiSrPO_4:Eu^{2+}$ without Mg doping, and a lower Eu content (1 mol%) was required in order to reach the maximum intensity. These results indicate that the blue emitting $Li(Sr, Mg)PO_4:Eu^{2+}$ phosphor is a promising candidate for phosphor-conversion white Light Emitting Diodes.

Keywords: Optical materials, inorganic compounds, chemical synthesis, phosphors

Mg^{2+} イオン添加による $LiSrPO_4:Eu^{2+}$ 蛍光体の発光強度向上

本研究は，リン酸塩化合物の青色発光蛍光体である $LiSrPO_4:Eu^{2+}$ 蛍光体のさらなる発光強度向上を目指した．$LiSrPO_4$ は一般的な固相反応で簡便に合成でき，600 ～ 1000 度の合成温度では低温相（斜方晶または単斜晶）となり，1000 度以上の合成温度では高温相（六方晶）の結晶構造をとる．Mg イオンを Sr イオンサイトに一部固溶させることにより，900 度の合成温度で高温相である六方晶の合成が行えることを見出した．この高温相となる $Li(Sr, Mg)PO_4$ に発光イオンとして Eu^{2+} イオンを固溶させた $Li(Sr, Mg)PO_4:Eu^{2+}$ 蛍光体の蛍光特性は，Mg イオン無置換の高温相の $LiSrPO_4:Eu^{2+}$ 蛍光体と比較して，発光強度が向上することが確認された．すなわち，Mg イオンを添加させることにより，$LiSrPO_4$ 蛍光体は低い合成温度で高発光強度を示す青色蛍光体を作製できることを見出した．

キーワード：光学材料，無機化合物，化学合成，蛍光体

Journal（掲載誌）
Materials Research Innovations Vol. 23, Issue 6, 359-362, Jul 2019
Taylor & Francis Online: www.tandfonline.com

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Mika Kato obtained her bachelor's degree from the Department of Architecture, College of Science and Technology, Nihon University in 1999, and then entered the Graduate School of Science and Engineering at the same university, where she received her master's degree in 2001 and doctorate (Engineering) in 2004.

After receiving her PhD, she worked as an assistant at Nihon University for one year, and then for four years (2005-2009) as a post-doctoral fellow. From 2009 to 2010, she worked as a post-doctoral fellow at Kansai University. From 2010 to 2011, she also worked as a professional researcher at Building Research Institute. (Worked at both Kansai University and Building Research Institute in 2010)

She joined Kanazawa Institute of Technology since 2013 as a lecturer in the Department of Architecture at the Faculty of Environment and Architecture, and was promoted to associate professor in 2017. After that, she moved to Nihon University, Faculty of Industrial Engineering, Department of Conceptual Design in 2018, as an associate professor.

Her research area is architectural and environmental engineering. She specializes in visual environment, light and color environment, and environmental psychology; specifically the following:

- Operation method of impression of brightness in architectural space;
- Light conditions that make people feel the softness of light;
- Development of daylight control device according to space application;
- Proposal of artificial lighting control system in the room linked to window surface luminance;
- Appropriate use of colors in sign planning; and
- Regulation method of excessive luminance in outdoor advertising.

Through these studies, she belongs to the Architectural Institute of Japan, the Illuminating Engineering Institute of Japan, the Japanese National Committee of CIE (Commission Internationale de l'Eclairage), etc., and is involved in the creation of academic and JIS standards. She has also been involved in a variety of educational activities, including a symposium for engineers and a hands-on program for students.

Research Achievements

1) Study on Applicability of Mean Luminance by Image Photometry as Spatial Brightness Index, Transactions of AIJ. Journal of environmental engineering, Vol. 84 No. 766, 1059-1066, Dec., 2019 (in Japanese)
2) Influence of Color Temperature and Interior Reflectance on Spatial Brightness Demand, Proceedings of the 29th Session of the CIE, Vol.2, 1399-1404, Jun., 2019
3) Development of Generic Colorimetry System for Evaluation of Lighting Environment, Proceedings of the 29th Session of the CIE, Vol.2, 1546-1550, Jun., 2019
4) Lighting Environment Evaluation and Luminous Flux Calculation for Selection of Ceiling Luminaire, Transactions of AIJ. Journal of environmental engineering, Vol. 81 No. 720, 163-172, Feb., 2016 (in Japanese)
5) Research on Acceptable Luminance Contrast Between the Window Using Blind and the Surrounding Wall, Proceedings of the 28th Session of the CIE, Vol.1 Part2, 1954-1959, Jun., 2015

Published Paper

Study on Applicability of Mean Luminance by Image Photometry as Spatial Brightness Index

Mika KATO, Megumi NUMAJIRI, Hideki YAMAGUCHI, Wataru IWAI, Katsuhiko SAKATA, Naoyuki SUZUKI, Naoya HARA and Nozomu YOSHIZWA

Spatial brightness is the impression of brightness perceived when one observes a certain space, and it is one of the factors in controlling the comfort of a space. In previous studies, Kato clarified the weighted mean luminance that reflects gaze frequency and the decrease in impression due to uneven distribution of luminance distribution. There are many studies on spatial brightness other than Kato's research, but the common index has not been defined yet. Although there are many similar viewpoints between indices, the presence of multiple indices has caused confusion about which index should be used by designers. Therefore, we thought that it was important to organize the explanatory variables between the researches, and the researchers of space brightness in Japan cooperated and set up a committee at the Architectural Institute of Japan and discussed. This paper is a report of an experiment performed by the committee.

This paper aims to clarify the applicable range of arithmetic and geometric mean luminance for estimating spatial brightness, compared with the interpretability of the arithmetic mean luminance of walls and a ceiling.

The focus of this paper is on mean luminance, which has the strongest effect on the impression of spatial brightness. There are two types of mean luminance: arithmetic mean luminance and geometric mean luminance. As is known by the Weber–Fechner law, it is said that human perception has a high correlation with a logarithmic scale, and there is a view that the geometric mean luminance is appropriate. On the other hand, the illuminance that has been used for a long time in lighting design is an arithmetic mean value, although it is weighted by cosine. The point at issue is which mean luminance is appropriate for explaining spatial brightness.

A subjective experiment was conducted in the mock-up of general offices with four kinds of luminaires: ceiling lights, downlights, wall-washer lights and pendant lights. The results showed that the arithmetic mean luminance of the 180- and 360-degree visual fields had a higher correlation with the impression of spatial brightness than the geometric mean luminance of the same visual field. This arithmetic mean indicates the interpretability of the spatial luminance estimate. This result will encourage the use of arithmetic mean brightness as an explanatory variable of spatial brightness. Other variables will continue to be considered based on experimental data.

Keywords: Spatial brightness, Arithmetical mean luminance, Geometric mean luminance,

空間の明るさ指標としての画像測光による平均輝度の適用性の検討

空間の明るさは，特定の空間を観察したときに知覚される明るさに関する印象であり，空間の快適さを制御する要因の１つである．加藤はこれまでの研究で，視線頻度を反映させた重み付け平均輝度と，輝度分布の偏在による印象の低下の影響を明らかにしてきた．加藤の研究以外にも空間の明るさに関する多くの研究があるが，共通の指標はまだ定義されていない．指標同士の類似視点は多いが，複数の指標があることで，設計者はどの指標を使うべきか混乱が起こっている．そこで，研究相互の説明変数の整理が重要と考え，日本にいる空間の明るさの研究者が協力して，建築学会に委員会を設置し議論を行ってきた．本論文はその委員会で行った実験の報告である．

本論文の検討対象は，空間の明るさの印象に最も強い影響がある平均輝度についてである．平均輝度には，算術平均輝度と幾何平均輝度の２種類がある．ウェーバー・フェヒナーの法則で知られるように，人の感覚は対数スケールとの親和性が高いと言われており，幾何平均輝度が適切との考え方がある．一方で，照明設計に長い間使用されている照度は，コサインの重み付けはあるが，算術平均値である．既存の研究は，どちらの平均輝度を用いて説明するかという点に相違がある．

実験は，４種類の照明器具（シーリングライト，ダウンライト，ウォールウォッシャー，ペンダント）を備えた一般オフィスの実大空間で実施した．結果は，180 と 360 度いずれの視野範囲においても，算術平均輝度は幾何平均輝度よりも高い説明力を持つことを示した．この結果は，算術平均輝度を空間の明るさの説明変数として利用することを後押しするだろう．他の変数についても引き続き実験データに基づく検討が行われていく予定である．

キーワード：空間の明るさ，算術平均輝度，幾何平均輝度，

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Research Achievements

1) “Morse Indices of the Solutions to the Liouville-Gel’fand Problem with Variable Coefficients”, Funkcialaj Ekvacioj 61 (2018) Number 2, 229-265.
2) “Interface Regularity of the Solutions to Maxwell Systems on Riemannian Manifolds”, Tokyo Journal of Mathematics 39 (2016) Number 1, 83-100.
3) “Interface Regularity of the Solutions for the Rotation Free and the Divergence Free Systems in Euclidian Space”, Tokyo Journal of Mathematics 36 (2013) Number 2, 473-482.
4) “Asymptotic non-degeneracy of multiple blowup solutions to the Liouville-Gel’fand problem with an inhomogeneous coefficient”, Journal of Mathematical Analysis and Applications 398 (2013), 692-706.

Published Paper

Morse Indices of the Solutions to the Liouville-Gel'fand Problem with Variable Coefficients

Tomohiko SATO and Takashi SUZUKI

In this paper, we consider the Liouville-Gel'fand problem with variable coefficients in a two-dimensional bounded domain with smooth boundary, and a sequence of l-point interior blow-up solutions to this problem. It is well-known that the l-tuple of blow-up points of the solution is a critical point of the Hamiltonian associated with point vortex system by Nagasaki-Suzuki in 1990 for constant coefficients, and by Ma-Wei in 2001 for variable coefficients, respectively.

We proved, first, an exact relation between Morse indices of the blow-up solution and those for the critical point of the Hamiltonian. Second, we proved a precise asymptotic behavior of eigenvalues up to the $3l$-th of the linearized eigenvalue problem to the Liouville-Gel'fand problem. In order to prove them, we use the scaling argument, the approximate eigenfunctions, and the Min-Max principle. The results are natural extensions of those for constant coefficients, which was studied by Gladiali-Grossi-Ohtsuka-Suzuki in 2014.

However, several technical difficulties occur in variable coefficients of the considered problem, and hence we had to employ the Taylor expansion of the natural logarithm of variable coefficients near the critical point of the Hamiltonian. Then we have precise estimates for each term of the Taylor expansion, which are important for showing the results.

Keywords: Liouville-Gel'fand problem, Point vortex, Hamiltonian, Morse index

関数係数を持つリュービル－ゲルファント問題の解のモース指数対応

境界が滑らかな 2 次元有界領域において，境界で 0 とするディリクレ条件をもつリュービル・ゲルファント問題（方程式 (L-G)：$-\Delta v=\lambda Ve^{v}$）を考える。ここで Δ はラプラシアン，λ は正のパラメーター，$V=V(x)>0$ は滑らかな関数係数であり，$v=v(x)$ は λ に対する解である。この (L-G) については Nagasaki-Suzuki (1990) や Ma-Wei (2001) により爆発機構の量子化，解の特異極限の分類，さらに点渦系のハミルトニアンによる爆発点の制御について研究され，特に，爆発点はハミルトニアンの臨界点である。本論文では (L-G)，$\lambda=\lambda_k \to +0$ ($k=1, 2, \cdots$) に対して領域内部 l 点の爆発解 $v=v_k$ を考え，さらに (L-G) の線形化固有値問題を考える。爆発解は，各爆発点に収束する領域内部のある点列 $\{x_k\}$ に対し $v_k(x_k) \to \infty$ ($k \to \infty$) を満たす解（の列）である。

主結果は，l 点爆発解の（拡張）モース指数と爆発点におけるハミルトニアンの（拡張）モース指数との関係，および線形化固有値問題の第 $3l$ 固有値までの漸近挙動である。ここで爆発解のモース指数は線形化固有値問題の 1 未満，拡張モース指数は 1 以下の固有値のそれぞれ重複を区別した個数である。また，ハミルトニアンのモース指数は，ハミルトニアンのヘッセ行列の負の固有値，拡張モース指数は 0 以下の固有値，のそれぞれ重複を区別した個数で与えられる。主結果は (L-G) の $V\equiv 1$ の場合を考えた先行結果（Gladiali-Grossi-Ohtsuka-Suzuki, 2014）の拡張である。議論の流れは基本的に先行結果に従い，爆発点近傍のスケーリングによる爆発解析を行う。さらに固有関数の近似およびミニ・マックス原理を用いてレイリー商を評価することによって結果を得る。この時 (L-G) の両辺を偏微分した式を考えるが，関数係数 V の偏微分を持つ項が発生し先行結果と比べて大きく異なる。このため，爆発点において V の自然対数をテイラー展開し，詳細な評価を行った。

キーワード：リュービル・ゲルファント問題，点渦系，ハミルトニアン，モース指数

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