多元質感知

International Symposium
“Past, Present and Future of Shitsukan Science and Technologies”

Dec. 5th – 6th, 2019

Shiran-Kaikan, Kyoto Univ.

Grant-in-Aid for Scientific Research on Innovative Areas
“Understanding human recognition of material properties for innovation in SHITSUKAN science and technology”

Program

Wednesday, 4th Dec 2019

17:30-19:30	**Welcome Party** (& Shitukan-no-Tsudoi Forum Social)

Thursday, 5th Dec 2019

9:50-10:00	**Opening Remarks**
10:00-10:25	**Katsunori Okajima** (Yokohama National University) *Modified Food Appearance Modifies the Taste*
10:25-11:05	**Charles Spence** (Oxford University, UK) *Gastrophysics: The Multisensory Science of Eating*
11:05-11:15	**Break**
11:15-11:40	**Maki Sakamoto** (The University of Electro-Communications) *Cross-modal Associations Between Shitsukan and Japanese Phonemes*
11:40-12:20	**Pascal Barla** (INRIA, France) *Material Qualities in the Eye of the Beholder*
12:20-13:30	**Lunch**
13:30-13:55	**Yoshinori Dobashi** (Hokkaido University) *Visual Simulation of Shitsukan Using Computer Graphics*
13:55-14:35	**Wenzel Jakob** (EPFL, Switzerland) *Capturing, Simulating, and Differentiating Light*
14:35-14:45	**Break**
14:45-15:10	**Imari Sato** (National Institute of Informatics) *Spectral Signature Analysis of Real Scenes*
15:10-15:50	**Boxin Shi** (Peking University, China) *Data-driven Photometric 3D Modeling for Complex Reflectances*
15:50-16:50	**Poster**
16:50-17:15	**Daisuke Iwai** (Osaka University) *Computational Projection Mapping for Optical Material Control*
17:15-17:55	**Bernd Bickel** (IST Austria, Austria) *Computational Design for Physical Reproduction of Material Properties*
17:55-18:20	**Takauyki Okatani** (Tohoku University) *Toward Visual Recognition of Shitsukan Concepts by Multi-modal Representation Learning*

Friday, 6th Dec 2019

10:00-10:25	**Shin'ya Nishida** (Kyoto University) *Image Features for Human Shitsukan Perception*
10:25-11:05	**David Brainard** (University of Pennsylvania, USA) *Measurement and Modeling of the Use of Color and Material in Naturalistic Tasks.*
11:05-11:15	**Break**
11:15-11:40	**Hiroyuki Kajimoto** (The University of Electro-Communications) *Measurement and Reproduction of Finger Skin Deformation*
11:40-12:20	**Lynette Jones** (M.I.T., USA) *Capturing Multisensory Interactions in Cutaneous Displays*
12:20-13:30	**Lunch**
13:30-13:55	**Hidehiko Komatsu** (Tamagawa University) *Neural Representation of Materials in Visual Cortex*
13:55-14:35	**Sylvia Pont** (TUDelft, Netherlands) *Light, Science and Art*
14:35-14:45	**Break**
14:45-15:10	**Takafumi Minamimoto** (National Institutes for Quantum and Radiological Science and Technology) *Neural Circuit for Value Coding and Value-based Decisions*
15:10-15:50	**Barry Richmond** (NIMH, USA) *Updates on Visual Recognition in the Ventral Visual Stream*
15:50-16:50	**Poster**
16:50-17:15	**Yukiyasu Kamitani** (Kyoto University) *Deep Image Reconstruction from the Human Brain*
17:15-17:55	**Gabriel Kreiman** (Harvard Medical School, USA) *Peeking Inside the Brain to Develop the Next Generation of AI*
17:55-18:20	**Izumi Ohzawa** (Osaka University) *Neural Basis of Fine Visual Discrimination*
18:20-18:30	**Closing Remarks**

Note: This symposium is video recorded, and the record may be shared through public video-streaming.

Posters

1. **Shogo Okamoto** (Nagoya University)
Temporal Dominance Methods and Multivariate Time-Series Analyses

2. **Scinob Kuroki** (NTT), **Masataka Sawayama** (NTT), **Shin'ya Nishida** (Kyoto University, NTT)
Haptic Metamers in Texture Perception

3. **Hsin-Ni Ho** (NTT), **Hiroki Terashima** (NTT), **Kohta Wakamatsu** (Toyohashi University of Technology), **Jinhwan Kwon** (The University of Electro-Communications, Kyoto University of Education), **Maki Sakamoto** (The University of Electro-Communications), **Shigeki Nakauchi** (Toyohashi University of Technology), **Shin'ya Nishida** (Kyoto University, NTT)
Visual Inference for Warm/Cold Perception of Surfaces

4. **Yuta Suzuki, Bruno Laeng, Tetsuto Minami, Shigeki Nakauchi** (Toyohashi University of Technology)
Pupil Response in Colorful Glare Illusion Depending on Observers' Iris Colors

5. **Takuya Koumura, Hiroki Terashima, Shigeto Furukawa** (NTT)
Modulation Transfer Functions In a Deep Neural Network Trained for Natural Sound Recognition

6. **Kyoko Suzuki** (Tohoku University), **Marie Oyafuso** (Tohoku University), **Yuka Oishi** (Niigata University of Health & Welfare), **Chifumi Iseki** (Yamagata University)
Visual and Tactile Texture Agnosia in Human

7. **Yu Sugiyama, Wataru Shimoda, Daichi Horita, Jaehyeong Cho, Gibran Benitez, Keiji Yanai** (The University of Electro-Communications)
CNN-based Material Image Recognition/Generation/Translation

8. **Masataka Sawayama** (NTT), **Pascal Barla** (INRIA), **Gaël Guennebaud** (INRIA), **Shin'ya Nishida** (NTT, Kyoto University)
Shading and Reflectance Estimation Based on Spectral Gradient Computation

9. **Jan Jaap R. van Assen** (NTT), **Shin'ya Nishida** (NTT, Kyoto University), **Roland W. Fleming** (Justus-Liebig-University Giessen)
Visual Perception of Liquids: Insights from Deep Neural Networks

10. **Rajani Raman, Haruo Hosoya** (ATR)
CNN Explains Tuning Properties of Anterior, but Not Middle, Face-Processing Areas in Macaque IT

11. **Junichi Chikazoe** (National Institute for Physiological Sciences), **Daniel Lee** (University of Colorado), **Nikolaus Kriegeskorte** (Columbia University), **Adam Anderson** (Cornell University)
Distinct Representations of Basic Taste Qualities in Human Gustatory Cortex

12. **Wu Wang, Jiajia Yang, Yinghua Yu, Jinglong Wu, Yoshimichi Ejima** (Okayama University)
The Effects of Training Time Interval and a Similar Task Training on the Tactile Angle Discriminability

13. **Takahisa M. Sanada** (Kansai Medical University)
Neural Mechanisms of Motion Defined Material Perception.

14. **Hiroki Ishizuka** (Osaka University)
Evaluation of a Tactile Display for Multiple Stimuli

15. **Ichiro Kuriki** (Tohoku University)
Lightness Perception and Contrast Sensitivity in HDR Display in Relation to Shitsukan

16. **Jun Saiki** (Kyoto University)
Neural Substrate Of Visual Working Memory For Objects' Roughness

17. **So Kanazawa** (Japan Women's University)
The Acquisition Process of SHITSUKAN Recognition: Perceptual Environment and Affective Information

18. **Naohisa Miyakawa, Yuji Nagai, Yukiko Hori, Takafumi Minamimoto** (National Institutes for Quantum and Radiological Science and Technology)
Amygdala Dysfunction Disrupts Socio-Emotional Representation in Macaque Ventral Visual Cortex

19. **Takahiro Miura** (AIST)
Unique Texture Perceptions by Visually Impaired People

20. **Ryusuke Hayashi** (AIST)
Neural Ensemble Representation of Orientation, Identity and Spiecies of Face in Monkey Inferior Temporal Cortex

21. **Toshiyuki Amano** (Wakayama University)
Material Perception Manipulation with Light-Field Projection

22. **Yasuko Sugase-Miyamoto** (AIST)
Representation of Facial Images with Different Skin Textures in the Temporal Visual Cortex

23. **Norihisa Miki** (Keio University)
Inverse/Direct Problems in Tactile Display Applications

24. **Takehiro Nagai** (Tokyo Institute of Technology)
Psychophysical Dynamics of Material Perception

25. **Masako Okamoto** (The University of Tokyo)
Neural Basis of Odor Quality: The Perspective of a Human EEG Decoding Study

26. **N. Wake, T.I.Shiramatsu, H. Takahashi** (The University of Tokyo)
Neural Correlates of Tinnitus

27. **Masashi Unoki** (Japan Advanced Institute of Science and Technology)
Feasibility of Vocal Emotion Conversion on Modulation Spectrogram

28. **Koshi Murata** (University of Fukui)
Neural Mechanisms of Odor-Induced Motivated Behaviors

29. **Gaku Hatanaka** (Osaka University), **Fang Yang** (Osaka University), **Mikio Inagaki** (Osaka University, NICT), **Ken-ichi Inoue** (Kyoto University), **Masahiko Takada** (Kyoto University), **Ichiro Fujita** (Osaka University, NICT)
Probing Functional Architecture for Prosessing of Texture in the Primate Visual Cortex by Using 2-Photon Imaging

30. **Tomoko Imura** (Japan Women's University), **Nobu Shirai** (Niigata University), **Masaki Tomonaga** (Kyoto University)
Visual Preference and Perception for Natural and Artificial Images In Chimpanzees and Human Children

31. **Yonghao Yue** (Aoyama Gakuin University)
Mixing Sauces: A Viscosity Blending Model for Shear Thinning Fluids

32. **Takuji Narumi, Yuji Suzuki, Tomohiro Tanikawa, Michitaka Hirose** (The University of Tokyo)
Controlling Food Experience Via Visual Texture Augmentation with Projection Mapping Techniques

33. **Yoshihiro Watanabe** (Tokyo Institute of Technology)
Altered Material by High-Speed Projection Display

34. **Takahiro Okabe** (Kyushu Institute of Technology)
Computational Illumination with Multispectral Light Stage

35. **Maki Sakamoto** (The University of Electro-Communications)
Onomatopoeia Map of Japanese Lacquer's Shitsukan

Modified food appearance modifies the taste

- Image processing and crossmodal effect on foods -

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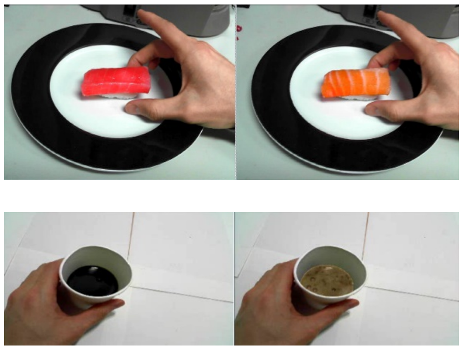

Food appearance is critical information for estimating edibility, freshness and softness of foods. We developed some image processing techniques to modify the food appearance naturally. The first method is Visual Texture Exchange (VTE). VTE enables us to change the visual texture of a food from the original surface to other actual one, e.g. from Tuna to Salmon, and from Black Coffee to Café Latte in real time (*See top Figures*). The second method is Luminance Distribution Modification (LDM). We found that LDM can modify the moistness and softness of foods in appearance. The third method is Gloss/Shade Filter Operation (GSFO) which can create any Oily/Dried and Burned/Raw foods from an original food image in appearance. By applying such image processing methods and Augmented Reality technology, we are investigating crossmodal effects of food appearance to the taste while keeping the ingredients intact, indicating that we can artificially control the taste by modifying food appearance with image processing. Finally, I will introduce the effects of melanopsin to food appearance as well as cones because melanopsin significantly contributes to brightness perception.

Reference:

Yang, J., Okajima, K., Kanazawa, S., & Yamaguchi,M.K. (2019). Infant can visually differentiate the fresh and degraded foods: evidence from fresh cabbage preference, Frontiers in Psychology, Vol.10 Article# 1553.

Ueda, J., & Okajima, K. (2019). AR food changer using deep learning and cross-modal effects," IEEE AIVR 2019. *in press.*

Yamakawa, M., Tsujimura, S., & Okajima, K. (2019). A quantitative analysis of the contribution of melanopsin to brightness perception, Scientific Reports, 9, Article# 7568.

Biography:

Katsunori Okajima received Ph.D. from Tokyo Institute of technology (Engineering) and joined National Defense Academy in 1990. He was also a visiting research fellow of National Research Council of Canada and a visiting associate professor of Tokyo Institute of Technology. Currently, he is a professor at Faculty of Environment and Information Sciences, Yokohama National University, and a department chair. He is an expert of “five-senses engineering”, such as vision, touch, taste and their crossmodal effects. For studying such topics, he is taking advantage of image processing, Virtual/Augmented Reality, Projection Mapping and Artificial Intelligence. He is the president of Vision Society of Japan, a study group chair of the Virtual Reality Society of Japan, an editorial board member of Color Research and Application, and a group leader of Innovative SHITSUKAN Science and Technologies.

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Gastrophysics: The Multisensory Science of Eating

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Perception-enhancing sculptural ceramics from Japanese potter Reiko Kaneko

Gastrophysics, the new science of eating, focuses attention on 'the everything else' apart from the food that nevertheless still influences the tasting experience, be it in the high-end restaurant or the home: Everything from the colour and texture of the plate on which the food is served, through the weight of the cutlery that is used to consume it (assuming that there is any, which can't always be guaranteed these days), not to mention the music that happens to be playing in the background. Gastrophysics aims to bring the scientific approach, inspired by the latest neuroscience insights concerning the multisensory integration of cues from taste, smell, touch, sight and sound, together with the best in culinary artistry, in order to help design more engaging, more enjoyable, and more memorable experiences for diners. In this talk, I will demonstrate how the diners' perception of the quality of food and drink is influenced by the multisensory aspects of cutlery and plateware, understood through the lens of the crossmodal correspondences.

Reference:

Spence, C. (2015). Multisensory flavour perception. *Cell*, **161**, 24-35.

Spence, C. (2017). *Gastrophysics: The new science of eating*. London, UK: Viking Penguin; Winner of the 2019 Le Grand Prix de la Culture Gastronomique from Académie Internationale de la Gastronomie.

Biography:

Charles Spence is Professor of Experimental Psychology at the University of Oxford, the UK. His research focuses on how a better understanding of the human mind will lead to the better design of multisensory foods, products, interfaces, and environments in the future. Over the last two decades, Charles has consulted for a number of multinational companies advising on various aspects of multisensory design, packaging, and branding. He has published 15 books and almost 1,000 peer-reviewed academic articles on the role of the senses in everyday life. See short video at: Charles Spence – Sensploration (FoST 2016). https://vimeo.com/170509976.; And profile at: http://www.newyorker.com/magazine/2015/11/02/accounting-for-taste; "The Perfect Meal" |Talk at Google: https://www.youtube.com/watch?v=JgUVjKsP_wc; AEG Tasteology: http://www.aeg.co.uk/taste/inspiration/tasteology/.

Cross-modal Associations Between Shitsukan and Japanese Phonemes

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	N = 1,397/1,566	Comfort Discomfort (0.11)	Bumpy Flat (−0.12)	Rough Smooth (−0.06)	Hard Soft (−0.18)	Non-elastic Elastic (0.05)	Slippery Sticky (0.25)	Dry Moist (0.43)	Warm Cold (−0.41)
/ʦ/+/u/	149	0.92	−1.87	−1.70	1.34	1.21	1.89	1.01	−1.18
/s/+/u/	94	1.13	−1.67	−1.78		0.87	1.70		
/s/+/a/	130	0.68		−0.68			1.14	1.08	
/p/+/a/	22								
/p/+/o/	29								
/k/+/a/	52				1.23	0.79	0.98	1.77	
/ɸ/+/u/	118	1.30			−1.73	−1.16			0.91
/m/+/o/	32	1.19	1.06	1.00					1.00
/g/+/a/	50		1.40	1.28	0.84			1.00	
/dʒ/+/a/	24		1.38	1.38	0.96			1.33	
/b/+/o/	63	−0.56	1.95	1.27	0.87	0.78			
/ʣ/+/a/	195	−0.49	0.87	1.52	0.48	0.88		1.24	
/g/+/o/	52		1.33	0.92	1.27	1.00		1.10	
/ʨ/+/i/	23	−0.87	1.35	2.52				1.43	
/b/+/u/	27					−1.33	−0.74	−1.00	
/g/+/u/	32		0.63		−1.44	−1.44	−0.66	−1.06	
/p/+/u/	57	0.63		−0.98	−2.05	−2.21		−1.49	
/ç/+/i/	18							−0.89	
/p/+/i/	22		−1.00					−1.91	−1.82
/b/+/e/	101	−1.41	−0.96		−1.50	−1.00	−2.29	−1.35	
/n/+/e/	26	−1.19		−0.88	−1.73	−1.04	−2.58	−1.81	
/p/+/e/	81	−0.41	−1.23	−0.64	−1.00	−0.65	−1.49	−1.00	

The values, which are significantly different from the average of 1566 cases for each scale (t-test, $p < 0.05$), and whose difference in absolute value from the average are larger than 0.5, are shown. Positive values are in orange (upper adjective in the first row), while negative values are in light blue.

Several studies have shown cross-modal associations between sounds and vision or gustation by asking participants to match pre-defined sound-symbolic words (SSWs), such as “bouba” or “kiki,” with visual materials. I introduce our studies on cross-modal associations of taste [1]/tactile[2]/visual sensations using spontaneous production of Japanese SSWs. Japanese language has a large number of SSWs that can represent a wide range of perceptual spaces with fine resolution. As shown in the figure above, we found that strong associations between sound and tactile impressions. For example, positive tactile ratings were associated with the back vowel (/u/), while negative ratings were associated with the front vowels (/i/ and /e/). Consonants were categorized based on vocal features and articulation. The category of the voiced consonants (e.g., /dz/ and /g/) corresponded to feelings of roughness, while that of voiceless consonants (e.g., /ʦ/, and /s/) corresponded to feelings of smoothness. I also introduce a unique system that can automatically estimate multidimensional ratings of Shitsukan from a single sound-symbolic word that has been spontaneously and intuitively expressed by a user[3]. When a user inputs a sound-symbolic word into the system, the system calculates ratings in terms of fundamental scales of affective and perceptual experiences. I also outline the advantage of our method in visualizing Shitsukan.

Reference:

[1]Maki Sakamoto and Junji Watanabe: Cross-Modal Associations between Sounds and Drink Tastes/Textures: A Study with Spontaneous Production of Sound-Symbolic Words, Chemical Senses, 41, 197-203. DOI: 10.1093/chemse/bjv078 (2016)

[2]Maki Sakamoto, Junji Watanabe: Bouba/Kiki in Touch: Associations Between Tactile Perceptual Qualities and Japanese Phonemes, Frontiers in Psychology, 9(295), 1-12. DOI: 10:3389/fpsyg.2018.00295 (2018)

[3]Ryuichi Doizaki, Junji Watanabe, Maki Sakamoto: Automatic Estimation of Multidimensional Ratings from a Single Sound-symbolic Word and Word-based Visualization of Tactile Perceptual Space, IEEE Transactions on Haptics,10(2), 173-182 . DOI: 10.1109/TOH.2016.2615923 (2017)

Biography:

Maki Sakamoto is Professor of Affective Engineering in Department of Informatics, University of Electro-Communications. She received her Ph.D. in Language and Information Sciences from the University of Tokyo in 2000. From 1998 to 2000, she was an Assistant Professor at the University of Tokyo. In 2000 she moved to the University of Electro-Communications as a Lecturer. She is a vice-director of Artificial Intelligence Exploration Research Center. Her current research interests are in language, cross-modal perception, and affective engineering. She is a board member of JSAI and JCSS and an academic editor of PLOS ONE.

Material Qualities in the Eye of the Beholder

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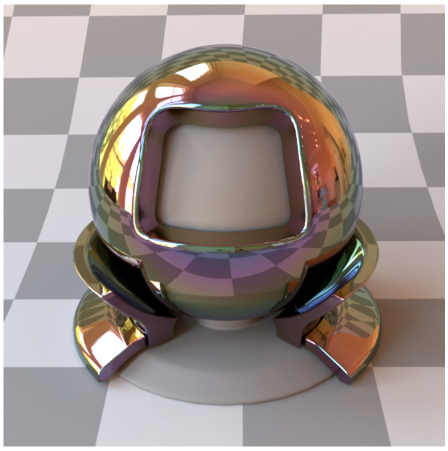

The physical description of a material is usually done through the Bidirectional Reflectance Distribution Function (BRDF), which characterizes reflectance at a point for any viewing or lighting direction. It is often assumed to be an objective characterization of a material. Yet a closer look at how BRDF models are used in Computer Graphics reveals they involve many choices: of scale, of geometric vs wave optics, of statistical assumptions, of model simplifications, etc. I argue that what motivates these choices remains subjective: what is of interest is often a combination of physical plausibility, visual adequacy, and mathematical convenience. I will present three projects where the material modeling decisions occur at different scales and entail different choices. I will start at the nano scale with a model of thin-film interference adapted to tristimulus rendering; then I will present a study of existing layered material models that work at the micro scale and the challenges posed by inverse design; finally I will introduce preliminary work on wet surfaces where meso-scale characteristics seem essential to conveil a liquid of adequate viscosity. These three projects will try to illustrate the intricate relationships between optics, graphics and vision for the specific case of material appearance.

Reference:

Belcour & Barla (2017) A Practical Extension to Microfacet Theory for the Modeling of Varying Iridescence, ACM Transactions on Graphics (proceedings of Siggraph)

Bati, Pacanowski, Barla (2019) Numerical Analysis of Layered Material Models, Research report (https://hal.inria.fr/hal-02157966)

Biography:

Pascal Barla received his PhD in Computer Science from Institut National Polytechnique de Grenoble in 2006. He later joined Inria in 2007, where he is currently a researcher and head of the Manao project team. His current research explores a variety of topics related to images: material properties, lighting design, image features, surface features, expressive shading, 2D animation, digital drawing, motion flows. He also has a profound interest in understanding how the optical structures of objects at microscopic scales and their agency at increasingly larger scales are related to visual awareness.

Visual Simulation of Shitsukan Using Computer Graphics

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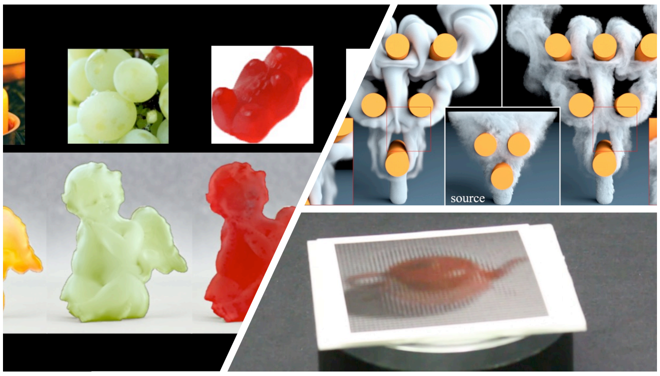

Computer Graphics has made a significant progress in past decades and has made it possible to synthesize highly realistic image. However, there still remain a problem; it is often difficult to synthesize the desired visual appearance or behavior of objects. The user often has to spend long time on choosing appropriate parameters for creating images with the desired visual appearances. In the SHITSUKAN project, we have developed a set of methods that help the user to design the desired appearances of objects. In this talk, I will introduce some of our recent projects. Particularly, I will talk about our approach for designing appearance of fluids, reflection from a real object, and translucency in an image. I would also like to talk about efficient methods for global illumination, video-based rendering and digitization of natural objects.

Reference:

Syuhei Sato, Yoshinori Dobashi, Theodore Kim, Tomoyuki Nishita, “Example-based Turbulence Style Transfer,” ACM Transactions on Graphics (Proceedings of SIGGRAPH 2018), Vol. 37 (4), Article No. 84 (2018).

Sakurai, Y.Dobashi, K. Iwasaki, T. Nishita, “Fabricating Reflectors for Displaying Multiple Images,” ACM Trans. Graph., Vol. 37, No. 4, Article 158 (2018)

Hideki Todo, Tatsuya Yatagawa, Masataka Sawayama, Yoshinori Dobashi, Masanori Kakimoto, “Image-based translucency transfer through correlation analysis over multi-scale spatial color distribution”, The Visual Computer, Volume 35, Issue 6–8, pp 811–822 (2019).

Biography:

Yoshinori Dobashi is an associate professor at Hokkaido University in the graduate school of information science and technology, Japan since 2000. His research interests center in computer graphics including lighting models. Dobashi received his BE, ME and Ph.D in Engineering in 1992, 1994, and 1997, respectively, from Hiroshima University. He worked at Hiroshima City University from 1997 to 2000 as a research associate.
Homepage: https://ime.ist.hokudai.ac.jp/~doba/

Capturing, simulating, and differentiating light

Wenzel Jakob
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Realism has been a major driving force since the inception of the field of computer graphics, and algorithms that generate photorealistic images using physical simulations are now in widespread use. These algorithms are normally used in a "forward" sense: given an input scene, they produce an output image. In this talk, I will present two recent projects that turn this around, enabling applications to problems including 3D reconstruction, material design, and acquisition.

The first is "Mitsuba 2", a new rendering system that is able to automatically and simultaneously differentiate a complex simulation with respect to millions of parameters, which involves unique challenges related to programming languages, just-in-time compilation, and reverse-mode automatic differentiation. I will discuss several difficult inverse problems that can be solved by the combination of gradient-based optimization and a differentiable simulation: surface/volume reconstruction, caustic design, and scattering compensation for 3D printers.

In the second part of the talk, I will present an ongoing effort that aims to build a large database of material representations that encode the interaction of light and matter (e.g. metals, plastics, fabrics, etc.). Capturing this "essence" of a material is challenging problem both from an optical and a computer science perspective due to the high-dimensional nature of the underlying space. I will show how an inverse approach can help evade the curse of dimensionality to acquire this information in a practical amount of time.

Reference:

Merlin Nimier-David, Delio Vicini, Tizian Zeltner, and Wenzel Jakob. 2019. Mitsuba 2: A Retargetable Forward and Inverse Renderer. In *Transactions on Graphics (Proceedings of SIGGRAPH Asia)* 38(6).

Jonathan Dupuy and Wenzel Jakob. 2018. An Adaptive Parameterization for Efficient Material Acquisition and Rendering. In *Transactions on Graphics (Proceedings of SIGGRAPH Asia)* 37(6).

Biography: Wenzel Jakob is an assistant professor at EPFL's School of Computer and Communication Sciences, and is leading the Realistic Graphics Lab. His research interests revolve around material appearance modeling, rendering algorithms, and the high-dimensional geometry of light paths. Wenzel is the recipient of the ACM SIGGRAPH Significant Researcher award and the Eurographics Young Researcher Award. He is also the lead developer of the Mitsuba renderer, a research-oriented rendering system, and one of the authors of the third edition of "Physically Based Rendering: From Theory To Implementation".

Homepage: https://rgl.epfl.ch/people/wjakob

Spectral Signature Analysis of Real Scenes

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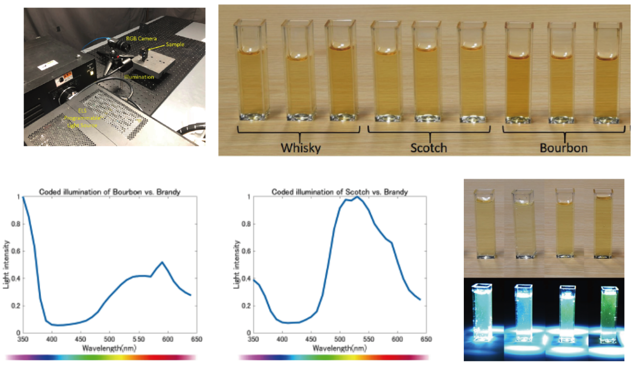

The spectral reflectance of objects provides innate information about material properties that have proven useful in applications such as classification, synthetic relighting, and medical imaging to name a few. In recent years, fluorescence analysis of scenes has received attention. What makes fluorescence different from ordinary reflection is the transfer of energy from one wavelength to another. it is well-known that the fluorescence excitation-emission characteristics of many organic objects can serve as a kind of "fingerprint" for detecting the presence of specific substances in classification tasks. In this talk, I will present a coded illumination approach whereby light spectra are learned such that key visual fluorescent features can be easily seen for material classification. I will also introduce scene analysis based on hyperspectral reflectance such as deriving analytical spectral appearance model of wet surfaces for recovering the original surface color and the degree of wetness from a single observation and a novel approach for hyperspectral reconstruction from RGB. Our approach simultaneously learns optimized camera spectral response functions (to be implemented in hardware) and a mapping for spectral reconstruction by using an end-to-end network.

Reference:

H. Okawa, M. Shimano, Y. Asano, R. Bise, K. Nishino, I. Sato: Estimation of Wetness and Color from a Single Multispectral Image, IEEE Trans. PAMI. DOI:10.1109/TPAMI.2019.2903496, 2019.

Y. Asano, M. Meguro, C. Wang, A. Lam, Y. Zheng, T. Okabe, I. Sato: Coded Illumination and Imaging for Fluorescence Based Classification, Proc. ECCV, pp. 502-516, 2018.

S. Nie, L. Gu, Y. Zheng, A. Lam, N. Ono, I. Sato: Deeply Learned Filter Response Functions for Hyperspectral Reconstruction, Proc. CVPR, pp. 4767-4776, 2018.

Biography:

Imari Sato received the BS degree in policy management from Keio University in 1994. After studying at Robotics Institute of Carnegie Mellon University as a visiting scholar, she received the MS and Ph.D. degrees in interdisciplinary Information Studies from the University of Tokyo in 2002 and 2005, respectively. In 2005, she joined the National Institute of Informatics, where she is currently a professor. Concurrently, she serves a visiting professor at Tokyo Institute of Technology and a professor at the University of Tokyo. Her primary research interests are in the fields of computer vision (physics-based vision, spectral analysis, image-based modeling). She has received various research awards, including The Young Scientists' Prize from The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology (2009), and Microsoft Research Japan New Faculty award (2011).

Data-driven Photometric 3D Modeling for Complex Reflectances

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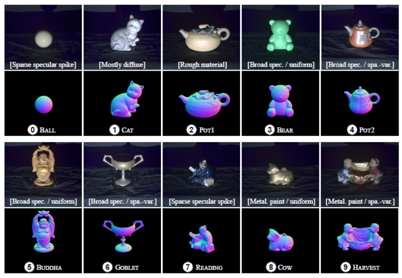

Modern 3D computer vision methods, represented by multi-view stereo and structure-from-motion, have achieved faithful 3D reconstruction from a set of images. Despite requiring more controlled setups than multi-view stereo, photometric approaches have proven to be invaluable tools in applications such as Hollywood movies, industrial quality inspection, and so on, since they can reconstruct fine surface details at superior quality. This talk will mainly cover photometric stereo techniques that take as input a set of images observed under different illumination conditions from a fixed viewpoint to compute the shape in the form of surface normals with the same high resolution as the 2D image. While conventional photometric stereo methods make various assumptions over reflectance and illumination, they are being relaxed in modern methods by powerful machine learning approaches so as to be practical in diverse scenarios, such as objects with complex reflectances. In addition, newly rendered datasets and captured real world datasets have been proposed for training and testing data-driven approaches for photometric stereo, which shows superior performance.

Reference:

[1] Boxin Shi, Zhipeng Mo, Zhe Wu, Dinglong Duan, Sai-Kit Yeung, and Ping Tan,"A benchmark dataset and evaluation for non-Lambertian and uncalibrated photometric stereo", TAPMI, 2019
[2] Lixiong Chen, Yinqiang Zheng, Boxin Shi, Art Subpa-Asa, and Imari Sato, "A micro-facet based model for photometric stereo with general isotropic reflectance", TPAMI, 2019
[3] Qian Zheng, Yiming Jia, Boxin Shi, Xudong Jiang, Ling-Yu Duan, and Alex C. Kot, "SPLINE-Net: Sparse photometric stereo through lighting interpolation and normal estimation networks", ICCV, 2019
[4] Guanying Chen, Kai Han, Boxin Shi, Yasuyuki Matsushita, and Kwan-Yee K. Wong, "Self-calibrating deep photometric stereo networks", CVPR, 2019

Biography:

Boxin Shi received the BE degree from the Beijing University of Posts and Telecommunications, the ME degree from Peking University, and the PhD degree from the University of Tokyo, in 2007, 2010, and 2013. He is currently a Boya Young Fellow Assistant Professor and Research Professor at Peking University, where he leads the Camera Intelligence Group. Before joining PKU, he did postdoctoral research with MIT Media Lab, Singapore University of Technology and Design, Nanyang Technological University from 2013 to 2016, and worked as a researcher in the National Institute of Advanced Industrial Science and Technology from 2016 to 2017. He won the Best Paper Runner-up award at International Conference on Computational Photography 2015. He served as an Area Chair for ACCV 2018, BMVC 2019, and 3DV 2019.
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Computational Projection Mapping for Optical Material Control

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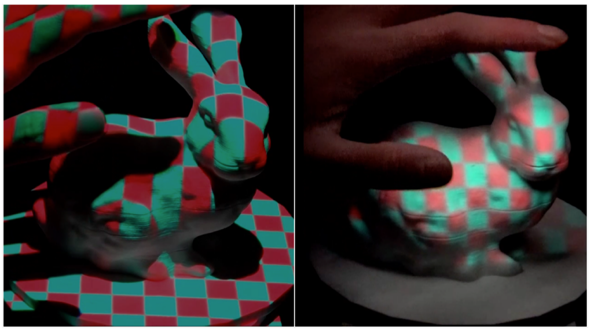

Normal projection mapping   Shadowless projection mapping

Projection mapping (aka spatial augmented reality) alters the appearance of a surface in the real world by superimposing computer-generated imagery onto it. While there are enormous expectations for its potential applicability, it is still hard to optically manipulate the surface materials with high fidelity. In particular, the projected results are always suffered from the complex reflectance properties of the surface, such as spatially varying textures, specular reflection, subsurface scattering, and inter-reflection, and also from the technical limitations of the current projector hardware such as low dynamic range, limited aperture size, narrow depth-of-field, and latency. We have developed computational projection mapping technologies to overcome the challenges and realize natural material controls beyond the capability of conventional projection mapping frameworks. The computational projection mapping is an emerging framework of the joint design of hardware, optics, and target surfaces with computational algorithms and perceptual considerations. In this talk, I will introduce a series of our recent works such as shadowless projector to demonstrate the feasibility of the computational projection mapping framework and discuss its future directions.

Reference:

H. Asayama, D. Iwai, and K. Sato, "Fabricating Diminishable Visual Markers for Geometric Registration in Projection Mapping," IEEE Transactions on Visualization and Computer Graphics, 2018.

K. Hiratani, D. Iwai, P. Punpongsanon, and K. Sato, "Shadowless Projector: Suppressing Shadows in Projection Mapping with Micro Mirror Array Plate," In Proceedings of IEEE Conference on Virtual Reality and 3D User Interfaces, 2019. (Best Research Demonstration Runner-up)

P. Punpongsanon, D. Iwai, and K. Sato, "FleXeen: Visually Manipulating Perceived Fabric Bending Stiffness in Spatial Augmented Reality," IEEE Transactions on Visualization and Computer Graphics (in press).

Biography:

Daisuke Iwai received his B.S., M.S., and Ph.D. degrees from Osaka University, Japan, in 2003, 2005, and 2007, respectively. He was a visiting scientist at Bauhaus-University Weimar, Germany, from 2007 to 2008, and a visiting Associate Professor at ETH Zurich, Switzerland, in 2011. He is currently an Associate Professor at the Graduate School of Engineering Science, Osaka University. His research interests include spatial augmented reality and projector-camera systems.
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Computational Design for Physical Reproduction of Material Properties

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Advanced fabrication techniques have grown in sophistication over the last decade, vastly extending the scope of structures and materials that can be fabricated. While new opportunities have emerged for the manufacturing of customized shapes, architected materials with novel functionalities, and active composites that can sense and respond to their environment, their potential impact is limited by the lack of efficient computational approaches for design. In this talk, I will describe the recent progress in computational fabrication toward novel concepts for modeling, designing, and reproducing objects with nontrivial material properties and functionalities. I will reflect on the successes and challenges of computational fabrication and discuss opportunities for further work in this area.

Reference:

Computational Design of Nanostructural Color for Additive Manufacturing.
T. Auzinger, W. Heidrich, B. Bickel. ACM Transactions on Graphics (Proc. SIGGRAPH 2018)

Geometry-Aware Scattering Compensation.
D. Sumin, T. Rittig, V. Babaei, K. Myszkowski, B. Bickel, A. Wilkie, J. Křivánek, T. Weyrich. ACM Transactions on Graphics (Proc. SIGGRAPH 2019)

Biography:
Bernd Bickel is an assistant professor heading the Computer Graphics and Digital Fabrication Group at the Institute of Science and Technology Austria (IST Austria). He is a computer scientist interested in computer graphics and its overlap with animation, robotics, materials science, and digital fabrication. His main objective is to develop new techniques for efficient design, simulation, and physical reproduction of digital content. Bernd obtained his master's degree in computer science from ETH Zurich in 2006 and graduated with a PhD from ETH Zurich in 2010 where he worked in the computer graphics laboratory with Markus Gross. From 2011 to 2012, Bernd was a visiting professor at the Technical University of Berlin, and in 2012, he became a research scientist and research group leader at Disney Research. In early 2015, he joined IST Austria. He received the ETH Medal for Outstanding Doctoral Thesis in 2011, the Eurographics Best PhD Award in 2012, the Microsoft Visual Computing Award in 2015, an ERC Starting Grant in 2016, the ACM SIGGRAPH Significant New Researcher Award in 2017, and a technical achievement award from the Academy of Motion Picture Arts and Sciences in 2019.
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Toward visual recognition of Shitsukan concepts by multi-modal representation learning

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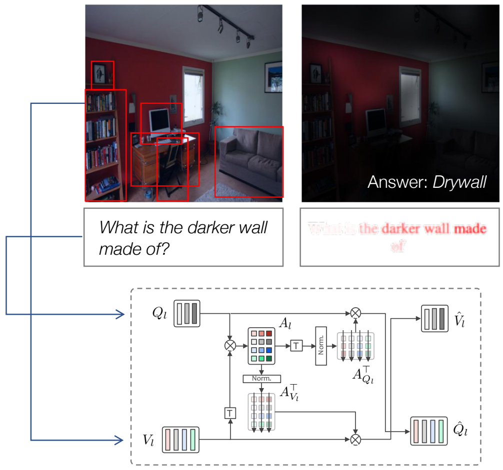

For the past several years, we have been conducting research on the development of a computer vision system that can recognize *Shitsukan* as humans do, with a particular focus on applications of deep learning methods. We first studied supervised learning of Shitsukan concepts, for which it is hard to provide true labels unlike object category classification. To mitigate the scalability issue with the approach, we next studied if it is possible and how to learn Shitsukan concepts from public data on the Web. Conducting a preliminary study of generating natural language text representing Shitsukan concepts, we now believe that the most important remaining problem is how to build a representation space of Shitsukan concepts bridging the two modalities, vision and language. Towards a solution to this, we have proposed a neural architecture for fusing vision and language representations, named dense co-attention networks, applying it to visual question answering (i.e., the task of answering a given question about the contents of a given scene image). We further extended this to enable to conduct multi-task learning of different vision-language tasks with a single network, aiming at coping with the issue of dataset bias, which has recently been recognized to be a major issue with applications of deep learning to high-level AI tasks.

Reference:

Duy-Kien Nguyen and Takayuki Okatani, “Multi-Task Learning of Hierarchical Vision-Language Representation”, Proc. CVPR 2019: 10492-10501, 2019.

Duy-Kien Nguyen and Takayuki Okatani, “Improved Fusion of Visual and Language Representations by Dense Symmetric Co-Attention for Visual Question Answering”, Proc. CVPR 2018: 6087-6096, 2018.

Sirion Vittayakorn, Takayuki Umeda, Kazuhiko Murasaki, Kyoko Sudo, Takayuki Okatani, Kota Yamaguchi, “Automatic Attribute Discovery with Neural Activations”, Proc. ECCV (4) 2016: 252-268, 2016

Biography:

Takayuki Okatani received his B.Sc. degree as well as his M.Sc. and Ph.D degrees in Mathematical Engineering and Information Physics from Graduate School of Engineering at Tokyo University, 1994, 1996, and 1999, respectively. Currently, he is directing the Computer Vision Laboratory at Tohoku University. He also serves as a Leader of Infrastructure Management Robotics Team at RIKEN Center for Advanced Intelligence Project (AIP) from 2016. His research interests are in the field of computer vision and machine learning.

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Image features for human Shitsukan perception

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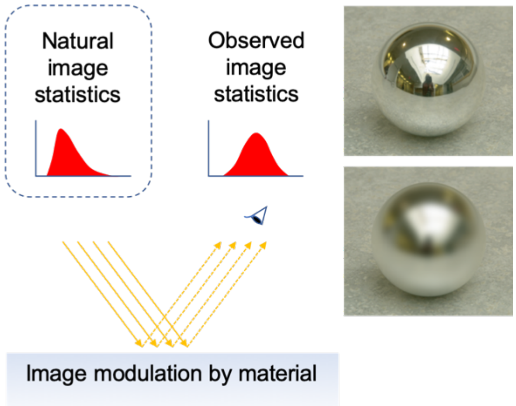

For visual estimation of material properties, or Shistukan, accurate inverse optics is too difficult. Instead, human material perception seems to rely on image features that are correlated with the material property under natural viewing environments. The critical features often take the form of image statistics, because many material properties can be characterized by how they optically modulate the natural image statistics. For instance, a critical image statistic for surface wetness perception is enhanced color saturations, while that for subresolution fineness perception is reduced luminance contrasts. There are optical reasons these image features vary in correlation with physical material properties, as well as psychophysical evidence that human material perception does respond to the features. We also propose that material and shape perceptions may be based on independent image features — material (surface reflectance) perception relies on the magnitude of luminance gradient, while shape perception relies on the order of luminance gradient. This is why the skewness of the luminance histogram strongly affects gloss perception, while not surface shape perception. I will also discuss the relationship of image statistics features with mid-level perceptual features, and deep neural network features.

Reference:

Nishida, S. (2019). Image statistics for material perception. Current Opinion in Behavioral Sciences, 30, 94–99.

Sawayama, M., & Nishida, S. (2018). Material and shape perception based on two types of intensity gradient information. PLoS Computational Biology, 14(4), e1006061–.

Sawayama, M., Adelson, E. H., & Nishida, S. (2017). Visual wetness perception based on image color statistics. Journal of Vision, 17(5), 7–24.

Biography:

Shin'ya Nishida received B.A., M.A. and Ph.D from Kyoto University (Psychology). After working at ATR Auditory and Visual Perception Labs, he joined NTT Labs in 1992. Since 2019, he is Professor at Dept Informatics, Kyoto University, and Research Professor at NTT Communication Science Labs. He is an expert of psychophysical study on human vision, such as motion perception, time perception and material perception. He is also interested in haptics, multisensory integration, time perception and visual media technologies. He is an editorial board member of Journal of Vision, Member of Science Council of Japan, and Project Leader of Innovative SHITSUKAN Science and Technologies.

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Homepage (NTT): http://www.kecl.ntt.co.jp/people/nishida.shinya/index.html

Measurement and modeling of the use of color and material in naturalistic tasks

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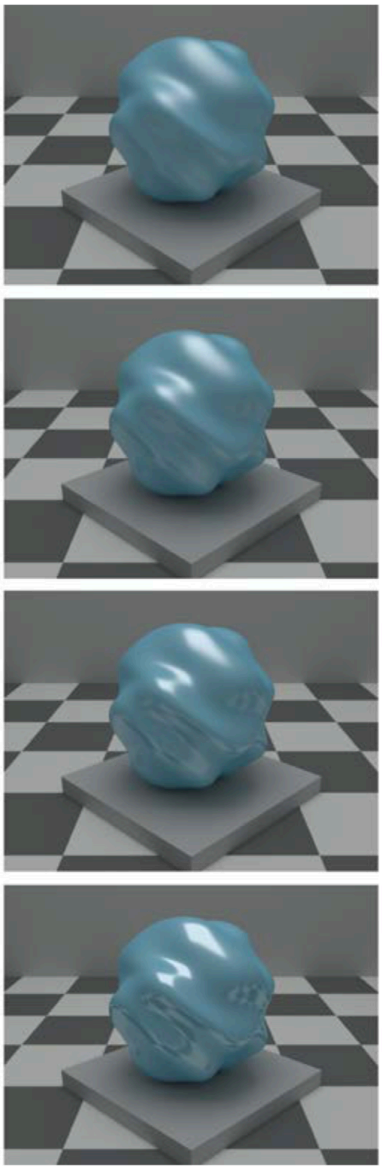

Perceived color and material are perceptual correlates of physical object surface reflectance, and as such provide representations that enable object identification and selection. Most studies of the perception of these attributes, however, ask the subject to rate or match, rather than to identify or select. We have developed methods for using object selection per se to assess perceived color and material, with these methods extensible to naturalistic stimuli and tasks. I will describe the methods and some of what we have learned using them, as well as discuss a computational framework that allows understanding the role played by early vision in shaping perceptual representations.

References:

Brainard, D. H., Cottaris, N. P., Radonjić, A. (2018). The perception of color and material in natural tasks. Royal Society Interface Focus, 8(4).

Cottaris, N. P., Jiang, H., Ding, X., Wandell, B. A., Brainard, D. H. (2018). A computational observer model of spatial contrast sensitivity: Effects of wavefront-based optics, cone mosaic structure, and inference engine. Journal of Vision, 19(4):8, doi: 10.1167/19.4.8.

Radonjić, A., Cottaris, N. P., Brainard, D. H. (2019). The relative contribution of color and material in object selection. PLoS Computational Biology, 15(4):e1006950.

Biography:

David H. Brainard is the RRL Professor of Psychology at the University of Pennsylvania. He received an AB in Physics (Magna Cum Laude) from Harvard University (1982) and an MS (Electrical Engineering) and PhD (Psychology) from Stanford University in 1989. His research focuses on color vision, intrinsically photosensitive retinal ganglion cells, retinal imaging, as well as computational models thereof. He is a fellow of the Optical Society, ARVO and the Association for Psychological Science. At present, he is the Associate Dean for for the Natural Sciences in Penn's School of Arts and Sciences. He also directs Penn's Vision Research Center, is the President of the Vision Sciences Society, is an Associate Editor of the Journal of Vision, and is co-editor of the Annual Review of Vision Science.
Homepage: https://color.psych.upenn.edu

Measurement and Reproduction of Finger Skin Deformation

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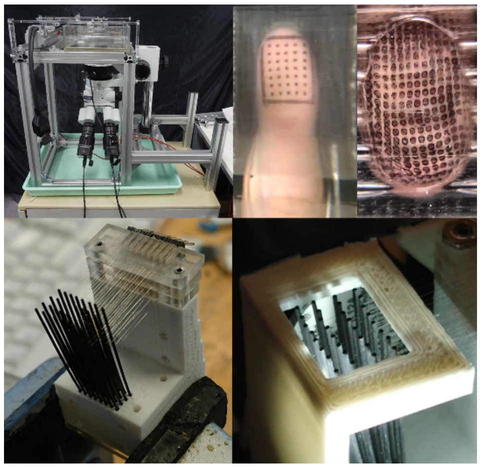

While many tactile displays have been proposed in the history of haptics research, it is still hard to reproduce arbitrary realistic tactile feeling. One important consideration is that many tactile displays are skin-deformation device, not surface-reproduction device. In other words, we need to know the mapping function from surface property (shape, friction, etc.) and interaction (finger speed, etc.), to skin deformation (spatial and temporal distribution) before making an appropriate rendering algorithm. From this viewpoint, measurement of skin deformation when touching an object is indispensable. Here I show a method for three-dimensional skin deformation measurement when finger traces the texture. The technique of optical index matching and stereoscopy are combined; the former makes the texture plate virtually transparent, and the latter enables three-dimensional measurement of markers on skin. The proposed method can observe skin deformation in the normal and tangential directions when the texture is larger than 2 mm. The observed results are reasonable at the level that the progress of the sinusoidal wave is also observed on the skin when the texture is sinusoidal, and the deformation with the same period is observed when the texture is rectangular linear grating. I also introduce novel tactile display utilizing heat actuation of Nichrome wire that achieved high resolution and fast activation.

Reference:

Kaneko & Kajimoto (2016) Method of Observing Finger Skin Displacement on a Textured Surface Using Index Matching, Euro Haptics Conference2016

Kajimoto & Jones (2019) Wearable Tactile Display Based on Thermal Expansion of Nichrome Wire, IEEE Transaction on Haptics, pp.257-268

Biography:

Hiroyuki Kajimoto received bachelor's degree in mathematical engineering and the PhD degree in information science and technology from the University of Tokyo, in 1998 and in 2006, respectively. He is a professor with the University of Electro-Communications, Japan. He was a research fellow of the Japan Society for the Promotion of Science from 2001-2003, and was assistant professor of the University of Tokyo from 2003-2006. His research interests include tactile display, tactile sensor, electrical nerve stimulation, human computer interaction, welfare device, and virtual reality. He is a member of the IEEE.

Capturing Multisensory Interactions in Cutaneous Displays

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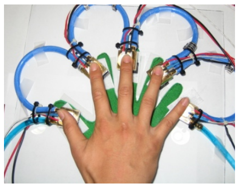

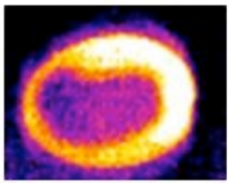

When we move our fingertips across a table or along a piece of fabric, we are immediately able to sense whether it is rough or smooth and even in the absence of vision we can probably determine what the table or cloth is made from. This ability to identify and perceive the properties of objects relies on our sense of touch or more accurately active touch or haptic sensing. It is not only tactile cues arising from mechanoreceptors in the skin that provide us with spatial and temporal information about objects, but also signals from thermoreceptors that sense changes in skin temperature associated with contacting objects made from different materials. Tactile and thermal displays designed to replicate these sensations in virtual environments or for teleoperated robotic systems have typically focused on a single modality rather than the multisensory experience associated with object contact. In our work we have sought to understand the multisensory interactions that occur in the cutaneous senses by examining how tactile and thermal information is processed. We are particularly interested in how these independent sensory systems function synergistically, given their profound differences in temporal and spatial processing.

References:

Jones, L.A. & Singhal, A. (2019). Sensory interactions in cutaneous displays. IEEE World Haptics Conference, 545-550.

Singhal, A. & Jones, L.A. (2018). Creating thermal icons – A model-based approach. ACM Transactions on Applied Perception, 15, Article 14 (22 pages).

Biography:

Lynette Jones received her PhD from McGill University in 1983 and then completed a postdoctoral fellowship at the Montreal Neurological Institute. She joined the Faculty of Medicine at McGill University in 1986 and in 1994 moved to the School of Engineering at the Massachusetts Institute of Technology (MIT). At present she is a Senior Research Scientist in the Department of Mechanical Engineering at MIT. She has contributed extensively to the area of haptics, tactile and thermal displays, and sensorimotor control of the hand. Her research group has built a number of tactile and thermal displays that have been used in research conducted by both academic and industrial organizations. Dr. Jones is a fellow of the IEEE and is the Editor-in-Chief of the IEEE Transactions on Haptics.

Neural representation of materials in visual cortex

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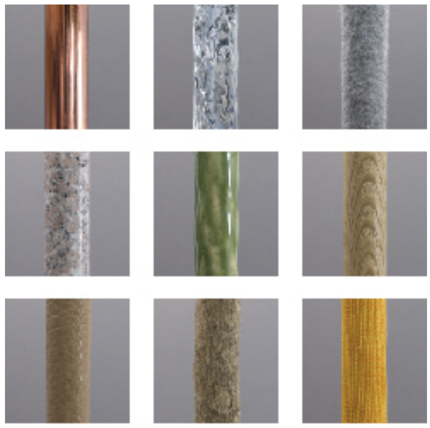

Material information is processed mainly along the ventral visual pathway of the cerebral cortex. Neuroimaging studies have shown that transformation of signals takes place along the hierarchy of this pathway where early areas represent low-level image statistics and higher ventral area represents cross-modal impression of the materials. By comparing neural representation of materials before and after the visuo-haptic experience in the monkey using fMRI, we found that visuo-haptic experience shapes cross-modal representation in the higher ventral cortex. Then, how is material information processed and distinguished in the ventral visual pathway? Processing of natural texture likely plays a key role because different classes of materials (e.g. wood, leather, fur) have specific surface textures. Analysis of neural selectivity to texture images show that higher order image statistics related to parametric description of natural textures are gradually extracted in the intermediate stages of the ventral visual pathway. Together, we can think that materials are visually represented by a combination of texture features in the intermediate stage of the ventral visual pathway, and that association with haptic information is made at the higher stage to form cross-modal impression of materials.

Reference:

Komatsu H, Goda N, “Neural mechanisms of material perception: quest on Shitsukan,” Neuroscience 392:329-347, 2018.

Goda N, Yokoi I, Tachibana A, Minamimoto T, Komatsu H, “Crossmodal association of visual and haptic material properties of objects in the monkey ventral visual cortex,” Curr Biol 26:928–934, 2016.

Okazawa G, Tajima S, Komatsu H, “Gradual development of visual texture-selective properties between macaque areas V2 and V4,” Cereb Cortex 27:4867–4880, 2017.

Biography:

Hidehiko Komatsu received his PhD in Engineering from Osaka University in 1982. In 1982, he joined the Faculty of Medicine in Hirosaki University as an assistant professor. After working from 1985 - 1988 in National Eye Institute in U.S.A. as a visiting associate, he joined the Electrotechnical Laboratory as a senior researcher. In 1995, he joined National Institute for Physiological Sciences as a professor. From 2017, he is the director and professor of Brain Science Institute of Tamagawa University. His primary research interests are the neural mechanisms of visual perception and cognition.
Homepage: https://www.tamagawa.jp/graduate/brain/staff/labs/komatsu.html

Light, science and art

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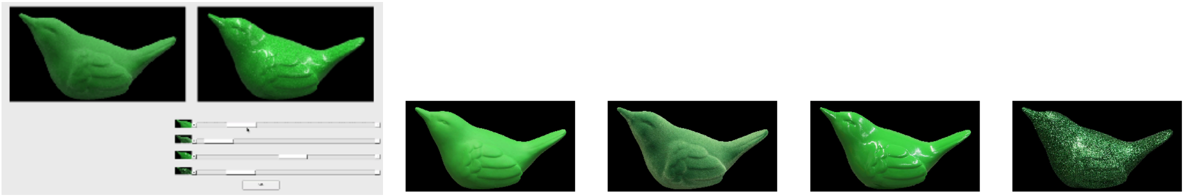

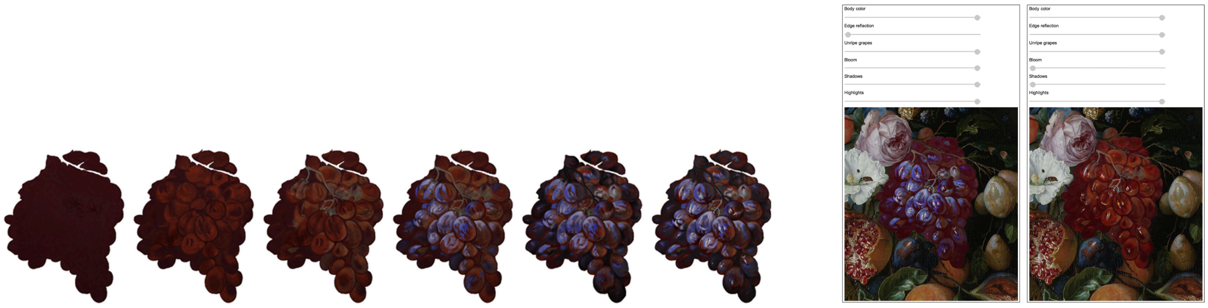

Materials need light to make them visible. Also, light needs materials to show. Together with the shape of objects and spaces they determine the "appearance" of spaces and objects, which forms the proximal stimulus for the human visual system. Appearance is a non-unique structure that confounds light, material and shape. Therefore light, material and shape perception interact. Understanding these interactions allows doing scientifically informed design. However, the range of possible light fields, materials, and shapes is endless. To get a grip on this endless variety we formulated canonical modes frameworks for light and materials. Combining these we investigated light-material interactions and whether those depended on shape and space. We found that an ambient-focus-brilliance light model can well predict material appearance variations for our canonical materials (specular, matte, velvety, glittery). Moreover, a principal component analysis (PCA) on rating data for these (only) 3 canonical lightings x 4 canonical materials matched quite well with the PCA space found for photographs of a wide variety of materials (Fleming et al., JOV 13(8), 2013) and of the PCA space found for materials depicted in paintings (van Zuijlen et al., under review), which suggests generic underlying mechanisms that are quite independent of medium and image-forming techniques. Combining art historical sources (Beurs, 1692, The big world painted small, translation in progress) with perception experiments and painting material research we aim to identify key features in the appearance or image structure that trigger such mechanisms, and how they can be combined in a "painterly approach".

References:

Pont SC, "Light: Toward a Transdisciplinary Science of Appearance and Atmosphere," Annual review of vision science 5, 2019.

Di Cicco F, Wijntjes MWA, Pont SC, "Understanding gloss perception through the lens of art: Combining perception, image analysis, and painting recipes of 17th century painted grapes," Journal of Vision 19(3), 7, 2019.

Di Cicco F, Wiersma L, Wijntjes MWA, Dik J, Stumpel J, Pont SC, "A Digital Tool to Understand the Pictorial Procedures of 17th Century Realism," Proceedings ECCV-VISART 2018.

Biography:

Sylvia Pont graduated in Experimental Physics (1993, Amsterdam University). She received her PhD (1997, Utrecht University) for a thesis on haptic perception. 1997-1999 she studied computer aids at Visio, and 1999 returned to Utrecht University to investigate real-world optics and visual perception. In 2008 she moved to TUDelft to work on applied perception for design and design for perception, developing design tools, practice oriented research methods, fundamental knowledge and design frameworks for lighting design and material and form communication. Sylvia Pont was appointed Antoni van Leeuwenhoek professor of Perceptual Intelligence in 2016. Her main interests are lighting design, visual communication of light, material, form and space, the measurement and tuning of appearance, and art.

Homepages:
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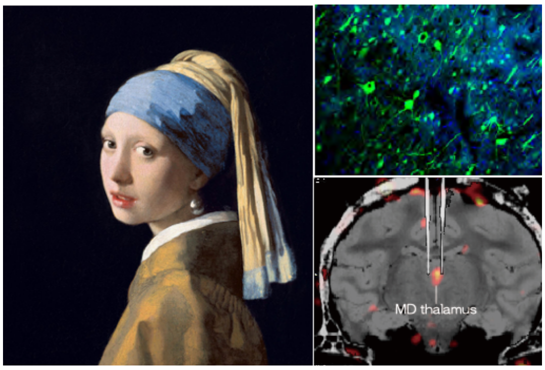
http://www.sylviapont.nl/

Neural Circuit for Value Coding and Value-based Decisions



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When looking at a painting, we recognize what is drawn (e.g., a girl and a pearl earring) — and emotional/affective responses (e.g., smiling or crying) and motivation (e.g., desire to approach/touch) are often evoked. As such, Shitsukan perception often accompanies affective responses, valuations and decisions. Why are we so fascinated by specific arts and crafts, placing a high value on them and trying to own them? The answer must be derived in our brain. In the SHITSUKAN project, we were seeking the answer to this question by studying the neural mechanism of affective/motivational responses, especially those underlying neural circuits and value-coding mechanisms. For this purpose, we developed a novel method for dissecting specific neural circuits in behaving monkeys. In this presentation, I will introduce our recent investigation of the role of distinct front-subcortical circuits in value-based decision-making.

References:

Fujimoto A, Hori Y, Nagai Y, Kikuchi E, Oyama K, Suhara T, Minamimoto T. (2019). Signaling incentive and drive in the primate ventral pallidum for motivational control of goal-directed action. J Neurosci. 39, 1793-1804.

Nagai Y, Kikuchi E, Lerchner W, Inoue KI, Ji B, Eldridge MAG, Kaneko H, Kimura Y, Oh-Nishi A, Hori Y, Kato Y, Hirabayashi T, Fujimoto A, Kumata K, Zhang MR, Aoki I, Suhara T, Higuchi M, Takada M, Richmond BJ, Minamimoto T. (2016). PET-imaging guided chemogenetic silencing reveals a critical role of primate rostromedial caudate in reward evaluation. Nat Commun 7, 13605.

Biography:

Takafumi Minamimoto received his PhD in Neuroscience from Osaka University in 2002 and then completed a postdoctoral fellowship in 2008 at the National Institutes of Health, USA. He then joined the National Institute of Radiological Sciences in 2008, where he is currently Group Leader of Systems and Neural Circuit at the Department of Functional Brain Imaging. His primary research interests are neural mechanism of motivation, emotion and decision-making. He is one of the pioneers in applying molecular and imaging technologies to non-human primates to investigate the function of specific neural circuits.

Updates on visual recognition in the ventral visual stream

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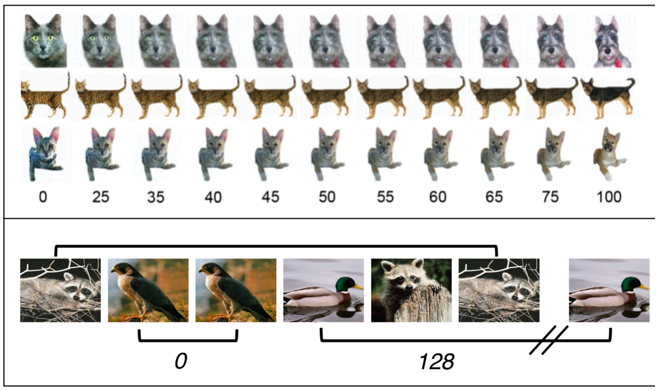

The ventral visual stream describes a set of connected brain regions that in sum underlie the ability to recognize visual stimuli. It is a set of brain regions each of which contributes to processing visual stimuli spread from its origin in primary visual cortex in the occipital lobe through the V's (V1-V4) to the inferior temporal cortex spread through areas TEO and TE. In our experiments damage in areas beyond TE, specifically the rhinal cortex has no effect on performance a visual categorization task. In the original description is was suggested that these regions function in a sequential feed-forward manner. Recently it has been pointed out that there are a considerable number of feedback connections, and feedforward connections that could lead to information 'skipping' a region, such as V4 projecting to both TEO and TE – TEO could in principle be skipped. Now we have found that in some tasks area TEO supplements the ability of area TE to carry out some visual recognition, specifically in visual categorization, that is, naming morphed images accurately as or dogs. However, in another type of visual recognition, so-called running recognition where a stimulus it must be recognized whether the stimulus has been seen before or not, damage to area TEO has no effect whereas removing area TE causes a severe impairment, Thus it seems that visual information gets to area TE via some route other than through TEO.

Reference:

Eldridge MA, Matsumoto N, Wittig JH Jnr, Masseau EC, Saunders RC, Richmond BJ. Perceptual processing in the ventral visual stream requires area TE but not rhinal cortex. Elife. 2018 Oct 12;7. pii: e36310. doi: 10.7554/eLife.36310.

Matsumoto N, Eldridge MA, Saunders RC, Reoli R, Richmond BJ. Mild Perceptual Categorization Deficits Follow Bilateral Removal of Anterior Inferior Temporal Cortex in Rhesus Monkeys. J Neurosci. 2016 Jan 6;36(1):43-53. doi: 10.1523/JNEUROSCI.2058-15.2016.

Biography:

Barry Richmond received a B.A. from Harvard University in 1965, and an M.D. degree from Case-Western Reserve University in 1971. He did residencies in Pediatrics at University Hospitals of Cleveland and Neurology in the Longwood Program at Harvard. He went to the NIH as a Postdoc with Dr. Robert Wurtz in 1976, and in 1981 started the Unit on Neural Coding and Computation in the Laboratory of Neuropsychology. The Unit became a permanent Section in 1987. Dr. Richmond has studied neural codes in the primate visual system, the circuitry underlying reward expectancy and reward seeking, and he has been among the pioneers using genetic tools to study cognitive functions in primates.

Deep image reconstruction from the human brain

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Our internal visual world is thought to be encoded in hierarchical representations in the brain. However, previous attempts to visualize perceptual contents based on machine-learning analysis of fMRI patterns have been limited to reconstructions with low level image bases or to the matching to exemplars. While categorical decoding of imagery contents has been demonstrated, the reconstruction of internally generated images has been challenging. I introduce our recent study showing that that visual cortical activity can be decoded (translated) into the hierarchical features of a pre-trained deep neural network (DNN) for the same input image, providing a way to make use of the information from hierarchical visual features. Next I present a novel image reconstruction method, in which the pixel values of an image are optimized to make its DNN features similar to those decoded from human brain activity at multiple layers. We found that our method was able to reliably produce reconstructions that resembled the viewed natural images. While our model was solely trained with natural images, it successfully generalized to artificial shapes, indicating that our model was not simply matching to exemplars. The same analysis applied to mental imagery demonstrated rudimentary reconstructions of the subjective content. Our method can effectively combine hierarchical neural representations to reconstruct perceptual and subjective images, providing a new window into the internal contents of the brain.

Reference:

Horikawa, T, Kamitani, Y (2017) Generic decoding of seen and imagined objects using hierarchical visual features. *Nature Communications* 8, 15037.

Shen, G, Horikawa, T, Majima, K, and Kamitani, Y (2019) Deep image reconstruction from human brain activity. *PLOS Computational Biology* 15, e1006633.

Biography:
Yukiyasu Kamitani received B.A. from The University of Tokyo in 1993, and Ph.D. from California Institute of Technology in 2001. After working at Harvard Medical School and Princeton University, he joined ATR Computational Neuroscience Laboratories in 2004, where he led Department of Neuroinformatics. Since 2015 he is Professor at Kyoto University. He is a pioneer of brain decoding, which combines neuroimaging and machine learning to translate brain signals to mental contents.
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Peeking inside the brain to develop the next generation of AI

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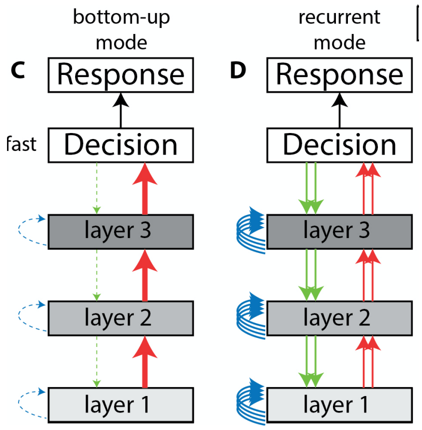

There has been tremendous progress in the development of deep convolutional neural network algorithms to address a wide variety of problems including pattern recognition tasks such as object labeling and games like chess or Go. These neural networks have been inspired by decades old research in Neuroscience elucidating the mechanisms underlying visual processing along the ventral visual stream. Despite these notable advances, human cognition still surpasses the best Artificial Intelligence algorithms to date in most problems in visual cognition. In this talk, I will outline specific examples of how advances in Neuroscience research can push the frontiers in AI. I will focus on problems like pattern completion, context reasoning, and visual attention, that require an interplay between bottom-up inputs and top-down signals that can integrate current inputs with task goals and previous knowledge. By combining behavioral measurements, neurophysiological recordings, and computational models, we can begin to decipher principles of brain computations that can be incorporated into novel biologically-inspired AI approaches.

Reference:

Zhang M, Feng J, Ma KT, Lim JH, Zhao Q, Kreiman G. (2018) Finding any Waldo: zero-shot invariant and efficient visual search. Nature Communications, 9:3730

Tang H, Schrimpf M, Lotter W, Moerman C, Paredes A, Ortega Caro J, Hardesty W, Cox D, Kreiman G. (2018) Recurrent computations for visual pattern completion. PNAS, 115:8835-884.

Biography:

Gabriel Kreiman received his MSc in Computational and Neural Systems and his PhD in Biology at Caltech in 2002. In 2007, he joined the Faculty of Harvard Medical School, where he is now Full Professor. He is also Associate Director of the Center for Brains, Minds, and Machines. His primary research interests are the computational mechanisms of visual perception and learning.
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Neural Basis of Fine Visual Discrimination

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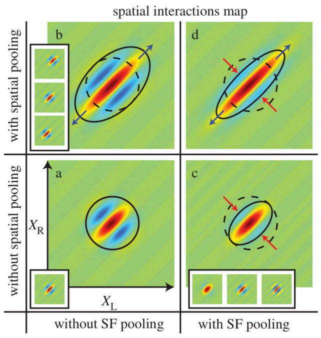

Our visual system is capable of discriminating small differences in visual stimuli, e.g., stereoscopic depth discrimination, where the discrimination threshold can reach down to several seconds of arc, as demonstrated by Westheimer & McKee and others. This is in spite of limitations imposed by intrinsic variability of neural responses, and limited dynamic range of neural signals where signal strength must be encoded by spike discharge that cannot exceed a few hundred spikes per second. Typically, a fine discrimination ability for a given stimulus dimension is closely related to the sharpness of neural tuning for that dimension. For example, for achieving a fine depth discrimination ability, a sharp binocular disparity tuning must be realized at some point in the visual system. We analyzed neurons in V1 if any mechanisms exist that enhance sharpness of neural tuning. Surprisingly, it turns out, a sharp disparity tuning is achieved by pooling of output of multiple neurons in the spatial frequency domain. The converse is also true. A sharp matching requirement for left-right spatial frequencies is achieved by pooling of output of multiple neurons in the space domain. Therefore, pooling generally broadens a tuning in the domain where pooling is done, but sharpens the tuning in the counterpart domain related via Fourier transform. Visual discrimination ability may also be enhanced by an appropriate form of adaptation that allows optimal use of the limited dynamic range of neural firing. A well-known example of such optimization is light adaptation for allowing the visual system to operate over ten log units of changes in ambient luminance from star-less night to illumination under bright sun light. There is also a mechanism for contrast gain control for cortical neurons. Both of these are based on gain changes. Distinct from gain adaptations, we have also found a novel mechanism for optimal use of the limited dynamic range in the form of offset adjustments, as observed in responses of V1 neurons.

Reference:

Kato D, Baba M, Sasaki KS, Ohzawa I, Effects of generalized pooling on binocular disparity selectivity of neurons in the early visual cortex. Phil. Trans. R. Soc. B 371: 20150266, (2016), doi: 10.1098/rstb.2015.0266

Biography:

Izumi Ohzawa received his BS degree in Electronics Engineering from Nagoya University in 1978, and Ph.D. in Physiological Optics (Vision Science) from University of California, Berkeley in 1986. After working as a postdoctoral associate, assistant and associate research physiologist at Berkeley from 1986 to 2000, he joined the Graduate School of Engineering Science, Osaka University as a professor in 2000. Since 2002, he is a professor in the Graduate School of Frontier Bioscieces, Osaka University. He is also a member of CiNet since 2013. His primary research interests are in neurophysiology of the visual system with emphases on binocular vision and stereopsis, texture, and shape perception.
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