The University of Electro-Communications
1-5-1 Chofugaoka, Chofu, Tokyo 182-8585, Japan
Tel: +81-42-443-5363
E-mail: hachisu@kaji-lab.jp
http://kaji-lab.jp/en/index.php?people/hachisu

Taku Hachisu

Career Objective

To work in a challenging research environment that would provide me with the opportunity to experience personal growth and development in my career as a researcher in Haptic and Engineering fields.

Research Interests

Augmented Reality, Haptic Display, Human-Computer Interaction, Virtual Reality.

Education

2012-present **Ph.D candidate in Informatics**, The University of Electro-Communications, Tokyo, Japan.
- Advised by Associate Professor Hiroyuki Kajimoto.

2010-2012 **M.E. in Informatics**, The University of Electro-Communications, Tokyo, Japan.

2006-2010 **B.E. in Human Communication**, The University of Electro-Communications, Tokyo, Japan.

Experience

2012-present **Japan Society for the Promotion of Science (JSPS)**, Japan
- Research Fellow (DC1).

2013 (6 months) **Microsoft Research**, Beijing, China.
- Internship Fellow.
- Human-Computer Interaction group.
- Advised by Dr. Masaaki Fukumoto.

2010 (3 months) **Institut National de Recherche en Informatique et en Automatique (INRIA)**, Rennes, Paris
- Visiting Student.
- Bunraku team.
- Advised by Dr. Anatole Lécuyer, Dr. Maud Marchal and Dr. Gabriel Cirio.
- Institutional Program for Young Researcher Overseas Visits - Scholarship for Internship, by JSPS.

Languages

French	Intermediate (daily conversation).
Chinese	Intermediate (daily conversation).
English	Fluent (785 TOEIC, Jun. 2012).
Japanese	Mother tongue.

Skills

Programming Languages

C/C++, OpenGL, OpenAL, OpenCV, Processing.

Applications

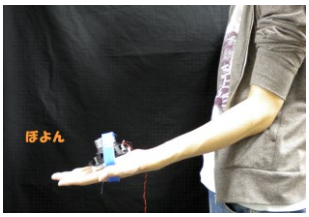
Adobe After Effects, Illustrator, Photoshop, Premiere,
MS-Word, Excel, PowerPoint,
Blender, Eagle, Max, MPLAB, Puredata, R, Scilab, SolidWorks.

Projects

Major involvement in the following projects:

i. ***Haptic Illusion of Elasticity***

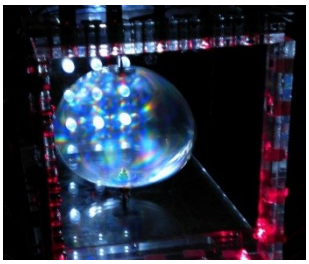
Collaborator: Sayaka Ohshima, Yuki Hashimoto and Hiroyuki Kajimoto
Period: 2009-2010



Summary: We found a new haptic illusion that is induced by a combination of a tactile stimulus and motor activity. When we presented a continuous vibratory tactile stimulus to the palm while moving the forearm vertically, a feeling of elasticity or "a soft rubber ball bouncing on the palm" is generated. We hypothesized that this illusion is caused by a well-known tactile suppression during motor activity. In the first of two experiments, we measured the optimal vibratory frequency for the illusion. In the second experiment, we measured the temporal behavior of tactile sensitivity to the vibration on the palm during periodical forearm motion. Based on the results of the experiments, we considered the mechanism of the illusion.

ii. ***Bubble Candle***

Collaborator: Asuka Ishii, Jun Ohara, Takuya Kai, Yuki Kuniyasu, Junya Miyake, Yuki Hashimoto and Hiroyuki Kajimoto
Period: 2009-2010



Summary: Soap bubble, whose transparent sphere has colored pattern caused by interference effect of visible light, is beautiful and has enchanted people through the ages. On the other hand, we can't appreciate it for a long time because it is fragile. This project presents a pseudo soap bubble dubbed "Bubble Candle", which lasts almost permanently by using rotating grating sheets instead of soapy water. It also presents the interaction that allows viewer to control the colored pattern and the shape of the bubble.
Video: http://bit.ly/V1SUIo (Japanese only)

iii. ***Rotary-Switch Feeling Feedback***

Collaborator: Yosuke Kurihara, Yuki Kuniyasu and Hiroyuki Kajimoto
Period: 2010-2012

Summary: In sports, dancing and playing music, it is important to achieve correct body movement as it greatly affects performance. However, matching one's movement with ideal movement is fundamentally difficult, because we do not have a detailed perception of our own body movement. In this study, we propose to present "rotary switch feeling" feedback as a new haptic cue. A periodical ticking sensation, like that of a rotary switch, can be presented at each joint so that the user vividly perceives his/her movement. This project presents a simple mechanical prototype that is attached to the elbow.

iv. ***Vection Field***

Collaborator: Hiromi Yoshikawa, Shogo Fukushima, Masahiro Furukawa and Hiroyuki Kajimoto
Period: 2010-2013

Summary: Today in general traffic field, visual signs and audio cues are used for pedestrian control. As the pedestrians need to acquire and recognize them, time delay between cognition and action occurs. To cope with this problem, some wearable devices were proposed that control the pedestrians intuitively. However, attaching and removing the devices are cumbersome and not practical. In this study, we propose a new visual navigation method for pedestrians using "Vection Field", where the optical flow is presented on the floor. The optical flow is presented by using lenticular lenses. The lenticular lens, that is the passive optical element, generates the visual stimulus based on the pedestrian's movement without electrical power supply. In this project, we designed a basic visual stimulus and evaluated principle of our proposed method for the directional navigation. The results revealed that the optical-flow composed of stripes and random-dot pattern both displace pedestrian's pathway significantly.

Video: http://bit.ly/VwZK8R

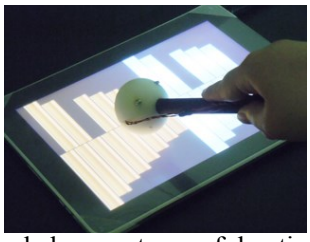
v. ***Virtual Chromatic Percussions Simulated by Pseudo-Haptic and Vibrotactile Feedback***

Collaborator: Gabriel Cirio, Maud Marchal, Anatole Lécuyer and Hiroyuki Kajimoto
Period: 2010-

Summary: Musical video games that allow users to play expensive musical instruments in a virtual environment constitute one of the most popular genres in the field of video games. Recent developments in motion input technology have enabled users to play the instruments intuitively and immersively. However, output technology, in particular haptic feedback, is not as advanced as input technology. We believe that providing a haptic sensation enriches the content of musical video games since the results of the motion input are fed back. To enrich the haptic sensation, we propose a system for playing virtual chromatic percussion, where the haptic feedback changes according to the instrument, as well as the acoustic feedback. In this study, we propose a system describing a novel stick type controller and pseudo-haptic feedback to enrich the haptic sensation of the content. We also present an application that provides a virtual environment for playing two chromatic percussion instruments, namely the xylophone and glockenspiel.

vi. ***HaCHIStick: Augmentation of Material Property***

Collaborator: Hiroyuki Kajimoto
Period: 2011-



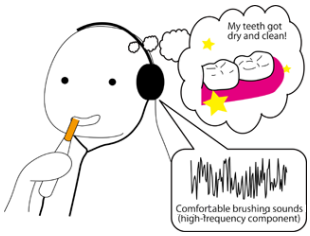
Summary: We propose a novel stick-type interface, the "HaCHIStick," for musical performance on a tablet PC. The HaCHIStick is composed of a stick with an embedded vibrotactile actuator, a visual display, and an elastic sheet on the display. By combining the kinesthetic sensation induced by striking the elastic sheet with vibrotactile sensation, the system provides natural haptic cues that enable the user to feel what they strike with the stick, such as steel or wood. This haptic interaction would enrich the user's experience when playing the instruments. The interface is regarded as a type of haptic augmented reality (AR) system, with a relatively simple setup.

vii. ***Augmentation of Obstacle Sensation***

Collaborator: Zhao Shuyang, Asuka Ishii, Yuki Kuniyasu and Hiroyuki Kajimoto
Period: 2011-2012
Summary: Horror computer games provide users with a mental stimulation that the real world cannot. Current horror games can provide the user with a visible ghost and stereo background sound to thrill the user. Inspired by obstacle sense- blind people localizing only with hearing, a novel method to augment existence is proposed. Obstacle sense is caused mainly by coloration by reflected sound and the attenuation by shielding. By focusing on the attenuation, we found an effective sense can be created by decreasing high frequency component and increasing low frequency component simultaneously. Experiments were conducted to evaluate our proposal.

viii. ***Augmentation of Toothbrush***

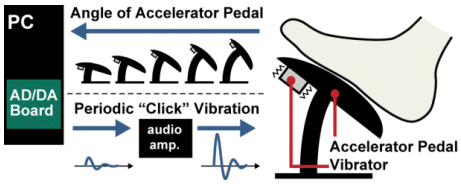
Collaborator: Hiroyuki Kajimoto
Period: 2012-
Summary: Brushing teeth is a daily habit to maintain oral hygiene, including the maintenance of oral cleanliness and prevention of caries and periodontal disease. However, tooth brushing is often not carried out correctly or forgotten because the task is boring. Although several works have contributed to improving brushing performance and motivation, the feedback seems to be very remote from the brushing itself, i.e., not intuitive. In this study, we establish two objectives to deal with these issues. The first is not to present information on a visual display, but to augment the ordinary tooth brushing experience consisting of haptic and auditory sensations, while the other is to design the modulation so that users feel as if their teeth are gradually becoming cleaner, thereby providing the necessary motivation. To achieve these aims, we propose a novel approach to augment the tooth brushing experience by modulating the brushing sounds to make tooth brushing entertaining in an intuitive manner. A microphone embedded in the toothbrush records the brushing sounds, which are presented to users after being modified by a PC. In the experiment, we demonstrate that increasing the sound gain and manipulating the frequency can control the overall impression of brushing by giving a sense of comfort and accomplishment.



Video: Coming soon.

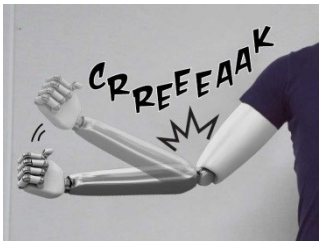
ix. ***Click-like Tactile Feedback for Accelerator Pedal Control***

Collaborator: Yosuke Kurihara and Hiroyuki Kajimoto
Period: 2012
Summary: Sensing the position and movement of the accelerator pedal in a vehicle is important for acceleration control and safety while driving. The accelerator pedal is controlled by the foot, but precise adjustment requires much training because the driver must rely on somatosensory cues, which provide limited feedback. In this study, we propose periodic tactile feedback for the accelerator pedal to provide an additional tactile cue. We conducted an experiment using a driving simulator to compare the lap time, the rate of off-track incidents and the subjective evaluation of controllability recorded in questionnaires. The experiment confirmed that the feedback makes the control of acceleration easier and facilitates safer driving.



x. Jointonation

Collaborator: Yosuke Kurihara, Katherine J. Kuchenbecker and Hiroyuki Kajimoto
Period: 2012-



Summary: Worlds of science fiction frequently involve robotic heroes composed of metallic parts. Although these characters exist only in the realm of fantasy, many of us would be interested in becoming them, or becoming like them. Therefore, we developed a virtual robotization system that provides a robot-like feeling to the human body not only by using a visual display and sound effects, but also by rendering a robot's haptic vibration to the user's arm. The vibrotactile stimulus was recorded using real robot actuation and modeled using linear predictive coding (LPC). We experimentally confirmed that the subjective robot-like feeling was significantly increased by combining the robot-vibration feedback with a robot-joint animation and creaking sound effects.

Video: http://bit.ly/1kl9v6l

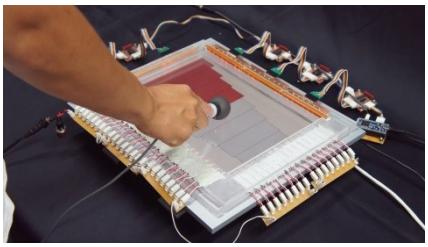
xi. Audio-Haptic Rendering of Water Being Poured from Sake Bottle

Collaborator: Sakiko Ikeno, Ryuta Okazaki, Shogo Fukushima and Hiroyuki Kajimoto
Period: 2012-

Summary: The impression of food can be affected by "rendition"—i.e., the sur-rounding environment such as the appearance of the food and the dish—not just by its taste. We focused on the sound and vibration of liquid being poured from a Japanese Sake bottle as a haptic rendition of liquid. Sake bottles are known for their unique "glug" sound and vibration which we believe affects the subjec-tive impression of the liquid in the bottle. To examine this idea, we propose a method that reproduces the vibration of pouring liquid from a Japanese Sake bottle by measuring and modeling real vibrations. We measured the vibration of water by tilting a Sake bottle at different angles, and created a model consisting of two decaying sinusoidal waves of different frequencies. To verify the appro-priateness of the model, we manufactured two types of devices and presented the modeled vibration characteristics.

xii. HACHIStack

Collaborator: Hiroyuki Kajimoto
Period: 2013-



Summary: We present a novel photo touch sensing architecture, HACHIStack. It can measure the approaching velocity of an object and predict its contact time with the touch screen using two optical sensing layers above the surface. Our photo sensing layers have three unique capabilities: high-speed sampling, velocity acquisition, and contact time prediction. This work quantitatively examines these capabilities through two laboratory experiments, and confirms that the capabilities of HACHIStack are sufficient for multimodal interaction, in particular, touch-based interaction with haptic enhancement. We then present three applications with HACHIStack: 1) chromatic percussions (xylophone and glockenspiel) with haptic feedback; 2) no-delay haptic feedback with the sensation of tapping on various simulated materials (e.g., rubber, wood and aluminum); and 3) a virtual piano instrument that allows players to perform weak and strong strokes by changing the tapping velocity.

Video: http://bit.ly/1cTECXc

xiii. ***VacuumTouch***

Collaborator: Masaaki Fukumoto

Period: 2014-

Summary: We present VacuumTouch, a novel haptic interface architecture for touch screens that provides attractive force feedback to the user's finger. VacuumTouch consists of an air pump and solenoid air valves that connect to the surface of the touch screen and suck the air above the surface where the user's finger makes contact. VacuumTouch does not require the user to hold or attach additional devices to provide the attractive force, which allows for easy interaction with the surface. This paper introduces the implementation of the VacuumTouch architecture and some applications for enhancement of the graphical user interface, namely a suction button, a suction slider, and a suction dial. The quantitative evaluation was conducted with the suction dial and showed that the attractive force provided by VacuumTouch improved the performance of the dial menu interface and its potential effects. At the end of this paper, we discuss the current prototype's advantages and limitations, as well as possible improvements and potential capabilities.

Video: Coming soon.

Publications

Journal (with peer review)

1. Taku Hachisu, Hiroyuki Kajimoto:
   Modulating Tooth Brushing Sounds to Affect User Impressions,
   International Journal of Arts and Technology, vol. x, no. x, pp. xxx-xxx, dd, mm, 2014. [printing]

International Conference (with peer review)

2. **Taku Hachisu**, Sayaka Oshima, Yuki Hashimoto, Hiroyuki Kajimoto:
   Haptic Illusion of Elasticity by Tactile Suppression during Motor Activity,
   in Proceedings of IEEE VR 2010 Haptics Symposium, pp.55-58, Waltham, Massachusetts, USA, 25-26 March 2010.

3. Masahiro Furukawa, Hiromi Yoshikawa, **Taku Hachisu**, Shogo Fukushima, Hiroyuki Kajimoto:
   "Vection Field" for Pedestrian Traffic Control,
   in Proceedings of ACM Augmented Human (AH) 2011, Tokyo, Japan, 12-14 March 2011. **[Best Paper Award]**

4. **Taku Hachisu**, Gabriel Cirio, Maud Marchal, Anatole Lécuyer, Hiroyuki Kajimoto:
   Pseudo-Haptic Feedback Augmented with Visual and Tactile Vibrations,
   in Proceedings of IEEE VR International Symposium on Virtual Reality Innovations (ISVRI) 2011, pp.327-328, Singapore, 19–20 March, 2011. **[Best Poster Award]**

5. Hiromi Yoshikawa, **Taku Hachisu**, Shogo Fukushima, Masahiro Furukawa, Hiroyuki Kajimoto:
   "Vection Field" for Pedestrian Traffic Control,
   in ACM SIGGRAPH 2011 Emerging Technologies, Vancouver, British Colombia, Canada, 7-11 August, 2011.

6. **Taku Hachisu**, Michi Sato, Shogo Fukushima, Hiroyuki Kajimoto:
   HaCHIStick: Simulating Haptic Sensation on Tablet PC for Musical Instruments Application,
   in Proceedings of ACM Symposium on User Interface Software and Technology (UIST) 2011, pp.73-74, Santa Barbara, California, USA, 16–19 October, 2011.

7. **Taku Hachisu**, Gabriel Cirio, Maud Marchal, Anatole Lécuyer, Hiroyuki Kajimoto:
   Virtual Chromatic Percussions Simulated by Pseudo-Haptic and Vibrotactile Feedback,
   in Proceedings of ACM International Conference on Advances on Computer Entertainment Technology (ACE) 2011, Lisbon, Portugal, 8–11 November, 2011.

8. Shuyang Zhao, **Taku Hachisu**, Asuka Ishii, Yuuki Kuniyasu, Hiroyuki Kajimoto:
   Obstacle Sensation Augmented by Enhancing Low Frequency Component for Horror Game Sound,
   in Proceedings of The 21st International Conference on Artificial Reality and Telexisitence (ICAT), Osaka, Japan, 28-30 November, 2011.

9. Yosuke Kurihara, Yuki Kuniyasu, **Taku Hachisu**, Michi Sato, Shogo Fukushima, Hiroyuki Kajimoto:
   Augmentation of Kinesthetic Sensation by Adding "Rotary Switch Feeling" Feedback,
   in Proceedings of ACM Augmented Human (AH) 2012, Megève, France, 8-9 March 2012.

10. Shuyang Zhao, **Taku Hachisu**, Asuka Ishii, Yuuki Kuniyasu, Hiroyuki Kajimoto:
    Augmentation of Obstacle Sensation by Enhancing Low Frequency Component for Horror Game Background Sound,
    in Proceedings of ACM Augmented Human (AH) 2012, Megève, France, 8-9 March 2012.

11. Hiromi Yoshikawa, **Taku Hachisu**, Shogo Fukushima, Masahiro Furukawa, Hiroyuki Kajimoto, Takuya Nojima:
    Studies of Vection Field II: A Method for Generating Smooth Motion Pattern,
    in Proceedings of Advanced Visual Interfaces (AVI) 2012, pp.705-708, Capri Island, Italy, 21-25 May, 2012.

12. **Taku Hachisu**, Michi Sato, Shogo Fukushima, Hiroyuki Kajimoto:
Augmentation of Material Property by Modulating Vibration Resulting from Tapping,
EuroHaptics 2012, vol.1, pp.173-180, Tampere, Finland, 12–15 June, 2012.

13. **Taku Hachisu**, Hiroyuki Kajimoto:
Augmentation of Toothbrush by Modulating Sounds Resulting from Brushing,
in Proceedings of the Advances in Computer Entertainment Conference (ACE) 2012, pp.31-43, Kathmandu, Nepal, 3–5 November, 2012.

14. Hiroyuki Okabe, **Taku Hachisu**, Michi Sato, Shogo Fukushima, Hiroyuki Kajimoto:
Quantitative Evaluation of an Illusion of Fingertip Motion,
in Proceedings of Interactive Tabletop & Surface (ITS) 2012, pp.327-330, Cambridge, USA, 11-14 November, 2012.

15. Maki Yokoyama, **Taku Hachisu**, Michi Sato, Shogo Fukushima, Hiroyuki Kajimoto:
Control of Ridge by Using Visuotactile Cross-Modal Phenomenon,
in Proceedings of Interactive Tabletop & Surface (ITS) 2012, pp.335-338, Cambridge, USA, 11-14 November, 2012.

16. Yosuke Kurihara, **Taku Hachisu**, Michi Sato, Shogo Fukushima, Hiroyuki Kajimoto:
Virtual Alternation of Body Material by Periodic Vibrotactile Feedback,
in Proceedings of IEEE Virtual Reality Conference (VR), Orlando, Florida, USA, 16-23 March, 2013.

17. Ryuta Okazaki, **Taku Hachisu**, Michi Sato, Shogo Fukushima, Vincent Hayward, Hiroyuki Kajimoto:
Frequency Consonance between Tactile and Audio,
in Proceedings of IEEE World Haptics Conference (WHC) 2013, Daejeon, Korea, 14-17 April, 2013.

18. Yosuke Kurihara, **Taku Hachisu**, Michi Sato, Shogo Fukushima, Hiroyuki Kajimoto:
Periodic Tactile Feedback for Accelerator Pedal Control,
in Proceedings of IEEE World Haptics Conference (WHC) 2013, Daejeon, Korea, 14-17 April, 2013.

19. Ryo Watanabe, Naoki Saito, Yuichiro Mori, **Taku Hachisu**, Michi Sato, Shogo Fukushima, Hiroyuki Kajimoto:
Development of Roller-Type Itch-Relief Device Employing Alternating Hot and Cold Stimuli,
in Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems (CHI EA) 2013, pp. 403-408, Paris, France, 27 April –2 May, 2013.

20. Shinya Kudo, Hiroyuki Okabe, **Taku Hachisu**, Michi Sato, Shogo Fukushima, Hiroyuki Kajimoto:
Input Method Using Divergence Eye Movement,
in Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems (CHI EA) 2013, pp. 1335-1340, Paris, France, 27 April –2 May, 2013.

21. **Taku Hachisu**, Hiroyuki Kajimoto:
HACHIStack: Dual-Layer Photo Touch Sensing for Haptic and Auditory Tapping Interaction,
in Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems (CHI), pp. 1411-1420, Paris, France, 27 April –2 May, 2013.

22. Yosuke Kurihara, **Taku Hachisu**, Katherine J. Kuchenbecker, Hiroyuki Kajimoto:
Virtual Robotization of the Human Body via Data-Driven Vibrotactile Feedback,
in Proceedings of the International Conference on Advances in Computer Entertainment Technology (ACE) 2013, Enschede, Netherlands, 12-15 November 12-15, 2013. **[Best Paper Silver]**

23. Sakiko Ikeno, Ryuta Okazaki, **Taku Hachisu**, Michi Sato, Hiroyuki Kajimoto:
Audio-Haptic Rendering of Water Being Poured from Sake Bottle,
in Proceedins of the International Conference on Advances in Computer Entertainment Technology (ACE) 2013, Enschede, Netherlands, 12-15November, 2013.

24. Yosuke Kurihara, **Taku Hachisu**, Katherine J. Kuchenbecker, Hiroyuki Kajimoto:
Jointonation: Robotization of the Human Body by Vibrotactile Feedback,

in ACM SIGGRAPH Asia 2013 Emerging Technologies, Hong Kong, China, 19-22 November, 2013.
[Emerging Technologies Prize]

25. **Taku Hachisu**, Hiroyuki Kajimoto:
Haptic Augmentation of Touch Panel with Approaching Velocity Sensing and Contact Time Prediction,
Appeared at the IEEE Haptics Symposium 2014, Houston, Texas, USA, 23-26 February, 2014. [demo]

26. **Taku Hachisu**, Masaaki Fukumoto:
VacuumTouch: Attractive Force Feedback Interface for Haptic Interactive Surface using Air Suction,
in Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems (CHI) 2014, Toronto, Canada, 26 April – 1 May, 2014. [printing]