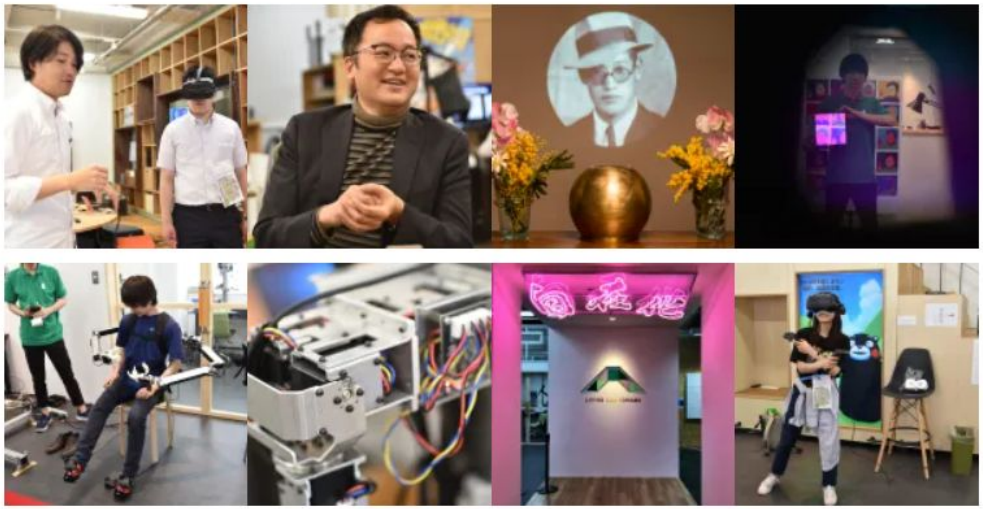
Balanced Glass Design: A flavor perception changing system by controlling the center-of-gravity

Masaharu Hirose
The University of Tokyo Tokyo, Japan
hirose@star.rcast.u-tokyo.ac.jp

Masahiko Inami
RCAST, The University of Tokyo
Tokyo, Japan
inami@star.rcast.u-tokyo.ac.jp

INFORMATION SOMATICS LAB

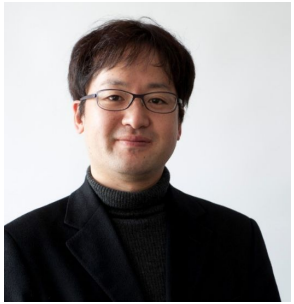


東京大学 先端科学技術研究センター
身体情報学分野 稲見・門内研究室

INAMI LAB, RESEARCH CENTER FOR ADVANCED SCIENCE AND TECHNOLOGY (RCAST), THE UNIVERSITY OF TOKYO

Masaharu Hirose

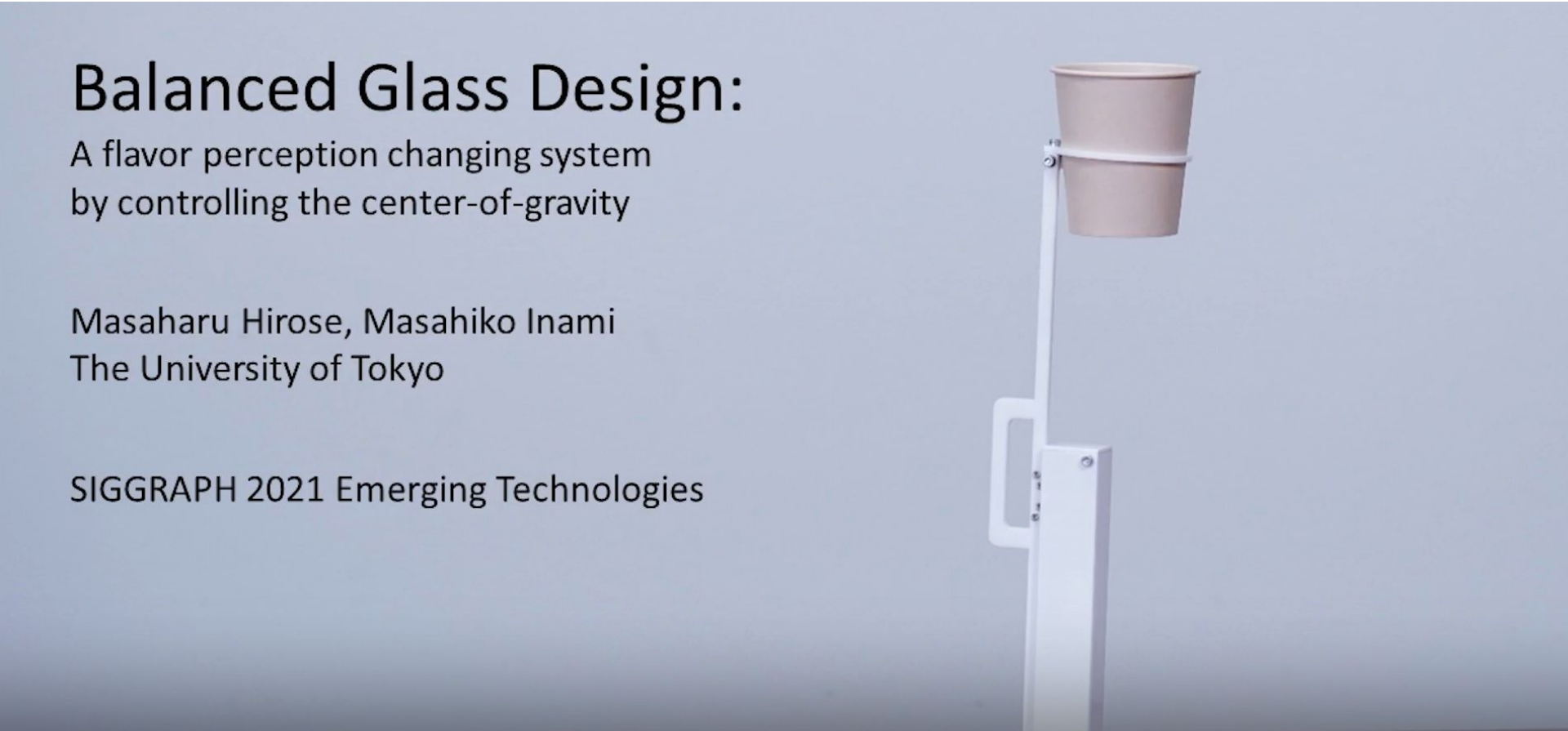
The University of Tokyo



Masahiko Inami

RCAST, The University of Tokyo

DEMO 影片


Balanced Glass Design:
A flavor perception changing system
by controlling the center-of-gravity
Masaharu Hirose, Masahiko Inami
The University of Tokyo
SIGGRAPH 2021 Emerging Technologies

ABSTRACT

In this paper, we propose **Balanced Glass Design**, a **system to change flavor perception**. The system consists of glass-type device **shifting its center of gravity in response to the user's motion** which allows drinking a beverage with a virtual perception of weight through drinking motion. **We thought It's possible to intervene in the user's perception of flavor by displaying virtual weight perception**, and so conducted experiments on weight perception and demonstrations as a user study. This paper describes the system design, the result of experiments, and comments obtained through a user study.

KEYWORDS

Cross-modal, Human Food Interaction, Virtual Reality

Cross-modal:指不同傳感器或不同模態之間的信息交互和整合。

INTRODUCTION

. Flavor perception involves multiple senses, not just taste. For example, smell and touch also play important roles in how we perceive food and drink.

. The study proposes a glass device that can change flavor perception by creating a virtual weight. The device's center of gravity shifts to change the beverage's weight and flavor. This idea is based on the hypothesis of cross-modal perception in taste and tactile sensation.

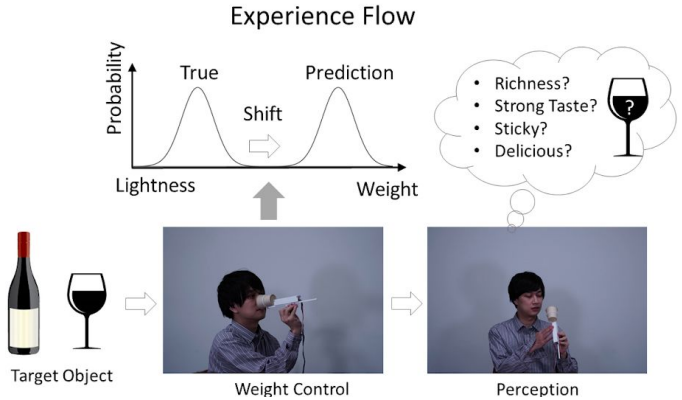
. The research draws on a previous study that found changes in cutlery size, weight, shape, and color can alter the thickness, saltiness, and perceived luxury of yogurt. The research suggests that controlling the information received from the glass can change the beverage's flavor.

The taste of cutlery: how the taste of food is affected by the weight, size, shape, and colour of the cutlery used to eat it

INTRODUCTION

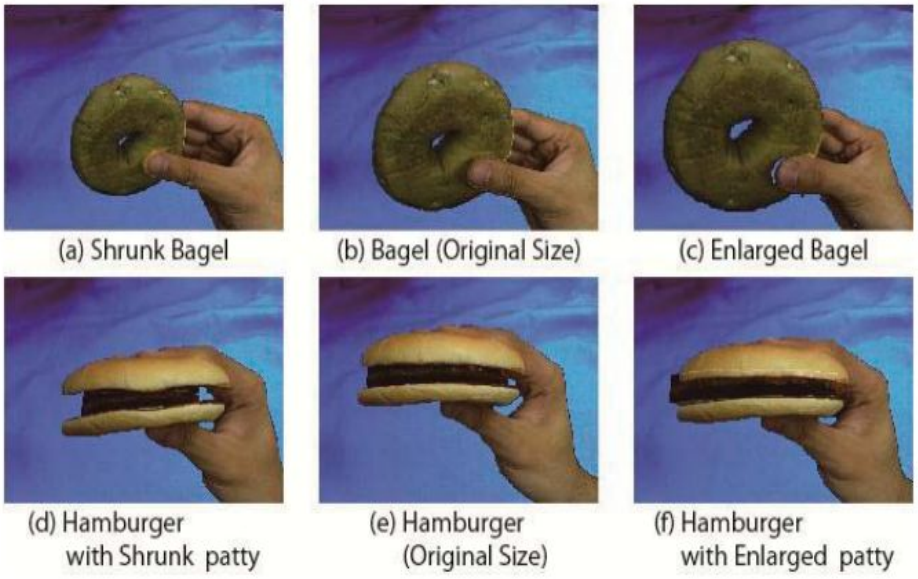
. The research team had previously proposed a system that presented the weight of food while eating, and showed that **increasing the weight of the food by changing the center of gravity of the tableware affected the food's flavor.** They extended this method to beverages in their current research and improved it to work for both heaviness and lightness.

. The demonstration focused on the perception of wine, which is complex and often described using metaphors like **"heavy" or "light"**. However, no one has ever tasted a physically "heavy" or "light" wine. The aim of the work is to show that **perceptions other than taste can change the sensation of a beverage**.



RELATED WORK

Many studies have been reported that aim to influence the perception of food from factors other than taste. For example, Narumi et al. proposed an AR/VR system to improve satiety by changing the apparent size of cookies [Narumi et al. 2012].



Augmented perception of satiety: controlling food consumption by changing apparent size of food with augmented reality

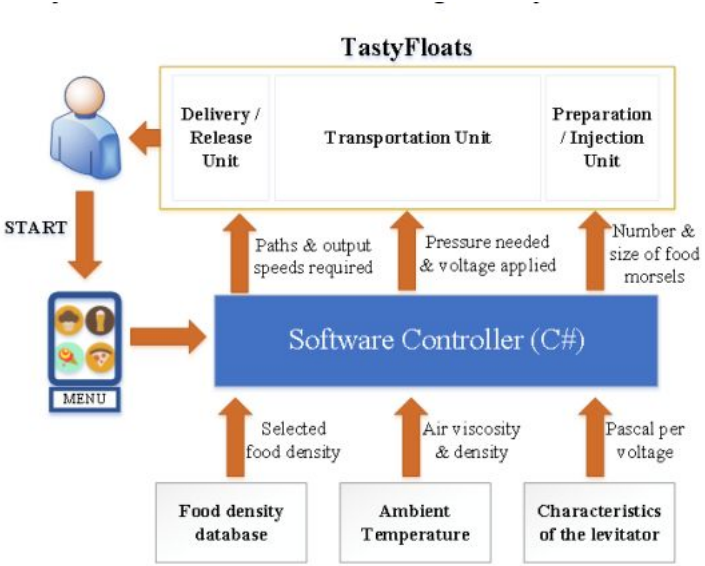
RELATED WORK

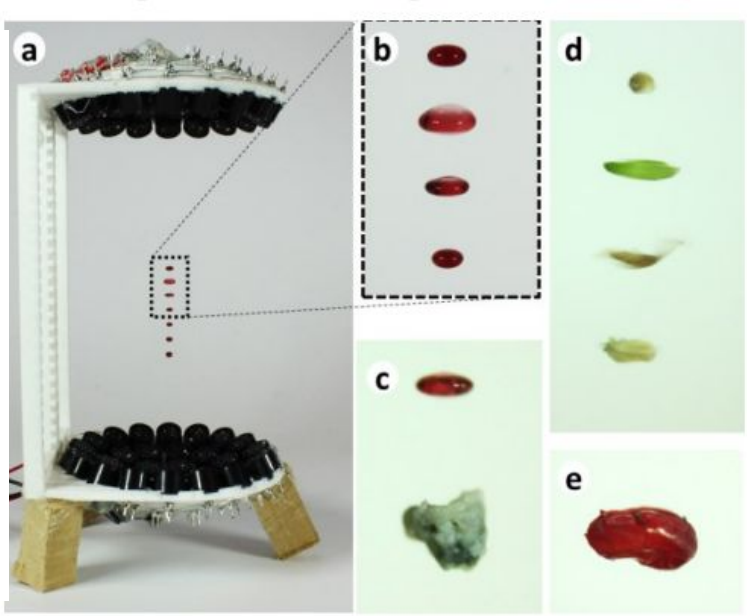
An example of applying thermal sensations, Suzuki et al. proposed a system to improve the flavor richness and aftertaste strength of beverages by presenting thermal sensations to the skin [Suzuki et al. 2014].

Affecting Tumbler: Affecting our flavor perception with thermal feedback

RELATED WORK

As a study that focuses on how to eat, Vi et al. proposed a gustatory interface using acoustic levitation and examined changes in the perception of sweet, bitter, and umami tastes [Vi et al. 2017].





TastyFloats: A Contactless Food Delivery System

RELATED WORK

In this study, we implemented a system that can present a wide dynamic range of weights by implementing a mechanism in which the power motor itself moves, similar to the work of Shigeyama et al [Shigeyama et al. 2019].

Transcalibur: A Weight Shifting Virtual Reality Controller for 2D Shape Rendering based on Computational Perception Model

BALANCED GLASS DESIGN

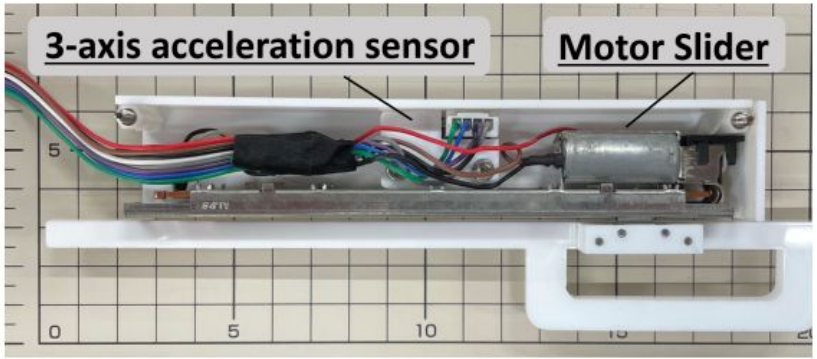
3.1 Mental Models

This mental model aims to change the flavor perception through the illusion that "I drank it while thinking it was heavy," or the unexpectedness that "I expected it to be heavy, but found it to be light at the moment I drank it".

The system aims to change the food perception by the weight perception due to the center of gravity changing, which means that we are using the illusion twice.At first, the weight presentation changes only the moment of inertia balance, and the overall mass does not change. Second, the purpose of the weight presentation is to change the level of satisfaction, taste, etc., which is entirely different from weight perception.

BALANCED GLASS DESIGN

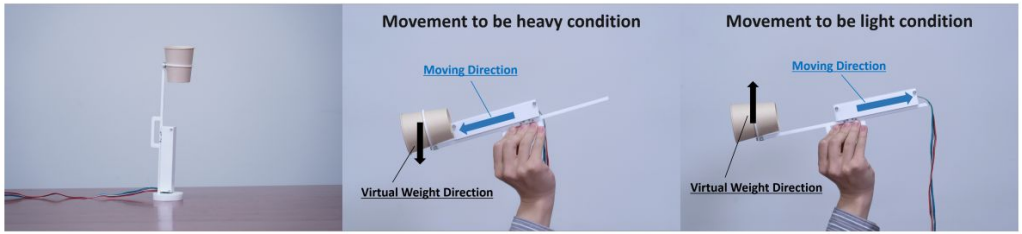
3.2 System Details



The processing flow of a system that uses a **Raspberry Pi 4** as the computer board. **An accelerometer (MPU 9250)** installed inside a glass-type device measures the tilt angle, which is used to control the position of a **motor slider (RSA0N11M9A0K)** and change the moment. The motor slider's position is controlled through a PID control of the current value using a motor driver (DR8833), and the position of the motor slider is measured using an A/D converter IC (MCP3208).

BALANCED GLASS DESIGN

3.2 System Details



The importance of balancing the mass of the entire device and the moving object in designing the center of gravity shift mechanism. **The goal is to make the overall mass light and the moving part as heavy as possible so that users can feel the change in moment**. To achieve this, the entire device is designed to be driven by the motor slider, which is the heaviest component. **The weight of the entire device is 127g**, and the weight of the moving part to change the center of gravity is **100g**, which moves **100mm**. **By shifting 79%** of the mass of the entire device, a **dynamic change in the center of gravity is achieved,** even though the overall mass is about the same as an ordinary wine glass. To reduce the overall weight and maintain hygiene, a disposable paper cup is used that can be attached to the part that touches the user's mouth.

EXPERIMENT

A psychophysical experiment to clarify how much weight the device is capable of presenting. In the experiment, we adopted the adjustment method.

(1) The subjects hold a device shifting the center of gravity in their left hand and other devices not moving (Slider Positionis 0) in their right hand.

(2) The subjects adjust the tip position's weight so that the counterbalance of both hands is the same.

(3) Perform this operation for the center-of-gravity presentation position 0 to 10.

Figure 3: A participant in the experiment

EXPERIMENT

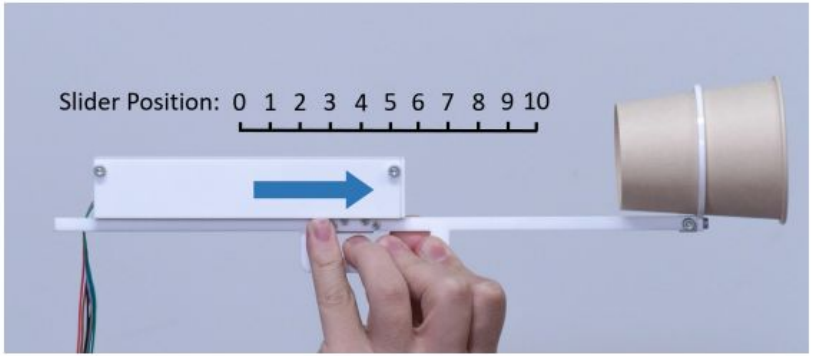


Figure 4: The slider position in the experiment

As a result of the experiment, we found that the moment's weight presentation increased steadily from 0 to 4 and 9 to 10 positions. On the other hand, **the subject could not feel any moment change between 4 and 9.** For the 4 to 9, it may be because the moving object is close to the handle from the 4 to 9 position. In this position, even if it moves, the change in the moment is slight. The results show that the device can present weight of 24.4[g] by position changes from 0 to 4, and present 31.7[g] for the entire device. Considering the weight of a sip of the drink, we can assume that it will give enough weight.

EXPERIMENT

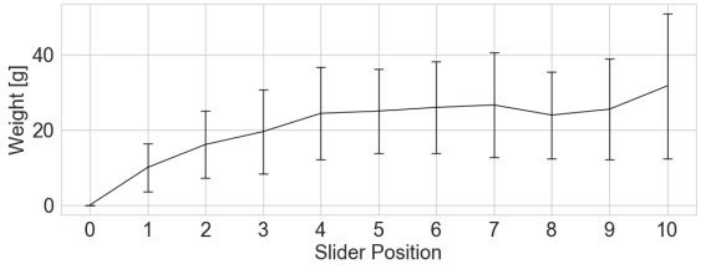


Figure 5: Experimental Results. Relationship between the moment and the presented weight. Maximum presented weight is 31.7[g]

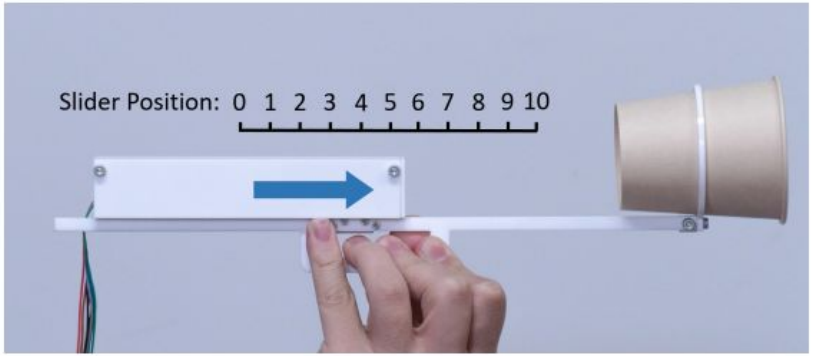


Figure 4: The slider position in the experiment

As a result of the experiment, we found that the moment's weight presentation increased steadily from 0 to 4 and 9 to 10 positions. On the other hand, **the subject could not feel any moment change between 4 and 9.** For the 4 to 9, it may be because the moving object is close to the handle from the 4 to 9 position. In this position, even if it moves, the change in the moment is slight. The results show that the device can present weight of 24.4[g] by position changes from 0 to 4, and present **31.7**[g] for the entire device. Considering the weight of a sip of the drink, we can assume that it will give enough weight.

DEMONSTRATION

We demonstrated the system to 20 people.

The participants chose five kinds of beverages (tea, juice, sports drink, coffee, and wine) and drank them in two different ways:

(1) Adding heaviness

(2) Adding lightness.

In the case of drinking while presenting heaviness or lightness, in advance, the participants drank the beverage in a state where the center of gravity shift is not, because we intend to make it easier to understand the change in flavor.

Comment for Adding Heaviness

- Since I felt weight was added while I was drinking it, I felt as if the amount of drink was not decreasing. I felt like I drank a lot. (Tea)

- I felt that the wine was more dry. This may have been because the changing weight distribution made me drink the wine with a different speed and volume than usual. (Wine)

- I couldn't perceive the weight, but I felt like the taste got stronger. It tasted better. (Juice)

- The speed at which the liquid entered my mouth changed relative to without the device and this caused the taste to change. It felt strange. I felt that it tasted better. (Tea)

- I felt like I was drinking something viscous. I feel like the cup's capacity is changing. (Sports Drink)

- When tipping the empty module, it feels like there's water in the cup even when there isn't.

Comment for Adding Lightness

- I couldn’t perceive a sense of lightness in terms of weight, but I felt like the taste was lighter. (Juice)

- It certainly felt lighter, but it just felt like I was drinking from just a light glass. (Tea)

- When I lighten it, I feel like the amount of drink does not decrease. (Tea)

- It slowed my drinking speed and moderated how the drink spread in my mouth. (Tea)

Overall

- I felt a clear change in the coffee and wine. I think this is because coffee and wine have a complex taste. On the other hand, it was difficult to feel a change with sports drinks and juices because their flavor is simple. (Wine, coffee, Sports Drink, Juice)

- The way the drink touched my mouth changed, so it obviously changed the taste as well. (Tea)

- If we could make the motor slide more smoothly and precisely according to the drinking motion, we could present weight to the user without them noticing. I thought, if such control were possible, it would be possible to cause behavioral changes or changes in flavor without the user noticing. (Tea)

The study found weight perception affected flavor perception and how the glass was tilted while drinking, which changed the taste. Perceptual changes varied depending on the drink consumed.

CONCLUSION

In this paper, we proposed **Balanced Glass Design**, a system to change a beverage's flavor by presenting virtual weight perception. We described the system design, the mental model, the experiments on weight perception, and the comments from the system demonstration participants. **The results of the demonstration suggested the possibility of the flavor perception change**. In the future, we plan to have more participants experience this system to clarify the mental model's general characteristics. With the results, we would like to conduct psychophysical experiments on the mental models' features and scientifically verify the flavor perception change and mental models.

REFERENCES

Eisuke Fujinawa, Shigeo Yoshida, Yuki Koyama, Takuji Narumi, Tomohiro Tanikawa, and Michitaka Hirose. 2017. Computational Design of Hand-Held VR Controllers Using Haptic Shape Illusion. In Proceedings of the 23rd ACM Symposium on Virtual Reality Software and Technology (Gothenburg, Sweden) (VRST '17). Association for Computing Machinery, New York, NY, USA, Article 28, 10 pages. https://doi.org/ 10.1145/3139131.3139160

Vanessa Harrar and Charles Spence. 2013. The taste of cutlery: how the taste of food is affected by the weight, size, shape, and colour of the cutlery used to eat it. Flavour 2, 1 (June 2013), 1-13 pages. https://doi.org/10.1186/2044-7248-2-21

Masaharu Hirose, Karin Iwazaki, Kozue Nojiri, Minato Takeda, Yuta Sugiura, and Masahiko Inami. 2015. Gravitamine Spice: A System That Changes the Perception of Eating through Virtual Weight Sensation. In Proceedings of the 6th Augmented Human International Conference (Singapore, Singapore) (AH '15). Association for Computing Machinery, New York, NY, USA, 33–40. https://doi.org/10.1145/2735711. 2735795

Kai-Chieh Huang, Chen-Kuo Sun, Da-Yuan Huang, Yu-Chun Chen, Ruei-Che Chang, Shuo-wen Hsu, Chih-Yun Yang, and Bing-Yu Chen. 2020. Glissade: Generating Balance Shifting Feedback to Facilitate Auxiliary Digital Pen Input. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (Honolulu, HI, USA) (CHI '20). Association for Computing Machinery, New York, NY, USA, 1–13. https://doi.org/10.1145/3313831.3376505

Ying-Ju Lin, Parinya Punpongsanon, Xin Wen, Daisuke Iwai, Kosuke Sato, Marianna Obrist, and Stefanie Mueller. 2020. FoodFab: Creating Food Perception Illusions Using Food 3D Printing. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (Honolulu, HI, USA) (CHI '20). Association for Computing Machinery, New York, NY, USA, 1–13. https://doi.org/10.1145/3313831.3376421

Takuji Narumi, Yuki Ban, Takashi Kajinami, Tomohiro Tanikawa, and Michitaka Hirose. 2012. Augmented Perception of Satiety: Controlling Food Consumption by Changing Apparent Size of Food with Augmented Reality. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Austin, Texas, USA) (CHI '12). Association for Computing Machinery, New York, NY, USA, 109–118. https://doi.org/10.1145/2207676.2207693

REFERENCES

Takuji Narumi, Shinya Nishizaka, Takashi Kajinami, Tomohiro Tanikawa, and Michitaka Hirose. 2011. Meta Cookie+: An Illusion-Based Gustatory Display. In Virtual and Mixed Reality - New Trends, Randall Shumaker (Ed.). Springer Berlin Heidelberg, Berlin, Heidelberg, 260–269.

Jotaro Shigeyama, Takeru Hashimoto, Shigeo Yoshida, Takuji Narumi, Tomohiro Tanikawa, and Michitaka Hirose. 2019. Transcalibur: A Weight Shifting Virtual Reality Controller for 2D Shape Rendering Based on Computational Perception Model. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (Glasgow, Scotland Uk) (CHI '19). Association for Computing Machinery, New York, NY, USA, 1–11. https://doi.org/10.1145/3290605.3300241

Chie Suzuki, Takuji Narumi, Tomohiro Tanikawa, and Michitaka Hirose. 2014. Affecting Tumbler: Affecting Our Flavor Perception with Thermal Feedback. In Proceedings of the 11th Conference on Advances in Computer Entertainment Technology (Funchal, Portugal) (ACE '14). Association for Computing Machinery, New York, NY, USA, Article 19, 10 pages. https://doi.org/10.1145/2663806.2663825

Chi Thanh Vi, Asier Marzo, Damien Ablart, Gianluca Memoli, Sriram Subramanian, Bruce Drinkwater, and Marianna Obrist. 2017. TastyFloats: A Contactless Food Delivery System. In Proceedings of the 2017 ACM International Conference on Interactive Surfaces and Spaces (Brighton, United Kingdom) (ISS '17). Association for Computing Machinery, New York, NY, USA, 161–170. https://doi.org/10.1145/3132272.3134123

Andre Zenner and Antonio Kruger. 2017. Shifty: A Weight-Shifting Dynamic Passive Haptic Proxy to Enhance Object Perception in Virtual Reality. IEEE Transactions on Visualization and Computer Graphics 23, 4 (April 2017), 1285–1294. https: //doi.org/10.1109/TVCG.2017.2656978

How Center-of-gravity Can Change Flavor Perception

1
JUL 2021

by SIGGRAPH Conferences | posted in: Conferences, Emerging Technologies, Hardware | 2

SIGGRAPH: What advice do you have for someone looking to submit to Emerging Technologies at a future SIGGRAPH conference?

MH: Creating a work of art requires a lot of effort, but I encourage you to give it a try. The ideas you have may seem usual to you, but to the SIGGRAPH community they may be novel, fresh, and creative. The SIGGRAPH community has a curiosity that allows us to go beyond.