令和２年度　未来研究ラボシステム　研究成果報告書

研究種目：共同研究　　研究期間：令和 2 年 10 月～令和 4 年 9 月

研究課題名：フード 3D プリンターと人工知能を使用して食事体験を向上させる計算フードテクスチャ

ラボ長

所属：システム創成専攻　システム科学領域

氏名：PUNPONGSANON PARINYA

研究成果

We propose a novel food system to physically augment target food by generating food texture on the different types of food using a food 3D printer support from artificial intelligence (AI) technologies. Hence, we can create food that users want to eat but do not have the opportunity to eat because of allergies or other physical health. For example, to produce the beef steak without actual meat by integrating alternative meat and vegetables, the system incorporates food texture information from actual steak before fabricated with an internal structure that could reproduce such texture different food using food 3D printer (F3P). Unlike another fabrication method such as traditional cooking or conventional industrial production, the food 3D printing provided accurate food production from a personal requirement perspective.

This annual report summarized a recent work in progress of this project, which are (1) *preparation of research environment* and (2) *preparation of food database*. The summarized of this fiscal year shown in Figure 1.

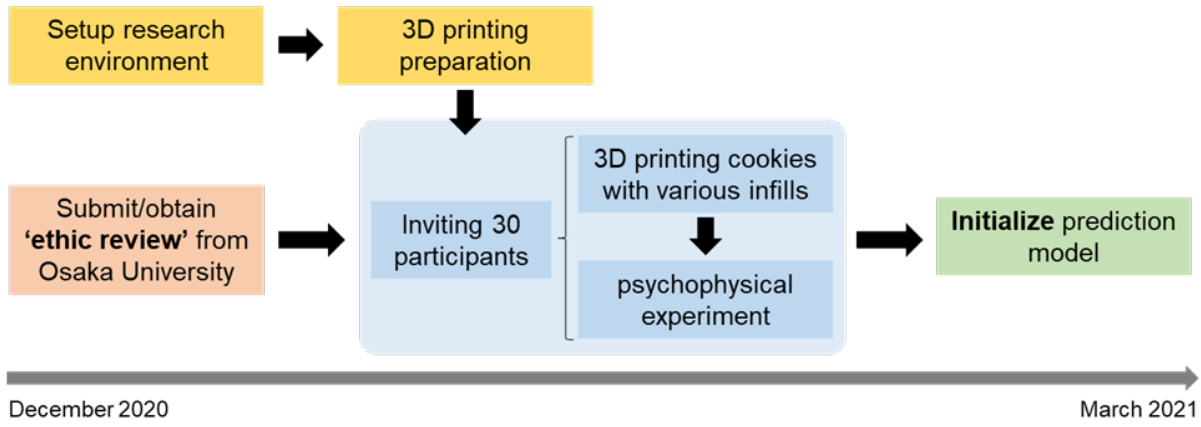

Figure 1 Summarized of research progress as of fiscal year 2020

1) <u>Preparation of research environment</u>

In this fiscal year, we have prepared the food 3D printer using pneumatic air dispenser system (Figure 2). The printer attached with the digital ultrasonic homogenizer to modulate the food with different viscosity (Figure 3). As shown in Figure 4, we vibrate the end tip of the nozzle that extrude the food from the syringe controlled by air dispenser to control the amount of food being extrude from the nozzle. We obtained a wider range of 3D printed food (e.g., the food with high or low viscosities) by controlling the nozzle tip of 3D printing with ultrasonic homogenizer. For example, we achieved to print a viscous meat by vibrating the nozzle tip

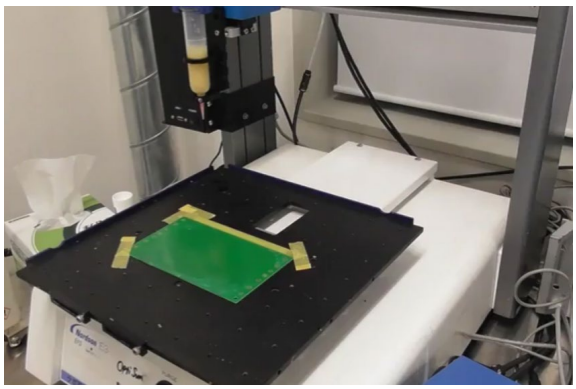

Figure 2 Food 3D printer with air dispenser system

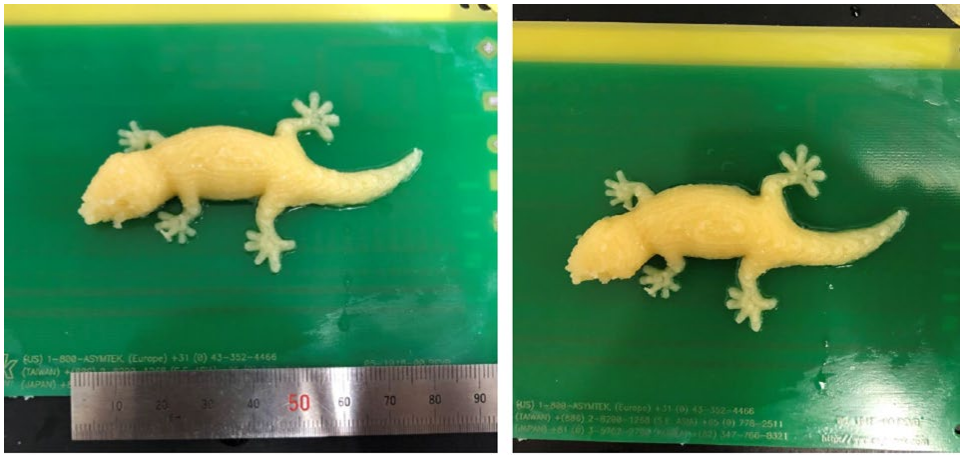

Figure 5 Food 3D printed results using air dispenser system

with 50 Hz and print a low viscous chocolate by vibrating the nozzle tip with 20 Hz. In this fiscal year, we also investigated the printing parameters, e.g., printing speed, air pressure, nozzle size, etc. to optimize the printing result. Our results found that we could allow to print the complex food with cookie dough material by using air pressure 0.50 Mpa, line speed 0.2 mm/s and nozzle range 18G, and meat dough material by using air pressure 0.6 Mpa, line speed 0.15 mm/s and muzzle range 16G, respectively. However, we still cannot print the food with higher viscosity than 400 Pascal/sec (e.g., mixed meat powder). We plan to conduct the follow up investigation in the next fiscal year.

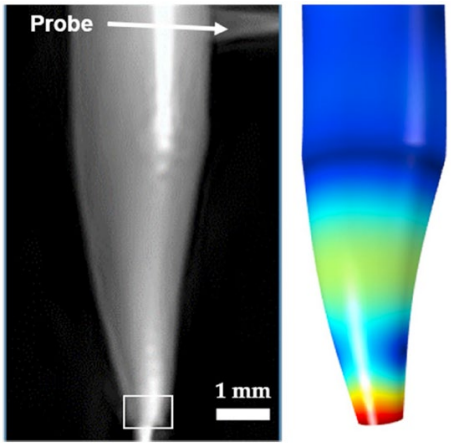

Figure 4 Nozzle bending controlled by ultrasonic homogenizer

2) <u>Preparation of food database</u>

As this project requires the food dataset to estimate and derive the computational model, i.e., augment target food by generating food texture on the different types of food, we plan to conduct the user study to obtain the dataset in the next fiscal year. To verify whether our experiment can obtain the data we want, we conducted a preliminary experiment to simulate the overall experiment procedure. To extract the food texture information, we used EMG sensor attached to the chewing muscles and directly record the data in real-time (Figure 5). To subjectively obtain the user food experience, we obtained the questionnaire from our previous study and utilize the magnitude estimation method to collect the data. We found that we could collected the data we want through the mockup experiment. Therefore, to conduct the actual experiment, we are preparing the IRB regards the requirement from IRB research ethic committees of Osaka University.

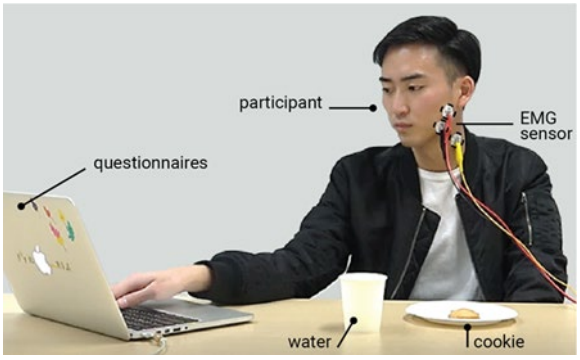

Figure 6 Mockup experiment setup

Since the shipment of the syringe air dispenser system at the first period of this project has been delayed due to the effect of COVID-19. The setting up of the research environment required the extension into the next fiscal year (2021) to follow up and cover up the range of 3D printed food with high viscosity as the purpose of this project. In addition, we will proceed the next step of this project to cover up the research plan.

キーワード： Food 3D Printing, Eating Experience, Mouthfeel

研究経費（R2 年度）の内訳

備品費	消耗品費	旅費	謝金	その他	合計
480,413 円	84,132 円	50,000 円	0 円	5,455 円	620,000 円

共同研究者等

（1）共同研究者（氏名・所属）

Stefanie Mueller・MIT CSAIL, USA

石塚裕己・大阪大学大学院 基礎工学研究科

発表論文等（令和 3 年 3 月 31 日現在）

〔雑誌論文〕

なし

〔著書〕

なし

〔学会発表〕

Parinya Punpongsanon and Hiroki Ishizuka. EdiSensor: Facilitating Food Electricity for Eating Habits Analysis. In proceeding of 2021 IEEE 3rd Global Conference on Life Sciences and Technologies (LifeTech 2021), pp. 108-109, 2021, Nara, Japan.

〔その他〕

なし

外部資金獲得状況・申請状況

JST ACT-X（AI 活用で挑む学問の革新と創成），［採用］2020 年 12 月～2023 年 3 月

参考となるＨＰ等

https://www.sens.sys.es.osaka-u.ac.jp/