Food Printing Technologies out of White Rice

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Abstract

One of killer applications for 3-D Printing 'at home' may be food printing. In Japan and Asian countries, white rice contains suitable properties to be used as the best deposited materials.

In this paper, we describe our trials to use white rice by combining with our original desktop 3D Printer and our original CAE software, and show context-based food applications.

1. Background and Context

Needless to explain, food printing is one of the most attractive fields of personal 3D printing especially 'at home'. Last year, we got lots of news of new food printers that use sugar, chocolate, or egg pastes for printing snacks, cookies, and pizzas [1][2][3][4], based on achievements of academic researches [5][6][7][8][9]. But in Japan, we cannot help applying white rice for food printing as the first priority.

As Asian people, we cannot survive without white rice. For breakfast, white rice and miso soup is a great combination; for lunch, a bento box is easy to carry and reasonably stylish; for dinner, nothing is better than sushi and sashimi with a beer.

So now, white rice is becoming the best material for "3D" printing because its stickiness is suitable for creating a 3D object. Figure.1 shows white-rice based 3D-Object by using molds, which was printed from FDM 3D printer.

Figure 1. a White Rice Object made with molds which was printed with FDM 3D-Printer © FabLab Kamakura (Youka Watanabe and Mio Kato)

2. Machine and Material

In this research, we developed an original food printer which directly deals with rice pastes (not rice itself) as materials. This machine is equipped with a special syringes to use with rice pastes, and air compressor for extruding. This structure was inspired by Fab@Home created in creative machine lab at Cornell university. But we adopted 'delta (otherwise, a parallel link structure) machine', because it is easy to attach and detach syringes for exchange/refill materials.

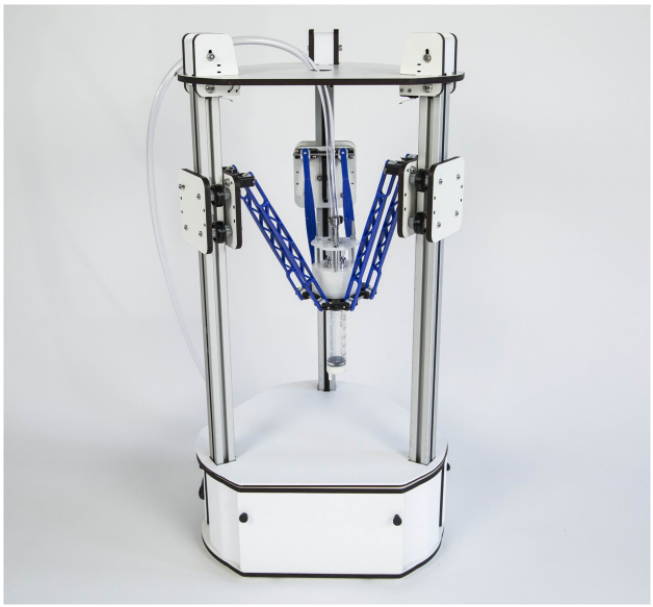
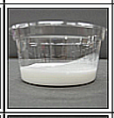


Figure 2. White Pastes Printer (Moeka Watanabe, Hiroya Tanaka Laboratory, Keio University) A video is shown at https://vimeo.com/85742975

Rice powder should be combined with some portions of water. Figure3 and Figure 4 shows our experiments to find out the best mix of rice pastes and water. It's impossible to eat rice pastes directly. So, it's necessary to oven it after printing for eating. As a result, the texture of food is very similar to MOCHI; rice cake, or UDON; Japanese noodle. Figure 5 shows one examples of food-printing-based cooking.

	上新粉	上用粉	徐細米粉	幼児粉	みじん粉
Water(%)	150	150	150	300	150
OutPut (CC)	30	30	8.7	4.2	2.8
Printed Out					
5 Minutes Later					

	白玉粉	もち粉	道明寺粉	寒梅粉
Water(%)	100	100	100	200
OutPut (CC)	30	6.2	–	–
Printed Out			Impossible to extrude	Impossible to extrude
5 Minutes Later			Impossible to extrude	Impossible to extrude

Figure 3. Experiments on Rice Pastes made from Rice powder and water for 3D Printing (Moeka Watanabe, Hiroya Tanaka Laboratory, Keio University)

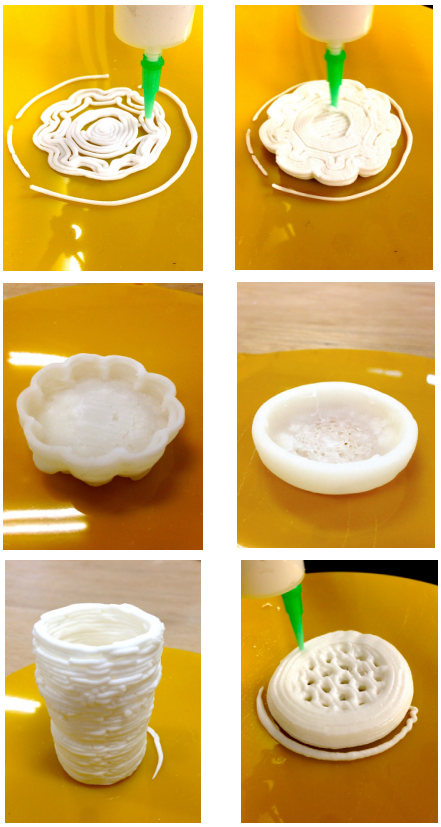


Figure 4 Rice Pastes Printing

Figure 5 Rice Pastes Printing

Other applications are shown in Figure.6. Printed edible cups, plates and bowls are suitable for Japanese style dinner, because we have a culture in which we drink soup at the end of a dinner course. For the future dinner, we would eat all forks and spoons made of rice with soup. We won't have to spend our time washing dishes after dinner any more. This application is inspired by the Japanese designer unit "Smile Park." Figure 7 is a shot from one of their movies for the future dinner.

Fig.6. Edible objects (Moeka Watanabe, Shigeki Shimizu, Takumi Moriya, Hiroya Tanaka Laboratory, Keio University)

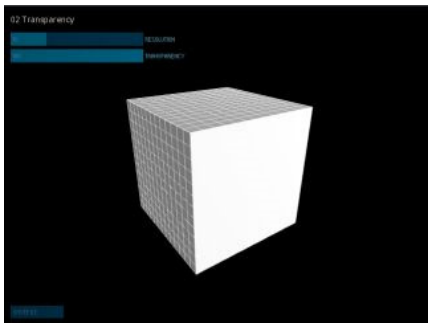
Fig.7. KUP by Smile Park : https://www.youtube.com/watch?v=FhiZGNzv06k

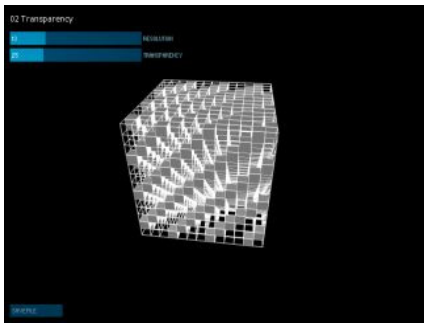
3. Software

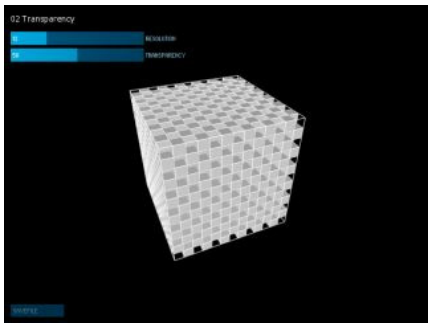
We have been developing Voxel-Based 3D CAD/CAM/CAE for many years. Food printing is one of application fields of our voxel software. Voxel-Based software enables us to design both 3D internal structure and 3D surface texture at the same time. It's very suitable for food printing, and food culture in Japan as well. Especially about white rice, we have thousand's year history of ONIGIRI (a rice ball). ONIGIRI is the most popular food in Japan. A chef who can adjust delicate hardness and softness of white rice ball is respected by all others.

Our software called "VoxEffects" enables us to adjust delicate hardness and softness of white rice ball (and even rice cube, rice tetrahedron, rice bunny and so on) in computational ways. "VoxEffects" is available at http://cfg.sfc.keio.ac.jp/

The software imports STL shape data and converts it to 'Voxel' model automatically, and users can design an internal structure by changing density/ transparency of an object (Figure8 and Figure 9). VoxEffects is compatible with VoxCad, which was developed by Dr. Jonathan Hiller in creative machine lab in Cornell, directed by Dr. Hod Lipson. VoxCad works as the fastest voxel-based FEM environment. This method would explore new possibilities of high quality food printing. Figure.10 shows the result of Voxel-based food printing.







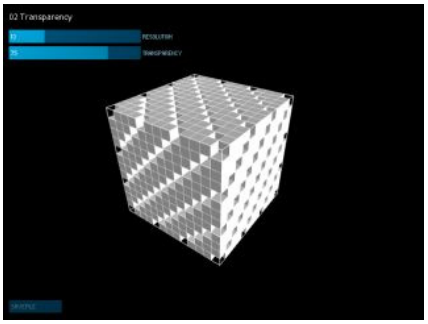
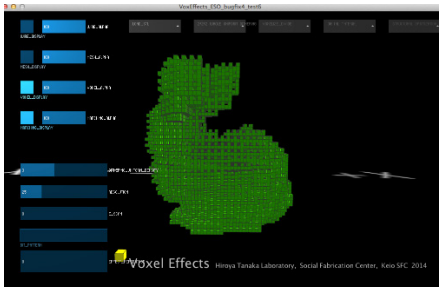


Figure 8 Control of internal structure



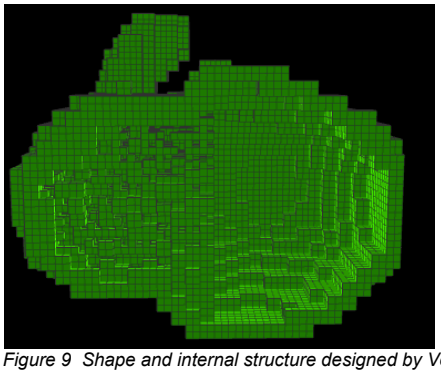


Figure 9 Shape and internal structure designed by VoxEffects

4. CNC flakes Plotter on white rice

In cooking, looking is as important as tastes. It makes people happy. In Japan, Bento is a domain in which people are competing visual qualities of food. In general, there are two different types of Bento; a partition type and a layer type. In a partition type, a small portion of vegetables, fishes and meats are vertically separated into blocks. In a layer type, white rice usually works as a white background canvas. A chef can 'draw' an image with seasoning and spices on it, layer by layer horizontally.

In the context of digital fabrication research, we also developed 'rice seasoning' flakes CNC Plotter for bento. User can import their favorite photo or image, and software automatically convert them to g-code, and the plotter starts to 'draw' patterns. User can exchange different colors of seasoning materials (as micro pellets) .

The video is shown at :
https://www.youtube.com/watch?v=bx8h9-ltJhQ

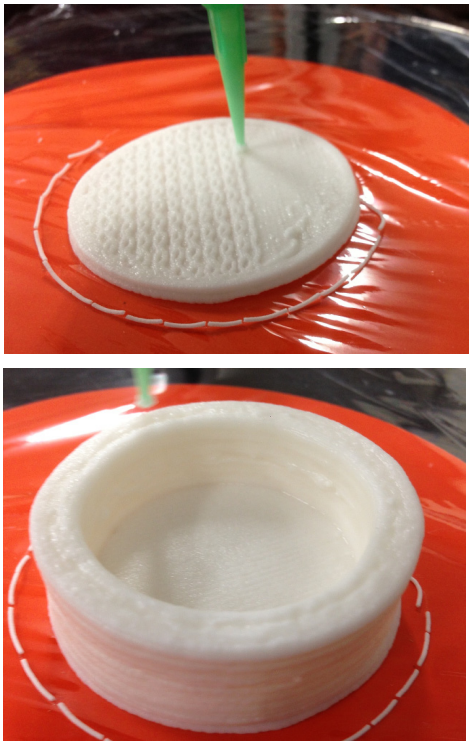


Figure 10 Rice Pastes Printing from Voxel model

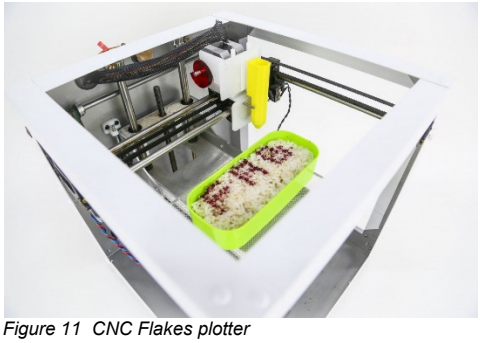


Figure 11 CNC Flakes plotter

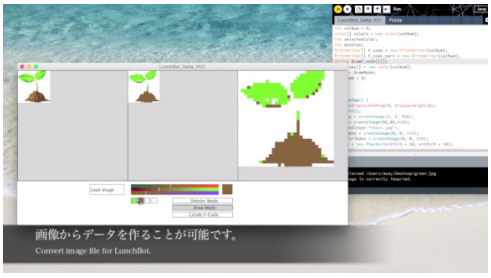


Figure 12 CNC Flakes plotter software

5. Conclusion and future scenario

We introduced our trials for food printings out of white rice. Here let us describe our future scenario from users' perspectives.

"A game-enthusiast boy will craft 3D shapes on his computer by using VoxEffects and collaborate with his mother who will operate a food 3D printer at the kitchen to print his data as food and edible dishes. A younger sister will play with edible small dolls. Grandmother enjoys using CNC plotter with her memorial photos."

For the next step, we are planning to combine our food printer and flakes plotter. Collaboration with recipe-collecting website like CookPad (http://cookpad.com) is also under planning.

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Author Biography

Hiroya Tanaka, Ph.D (Engineering), born in 1975, Associate Professor at Keio Univeristy SFC. The Founder of Fab Lab Japan. His research interests cover from 3D CAD/CAE/CAM to a novel 3D Printer. He is now leading the research team of Center of Innovation Programs in Japan, as a director of Keio University Social Fabrication Laboratory.
Atsushi Masumori is a visiting researcher in the lab. Yoshihiro Asano and Moeka Watanabe are students in the lab.