

2020年度  
教員研究発表会

# Point Cloud Processing Method for Food Volume Estimation Based on Dish Space

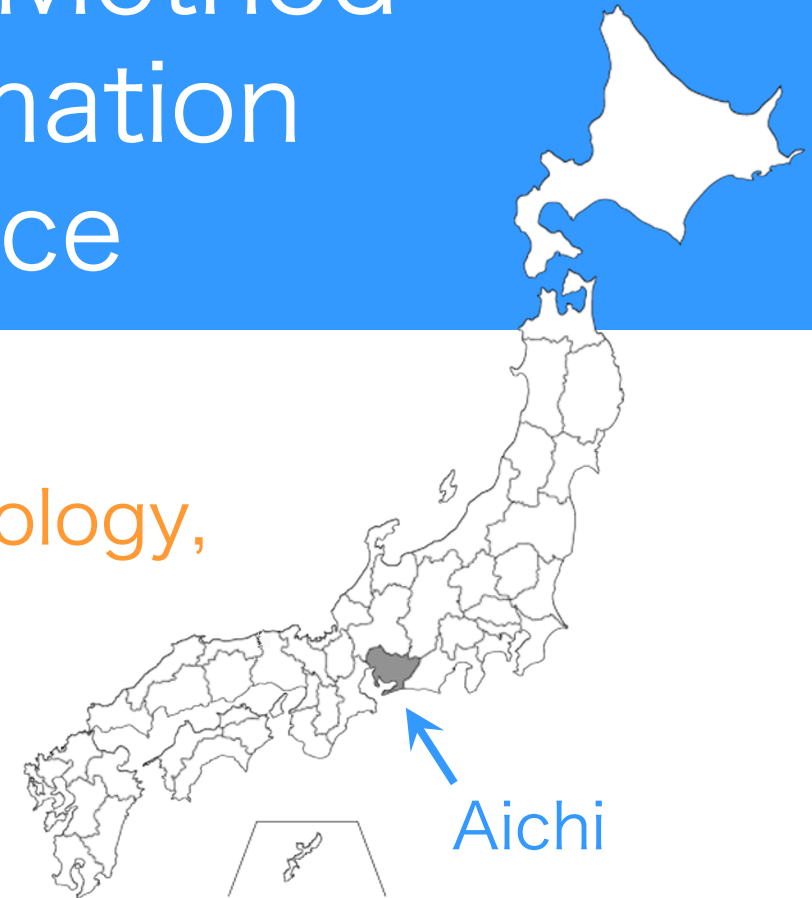
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## Introduction

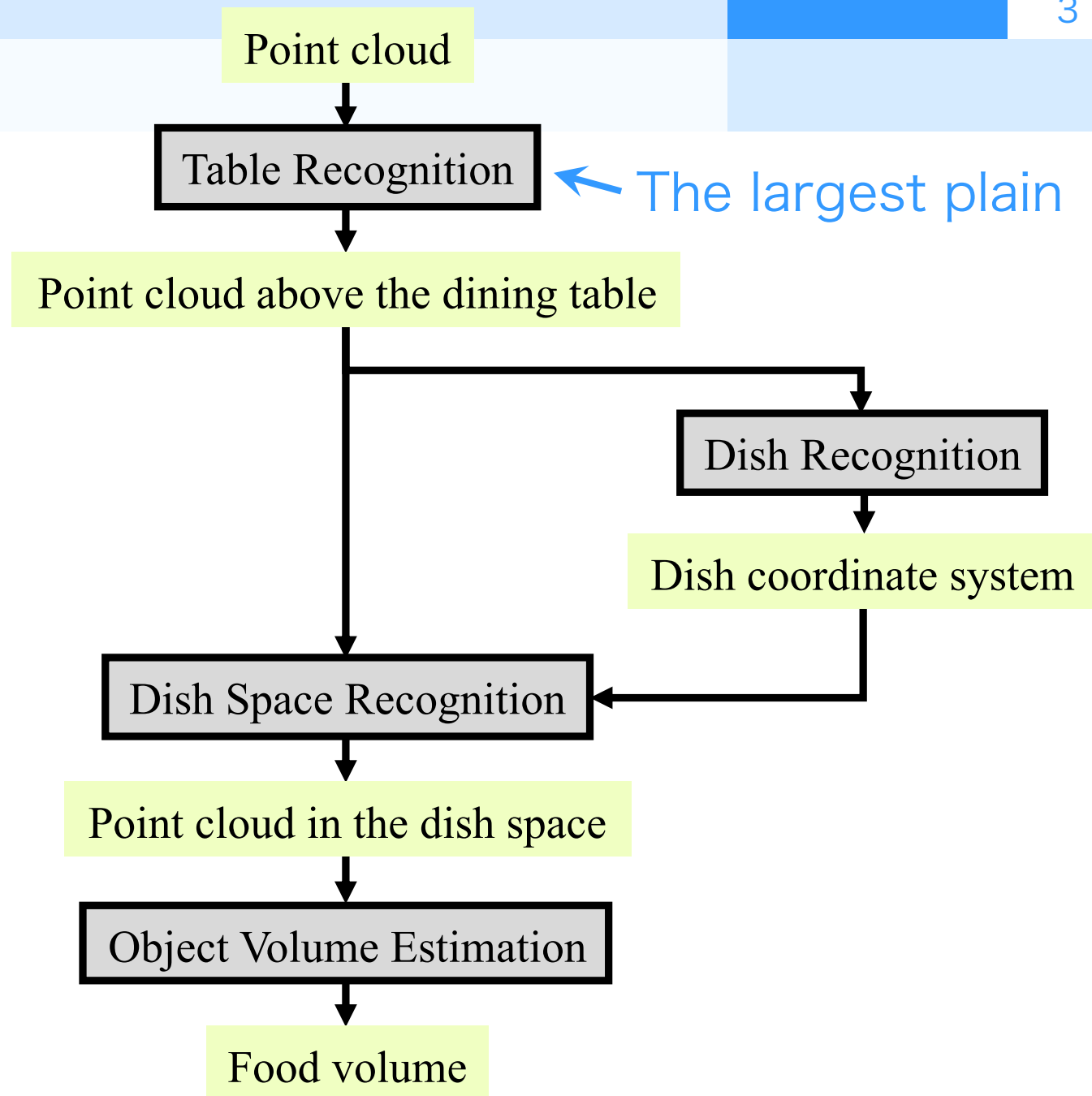
- ★ We have been developing a medication management support system to remind an older person at home.
- ★ The system must estimate the amount of food and recognize the end of a meal to make a reminder at the right time.
- ★ In previous studies, special colored dishes were used.
- ★ A three-dimensional point cloud is a set of points and can be used for object and shape recognition.
- ★ We are attempting to estimate the volume of food based on a point cloud.



A point cloud of a torus

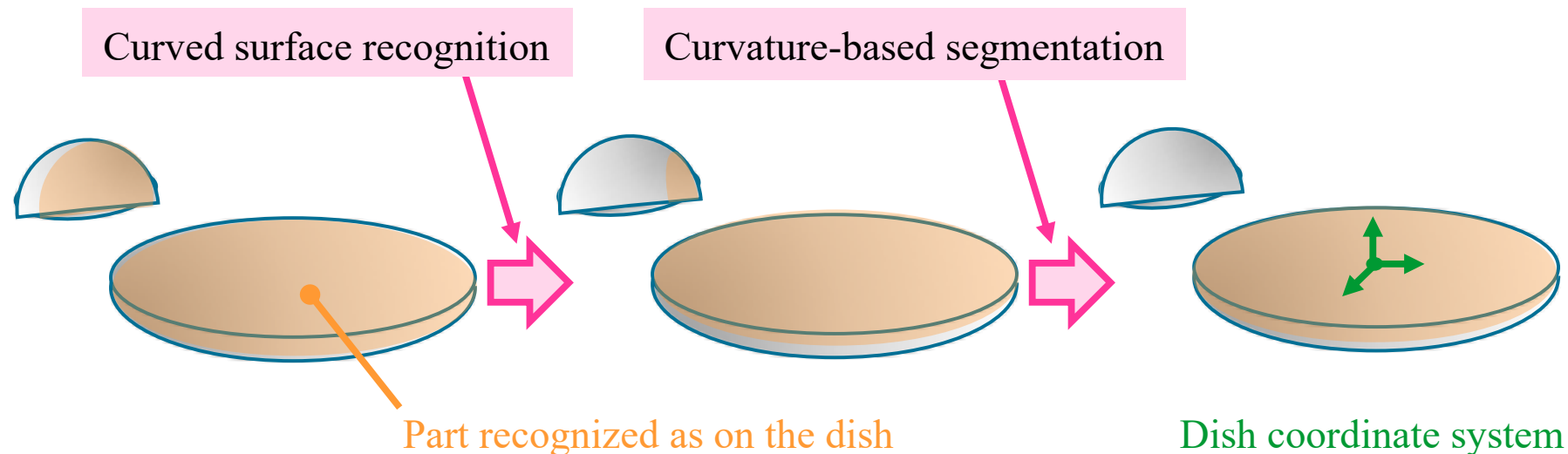
## Proposed Method

- ★ The proposed method mainly consists of four processes.
- ★ In this work, we newly added the Dish Space Recognition process to increase the estimation accuracy.
- ★ In addition, we improved the Dish Recognition process to ignore objects other than dishes.



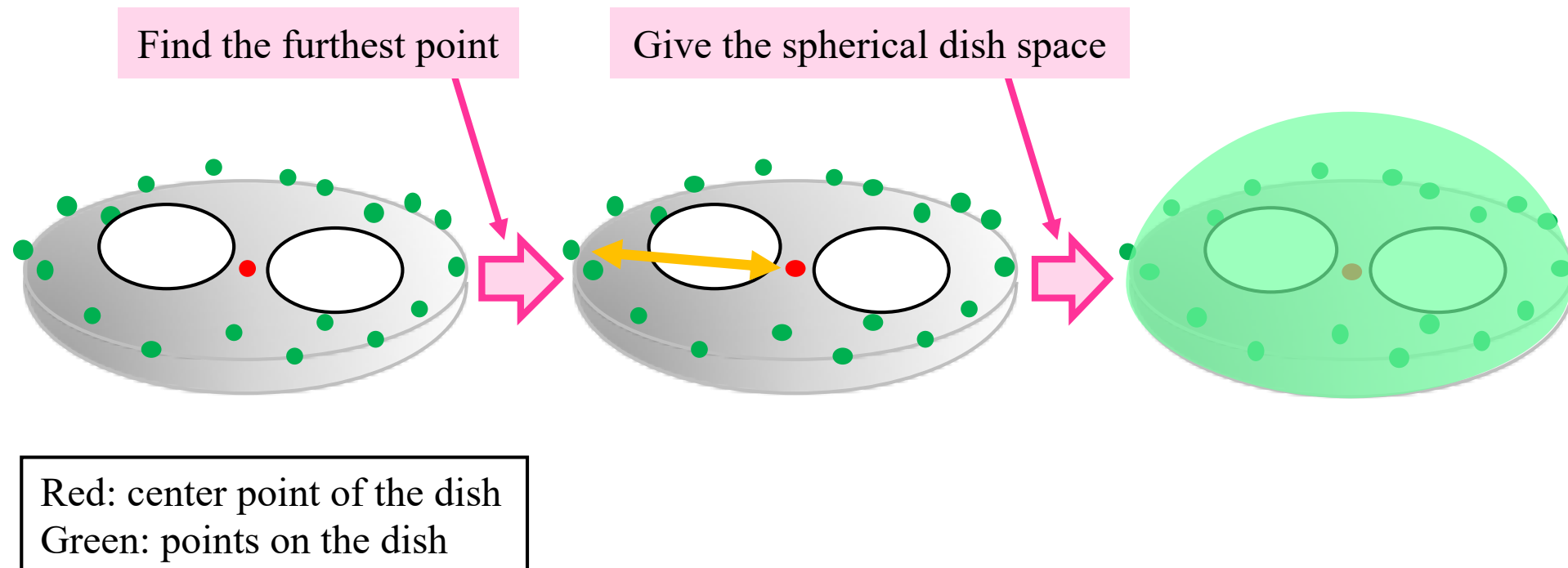
# Dish Recognition

- ★ Dishes are defined as objects with a convex downward curved surface.
- ★ The LMedS method is used to recognize a curved surface.
- ★ The point cloud on the dish and the rest are divided using a segmentation method called region growing.



# Dish Space Recognition

- ★ Spherical space is used to express a dish space.
- ★ A sphere having a radius equal to the maximum distance from the center is obtained as the dish space.



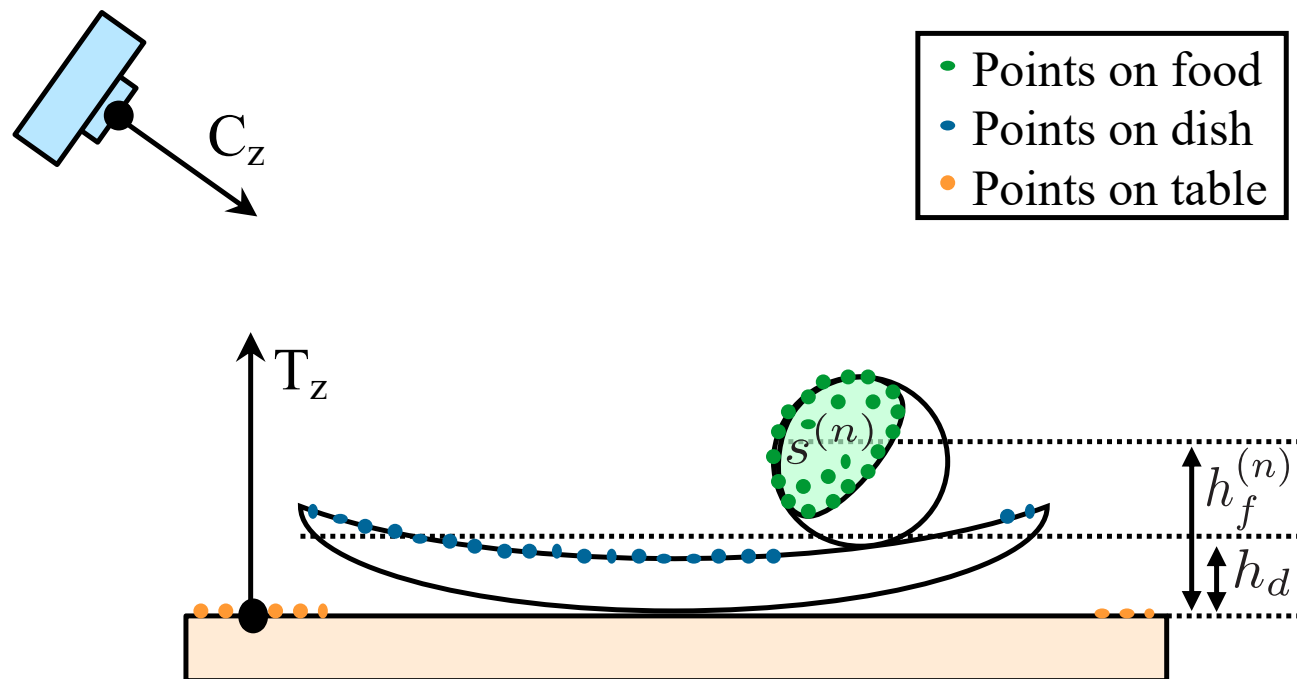
# Food Volume Estimation

- ★ All objects existing in the dish space are determined to be food.
- ★ The area and height of each object are calculated based on the point cloud and multiplied.

$$v^{(n)} = s^{(n)} \times (h_f^{(n)} - h_d)$$

$$v = \sum_{n=1}^N v^{(n)}$$

$N$  : number of segments of food



# Experiments

## Number of Masses – Methods



(a) Four masses

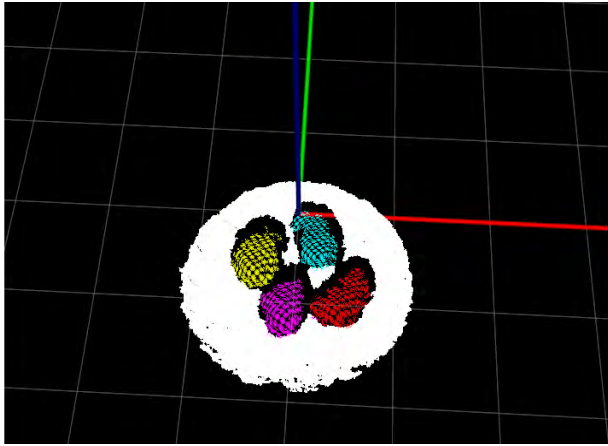


(b) Two masses

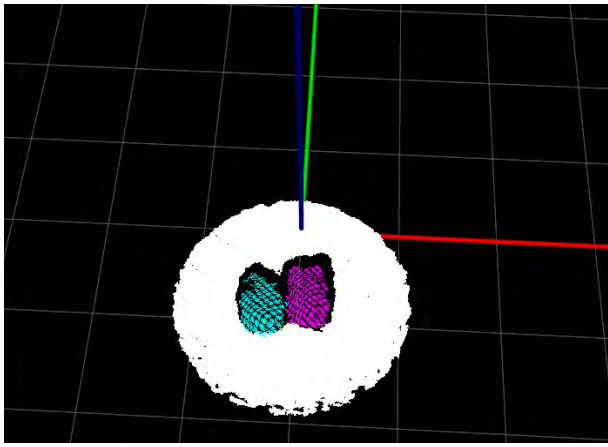
- ★ Astra S (sold by Orbbec) was selected as an RGB-D camera and was fixed on a tripod at 50 cm from the table.
- ★ Clay made from rice was used as mock food.
- ★ Four 100 cm<sup>3</sup> clay masses were made, and the number of masses reduced from 4 to 0.
- ★ Only a dish with clay masses was placed on the table.



# Number of Masses – Results



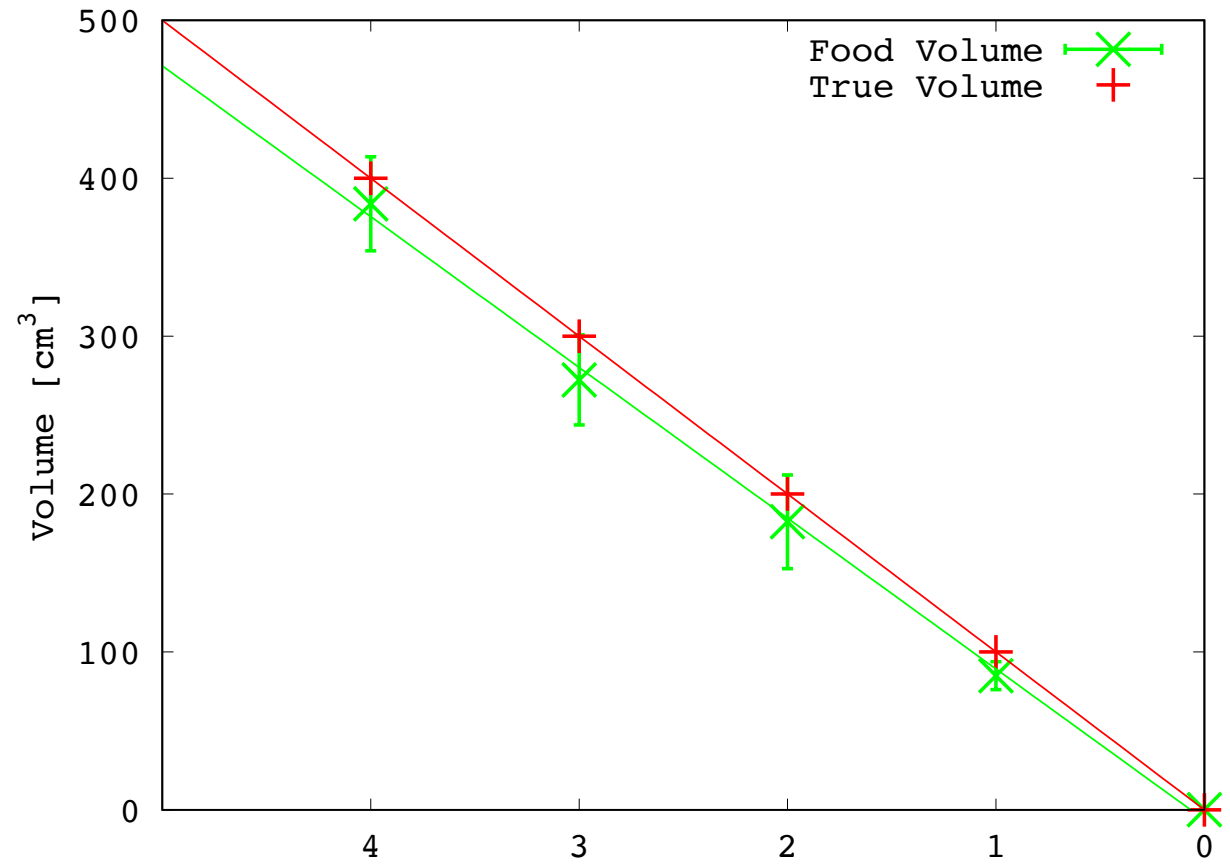
(a) Four masses



(b) Two masses

[Lines]  
 Red: X-axis  
 Green: Y-axis  
 Blue: Z-axis

[Points]  
 White: on dish  
 Magenta: on first mass  
 Cyan: on second mass  
 Yellow: on third mass  
 Red: on fourth mass



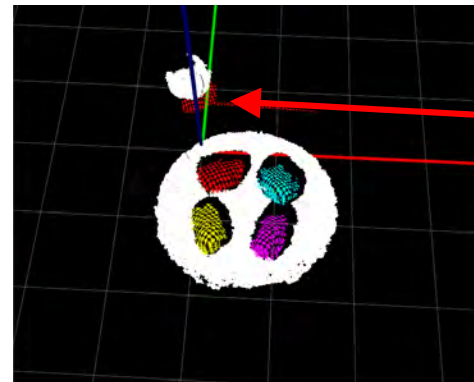
The proportional relationship between number and volume

➡ Meal end recognition

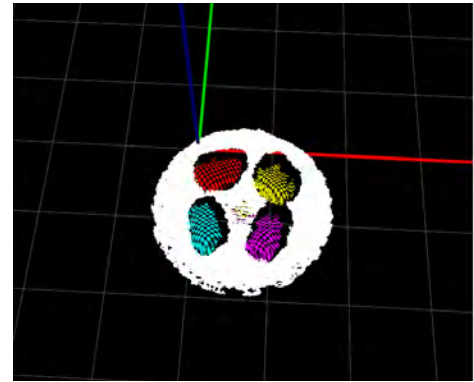
# Effect of Dish Space Recognition

Situation A: without the bowl

Situation B: with the bowl



(a) Without dish space recognition



(b) With dish space recognition

- [Lines]
  - Red: X-axis
  - Green: Y-axis
  - Blue: Z-axis
- [Points]
  - White: on dish
  - Magenta: on first mass
  - Cyan: on second mass
  - Yellow: on third mass
  - Red: on fourth mass

Situation	Dish Space Recognition	Average	SD
A	Without	368.14	18.48
A	With	375.36	18.84
B	Without	414.13	128.54
B	With	322.12	79.57

True: 400 cm<sup>3</sup>

The Standard Deviation of the method with the dish space recognition process is about 60% of that without the process.

## Conclusion

- ★ We proposed a point cloud processing method for stably estimating the volume of food by recognizing the dish space.
- ★ The error rate and stability of estimation still need to be improved, but the proposed method can be used enough to judge the end of a meal for medication management support.
- ★ We are going to improve the method so that the volume of food can be estimated even when many objects are placed on the table.

