Applying Robotics Technologies to Agriculture
- Blueberry Harvesting,
- Plantroid (Plant-Pot Robot System), and
- Fruit Identification

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Tokyo Univ. of Agri. & Tech.
(Human/Living Things) & Robot

- Structure/Control of Human or Animals

- Sophisticated Intelligence in Our Daily Lives
Research in our group of TUAT (Tokyo Univ. of Agri. & Tech.)

- Robot Technologies
  - Success in industries (fixed works, high speed/precision)
  - Future in daily lives (intelligence, complex manipulations)

Points: **intelligence, complex actions**

Learn from Human (structure, information processing, control)

- What we are studying:
  - Structure: musculoskeletal, flexible, manyDOF, ...
  - Info. Proc.: recognition, tidying up, harvesting, ...
  - Control: dynamic, bilateral(operation), autonomous, …
Applications to Agriculture

- Blueberry Harvesting,
- Plantroid (Plant-Pot Robot System), and
- Fruit Identification
Blueberry Harvesting Robot

- Recognizing color & depth of fruits (DepthSense311)
- Measuring softness
- Picking based on easiness of picking

- color + depth (distance) → measuring 3D position of a blue fruit
- Force sensor (strain gauges) → measuring softness of a blue fruit
- Negative pressure control → picking only easy-picking fruits
Blueberry Harvesting Robot

1. **Image processing**
   - Detecting blue area
   - Detecting circular edges

2. **Measuring reaction force when pushed**
   - Force sensor (strain gauge)

3. **Easiness of picking up (by pressure control)**
   - Control negative pressure
   - Case of an easy-to-pick fruit
   - Case of not an easy-to-pick fruit

- **DepthSense311**
  - (color & 3D camera)

**Softness sensing**

**Picking only easy-to-pick fruits**
Blueberry Harvesting Robot

Harvesting

camera view

distance (depth) image

1. がく検出に基づく果実着生方向からアプローチするための位置・姿勢へ移動

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Robotization of Plants

Plant Factory of TUAT (Tokyo Univ. of Agri. &Tech.)

- rooms of seasons (controlling the environment)
- moving plant-pots from a room to another room

Autonomous moving plant pot

Sensors
- temperature
- weight
- brightness
- CO₂
- camera
- etc.

- sensing plant and environment
- autonomous moving according to various conditions
High density to sunny area / replacement

High density

So good!!

replacement

Too cold.

Too hot.
Control based on each temperature

Photosynthetic rate

low → high

Plantroid

low → high

Leaf temperature

Too cold → Good!!! → Too hot

Mizuuchi Lab.
http://mizuuchi.lab.tuat.ac.jp/
Plantroid

Plantroid
Plant pot robots system

TUAT Mizuuchi Lab.
Collecting Information on Growing Fruits

Collecting detailed information during growing

**Identification of Individual Fruits**

fruit A, fruit B, fruit C

Growing log of each individual fruit

sugar content, acidity, size, color, ...

cultivation log

environmental information

PC

Utilizing information

- Improving cultivation
- Sharing know how
- Guiding with quantitative data

producer

data and analysis

• Guarantee of quality
• Individual’s needs of fruits

consumer

Collecting Information on Growing Fruits

Growing log of each individual fruit

Mizuuchi Lab.
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Identification of each fruit of a tree

Using 3D information of the fruit tree

Identification based on measuring 3D positions of each fruit
⇒ movement with wind or growing

Based on connections of branches

Fruit Identification
• No IC tags nor printing
• Robust against movement (wind, growing)
Experiment of a persimmon tree

The selected tree for the experiment

- comparatively sparse leaves
- comparatively small tree
The recognition result

Merged 3D data (point cloud)

Recognized branches and fruits

Converted to 3D graphic data

red: paths without occlusion
green: paths with occlusions
Towards automatic data collection

- Depth camera
- Small computer

View from the drone

Resulting recognized structure

Mizuuchi Lab.
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Summary

- Blueberry harvesting robot
  - Judging ripeness with 3 criteria
- Plantroid (plant-pot robot)
  - Moving to the sunny area
- Fruit identification
  - Based on brunch structure