TJ-SIF ICT Fair IOT-34

For the smart mandarin harvesting in the future

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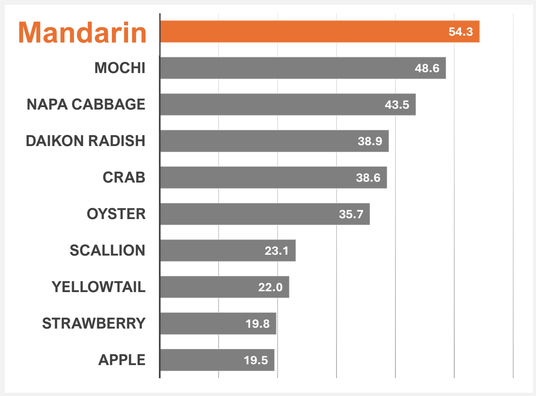
1. Introduction

Japanese Survey in 2023:

What foods do you want in winter?

For aged 15~64,
Multiple answers,
N = 5259

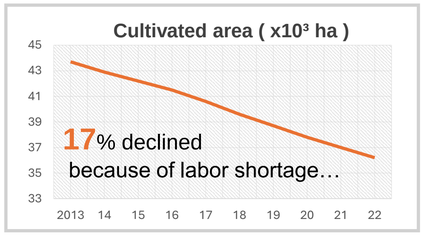
A web research for LINE users

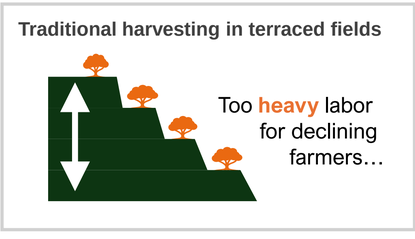


Mandarin (みかん / ส้ม)

- Sweet, small and seedless citrus harvested around winter
- Many varieties and hybrids cultivated and developed in Japan
- A familiar and auspicious fruit since a long ago

Mandarin is the most iconic fruit of winter and have been loved as a familiar sweet fruit as the survey results show. However, with the aging population, the number of farmers is decreasing significantly. The traditional terraced farming method, known as "dandan-batake", is a major burden for farmers.





2. Concepts

Meanwhile, smart agriculture is being promoted worldwide as two example shows. Using drones for pesticide spraying and satellites for harvesting are particularly well-known. Also, from my experience, I have learned about what small drones and image analysis are good/bad at through programming, and I thought that I could make use of these strengths in this project. In addition, if we can use image processing to determine whether mandarins are ready to be harvested, it would lead to more efficient harvesting.

How about using small, camera-equipped, self-driving drones that fly automatically using image processing technology, combining the strengths of both methods? To support it, I conducted experiments mainly, and performed a simulation.

[e.g. 1]
Using **drones** to efficiently spray pesticides **unmanned**

[e.g. 2]
Using **image analysis** to identify colors and harvest crops

What drones are good at:
- Move easily in narrow terraced fields and between objects
- Fly steadily even when high up

What image analysis are good at:
- Quickly and accurately calculate using numbers from images based on conditions

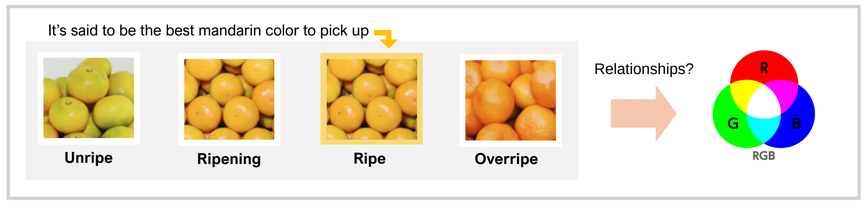
Based on my experience with programming TELLO drones using Python for specific movements

Based on my experience using MATLAB image processing to visualize subtle color differences

3. Research Question

Farmers:
Use comprehensive judgement from experiences

Factories:
Analyze various data obtained through advanced technology



I posed the research question:

How can we decide whether to harvest mandarins only using image analysis?

For Japanese people, the primary criterion for delicious mandarins is their sweetness. And it's related with their ripeness. I needed a way to use images to tell if mandarins are ripe and sweet enough to pick. Farmers have developed their judgment over many years of experience, which is hard to replicate with technology. They can tell when mandarins are ripe by looking at them and feeling them. High-quality optical sensors used for quality control in large farms are also very expensive and technically complex.

However, in both methods, the quality of the oranges is determined by detecting the color of the peel. I thought that some RGB data obtained from image analysis might be related to their sweetness.

4. Experiment

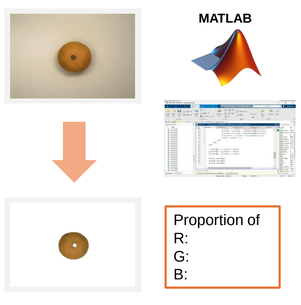
Sweetness

- bought 48 mandarins from same production area
- peel, squeeze the juice, and mix

(using a tea bag to remove the cloudiness from the juice)

- measure sweetness using a refractometer

RGB



- take photos of all the oranges in the same location with consistent lighting
- write and execute a program to standardize the brightness component in HSV to improve accuracy
- Output the number of RGB elements contained in each channel, and based on their total sum, calculate the ratio of the three elements

CORRELATION

Under strictly controlled conditions, we calculated the correlation coefficients between sugar content and RGB values and generated graphs. Since RGB represents the three primary colors, we also calculated the ratios, differences, and products of two values to explore deeper relationships.

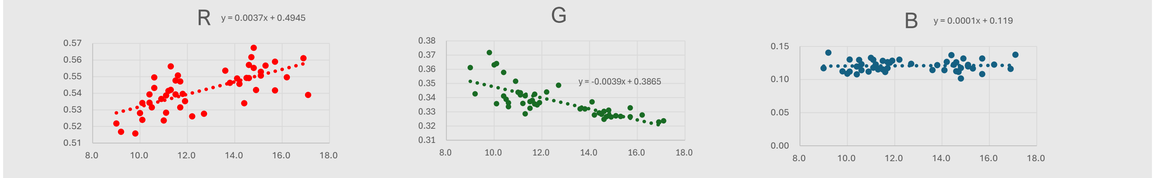
Sweetness with
R, G, B
R/G, G/B, B/R
R-G, G-B, R-B
R*G, G*B, B*R

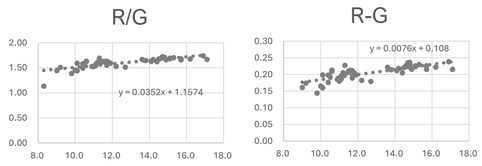
5. Findings

Based on the findings from the experiment, we analyzed the relationship between the RGB ratios and sugar content from various perspectives. This supports our research question, suggesting that we can use color to determine the best time to harvest.

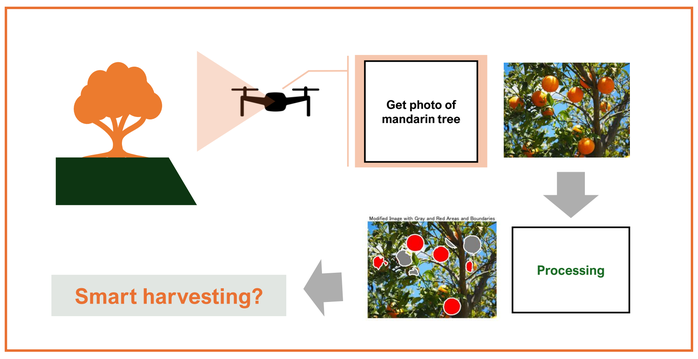
Correlation coefficient with each sweetness

R	0.6732	R/G	0.782776	R-G	0.76365	R*G	-0.44409
G	-0.7526	G/B	-0.32232	G-B	-0.55306	G*B	-0.31998
B	0.0367	B/R	-0.14684	R-B	0.44350	B*R	0.273526





In the data involving the red (R) and green (G) components, a moderately high correlation was observed. This suggests that the sugar content of the oranges can be somewhat determined by their color. Furthermore, it implies that the criteria for deciding when to harvest the oranges could potentially rely on the color elements.



6. Conclusion

Because I found a correlation, I can create a program to mark mandarins that are ready to harvest based on their color. This could be an example of smart farming.
There are still many challenges, but I will continue to learn and use technology effectively. I aim to contribute to regional revitalization, preserve Japanese traditions, and protect the landscape.

References

1. Introduction, 2.Concepts

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3. Research Question, 4. Findings

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5. Conclusions

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