The effect of Color Spaces and Spectra on a Strawberry Prediction Model

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RESEARCH QUESTION

Would data from more color spectrum such as the near-infrared range and data presented in other color spaces improve the performance of the prediction model, in terms of accuracy?

1. INTRODUCTION

The goal is to build a feature selection model, using segmented images of strawberries. From here we want to use different color spaces and spectra to see if we can improve the accuracy of this model.
This is done to reduce food waste. We can namely improve harvest time if we can predict the ripeness accurately.

2. METHOD

- Data Exploration
- Linear Regression as estimation
- Accuracy calculated in mean squared error
- Color conversion to achieve different color spaces. Pros and cons of the 3 used spaces are explained in figure 1.

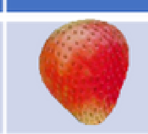
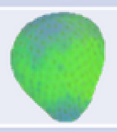
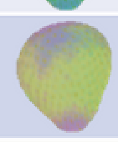
Color Space	Visualization	Pros	Cons
RGB		- Widely used - Easy to understand	- Different per device
YCbCr		- Split chrominance and luminance	- Nonlinear from RGB
Lab		- Linear from RGB - Split chrominance and luminance	- More costly

Figure 1: 3 color spaces with pros and cons

3. DATA

- 12.000 segments
- 305 strawberries with measurements
- 254 ripeness evaluations on segments

In figure 2 an image is shown. Using the provided polygons we can get the segment with the corresponding labels out.

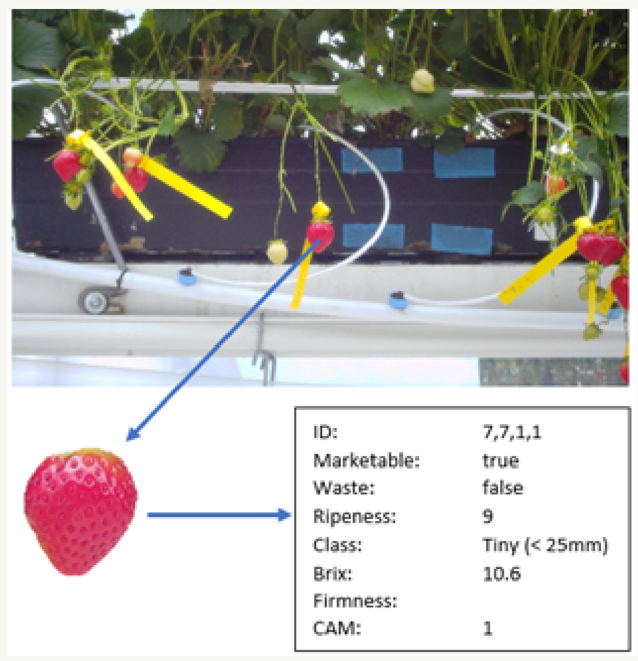


Figure 2: Example of a branch in RGB with a segment and its measurements

4. EXPERIMENTS & RESULTS

Python's OpenCV library [1] was used to achieve the three color spaces from figure 1.
For the linear regression, the Seaborn library [2] was used. This calculates the lowest standard error for a line between all observations.

Regression Metrics:

Color Spaces

- Median of the 3 ripeness evaluations for each segment
- 80/20 train/test split

RGB: Difference between mean red and green pixel value
CIELab: Mean pixel value of a-axis
YCbCr: Mean pixel value of red chrominance layer

Near-infrared (NIR):

- Got 39 segments with ripeness out of the NIR images
- Mean Wavelength used as metric

With the training set the estimation is achieved, which is the red line in figure 3. Using this estimation, the MSE is calculated on the test set. These results are depicted in table 1.

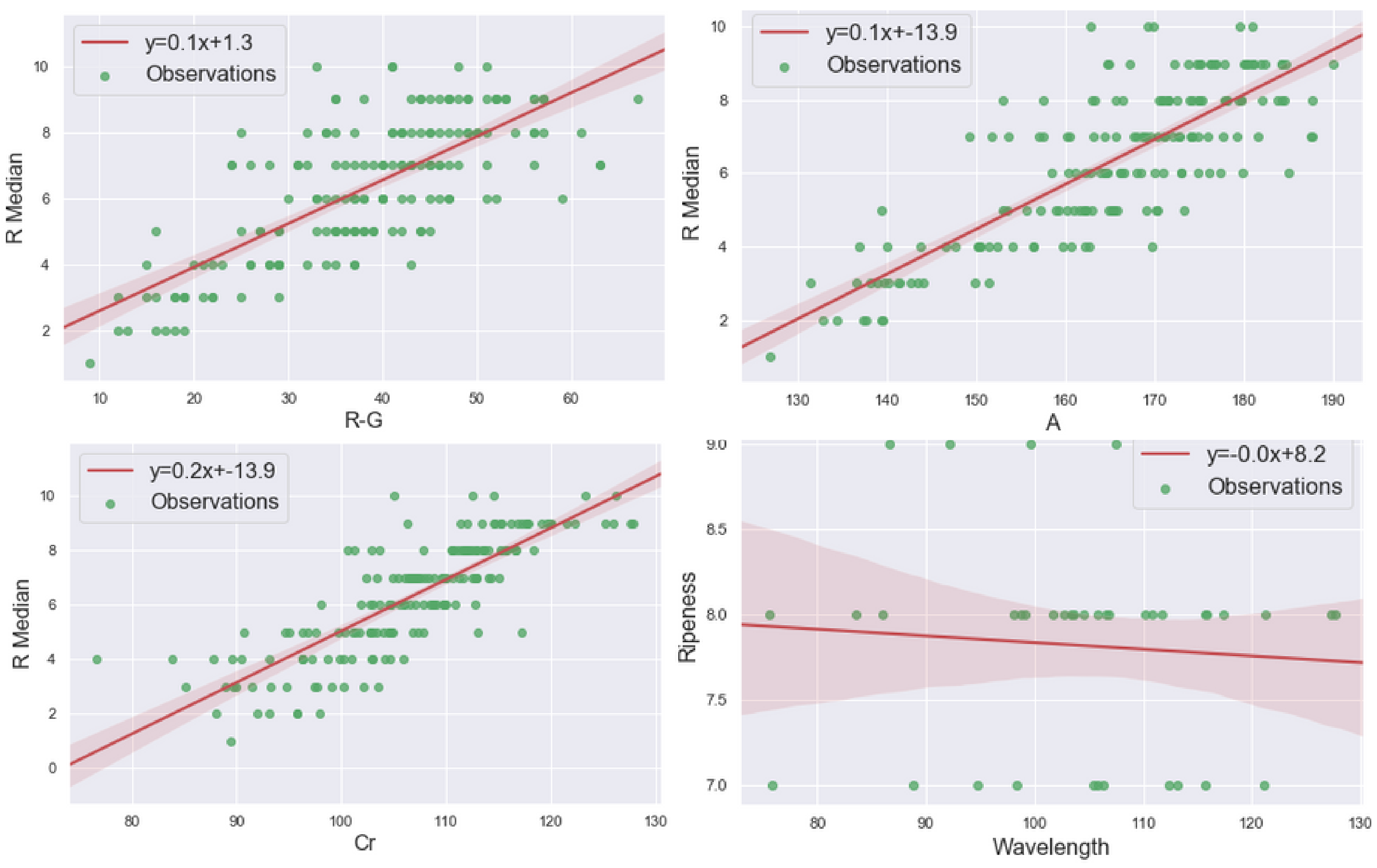


Figure 3: Linear regression of RGB, CIELab, YCbCr and NIR

Results of Linear Regression				
Color Space	RGB	CIELab	YCbCr	NIR
MSE	2.33	1.76	1.35	0.35

Table 1: Results of Linear Regression

5. CONCLUSION & LIMITATION

- CIELab and YCbCr outperform RGB as they seperate the luminance and chrominance. This means that different color spaces can improve the accuracy in this prediction model.
- Near-infrared seems to have a good accuracy, but the linear regression gives a bad estimation. This is due to the fact that only ripeness levels of 7-9 are known from the 39 segments. Therefore, we can conclude that for NIR we don't have enough information to create a propper estimation.

Future Work:

- Look into the effect of NIR and other color spectra when more data is available
- Use more features, like brix and firmness, to improve the prediction model
- Use more color spaces to give a deeper understanding in the effects

REFERENCES

[1] Opencv-python. URL: https://pypi.org/project/opencv-python/.
[2] Michael Waskom. Statistical Data Visualization¶. 2021. URL: https://seaborn.pydata.org/.

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