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Real-World Smartphone Sensing

Team D: BananaCo  
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# Introduction

The Idea

- detecting bananas as bananas via image detection

- detect state of the banana (--> see "how to define ripeness")

- give information of banana ripeness

How to define the ripeness levels of a banana

- criteria (color, structure, ...)

--> what is green/yellow

--> what are dark spots on a banana

--> the general banana ripening process (scientific part)

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Figure 1: Sample Figure

## Intro to bananas

In general, a distinction must be made between *plantains* and *fruit-bananas*. In the context of *BananaCo* project, only the latter is taken into consideration. Both originate from tropical regions in Africa and South America. While fruit-bananas are directly edible, plantains require to be cooked first to be palatable. In opposite to fruit-bananas, plantains are rather angular and thicker. In addition, plantains are coloured pale-yellow, grey or cream; once ripe they are characterised by a violet or black peel.

## Background / Literature review

Maturity stage of fresh banana is important for marketing, for both, dealers and end consumers. In early ripening stages, banana fruits synthesize compounds such as alkaloids and tannins, making the fruit taste bitter and astringent. In progressing stages of growth, the fruit incorporates water, sugars, starches, acids and vitamins, turning from green to yellow, then yellow with brown spots. Finally, starch and acid contents decrease, while sugar increases; alkaloids and tannins disappear, aromas develop. The calorie content remains the same, independent of the degree of maturity.

“To ensure the productivity, competitivity, quality standards, and reliability of banana fruit products, automatic image processing tools based upon intelligent techniques are paramount over visual features methods.” [Mazen2019]

## Maturity assessment

### General criteria

In theory, one can use several aspects to determine the maturity of fruits in general and banana, encompassing:

* size / shape,
* peel texture features,
* degree of hardness (hard / soft),
* starch / sugar proportion,
* smell,
* flavour (blunt / sweetish / sweet) and, of course the
* peel colour (green / yellow / brown).

### Visual criteria

In literature, a lot of methods developed for ripeness classification involve *colour moments* and *colour histogram*. Also, the variance of RGB (Red Green Blue) or HSV (Hue, Saturation, Value) colour spaces of the banana fruit have been utilised for analysis. According to [Mazen2019], the classification of banana fruits as under-mature, mature and over-mature reached an accuracy of 99.1 %. BananaCo focuses onto visual, i.e. image recognition. Suitable aspects include:

* size / shape,
* peel colour,
* development / mottle of brown spots and
* analysis of peel texture features.

## Classification

Regarding literature, one encounters most approaches in classifying the maturity level of fruit-bananas to be based on at least five, more frequent seven or even 15 stages. In the scope of BananaCo project, the smartphone camera is used to scan fruits and determine their maturity based on visuals. To limit the complexity within the boundaries of the project, the granularity is limited to subsequent three ripening stages with according feature aspects (table 1):

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Peel colour** | **Maturity stage** | **Feature Aspects** | | |
|  |  |  | *Stern* | *Fruiting body* | *Tip* |
| 0 | green | unripe | green | green | green |
| 1 | yellow | ripe | yellow | yellow | brown |
| 2 | brown | overripe | brown | brown, at least 50 % of peel surface | brown |

Table 1: Maturity categories

These criteria are used afterwards to manually categorise banana images into three maturity stages (unripe, ripe, overripe, cf. figure 2). The images will then be labelled and fed into the computer vision / neural network, serving as training data.



Figure 2: Banana ripe stages as used for BananaCo classification, from left to right: unripe, ripe, overripe

# Conclusion

Appendix

List of abbreviations

|  |  |
| --- | --- |
| **Abbreviation** | **Explanation** |
| BananaCo | “Banana colour”, the title of the project related to the undertaking of recognising the ripeness of fruit-bananas with the help of computer vision … |
| HSV | Hue Saturation Value colour model |
| RGB | Red Green Blue colour model |

References

[Mazen2019] *Mazen, Fatma M. A., Nashat, Ahmed A. (2019)*, Ripeness Classification of Bananas Using an Artificial Neural Network. Arabian Journal for Science and Engineering 04/2019, 1-10.

[Mendoza2005] *Mendoza, F., Aguilera, J. M., Dejmek, P. (2005)*, Predicting Ripening Stages of Bananas (Musa cavendish) by Computer Vision. Acta horticulturae 682, 1363-1370.

[Prabha2013] *Surya Prabha, D., Satheesh Kumar, J. (2013)*. Assessment of banana fruit maturity by image processing technique. Journal of food science and technology 52(3), 1316-27.

1. [footnote 1] [↑](#footnote-ref-1)
2. [footnote 2] [↑](#footnote-ref-2)