Fruit Color Estimation based on Mathematical Morphology

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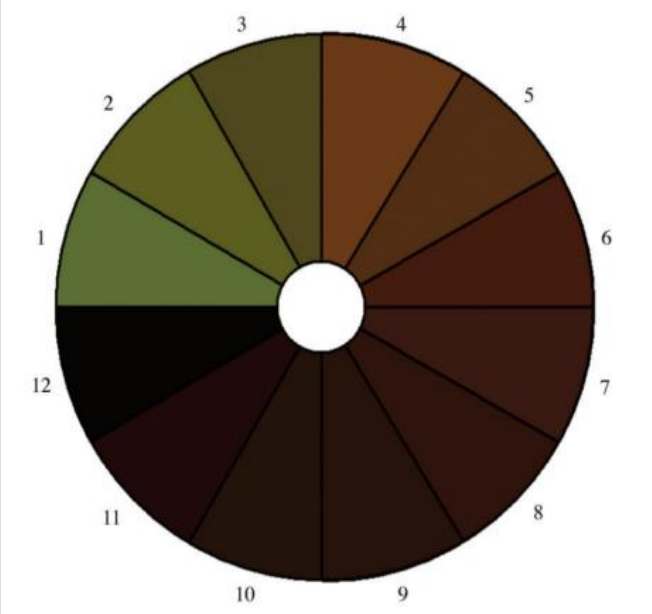
Motivation

- The color is an important parameter to determine fruit maturity.
- For fruit such as grapes, raspberries, olives, among many others, there are color tables associated to fruit maturity.
- The maturity is one of the most important indicators to determine the optimal moment for harvest

Motivation

- In this moment in the vines, there are methods for estimating the mature in the grapes.

- The first is a simple visual estimation, in which a human expert inspects the fruit and assigns a color from a color table. This method is simple, but it is very imprecise and subjective, since it depends on the experience of the human expert.



Motivation

- Instruments called Colorimeters are also used. These instruments allow an accurate estimation of color; however, these kinds of instruments are a high cost.

- This work presents a new approach to color estimation, proposing to consider all central tendency of colors. channels of the color model and to adopt the median for a robust measure of central tendency of colors.

- The need of to estimate one color arises for to compare the color obtained with color chart, but the seed have many colors between green and brown.

- This study is a step to develop an application of low cost and to reach of all.

Outline

- Color estimation based on vector sorting
- Experimentation.
- Results.
- Conclusion.
- Acknowledgment

Color estimation based in vector sorting

- The proposed color estimation method takes the information from the 3 channels of the color model.
- The median of the colors is computed, since it is known that the median is a robust estimator of central tendency in the presence of outliers.
- Also the median is used because of traditional form is obtained after sorting of elements.
- The problem consist of the sorting of colors represented by a vector of three components.

Color estimation based in vector sorting

- Sorting multidimensional data is a complex task.

- The ordering of vectors is part of the problems addressed by Color Mathematical Morphology. Where the final goal is to obtain a minimum or maximum color for functions as to erode and to dilate respectively in an image.

- It is possible to conclude that this problem does not have a single solution, with the proposed approaches being criteria that depend on the particular problem.

- A method proposes in [1], inspired by the behavior of the electrostatic potential for the sorting of colors in the CIE Lab model.

- The color model CIE Lab is adopted because this model is perceptually correct.

Experimentation

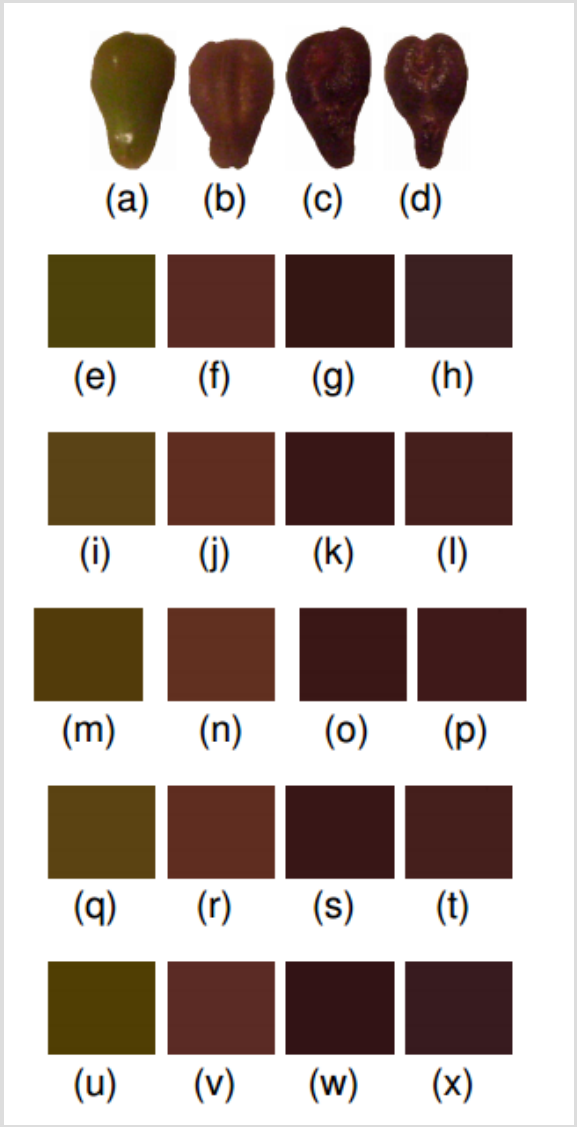
- The experimentation considers seeds of grapes, at different stages of maturity.

- The images are obtained with a digital camera, which are case studies of FONDEF project mentioned at the beginning of the presentation.

- A point of reference or Ground Truth, the color supplied by a human expert is defined as true color. This expert is highly trained in visual estimation of seed color and is the author of pioneering research in this area [2].

- The experimentation considers three typical methods of color estimation reported in the literature: the mean by channel (M1). the mode by channel (M2), the median by channel (M3), and the proposed method which takes the median from all three channels (PM).

Results



- Seed
- Expert Color
- Mean by color channel
- Mode by color channel
- Median by channel method
- Median by Proposed method

Results

Method	Seed 1	Seed 2	Seed 3	Seed 4
Expert Color	[28,-2,33]	[23,21,15]	[12,15,9]	[16,13,5]
Mean by Color Channel	[30,5,30]	[25,21,19]	[13,17,8]	[17,18,10]
Mode by Color Channel	[27,5,32]	[26,21,20]	[13,17,9]	[15,18,9]
Median by Color Channel	[30,5,32]	[25,21,19]	[12,18,8]	[17,18,10]
Median by Proposed Method	[27,2,35]	[24,21,14]	[11,16,6]	[14,15,4]

TABLE I. OBTAINED COLORS.

Results

- While at first glance there is little variation between the colors provided by the different methods, it is observed that the computation of the distance yields significant differences that allow for differentiation between the performances of each method.

Method	Seed 1	Seed 2	Seed 3	Seed 4
Mean by Channel Distance	7,81	2,72	3,34	5,40
Mode by Channel Distance	7,12	4,07	2,40	5,23
Median by Channel Distance	7,54	2,96	3,28	5,14
Median by Proposed Method	4,21	1,85	2,23	3,32

TABLE II. DISTANCE FROM EXPERT COLOR.

Conclusions

- A method for computing the representative color of fruit has been proposed, applied to color estimation of grape seeds.

- The proposed method has three important features.
  - The method considers the CIE Lab uniform color model, which is consistent in terms of color differences and their Euclidean distances.
  - It employs information from all 3 channels of the color model.
  - Adopts a robust estimation of the central tendency of the colors by computing the median.

- Together, these three features significantly improve color estimation compared to the methods reported in the literature

Acknowledgment

Estimación de la Madurez Fenólica de la Uva basada en Imágenes de la Semilla

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References

- [1] Hanbury Allan, and Jean Serra. "Mathematical morphology in the CIELAB space." Image Analysis and Stereology 21.3 (2002): 201-206.

- [2] Fredes Claudio, et al. "Relation between seed appearance and phenolic maturity: A case study using Grapes cv. Carménère." Chilean Journal of Agricultural Research 70.3 (2010): 381-389.

Thanks for your attention

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