Introduction

Grape growers are facing challenges optimizing irrigation and harvest dates due to hotter, drier seasons compressing harvests. Knowing quantitatively in the vineyard:

- Berry volume and homogeneity,
- Berry dehydration (yield loss),
- Bunch and vineyard homogeneity, and
- White grape berry skin colour to decide on optimal harvest window, will help growers and winemakers to make better decisions.

We are developing a smartphone based imaging tool that will help growers to make decisions related to irrigation and harvest in real-time.

Materials and Methods

The study was done in Orange at the Cumulus and See Saw (JJ) vineyards. The grapes studied were chardonnay and Sauvignon Blanc. Six grape bunches were tagged and photographed over a period of four weeks to follow berry size and colour. At each visit, three grape bunches were photographed and then cut from the vine to be analysed. The size and weight of the berries were measured; the berry skin colour was determined using the Dyostem imaging device (vivelys.fr).

Image analysis was done using the Matlab image processing toolbox. A prototype smartphone app was also developed.

Results

Image Analysis: Automatic Detection of Berries

Fig. 1: chardonnay berries detected using Matlab imfindcircle algorithm.

![Image of chardonnay berries detected](image1.png)

Fig. 2 a: volume distribution measured for a chardonnay grape.

![Volume distribution graph](image2a.png)

The volume distribution shows two peaks near 0.65 and 0.8-0.9 cm³ for both the measured and calculated berry volumes. So far we are only sampling about 60% the berries presented at the bunch surface.

Fig. 2 b: volume distribution calculated by the algorithm for the same grape.

![Volume distribution graph](image2b.png)

Fig. 2 c: hue tint angle distribution calculated for the chardonnay grape.

![Hue tint angle graph](image2c.png)

The tint angle is in the 90-100 range suggesting that the grape are not ripe. The Dyostem measured tint angle was 82-100.

Colour Calibration

![Colour calibration graphs](image4.png)

Fig. 4 a: photograph of grape taken in the vineyards
Fig. 4 b: colour-balanced photograph using the colour checker card.
Fig. 4 c: colour-balanced photograph ready for analysis.

Light incidence, time of the day, lighting conditions introduce a colour cast to digital photographs. In order to be able to measure the colour of the berries precisely, this colour cast must be eliminated. This is done by using a calibrated colour card. A picture of the colour card is taken under the same lighting conditions as the grape. Colour correction can then be done based on the known RGB values of the colour card. Squares on the card can be used to calibrate distance.

Future Work

- Testing of compact codes for Android phones.
- Generation of calibration procedures to accommodate varying light intensities, illumination conditions, background colours and viewing angles, to ensure colour accuracy;
- Accuracy of image analysis, by comparison with lab analysis of grape samples;
- Use of machine learning (ie, statistical techniques) to correct for varying conditions, measurement bias;
- User experiences with the system, to ensure simple and robust operation.

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