Developing a Mobile App to Estimate Grape Volume and Colour for Harvest

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Introduction

Recently, mobile Apps using image processing and machine learning have gained popularity for various real-life agricultural applications due to its low cost, portability and ease to use nature. This poster will present an Android App development procedure to extract grape berry volume and colour features to predict a suitable harvest window according to a preferred wine style for large-scale vineyard management. This App detects and segments berries within images based on colour and shape. In practice, automatic brightness control and image correction operations prevent a smartphone camera from determining correct colour information. Consequently, an illumination correction algorithm was developed for determining accurate colour information to cope with variable ambient light conditions associated with field-derived images. Two sets of images are shown in Figure 1: (a) in natural daylight and (b) artificial shade to block the sunlight on the same bunches. Then, the hue colour angle (HCA) is determined for each pixel, which is a measure of berry colour. Depending on the HCA distributions, the approximate colour of the berry is determined. This process can determine correct HCA under different weather condition (i.e., sunny, cloudy or any shade). These HCA and volume information will assist to predict harvesting date and recommendations to grape growers and winemakers.

Method

1. Berry Segmentation

Figure 2 (a) shows an algorithm that was designed for image processing and machine learning flows for white grapes. An important part of the investigation was to locate the grape berries in the image by modelling them as circular objects. This was performed using the Circular Hough Transform (CHT), which is a well-established technique in machine learning for detecting circles. Before searching for circles, we need to fix the parameters CircleRadius (i.e., Rmax, Rmin), ObjectPolarity (i.e., bright/dark), Sensitivity (i.e., 0 to 1) and EdgeThreshold (i.e., 0 to 1) for detecting berries. This technique provides the radius of each berry with centre coordinates and is used to segment each berry.

2. Illumination Correction

The illumination correction technique is shown in Figure 2 (b). For displaying consistent colour, gamma-correction requires an image with standard red, green and blue (sRGB) colour space. The sRGB gamma-corrected image is converted to the CIE XYZ colour space for illumination correction algorithm. Therefore, once the image is corrected by the gamma correction technique and converted to XYZ, a standard illumination correction must take place to transform the color from D65 (i.e., standard illumination conditions) to E (Equilibrium or the same energy at all wavelengths: white light illumination). This process is called chromatic adaption. Then, X and Y components are normalized (i.e., x_w,y_w) and determined the HCA using Figure 3. The only berry with that lie within specific HCA intervals (i.e., 50° to 180°) are selected to determine average HCA. If more data sets on the berry color are available, these upper and lower limits may be adjusted.

Experimental Results

Photographic images were collected for Chardonnay bunches from a vineyard in Gundagai (NSW) for analysis. Figure 4 (a) and (b) show image with natural light and with an artificial shade. The phone app was used to analyse the bunches for the HCA and volume distributions. Figure 4 (c), (d) and (e) show detected, segmented and volume distribution of berry respectively for the image which was captured in natural daylight. Figure 4 (h) (i.e., with illumination correction) shows more consistent HCA compared to the Figure 4(g) (i.e., without illumination correction).

Conclusion and Future Work

The developed smartphone app can analyse the image, detects and samples the visible berries based on local features (e.g., color and shape), and determines the volume and hue distributions of the sampled berries. However, there is a need to conducted further research to predict an optimal harvest window according to the preferred wine style.

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