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A camera and laser system for automatic vine balance assessment.

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http://www.cascrop.com/publications/2011_ASABE_Grocholsky_ACameraandLaserSystem.pdf

Background. A balance between crop weight and canopy volume is a key goal for vineyard management and production efficiency. Traditional methods for measuring canopy performance, such as manual counting of clusters and destructive cluster weight measurements, are very labor intensive and may not accurately reflect vine-to-vine variability within a vineyard. We demonstrate an automated system for estimating crop weight and canopy volume which uses cameras and laser sensors attached to vineyard machinery in Traminette, Riesling, and Concord vineyards.

Experimental design. For canopy measurements, two laser scanners were mounted on a vehicle at heights of 0.5 and 1.6 meters (Figure 1). As it moved down the rows, each scanner performed 75 scans per second over a 180 degree field of view, and the scans were used to produce a 3D image of the two acre, high wire (6'') cordon-trained Concord vineyard. Data for specific vines within row were extrapolated based on the time stamp for the scanner's entrance and exit from a row. During the winter of 2009-2010, vines were manually pruned, and dormant cane pruning weights were collected on 1250 vines for comparison to the estimates generated by the scanners.

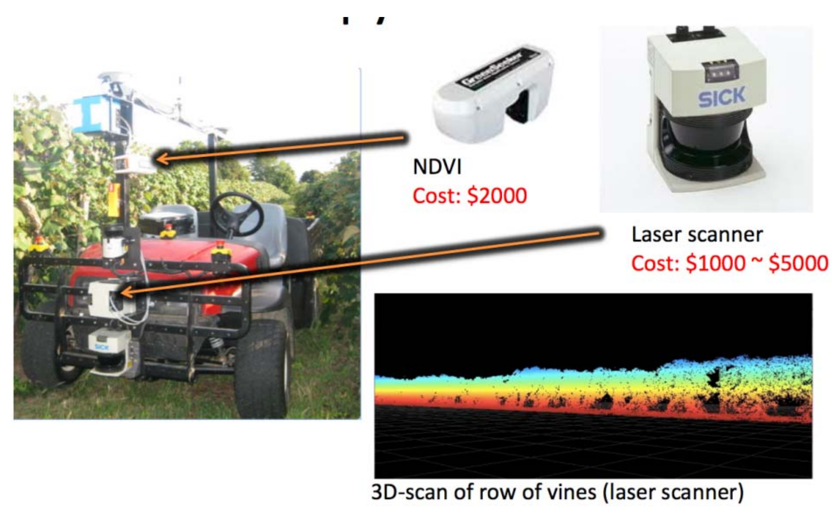

Figure 1: Set up for automated laser scanner canopy measurement.

For crop size measurement, a digital camera (Canon SC200IS) was mounted with halogen lamps on a small vineyard utility vehicle. The halogen lamps improved the lighting in the fruit zone. The camera was set to continuous capture mode, with a resolution of 3264 x 2448 pixels, and the system was used to measure the crop in a total of 244 Riesling and Traminette vines (Figure 2). The vehicle was driven at approximately 0.5 m/sec. The images were processed using an algorithm to detect and count the crop, including the number of clusters per vine, number of berries per cluster, and berry size.

Results. The estimates of canopy volume from laser scanning were strongly correlated with actual vine pruning weights (0.65). For yield estimation, the camera assisted- berry counts were compared to actual harvest weights from the Riesling and Traminette vineyards. Berry counts produced more accurate yield estimates than did cluster counts, because late in the season clusters tend to grow over each other. The camera-based estimates were strongly correlated with the actual harvest weights (0.74). When a mathematical correction factor was applied to calibrate for berries that were out of view or missed by the automated detection, the estimated crop weight was within 9.8% of the actual harvest weight. This exceeds the accuracy possible with current practices that utilize limited sampling within a vineyard.

Figure 2. Imaging for automated crop size measurement.

Conclusions

- This study shows that laser sensing and computer vision can provide high resolution, automated measurements of canopy volume and estimates of crop yield.
- Laser-based volume measurements were strongly correlated with dormant pruning weight, the most common manual metric for canopy volume.
- In 450 meters of vineyard, the estimated crop weight of a row of vines was within 9.8% of the actual weight.

The bottom line: This and other automated approaches will enable vineyard managers to make precise adjustments to vine canopy and yield.

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