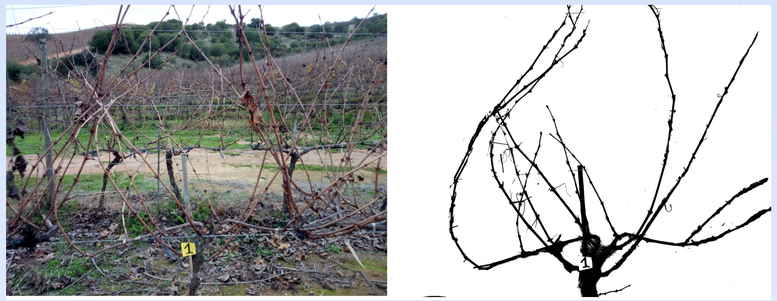
AI for Agriculture: Estimating Vigor on California Vineyards

Maria Pantoja (email@calpoly.edu) & Andres Honeyman (andres.honeyman@inacapmail.cl) & Chris Lupo (clupo@calpoly.edu) & Jean Dodson Peterson(jdodsonp@calpoly.edu)

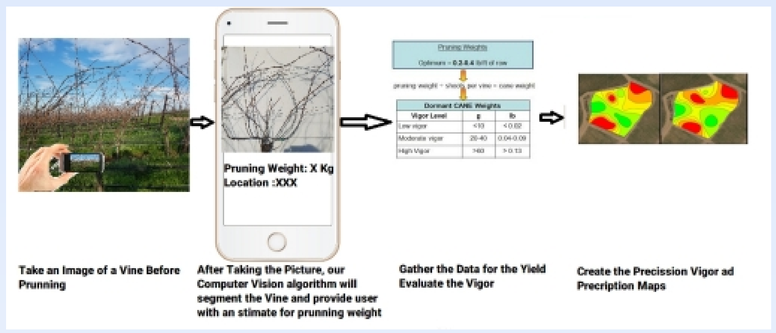
CAL POLY SAN LUIS OBISPO

Abstract

According to the California Department of Food and Agriculture the total investment in AI technology in agriculture was around $5 billions on 2017 and this number is expected to grow even more in the next years [1]. Recent advances in agricultural management have dramatically improved agriculture in California and around the world. These advances are partially due to the ability to adapt to local factors that influence crop yield such as climate, growing region and soil type. As a result, a wide range of plant densities and training/trellis systems are used by growers to optimize harvest practices. In viticulture a primary consideration when selecting the proper trellis system is the vine vigor. Highly vigorous vines require larger trellising systems, more space or a de-vigorating rootstock compared to low-vigor vines. Traditionally the vigor or also known as the vine balance value, estimated using the RAVAZ Index (Ravaz), has been obtained by growers and researchers by manual weighing the pruning and correlating it to the harvest weight. One of the main challenges being faced by the scientific community in viticulture is early yield prediction. Since the pruning happens at specific times, for example in CA is in February, growers can only estimate these values after the pruning months. Another problem with this method is that it requires expensive manual labor, since in order to be effective many samples needs to be taken in different areas in the vineyard to obtain all variations naturally occurring on every vineyards.



a) Original Image b)Vine Segmentation



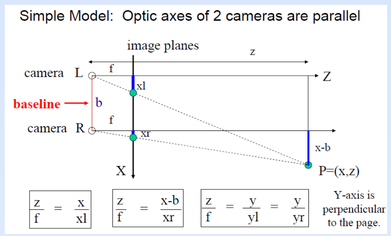
Vigor Estimation Work Flow

- Results will be used to improve the way local growers plan the annual winter pruning, advancing in the transformation to precision viticulture.
- In this paper we describe the process we use to get the segmentation of the vine trees directly from the image using Deep Learning (DL) techniques .

Implementation

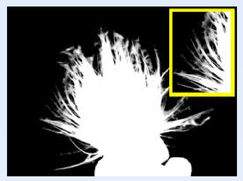
Estimating the balance or vigor in vines, as the yield to pruning weight relation, is a useful parameter that growers use to better prepare for the harvest season and to establish a precision agriculture management of the vineyard, achieving a specific-site planing of the cultural practices like pruning, debriefing or budding. Traditionally this parameter has been obtained by growers by manual weighing the pruning and correlating it to the harvest weight obtained in the same area. Since is a very manual and time consuming task, growers usually obtain this number by just taking a couple of samples and extrapolating this value to the entire vineyard, loosing all the variability present in theirs fields, which leads to loss in grape quality and quantity. In this project we develop a computer vision based algorithm that automatically estimate the vigor of the plant.
Most phones create depth maps to intelligently blur background and create professional portrait effects. In this paper we use the depth maps from smart phones to create trimaps images. A trimap image contains three regions: known background, known foreground, and an unknown region.

Vine Segmentation using Trimap



Disparity to Create Depth Map on Dual Camera Phones

We tested Mask R-CNN [2].The problem is that tree branches are difficult to segment since background pixel color are very similar to the foreground. We need a more delicate segmentation like the solution proposed in [3]-[4].



Sample Result of Segmentation Using [3]-[4]

In [3] the deep model has two parts. The first part is a deep convolutional encoder-decoder network that takes an image and the corresponding trimap as inputs and predict the alpha matte of the image. The second part is a small convolutional network that refines the alpha matte predictions of the first network to have more accurate alpha values and sharper edges.

Results

Vine Segmentation Result

Vigor Maps

Proposed algorithm for segmentation.

- Use the distance tool to make sure the camera is at 1m of the vine
- Capture the image in portrait mode RGB
- Obtain the Depth Map for the previous image
- Create a Trimap using Depth Map.
- Deep Image Matting as based for the DL application
- Create the Vigor Maps
- Provide precise pruning instruction according to the Vigor Map

Conclusions

Agriculture Technologies is a booming industry, according to Forbes magazines the estimates for the USA expense in this industry for next year is 5 billion dollars. This project is one of many projects being develop at CalPoly to help local growers. In this particular project we provide a automatic and easy way for viticulturist to create accurate precision maps of their vineyards.

References

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[4] Weijie Zhao Hongtao Lu Yaoyi Li, Jianfu Zhang. Inductive guided filter: Real-time deep image matting with weakly annotated masks on mobile devices. *Shanghai Jiao Tong University*.