COMP4DRONES

Framework of Key Enabling Technologies for Safe and Autonomous Drones

C4D-UC5-UNISS – Detection of Grape Bunches

Introduction

An early estimation of the exact number of fruits, flowers, and trees helps farmers to make better decisions on cultivation practices, plant disease prevention, and the size of the harvest labor force. The current practice of yield estimation based on the manual counting of fruits or flowers is a time-consuming and expensive process and it is not feasible for large fields. Automatic yield estimation using machine learning and robotic UGV agriculture provides a viable solution. The successful counting of the objects present in the scene depends on the availability of a large number of training samples. An offline detector of grape bunches developed for the UGV rover realized in the C4D project based on a deep convolutional neural network able to detect vine bunches directly on the field will be presented.

Datasets

Two different datasets were used in the study:

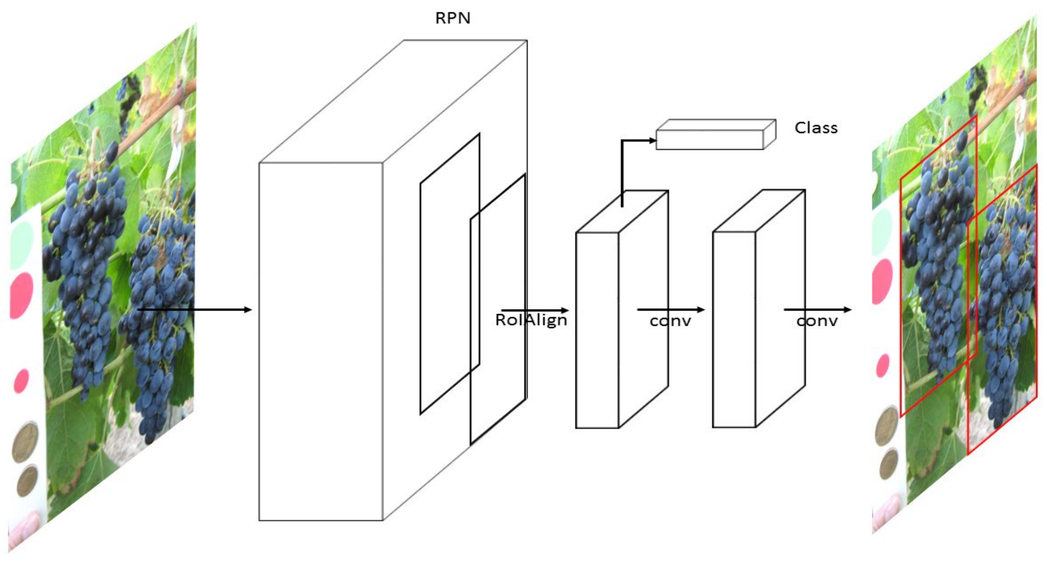
GrapeCS-ML dataset, containing more than 2000 images of 15 grape varieties at different stages of development and collected in three Australian vineyards. The images are divided into five subsets and were used to train the grape detector.

Internal Dataset, containing 451 images of several different grape variety collected all around in Sardinia Island (Italy) and were used to further test the network capability to correctly detect grape bunches of varieties never seen before .

GrapeCS-ML Dataset		
Train	Set 1	1114 images
Validation	Set 2	505 images
Test	Set 3	204 images
	Set 4	242 images
	Set 5	49 images
UniSS Dataset		
451 images		

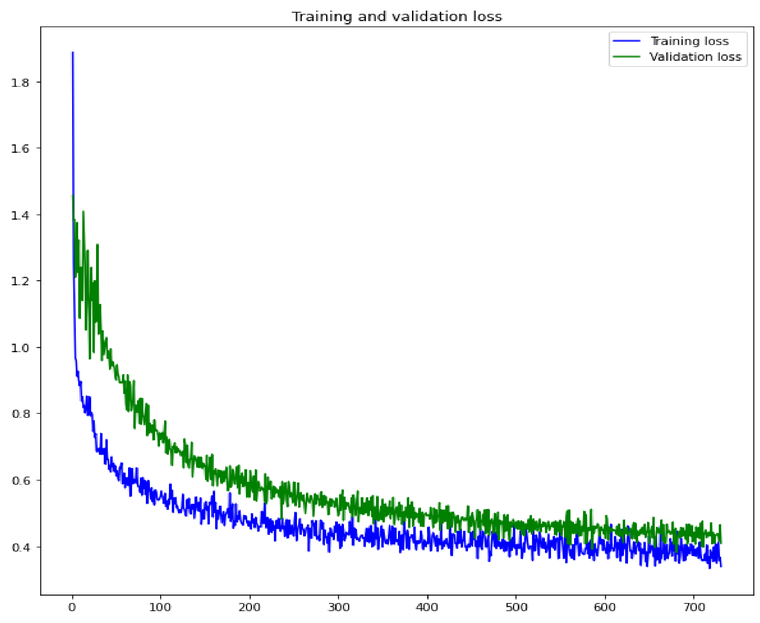
Mask R-CNN framework

The Python implementation of the Mask R-CNN Framework has been trained to detect grapes bunches of different varieties and under different environmental conditions.

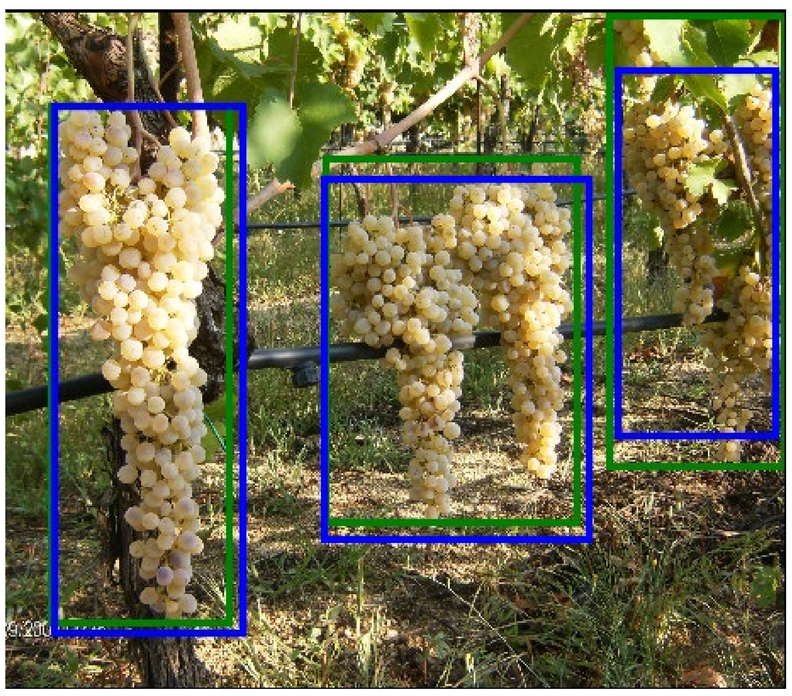


The first stage is called Region Proposal Network (RPN) and is a fully convolutional network trained to estimate the position of bounding boxes. The second stage corrects the RoI misalignments and output the bounding boxes and the segmentation masks of the selected object. In this work, we only trained the system to extract the bounding boxes values while ignoring the segmentation.

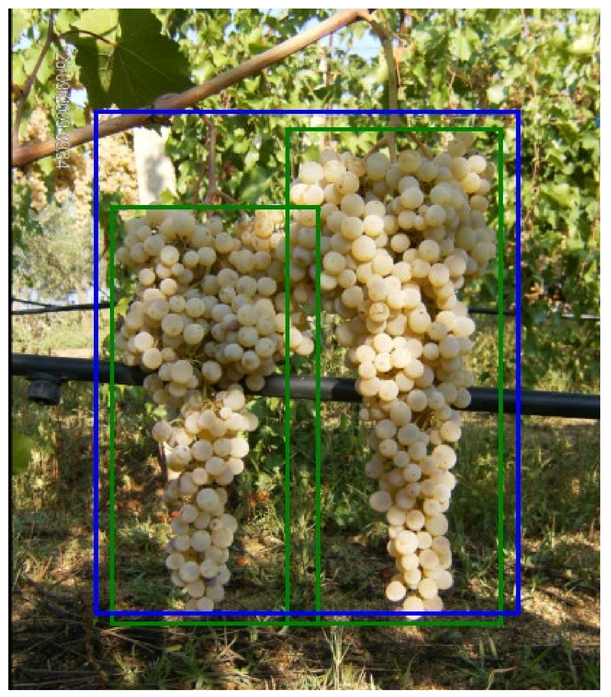
Experimental Results



	mAP
Validation (Set 2)	93.97%
Test (Set 3 + Set 4 + Set 5)	92.78%
Set 3	98.77%
Set 4	89.18%
Set 5	85.64%
Internal Dataset	89.90%



Examples of grape bunches correctly detected (green=annotation, blue=detection)



Examples of grape bunches uncorrectly detected (green=annotation, blue=detection)

Conclusions

The achieved results represent a valuable first step within the activities of the Comp4Drones (C4D) project. Starting from images' collection, it would be possible to more precisely monitor the development of the grapes, estimate the yield in terms of quantity and quality, and predict the appropriate time for harvesting. In C4D the idea is to allow running those types of analysis both off-line and on-line.

Ghiani, L.; Sassu, A.; Palumbo, F.; Mercenaro, L.; Gambella, F. In-Field Automatic Detection of Grape Bunches under a Totally Uncontrolled Environment. Sensors 2021, 21, 3908. https://doi.org/10.3390/s21113908

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