Early forecast of apple and pear yield based on visualisation of tree crown

Denis STAJNKO
University of Maribor, Faculty of Agriculture and Life Sciences, Maribor, Slovenia
e-mail: denis.stajnko@um.si

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Introduction

• The goal of intensive apple and pear growing is the production of regular and abundant quantities of first-class fruits.

• Pome fruits are known on alternative bearing, which requires adjustment of work and storage capacities every year.

• Manual measurements in orchards are time intensive, together with the use of growing curves enables early prediction of the yield on large uniform plantations, while smaller fruit growers are still left without this information.
• Digital technology enables faster and more objective collection and processing of data.
• Modern computer technology is already emerging in agriculture as well and it is present in fruit growing.
• Its special part - artificial vision - is already an integral part of modern fruit sorting and packaging lines,...
• However, the use of visualisation and image analysis for monitoring growth and development of fruits, with special emphasis on early yield estimation is still developing
Challenges

a) Trees are 3D shapes which needs to be captures on 2D. How to capture images and what is the lost of information?

b) Young fruits are small, often green coloured and covered by leaves, brenches and other obstacles. Algorithm?

c) The yield is a function of number of fruits and their weight at harvest. Estimation?
Figure 1. The majority of fruits are growing on the outside the crown, so we assume the 3D canopy as 2D plane. We are sampling only parts of surface.
Figure 2. We need to capture images perpendicularly to the trees and an object with known diameter (tennis ball 65 mm)
Figure 3: By changing the distance between the camera and the tree, we are changing the ratio between pixels/mm.
Algorithm
Labview
IMAQ Vision only on Windows and Mac
Figure 4: Working platform of the algorithm
Transformation of RGB image (top) into its basic colour planes
Red (R)  Green (G)  Blue (B)  Intensity (I)  Hue (H)  Saturation (S)
Red (R)  Green (G)  Blue (B)  Intensity (I)  Hue (H)  Saturation (S)
Red (R)  Green (G)  Blue (B)  Intensity (I)  Hue (H)  Saturation (S)
Red (R)  Green (G)  Blue (B)  Intensity (I)  Hue (H)  Saturation (S)
Histograms
Figure 5. Binarisation after several filtering steps and application of templates.
Result is a number and diameter of fruits.
Figure 6: Sample of growing curves of ‘Fuji’ variety between 2005 and 2009 (Gačnik)
Figure 7: Results of early yield estimation for Slovenia in 2018 (green columns is a difference)
Conclusions

• Image analysis enables modelling of apple and pear fruit development and estimation of the harvested yield under orchard conditions with 90-95 % accuracy.
• Presented algorithm is used for WAPA annual statistics in Slovenia since 2004.
• It has been evaluated also in Austria, Germany, Swiss, Italy and Croatia,
• But, accurate information is not always welcome, as discrepancies between actual yields and forecasts always allow for speculation in marketing
• For broader application (individual farmers) the algorithm needs to be rewritten for Android so it can be used on smart phones or tablets.
Thank you for your attention