frontiers | Frontiers in Plant Science

TYPE Original Research
PUBLISHED 01 December 2022
DOI 10.3389/fpls.2022.1041791

OPEN ACCESS

EDITED BY
Ruirui Zhang,
Beijing Academy of Agricultural and Forestry Sciences, China

REVIEWED BY
Lian Hu,
South China Agricultural University, China
Zhonghua Miao,
Shanghai University, China

*CORRESPONDENCE
Jiangtao Qi
qijiangtao@jlu.edu.cn

SPECIALTY SECTION
This article was submitted to Technical Advances in Plant Science, a section of the journal Frontiers in Plant Science

RECEIVED 11 September 2022
ACCEPTED 10 November 2022
PUBLISHED 01 December 2022

CITATION
Zhang W, Chen X, Qi J and Yang S (2022) Automatic instance segmentation of orchard canopy in unmanned aerial vehicle imagery using deep learning.
Front. Plant Sci. 13:1041791.
doi: 10.3389/fpls.2022.1041791

Automatic instance segmentation of orchard canopy in unmanned aerial vehicle imagery using deep learning

Weirong Zhang[1,2], Xuegeng Chen[3], Jiangtao Qi[1,2]* and Sisi Yang[4]

[1]Key Laboratory of Bionic Engineering, Ministry of Education, Jilin University, Changchun, China, [2]College of Biological and Agricultural Engineering, Jilin University, Changchun, China, [3]College of Mechanical and Electrical Engineering, Shihezi University, Shihezi, China, [4]Institue of Scientific and Technical Information of Jilin, Department of Science and Technology of Jilin, Changchun, China

The widespread use of unmanned aerial vehicles (UAV) is significant for the effective management of orchards in the context of precision agriculture. To reduce the traditional mode of continuous spraying, variable target spraying machines require detailed information about tree canopy. Although deep learning methods have been widely used in the fields of identifying individual trees, there are still phenomena of branches extending and shadows preventing segmenting edges of tree canopy precisely. Hence, a methodology (MPAPR R-CNN) for the high-precision segment method of apple trees in high-density cultivation orchards by low-altitude visible light images captured is proposed. Mask R-CNN with a path augmentation feature pyramid network (PAFPN) and PointRend algorithm was used as the base segmentation algorithm to output the precise boundaries of the apple tree canopy, which addresses the over- and under-sampling issues encountered in the pixel labeling tasks. The proposed method was tested on another miniature map of the orchard. The average precision (AP) was selected to evaluate the metric of the proposed model. The results showed that with the help of training with the PAFPN and PointRend backbone head that AP_seg and AP_box score improved by 8.96% and 8.37%, respectively. It can be concluded that our algorithm could better capture features of the canopy edges, it could improve the accuracy of the edges of canopy segmentation results.

KEYWORDS

deep learning, instance segmentation, orchard, canopy, convolutional neural network, unmanned aerial vehicles