基于改进 YOLOv7 的油茶果采收机器人树干检测方法

刘洋

（中南林业科技大学 410018）

摘要：

树干检测与识别是油茶果采收机器人的关键技术之一。传统的油茶果采收机树干检测方法主要依赖采收操作员的视觉判断，然而这样存在较大的识别误差和采收振动点错误定位的问题。基于视觉感知的树干检测与识别能够帮助油茶果采收机器人在非结构化环境中准确高效地检测和定位振动或采摘点。本文提出了一种基于改进 YOLOv7 网络的油茶果树干检测与识别方法。首先，在 YOLOv7 的主干层中添加了注意机制模块，以增强识别算法对树干的特征提取，从而使识别网络更专注于目标物体的检测。其次，设计了一种基于 Facol-EIoU 的加权置信度损失函数，用于替换 YOLOv7 网络中的原始损失函数，从而增强了油茶树干检测与识别的性能。最后，研究团队对 YOLOv3、YOLOv4、YOLOv5、YOLOv7 和改进的 YOLOv7 模型进行了树干检测对比实验。实验结果表明，本文提出的方法在油茶树干识别上取得了显著的成绩。平均精度达到了 89.2%，召回率达到了 0.94，F1 值为 0.87，平均检测速度为 0.018 秒/张，超过了 YOLOv3、YOLOv4、YOLOv5 和 YOLOv7 模型的表现。改进的 YOLOv7 模型表现出色，能够使油茶果采摘机器人在无结构的果园中有效地检测树干。这一方法能够为油茶果采收机器人的发展提供了有力的技术支持。

Abtract:

Trunk recognition is a critical technology for Camellia oleifera fruit harvesting robots, as it enables accurate and efficient detection and localization of vibration or picking points in unstructured natural environments. Traditional trunk detection methods heavily rely on the visual judgment of robot operators, resulting in significant errors and incorrect vibration point identification. In this paper, we propose a new method based on an improved YOLOv7 network for Camellia oleifera trunk detection. Firstly, we integrate an attention mechanism into the backbone and head layers of YOLOv7, enhancing feature extraction for trunks and enabling the network to focus on relevant target objects. Secondly, we design a weighted confidence loss function based on Facol-EIoU to replace the original loss function in the improved YOLOv7 network. This modification aims to enhance the detection performance specifically for Camellia oleifera trunks. Finally, trunk detection experiments and comparative analyses were conducted with YOLOv3, YOLOv4, YOLOv5, YOLOv7 and improved YOLOv7 models. The experimental results demonstrate that our proposed method achieves an mAP of 89.2% , Recall Rate of 0.94, F1 score of 0.87 and Average Detection Speed of 0.018s/pic that surpass those of YOLOv3, YOLOv4, YOLOv5 and YOLOv7 models. The improved YOLOv7 model exhibits excellent trunk detection accuracy, enabling Camellia oleifera fruit harvesting robots to effectively detect trunks in unstructured orchards.