

基于无人机视觉的轻量级野火烟雾监测算法

李冠逸¹ 程朋乐^{1*} 刘晓东²

(1. 北京林业大学工学院 北京 100083; 2. 北京林业大学生态与自然保护学院 北京 100083)

摘要: 森林火灾对人们的生活环境造成了严重影响。目前, 无人机能够快速检测森林火灾。但由于无人机上处理能力有限, 烟雾检测算法的准确性较低, 处理速度较慢。本文提出了一种针对无人机(UAV)图像的早期野火烟雾检测系统, 利用改进的YOLOv7模型(称为YOLOv7-MS, Modified Smoke)。使用现有的无人机图像, 整理了一个包含4000多张野火图像的数据集。我们的方法引入了几项改进。首先, 我们提出了一种新颖的3FIoU损失函数, 以提高训练过程中的稳定性和加快收敛速度。其次, 我们通过采用FasterNet技术优化了主干网络, 以减少参数数量并提高检测速度。第三, 我们通过实现渐进特征金字塔网络(AFPN), 解决了非相邻层之间间接交互带来的信息损失和质量下降问题。最后, 我们将三维注意力机制整合到网络中, 以增强对目标的关注。实验结果显示, 我们的YOLOv7-MS方法在自定义图像数据集上进行评估时, 平均精度(mAP)达到了79.3%, 同时保持了175 fps帧率, 优于其他单阶段目标检测器。

Lightweight Wildfire Smoke Monitoring Algorithm Based on Unmanned Aerial Vehicle Vision

Guan-Yi Li¹ Peng-Le Cheng^{1*} Xiao-Dong Liu²

(1.The school of Technology, Beijing Forestry University, Beijing 100083; 2. School of Ecology and Nature Conservation, Beijing Forestry University, Beijing 100083)

Abstract: Forest fires have a serious impact on people's living environment. Currently, drones enable rapid detection of forest fires. Due to the limited processing capabilities of onboard drones, the accuracy of smoke detection algorithms is low, and the processing speed is slow. This paper proposes an early wildfire smoke detection system designed for unmanned aerial vehicle (UAV) images, leveraging a modified YOLOv7 model, termed YOLOv7-MS (Modified Smoke). A dataset of more than 4,000 wildfire images was curated using existing UAV imagery. Our approach introduces several advancements. First, we propose a novel 3FIoU loss function to enhance stability and expedite convergence during training. Second, we optimize the backbone network by employing the FasterNet technique to reduce the number of parameters and increase the detection speed. Third, we address information loss and quality degradation problems by implementing the Asymptotic Feature Pyramid Network

(AFPN) to counter indirect interactions between non-adjacent layers. Finally, we integrate a three-dimensional attention mechanism into the network to enhance focus on the target. Experimental findings showcase the efficacy of our YOLOv7-MS method, achieving a mean Average Precision (mAP) of 79.3% while maintaining a frame rate of 175 fps, outperforming other one-stage object detectors when evaluated on customized image datasets.