ICIEA 2022

16 - 19 Dec 22
Chengdu, China

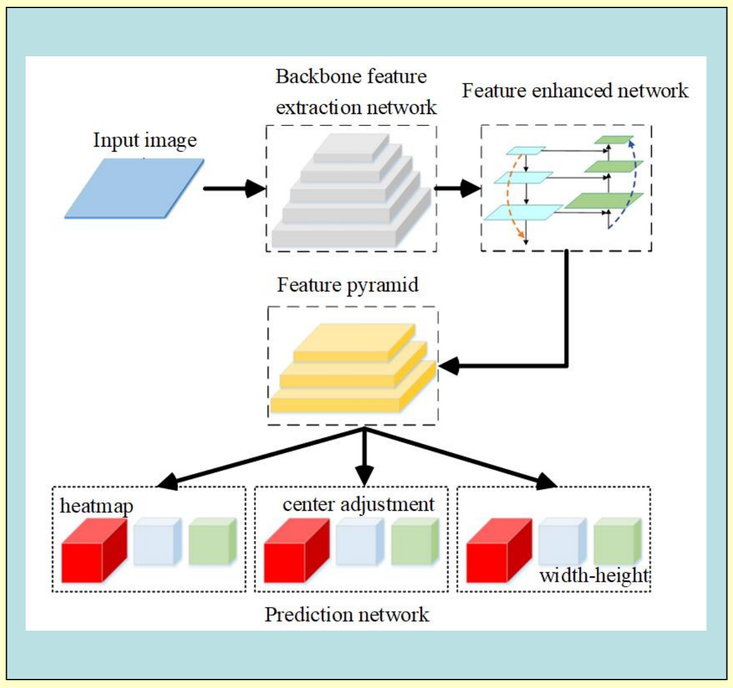
ICIEA22-000221

Research on Single Object Detection Technology Based on Infrared Multi-spectrum Fusion

Yan Zhang, Haojie Deng, Chunling Yang, Xuqiang Yang, Ming Qi, Yuze Li

Harbin Institute of Technology

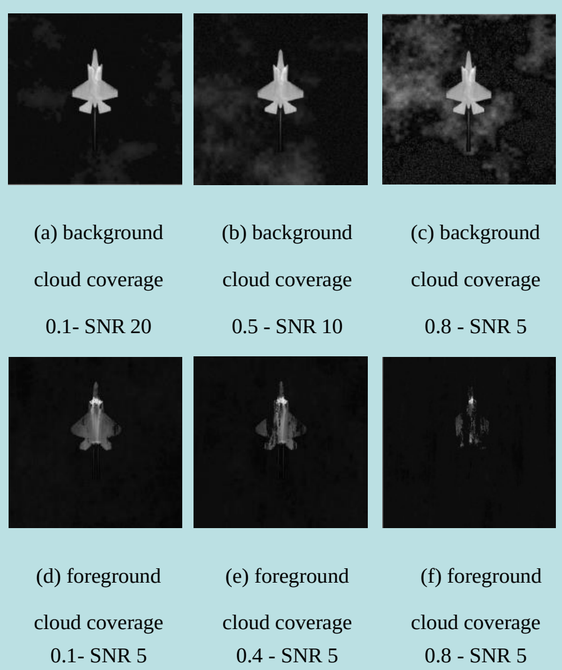
Infrared object detection algorithm based on improved CenterNet



The overall structure of CenterNet-E

For infrared object detection scenarios, a detection network with both accuracy and speed was built. The overall framework is mainly based on the typical anchor-free mechanism of the CenterNet network proposed improved algorithm. First, the appropriate backbone feature extraction network is selected based on the number of parameters, calculation amount and detection accuracy, and an attention module is added to improve the detection performance while giving attention to speed. Then a feature enhancement module is added to fuse the feature maps with different resolutions. The enhancement module is lightweight using a jump connection of large residual edges. Then a single detection head is replaced by a plurality of detection heads for the prediction module, and the prediction is carried out by using the thermal diagram branch auxiliary width-height.

Test results analysis of detection network



Infrared object simulation image

Models	P	R	F1	mAP	FPS
FasterRCNN	88.34%	73.86%	80.00%	83.39%	25
YOLOv4	91.08%	67.64%	77.75%	86.25%	49
SSD	86.96%	68.31%	74.50%	82.98%	33
CenterNet	89.30%	68.83%	77.50%	83.89%	101
CenterNet-E	89.91%	71.34%	79.50%	86.59%	73

CenterNet-E compared to other algorithms

CenterNet-E was slightly less accurate than YOLOv4, but the recall rate of YOLOv4 was much lower than that of FasterRCNN and CenterNet-E (FasterRCNN was less accurate than CenterNet-E). CenterNet-E is ahead of other algorithms in terms of mAP. And the detection speed is only slightly lower than CenterNet algorithm. Based on all detection metrics, CenterNet-E proposed in this paper can balance all detection indexes well and achieve optimal detection results while running at a high frame rate.

Summary

Infrared multi-spectrum fusion technology is investigated to detect single object in this paper. Considering the characteristics of multi-spectral image, the preprocessing algorithms are implemented on the infrared multi-spectral simulation system to enhance short-wave image and filter noise for medium-wave image and long-wave image. After comparison and design, Nonsubsampled Contourlet Transform is selected as the fusion strategy. For infrared object detection scenario, CenterNet-E network based on CenterNet is designed to achieve better performance in detection speed and accuracy. Its backbone feature extraction network is resnet50 and integrates attention mechanism, feature enhancement module, and multi-head prediction module. To evaluate the detection performance, Infrared Target Dataset (ITD) is built by means of optical modeling. The experiment results show that the mAP value of CenterNet-E on ITD is 3% higher than CenterNet and the frame rate is 49% higher than YOLOv4.