

Study of Device State Recognition Algorithm Based on Improved YOLOv3

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Abstract

In view of the timeliness and accuracy of traditional state recognition algorithms, this paper proposes an improvement measure for foreground segmentation and target recognition. Foreground segmentation is to model the background information in the scene before recognizing the image, to separate the foreground target from the scene, at the same time to reduce the impact of noise, shadow and other environmental changes as much as possible, and then segment the target through a sliding window strategy. Target recognition is improved with reference to the PRN network and anchorboxes mechanism, and a more advanced clustering k-means++ algorithm is applied. The method has low error rate, high signal-to-noise ratio and fast processing speed. Finally, the proposed improved algorithm is applied to device status recognition, which shows the advanced nature of the algorithm.

Keywords: background model; image recognition; image segmentation; clustering algorithm; algorithm optimization.

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INTRODUCTION

In substations, real-time monitoring of equipment status is required to prevent accidents caused by sudden changes of it. The actual state of the pressure plate and knife gate needs to be accurate in the daily production and maintenance of the substation [1]. Video surveillance has been fully implemented in some modern substations, thus, the control center can observe the real-time status of the production site, including status images such as pressure plates and knife gates.

This paper takes the substation protection cabinet pressure plate as the research object, and uses the foreground segmentation and target recognition technology to process the image. Then, after algorithm optimization, the YOLOv3 method is used to train the equipment state detection model.

YOLOv3 Algorithm Model

Model Characteristics

Since the traditional meter recognition algorithm uses only image processing algorithms, the accuracy is not high [2]. Deep learning target detection technology has been widely used in recent years, and as one of the representative models of target detection, the biggest feature of the YOLOv3 algorithm models is its fast speed and high accuracy, so it is the first choice for real-time image processing.

The characteristics of the YOLOv3 algorithm model are: drawing on the residual network structure, forming a deeper network level and multi-scale detection, which improves the detection effect of mAP and small objects [3]. If COCO mAP50 is used as the evaluation index, the performance of YOLOv3 is quite amazing. In the case of equivalent accuracy, the speed of YOLOv3 is 3 or 4 times that of other models.

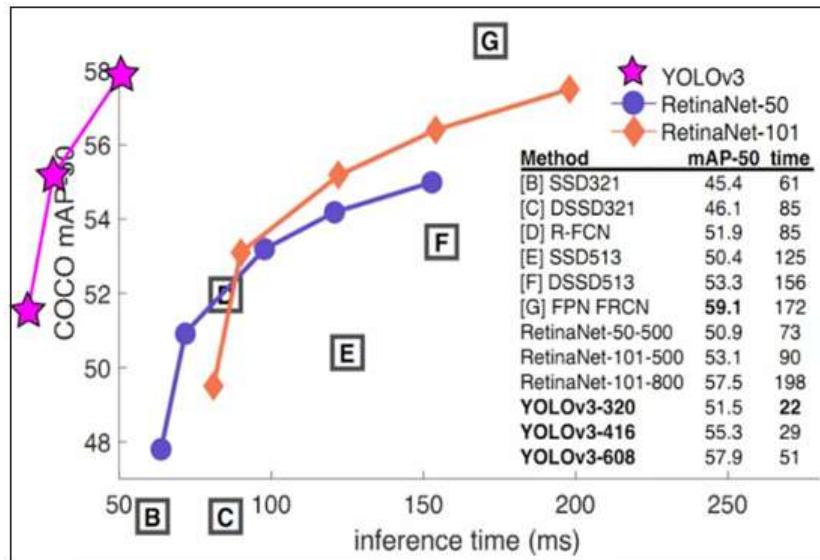


Fig-1: Comparison of YOLOv3 algorithm models

Model Structure

The structure of the YOLOv3 algorithm model is: in simple terms, in terms of basic image feature extraction [4], YOLO3 uses a network structure called

Darknet-53 (containing 53 convolutional layers), which draws on the practice of residual networks and sets up shortcut connections between some layers.

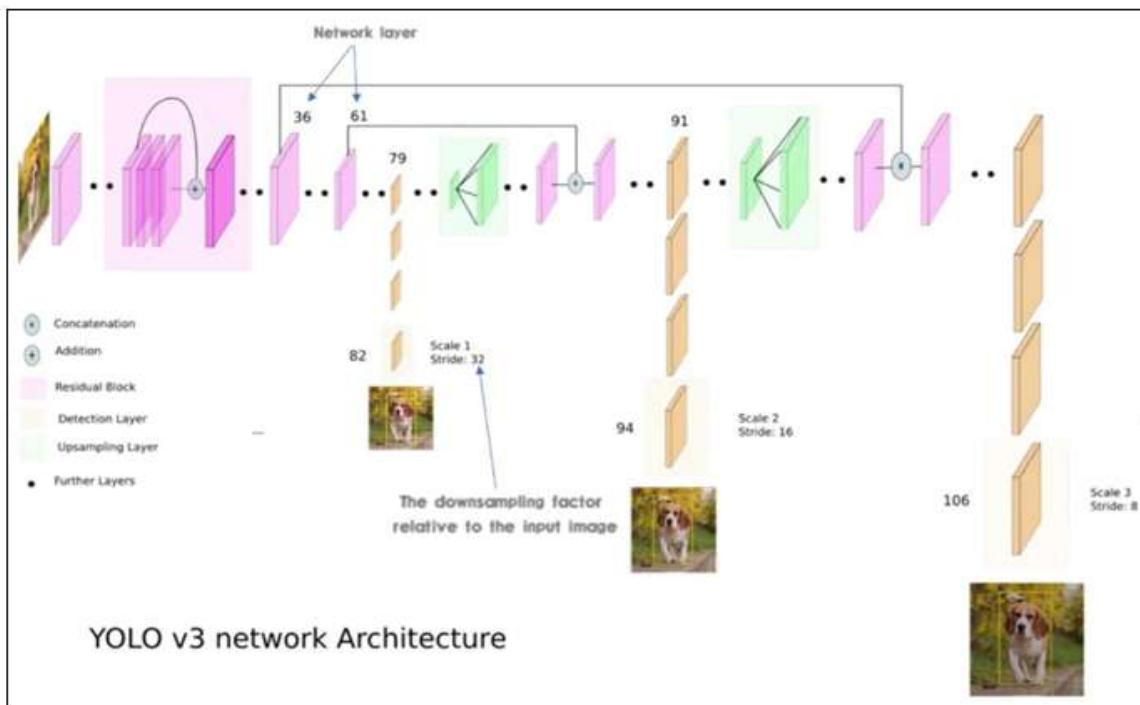


Fig-2: YOLOv3 algorithm model structure diagram

The network structure of YOLOV3 is divided into the following modules [5]. The first layer is the convolution layer, where we put a picture. The number of channels of the image is 3, and the pixels are 416*416. We use 32 convolutional layers to extract image features [6]. The size of each convolution kernel is 3*3 and the step size is 1. After the convolution operation, a 416*416 32-channel feature map is obtained.

The second layer is the res layer, which is derived from the nearest layer. In order to solve the phenomenon of network gradient dispersion or gradient explosion [7], it is proposed to change the layer-by-layer training of deep neural network to step-by-step training, and divide the deep neural network into several sub-segments, each of which contains relatively shallow content.

The third part is dark -53: a total of 53 convolutional layers from layer 0 to layer 74, the rest are reslayers. At the same time, in the case of better performance, its efficiency is 1.5 times that of resnet-101. Its efficiency is almost twice that of resnet-152, the same effect as resnet-152. The last layer is the feature interaction layer of the yolo network. It is divided into three scales. After the training, we will get the target box and category probability [8]. By setting the threshold, we can predict the target.

YOLOv3 algorithm model improvement scheme Foreground Segmentation

For the image collected by the camera, in order to reduce the interference of the background area on the identification target, we model the background information in the monitoring scene before identifying the image. The goal is to separate the foreground target from the scene, and at the same time reduce the impact of noise, shadows and other environmental changes as much as possible, and then segment the target we need through a sliding window strategy to facilitate later identification.

Target Recognition

The report algorithm contains two parts of optimization. Part of it is based on the detailed understanding of the YOLOv3 operation mode, using the anchorboxes mechanism used by the PRN network and Box regression to improve. Its role is to generate

object proposals in the network, generate Bounding Boxes through screening, and obtain new anchor boxes through more advanced clustering algorithms. Specifically, a more advanced clustering k-means++ algorithm is applied, and the loss function is calculated with IoU.

The original K-means algorithm initially randomly selected K points in the data set as the cluster center. However, K-means++ selects K cluster centers according to the following ideas: Assuming that n initial cluster centers have been selected ($0 < n < K$), when selecting the $n+1$ th cluster center: The point farther away from the current n cluster centers will have a higher probability to be selected as the $n+1$ th cluster center. When selecting the first cluster center ($n=1$), the random method is also adopted. It is better for the cluster centers to be farther away from each other. Although this improvement is intuitive and simple, it is very effective.

EXPERIMENT AND ANALYSIS

Testing process

The main function of the opening and closing status module is to analyze the operating status of the electrical equipment through automatic detection in complex scenarios. Detection identification set, data calibration, training package, front-end application. The process is shown below:

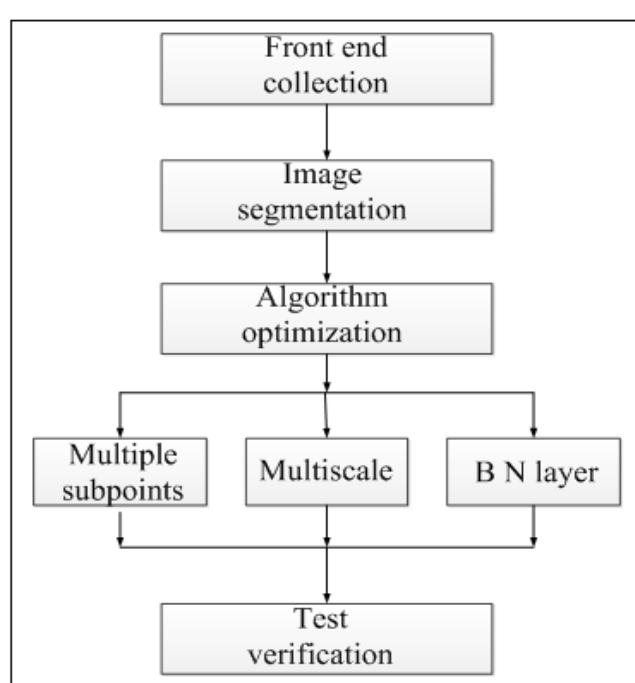


Fig-3: Flowchart of target recognition

Algorithm Comparison Analysis

The experiment selected about 8,000 sample images collected from the substation site, with a total number of about 20,000 targets, including 6,800 training sets and 1,200 test sets. Based on the improved

YOLOv3 algorithm model for identification and analysis, a comprehensive evaluation was carried out from the officially recognized evaluation standards (accuracy, false detection rate, and missed detection rate).

Table-1: Data before improvement

Accuracy	0.85
False detection rate	0.05
Missed detection rate	0.10

Table-2: Data after improvement

Accuracy	0.91
False detection rate	0.02
False detection rate	0.07

For the same test set, the accuracy, false detection and missed detection rate of the algorithm are improved by 6%, 3%, and 3% respectively compared with the original algorithm. Especially for the situation where the target is difficult to distinguish in a complex background, it has better promotion and improvement.

CONCLUSION

Based on YOLOv3, this paper proposes an improvement measure for the device state recognition algorithm. Foreground segmentation is better than the fuzzy C-means method and the OTSU method. The segmentation effect of this method is better, especially when image brightness is uneven and contrast is low, the segmentation error is small. However, the operation efficiency needs to be improved in the future.

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