Woody International Publish Limited
An Multidisciplinary Academic Journal Publisher

Journal of Theory and Practice in Engineering and Technology, Volume 1, Issue 2, 2024
https://www.woodyinternational.com/

Garbage Classification and Recognition Model based on YOLOv5

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Abstract: ***In response to the garbage classification implemented by the state and to assist citizens in effectively sorting and discarding garbage, we studied the image-based garbage detection and classification model to realize the recognition and detection of garbage. The garbage classification model based on YOLOv5s is trained on the GPU server. Then the trained model is deployed to the server, and the user of wechat applet takes photos and uploads photos to the server. The server processes the images through the model and returns the processed images to the wechat applet. Users can determine the category of garbage through photos, so as to classify the garbage. Finally, the trained model can identify 44 types of garbage, and has good performance in recognition accuracy and response speed.***

Keywords: YOLOv5s network; Garbage classification; Object detection.

Cited as: Zhao, H., & Hu, X. Garbage Classification and Recognition Model based on YOLOv5. *Journal of Theory and Practice in Engineering and Technology*, *1*(2), 8–13. Retrieved from https://woodyinternational.com/index.php/jtpet/article/view/43

1. Introduction

With the acceleration of urbanization and the improvement of people's living standards, the garbage problem is becoming increasingly serious, so we need to take effective measures to deal with this problem. Garbage classification is one of them. By classifying garbage, we can collect and treat recyclable items, harmful garbage and other garbage separately to reduce the negative impact on the environment. At the same time, waste classification can also promote the reuse of resources, reduce the consumption of natural resources, and contribute to the realization of sustainable development.

2. Waste Classification Model based on YOLOv5

The whole network framework of YOLOv5 is composed of four parts: input, backbone, neck and output. The input end: adaptively scaling the image, using mosaic data enhancement method to automatically calculate the best anchor box value of the dataset. The goal of backnone network is to extract the features of the input image and continuously reduce the feature map. It is mainly composed of CBL, focus, CSP and spp modules. Ocus is to convert the information of the x*y spatial dimension of the input image into the channel dimension. Both X and Y sizes are reduced to half of the original. At the same time, the channel is enlarged to four times of the original, and the double feature sampling map without information loss can be obtained. Neck structure mainly realizes the fusion of shallow graphic features and deep semantic features.

At the same time, the top-down FPN and the bottom-up pan structure are used, and the csp2 structure is used to enhance the ability of feature fusion. YOLOv5 also introduces new technologies such as adaptive receptive field and multi-scale training, which further improves the performance of the model. The specific network structure is shown in Figure 1.

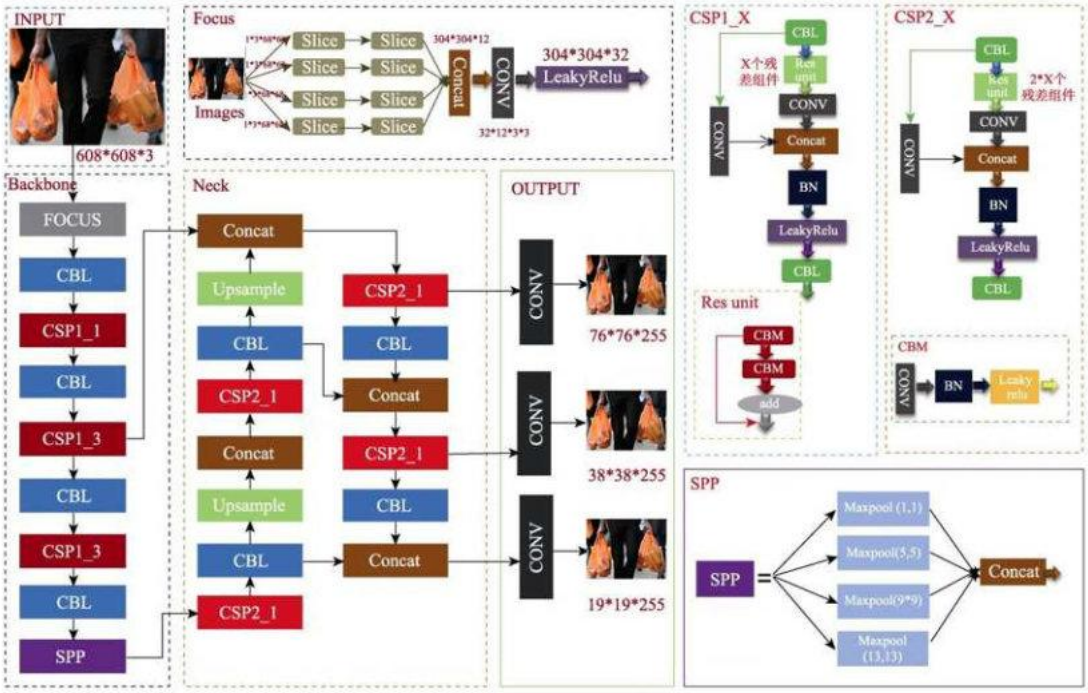

Figure 1: YOLOv5 network structure

3. Dataset Selection

First, data collection refers to obtaining image data related to garbage classification from various channels. These data come from public data sets, as well as their own collection and shooting. A total of 1.5W pictures cover 44 types of waste, including plastic bottles, batteries, plastic bags, etc. An example is shown in Figure 2

Figure 2: sample dataset

4. Optimization of YOLOv5 Model

4.1 Small Target Detection

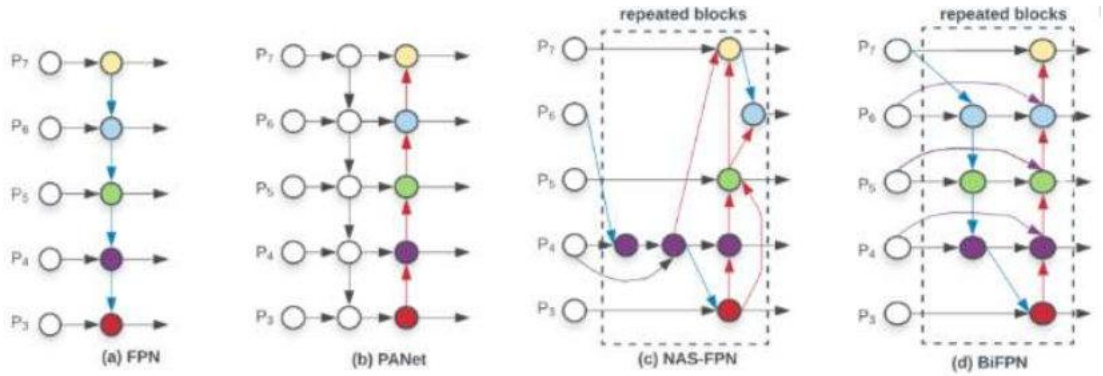

Figure 3: before adding attention mechanism

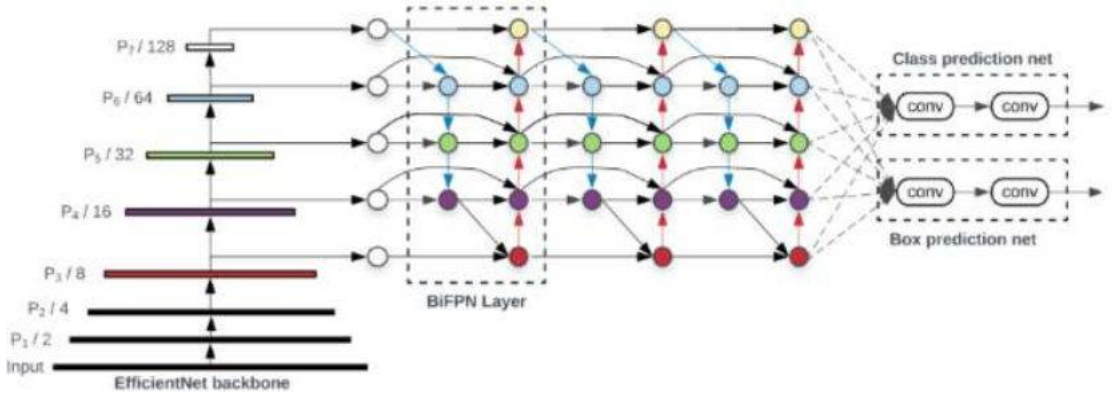

Figure 4: after adding attention mechanism

One reason for the poor effect of small target detection in YOLOv5 is that the size of small target sample is small, while the subsampling multiple of YOLOv5 is large, which makes it difficult to learn the feature information of small target in the deep feature map. Therefore, we propose a method to add a small target detection layer, that is, the shallow feature map and the deep feature map are spliced for detection. By modifying the model file yaml of YOLOv5, small targets can be detected. The specific approach is to add a group of smaller anchors. However, this will increase the amount of calculation and reduce the speed of reasoning and detection. Nevertheless, this method does show good results in improving small target detection.

4.2 Attention Mechanism

The blue part in the figure below is the top-down path, which transmits the semantic information of high-level features; The red part is a bottom-up path, which transmits the location information of low-level features; The purple part is a new edge added between the input node and the input node in the same layer.

We can delete nodes with only one input edge. This strategy is very simple: if a node has only one input edge and has no feature fusion function, its contribution to the fusion of different features in the feature network is minimal. Deleting such nodes will not have much impact on our network, but also simplify the two-way network structure. As shown in the figure, for the first node on the right of P7 of node D.

We add an additional edge between the original input and output nodes of the same layer, which can integrate more features without adding too much cost.

In order to achieve higher-level feature fusion, we are different from panet with only one top-down and one bottom-up path. For each bidirectional path (top-down and bottom-up), we regard it as a feature network layer and repeat the same layer for many times. As shown in the following figure, bifpn has been repeatedly used in the network structure of efficientnet. This number of repetitions is not our setting, but is included as a parameter with the network design and calculated through NAS technology.

5. Model Training Data

The pre training weight is YOLOv5s.pt, the input image size is 640 × 640, the maximum number of iterations is 400, the batch_size is set to 32 according to the GPU specification, the training thread is set to 8, and other parameters are set by default. Some training results are as follows.

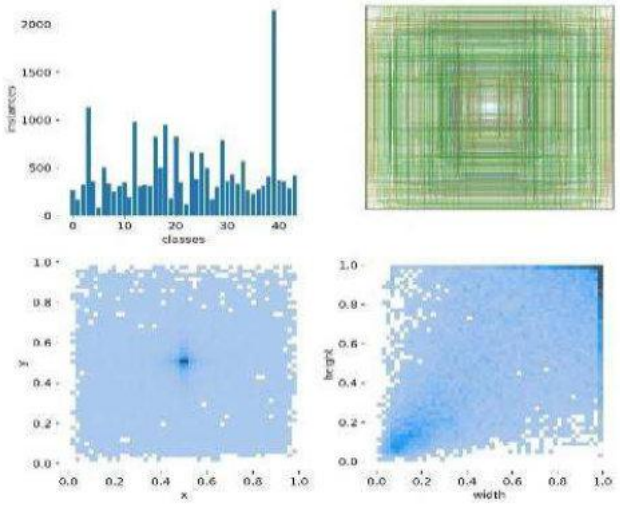

Figure 5: number, size and center point distribution of labels

6. Conclusion

In order to improve the response speed of the model, we selected the YOLOv5s network model for training, and added the small target detection mechanism and attention mechanism to ensure a high recognition rate and reduce the recognition response time. Some test results are shown in Figure 6.

Figure 6: partial test example

Funding

Fund Project: Autonomous region level college students' innovation and entrepreneurship training project "garbage classification and identification applet based on YOLOv5" (s202310694048).

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