An Intelligent Identification and Detection Method for Forest Pests Based on YOLOv5s Algorithm

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***Abstract*—Accurate identification of pests is the basis of forestry pests prevention and management. This paper uses the YOLOv5s algorithm to train the pest intelligent identification model by using the cosine annealing learning rate to adjust the learning rate during the training process.The model can identify 15 common forestry pests.When their different physiological forms such as eggs, larvae,pupae and adults are concluded,the model can identify a total of 39 categories accurately.**

***Key words*—Deep learning;YOLOv5s;Forestry pest detection**

I.INTRODUCTION

Forestry pest control is an extremely important content in forestry construction. By the end of 2020, my country's forest coverage rate has reached 23.04%.Our country forest area is very small, but it is one of the countries where forestry pests and diseases occur more severely in the world [1]. There are more than 200 kinds of forestry pests that often cause harm,among which more than a dozen kinds are particularly serious, such as pine wood nematode, pine caterpillar, American white moth, pine ink longicorn beetle, yellow spotted longicorn beetle and so on. Large-scale outbreaks of pests be avoided as early as possible only by accurately and timely monitoring and killing forest pests.To achieve this goal, we must first realize the accurate identification and classification of forestry pests.

The traditional pest identification method is generally based on the shape characteristics of pests by experts and technicians, comparing with the accurately recorded type specimens to give the types of pests, whose efficiency and accuracy are limited. In recent years, computer vision and deep learning models have developed rapidly, and researchers have also applied these technologies to the field of pest detection and control. Li Wenyong et al.[2]proposed an algorithm to identify automatic trap target pests through representing and learning the pose features of orchard pests. CHENG X et al. [3] built a new convolutional neural network model for pest identification by using the residual module in RESNET for reference and deepening the network on the basis of Alex net.Zhou Aiming [4] realized the identification and counting of rice pests based on deep learning technology, and the recognition accuracy was about 90%. LINTL et al.[5] realized pests detection in the growth of sweet peppers based on the Faster R-CNN method. Li Hengxia et al.[6]proposed a rape pest detection better adapt to different data sets based on deep convolutional neural network.

In this paper, the algorithm YOLOv5s is applied to the field of forestry pest detection.And it is the latest first-order target detection algorithm with fast detection speed.In the training process, the cosine annealing learning rate method is used for model training, and the Focus layer of YOLOv5s is improved. The trained model classifies 39 kinds of pests, and the test accuracy on the training set is as high as 98.6%, The correctness of the test set is 94.5%, and the speed is improved.

II.YOLOV5 MODEL INTRODUCTION

The YOLO algorithm is a new target detection framework developed by Redmon et al. [7] and it can convert the target detection problem into a regression problem[8]. The YOLOv5 algorithm is the latest version.Currently,there are four models such as v5x, v5l, v5m, and v5s. The smallest v5s model is only 27MB, which is only 11% of the YOLOv4 model. The speed reaches 140 frames per second.It is currently the fastest algorithm in target detection[9-12].

Compared with the original YOLOv3 and YOLOv4 framework, the YOLOv5 model has been improved in data enhancement, selection of loss function, and selection of activation function. On the activation function, YOLOv5 algorithm selects Leaky ReLU and Sigmoid as the activation function replacing the Swish function in YOLOv4. In terms of loss function, YOLOv4 algorithm selects CIOU as the coordinate value loss function, while YOLOv5 algorithm selects GIOU as the coordinate value loss function. YOLOv5 adaptively learns the initial anchor box size before each detection, which can better adapt to different data sets.The network model structure is shown in Figure1.

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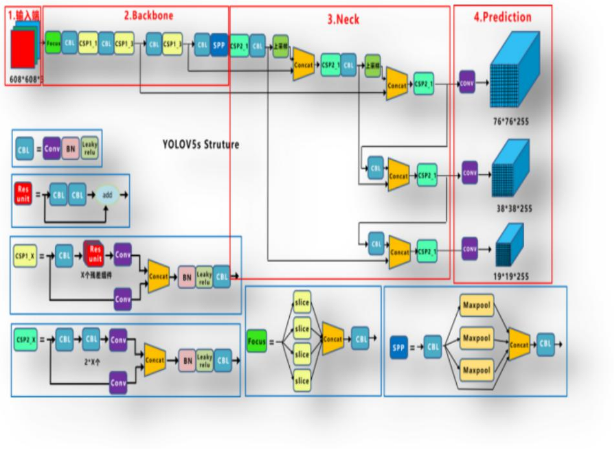

Figure1 YOLOV5 model network structure

III. EXPERIMENTS AND RESULTS

A. Data set production

Data were collected through web crawlers and open source data sets, etc.We have collected 15 common pests and their different physiological forms.And finally we get a total of 39 categories pests. The actual training and test data sets select 1357 pictures.Data sets are shown in Figure 2.


Figure2 Training samples

B. Data processing

The data set expansion is realized by using OpenCV Python tools based on image radiation transformation, noise distribution, horizontal mirror and other operations.An example of data enhancement is shown in Figure3


Figure3 Data enhancement processing

After the data is expanded, the 15 pest species and the number of samples for each type are expanded as shown in Figure4. The original 1357 pictures have been expanded to 3000, and a total of 27000 label objects are included.Training sets and test sets are divided by 8:2.

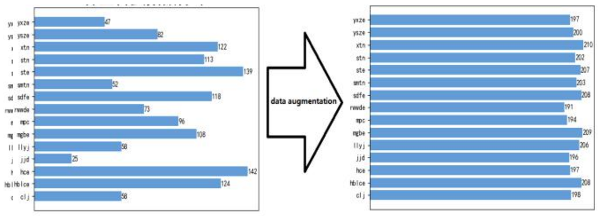

Figure4 Data distribution after enhancement

C.Picture Annotation

The annotation interface with LabelImg software is shown in Figure5 and Figure6.

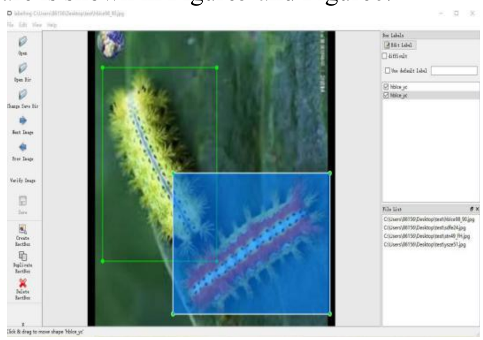
Figure 5 Annotated brown-edge green spiny moth-larva

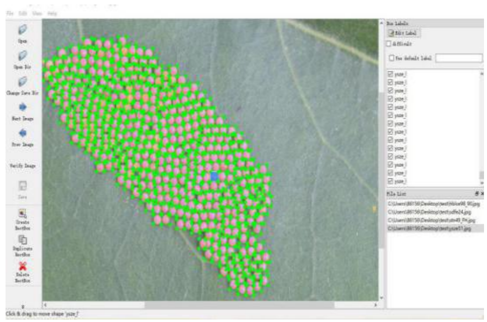
Figure6 Annotated Yang Fanzhou Moth-Egg

D. Model Training

- Experimental Environment

The experimental environment selects the pytorch architecture.CPU is i7-11800H, and the graphics card is RTX3070.

- Model Evaluation

This paper uses the cosine annealing learning rate to adjust the learning rate. The cosine annealing learning rate is different from the traditional learning rate. With the increase of epoch, the learning rate first drops sharply, then rises sharply, and then this process is repeated continuously.The experimental results show that the yolov5s algorithm using the cosine annealing fully meets the needs of fast and accurate use. The training loss after the algorithm optimization has a shock phenomenon at the beginning, but then Loss tends to steadily decrease. As shown in Figure7.

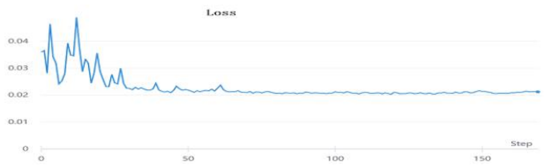

Figure7 Loss1

The convergence of the training model after the first 170 epochs tends to be flat. In response to this situation, a new training set and a test set are re-adjusted and divided, and the learning rate is reduced by 10 times, and the second round of training is carried out. After the second round of training, Loss tends to 0. As shown in Figure8 below.The test accuracy of pest identification rate on the training set is as high as 98.6%, and the test set is about 94.5%. So far, the model training is completed.

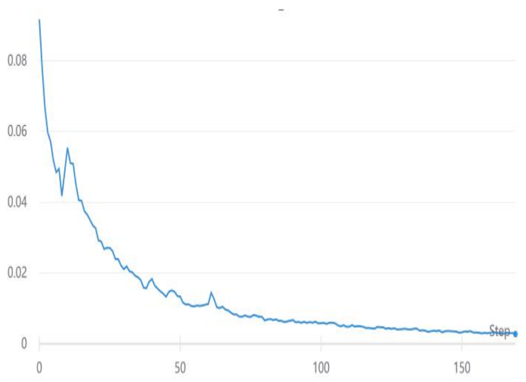

Figure8 Loss2

IV.CONCLUSIONS

In summary, it is proposed to use YOLOV5s network model to identify and classify forest pests. This method has been experimentally tested and has a high accuracy rate. However, because the training data and the user test data are taken in different ways, it has a certain impact on the accuracy. The transfer learning can be made on the existing basis to make the algorithm more accurate. The recognition speed and accuracy can be dynamically adjusted according to the computing performance of the terminal device.

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