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Two-Dimensional Codes Recognition Algorithm Based on Yolov5

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Abstract: *In order to realize fast and high-precision recognition of QR codes, a QR code recognition method using YOLOv5 algorithm is designed. The original image of the QR code will be obtained by using the LabelImg annotation tool and data enhancement method to build a data set, and trained by the YOLOv5s model. The experimental results show that the test on the real two-dimensional code can be effectively identified, and the average accuracy rate is about 90%, which can meet the requirements of real-time identification of the two-dimensional code when using an augmented reality device.*

Keywords: *YOLOv5s; real-time recognition; QR code*

1. Introduction

QR code, also known as quick response code [1], its identification technology has been born for many years, and the decoding speed is extremely fast. It is often used in the fields of commodity packaging, logistics and transportation, mobile terminals, living consumption, and online and offline payments. Two-dimensional codes have attracted a lot of attention because of their novel storage, transmission and identification technologies in information [2]. The convenience brought by QR code to life is obvious. However, in the process of exploring the source of items, QR code also brings other problems, such as the process of printing, collecting and identifying QR code images. Many of the problems were difficult to solve and greatly delayed the progress of the work. For example, due to the angle of acquisition or the distortion of the QR code itself, the original regular QR code is deformed, which leads to problems that are difficult to identify [3].

Wang Hongyan et al [4] introduced the information transmission of QR code, Lu Yang, Gao Huimin et al proposed a method of binarization combining improved homomorphic filtering and Otsu algorithm [5], Liu Jihong and other scholars proposed an adaptive threshold method [6] for processing Information-rich image edges. Lei et al. proposed a morphological-based binarization method [7], which can be applied to QR code recognition devices.

With the revival of artificial intelligence technology, especially deep learning, many neural network frameworks for target detection and localization have emerged, such as the YOLO series using the one-stage scheme and the RCNN series using the two-stage scheme [8]. Based on the response time requirements of application scenarios, this paper designs a batch QR code recognition system with the YOLOv5 framework as the core, which realizes the rapid positioning and accurate decoding of batch QR codes, and greatly improves the work efficiency of related industries.

2. Introduction to YOLOv5 algorithm

The YOLOv5 (you only look once) algorithm is a relatively advanced convolutional network at present. This algorithm is improved on the basis of the YOLOv3 algorithm and is the most advanced target detection technology today. The YOLO network is mainly composed of five main components: Input, Backbone, Neck, Dense Prediction and Spare Prediction. As shown in Figure 1:

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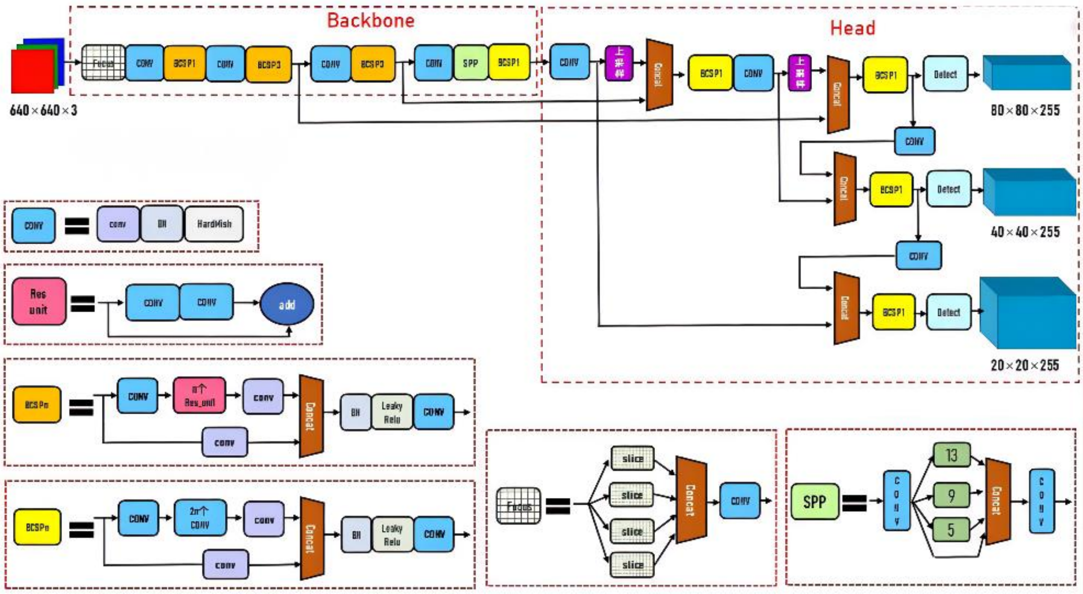

Figure 1: YOLOv5 algorithm network structure diagram

Input: It consists of three parts: Mosaic data enhancement, automatic adaptation of anchor boxes and adaptive image scaling. Mosaic enhancement can scale several pictures randomly and stitch them into one picture. Different pictures have different lengths and widths. The method is to uniformly scale the original picture to a standard size, and then send it to the detection network. Adaptive anchor box calculation, there are anchor boxes with initial set length and width for different data sets. During network training, the network outputs the predicted frame on the basis of the initial anchor frame, and then compares it with the ground truth of the real frame, calculates the difference between the two, and then updates it in reverse to iterate the network parameters.

Backbone: In the structure of Yolov5s, the original 608 × 608 × 3 image is input into the Focus structure, and the slicing operation is used to first become a 304 × 304 × 12 feature map, and then go through a convolution operation of 32 convolution kernels, and finally become into a feature map of 304×304×32. Two CSP structures are designed in Yolov5, the CSP1_X structure is used in the Backbone backbone network, and the other CSP2_X structure is used in the Head. Using the CSP module, the feature map of the base layer is first divided into two parts, and then they are merged through a cross-stage hierarchical structure, which can reduce the amount of calculation and ensure the accuracy.

Head: This structure includes the structure and Prediction using FPN+PAN. In the FPN+PAN structure of Yolov4, ordinary convolution operations are used. In the FPN+PAN structure of Yolov5, the CSP2 structure designed with reference to CSPNet is adopted to strengthen the ability of network feature fusion. Prediction in Yolov5 uses CIOU_Loss as the loss function of the Bounding box. And in the post-processing process, many target boxes are screened.

3. Test results and analysis

3.1. Dataset Preparation

Downloading pictures with two-dimensional codes from the website. The data mainly comes from the photos of common two-dimensional code scenes in daily life and the picture information of various two-dimensional codes in the Internet. The original format of the pictures is PNG format. The corresponding annotation information format of the picture is in json format. In order to adapt to the YOLO network model, it first needs to be converted into XML format, and finally into YOLO format. In this experiment, 2010 QR code data sets were selected and divided into training set 1588 and test set 421 with a ratio of 8:2. Some pictures are shown in Figure 2.

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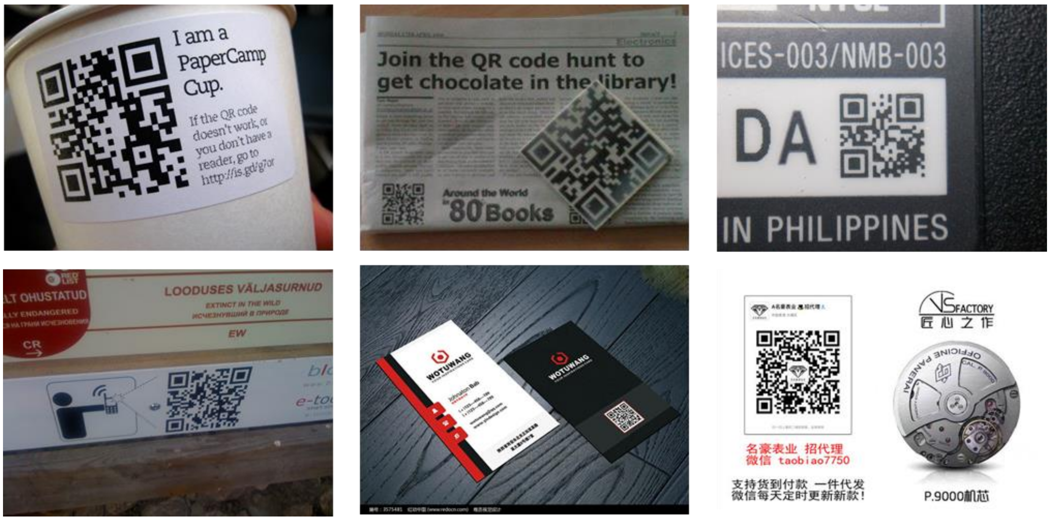

Figure 2: Partial sample

3.2. *YOLO v5 architecture selection and training parameters*

In this paper, the YOLOv5s algorithm is selected, and the number of parameters is only 7.5M. The model has a small number of parameters, low computational overhead, and is very friendly to mobile deployment. The main training configuration parameters in this paper are set as follows: the training period (epochs) is 100, the batch size (batch size) is 16, and the image size is 640×640. Use the above QR code data set for training and build the Pytorch deep learning platform. The specific environment configuration of the experiment is: Windows11 operating system, CPU is i7-9750H@2.60GHz, GPU is NVIDIA GeForce GTX 1660 Ti, video memory 8G, memory 16G, The acceleration system is CUDAv11.4, CuDNNv10.2, the pytorch version is 2.2, and the compiled language is Python3.7.

3.3. Evaluation indicators

In terms of recognition accuracy, the average precision (mean Average Precision, mAP) is calculated based on the precision rate and recall rate, as the final evaluation index of precision, to measure the comprehensive performance of the trained model on all categories, and will be merged the ratio is 0.5 as the threshold for judging whether the detection is successful or not. In this experiment, precision rate, false positive rate and cross-union ratio are used to measure the effectiveness of the method. The calculation formula is:

$$precision = \frac{TP}{TP+FP} \qquad FP = \frac{FP}{FP+TN}$$

$$IOU = \frac{PA \cap OA}{PA \cup OA}$$

In the formula: TP is the positive sample that is predicted correctly; FP is the positive sample that is incorrectly predicted by the model; FN is the negative sample that the model predicts negative value; TN is the negative sample that predicts the positive value; PA is the helmet area after detection; OA is the marker area.

3.4. Identification results and analysis

Through training, the corresponding training weight file is obtained, and the weight training file is used to identify the image. This paper shows that the results of YOLOv5s training after 200 epochs are shown in Figures 3 and 4. The training set PR_curve is shown in Figure 3(a), mAP@0.5=0.910; the test set PR_curve as shown in Figure 3(b), mAP@0.5=0.916. The model has fewer parameters and lower computational overhead.

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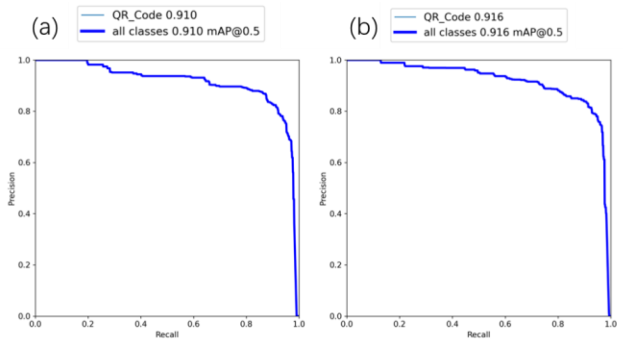

Figure 3: (a) Training set PR_curve (b) Test set PR_curve

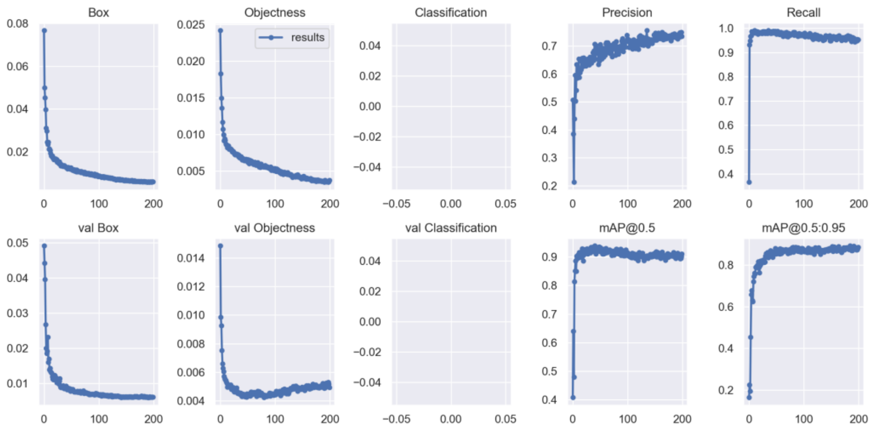

Figure 4: Results

After 200 epochs, the precision rate keeps rising until it tends to balance at about 75%. Although the recall rate fluctuates slightly, it is basically stable at 95%. mAP@0.5 also basically remained above 90%. The model recognition effect is shown in Figure 5(a); the recognition effect of the QR code and web page, white background and multiple QR codes is shown in Figure 5(b).

Figure 5: Identification results

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4. Conclusion

It can be seen from the above tests that the system has a high decoding accuracy for batch QR codes, and the positioning accuracy still needs to be improved. The preliminary analysis is that the data set samples are too low, and the follow-up will increase the data set and increase the application scenarios. , improve the decoding algorithm, etc. to improve and optimize.

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