

## 3. Target detection

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##### 3.1. Model structure

##### 3.2. Code analysis

##### 3.3. Start

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The main problem solved in this section is how to use the dnn module in OpenCV to import a trained target detection network. But there are requirements for the version of opencv.

At present, there are three main methods for target detection using deep learning:

- Faster R-CNNs
- You Only Look Once(YOLO)
- Single Shot Detectors(SSDs)

Faster R-CNNs is the most commonly heard neural network based on deep learning. However, this approach is technically difficult to understand (especially for deep learning newbies), difficult to implement, and difficult to train.

In addition, even if the "Faster" method is used to implement R-CNNs (where R represents the region proposal), the algorithm is still relatively slow, about 7FPS.

If we are pursuing speed, we can turn to YOLO because it is very fast and can reach 40-90 FPS on TianXGPU, and the fastest version may reach 155 FPS. But the problem with YOLO is that its accuracy needs to be improved.

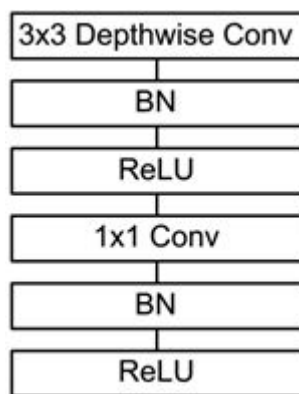
SSDs were originally developed by Google and can be said to be a balance between the above two. Compared with Faster R-CNNs, its algorithm is more straightforward. Compared with YOLO, it is more accurate.

### 3.1. Model structure

The main work of MobileNet is to use depthwise separable convolutions (depth-level separable convolutions) to replace the past standard convolutions (standard convolutions) to solve the problems of computational efficiency and parameter quantity of convolutional networks. The MobileNets model is based on depthwise separable convolutions (depth-level separable convolutions), which can decompose standard convolutions into a depth convolution and a point convolution ( $1 \times 1$  convolution kernel). **Depthwise convolution applies each kernel to each channel, while  $1 \times 1$  convolution is used to combine the outputs of channel convolutions.**

Batch Normalization (BN) will be added to the basic components of MobileNet, that is, in each SGD (stochastic gradient descent), standardization processing will be performed so that the mean of the result (all dimensions of the output signal) is 0 and the variance is 1. Generally, when you encounter problems such as slow convergence or gradient explosion during neural network training, you can try BN to solve the problem. In addition, in general use, BN can also be added to speed up training and improve model accuracy.

In addition, the model also uses the ReLU activation function, so the basic structure of depthwise separable convolution is shown in the following figure:



The MobileNets network is composed of many depthwise separable convolutions shown in the figure above. Its specific network structure is shown in the figure below:

Type / Stride	Filter Shape	Input Size
Conv / s2	$3 \times 3 \times 3 \times 32$	$224 \times 224 \times 3$
Conv dw / s1	$3 \times 3 \times 32$ dw	$112 \times 112 \times 32$
Conv / s1	$1 \times 1 \times 32 \times 64$	$112 \times 112 \times 32$
Conv dw / s2	$3 \times 3 \times 64$ dw	$112 \times 112 \times 64$
Conv / s1	$1 \times 1 \times 64 \times 128$	$56 \times 56 \times 64$
Conv dw / s1	$3 \times 3 \times 128$ dw	$56 \times 56 \times 128$
Conv / s1	$1 \times 1 \times 128 \times 128$	$56 \times 56 \times 128$
Conv dw / s2	$3 \times 3 \times 128$ dw	$56 \times 56 \times 128$
Conv / s1	$1 \times 1 \times 128 \times 256$	$28 \times 28 \times 128$
Conv dw / s1	$3 \times 3 \times 256$ dw	$28 \times 28 \times 256$
Conv / s1	$1 \times 1 \times 256 \times 256$	$28 \times 28 \times 256$
Conv dw / s2	$3 \times 3 \times 256$ dw	$28 \times 28 \times 256$
Conv / s1	$1 \times 1 \times 256 \times 512$	$14 \times 14 \times 256$
5×	Conv dw / s1	$3 \times 3 \times 512$ dw
	Conv / s1	$1 \times 1 \times 512 \times 512$
	Conv dw / s2	$3 \times 3 \times 512$ dw
	Conv / s1	$1 \times 1 \times 512 \times 1024$
	Conv dw / s1	$3 \times 3 \times 1024$ dw
	Conv / s1	$1 \times 1 \times 1024 \times 1024$
	Avg Pool / s1	Pool $7 \times 7$
	FC / s1	$1024 \times 1000$
	Softmax / s1	Classifier

### 3.2. Code analysis

list of recognizable objects

```
[person, bicycle, car, motorcycle, airplane, bus, train,
truck, boat, traffic light, fire hydrant, street sign,
stop sign, parking meter, bench, bird, cat, dog, horse,
sheep, cow, elephant, bear, zebra, giraffe, hat, backpack,
```

```
umbrella, shoe, eye glasses, handbag, tie, suitcase,  
frisbee, skis, snowboard, sports ball, kite, baseball bat,  
baseball glove, skateboard, surfboard, tennis racket,  
bottle, plate, wine glass, cup, fork, knife, spoon, bowl,  
banana, apple, sandwich, orange, broccoli, carrot, hot dog,  
pizza, donut, cake, chair, couch, potted plant, bed, mirror,  
dining table, window, desk, toilet, door, tv, laptop, mouse,  
remote, keyboard, cell phone, microwave, oven, toaster,  
sink, refrigerator, blender, book, clock, vase, scissors,  
teddy bear, hair drier, toothbrush]
```

Load the category [object\_detection\_coco.txt], import the model [frozen\_inference\_graph.pb], and specify the deep learning framework [TensorFlow]

```
# Load COCO class name  
with open('object_detection_coco.txt', 'r') as f: class_names =  
f.read().split('\n')  
# Display different colors for different targets  
COLORS = np.random.uniform(0, 255, size=(len(class_names), 3))  
# Load DNN image model  
model = cv.dnn.readNet(model='frozen_inference_graph.pb',  
config='ssd_mobilenet_v2_coco.txt', framework='TensorFlow')
```

Import the image, extract the height and width, calculate a 300x300 pixel blob, and pass this blob into the neural network

```
def Target_Detection(image):  
    image_height, image_width, _ = image.shape  
    # Create a blob from an image  
    blob = cv.dnn.blobFromImage(image=image, size=(300, 300), mean=(104, 117,  
123), swapRB=True)  
    model.setInput(blob)  
    output = model.forward()  
    # Iterate through each test  
    for detection in output[0, 0, :, :]:  
        # Extract the confidence of the detection  
        confidence = detection[2]  
        # Draw bounding boxes only if detection confidence is above a certain  
threshold, otherwise skip  
        if confidence > .4:  
            # Get the ID of the class  
            class_id = detection[1]  
            # Map class id to class  
            class_name = class_names[int(class_id) - 1]  
            color = COLORS[int(class_id)]  
            # Get bounding box coordinates  
            box_x = detection[3] * image_width  
            box_y = detection[4] * image_height  
            # Get the width and height of the bounding box  
            box_width = detection[5] * image_width  
            box_height = detection[6] * image_height  
            # Draw a rectangle around each detected object  
            cv.rectangle(image, (int(box_x), int(box_y)), (int(box_width),  
int(box_height)), color, thickness=2)  
            # Write class name text on detected objects
```

```

        cv.putText(image, class_name, (int(box_x), int(box_y - 5)),
cv.FONT_HERSHEY_SIMPLEX, 1, color, 2)
    return image

```

### 3.3. Start

```

cd ~/yahboomcar_ws/src/yahboomcar_visual/detection
python target_detection.py

```

If it is not target detection, click the image box and use the keyboard [f] key to switch.

```

if action == ord('f') or action == ord('F'): state = not state # Function
switching

```

