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Research on Species Intrusion Recognition Prevention and Control Based on AlexNET

Yiming Liu[1], Yimin Yu[2], Chenhang Ding[2], Yifan Liu[1,*]

[1]*Faculty of Maritime and Transportation, Ningbo University, Ningbo, Zhejiang, 315832, China*

[2]*Faculty of YANGMING, Ningbo University, Ningbo, Zhejiang, 315211, China*

*Corresponding author

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Abstract: Asian giant hornet originated from South-East Asia. They can spread to other regions by accident and cause aggressive effects on local species (such as native bees). Once the Asian giant hornet is found, it is necessary to be vigilant in the corresponding larger geographic area. However, the public cannot accurately identify whether it is an Asian giant hornet, causing a large number of mistaken sightings. Therefore, it is urgent to effectively recognize the positive reports of the Asian giant hornets, and to further find a reliable way to curb their spread hornets and eventually eradicate them. We screen and transform the specified information in data processing. In the literature, we establish an image recognition model based on deep learning, as well as carry out the transfer learning of the Asian giant hornets on the basis of the AlexNet model.

1. Introduction

Can you imagine a beehive full of honey heads and torn bodies? Dozen Asian giant hornets could kill tens of thousands of bees in just a few hours. In Japan, they are also referred to as the "killer bees". Compared with the regular bees, the Asian giant hornets fly very fast, have larger size and the stronger toxicity. Once after being angry, they will hold onto and sting the target, which is likely to lead to the target's death. According to the report of National Vital Statistics System, a total of 1,109 deaths from hornet, wasp, and bee stings occurred during 2000–2017 [1]. There is no doubt that the presence of the Asian giant hornets will seriously affect the survival of native bee, as well as may sting more people in the future.

2. An Image Recognition Model Based on Deep Learning

AlexNet has eight main layers, including five convolutional layers and three fully connected layers. The network structure is shown in the Figure 1. Using AlexNet for migration learning can reduce the training time of the network, and at the same time we can use a smaller number of training images to quickly transfer the learned features to new tasks

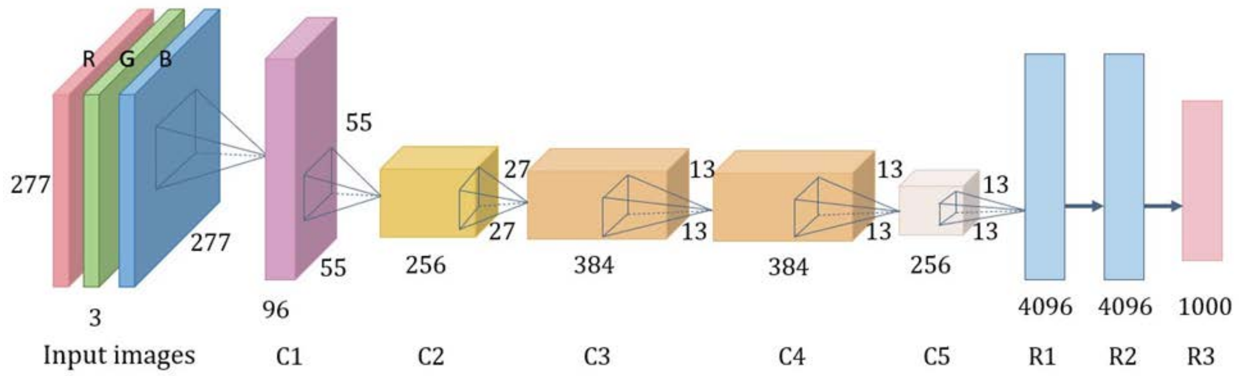

Figure 1: AlexNet network graph

The main process of AlexNet for transfer learning [2] [3] is as follows:

Step 1: Start with the image input layer. A total of five convolutional layers and three fully connected layers need to be passed through. The activation function forms the current layer of neurons to obtain the feature map of the current convolutional layer. This cycle can be described as:

$$X_j^l = F\left(\sum_{i\in M_j} X_i^{l-1*} w_{ij}^l + w_b\right)$$

Where X_j^{l-1} represents the feature mapping j of the pooling layer l,$*$ is the symbol in the convolution operation, $w_{ij}^l + w_b$ describes the weight and offset.

Step 2: Use ReLU activation function. The traditional activation function choices include logistic, tanh, arctan functions and so on. But in the deep model, these functions will encounter the problem of vanishing gradient. To solve this problem, a new activation function is proposed as a linear rectification unit (*ReLU*), which is defined as:

$$\mathrm{Re}LU(x) = \max(x, 0)$$

This function indicates that if the input *x* is not less than 0, its gradient is always 1.

Step 3: Use Dropout to avoid overfitting. In dropout, only a part of neurons is trained in each iteration, which forces neurons to cooperate with other neurons, reduces the joint adaptability between neurons, and improves generalization ability. The training network can be seen as being divided into several sub-networks with Dropout. But for each subnet. They may overfit to a certain extent, but they all have the same loss function.

Step 4: Use the maximum pooling layer for dimensionality reduction sampling. On the one hand, this process does not change the number of feature mappings. On the other hand, the dimensionality reduction process removes unnecessary information and reduces the number of feature maps. The dimensionality reduction process can be described as:

$$X_j^l = F\left(\text{ down }\left(X_j^{l-1}\right) + w_b\right)$$

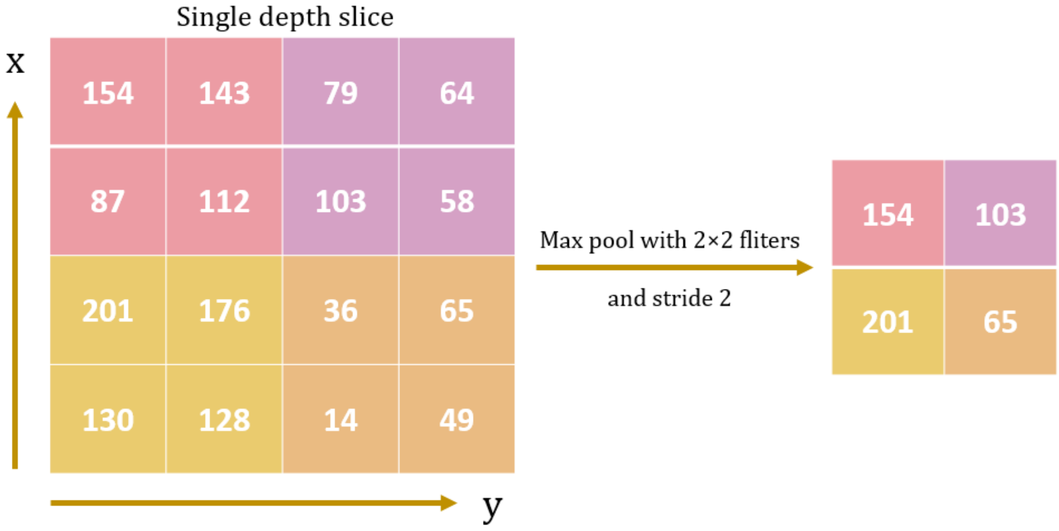

Figure 2: Maximum pooling graph

The schematic description of the maximum pooling layer is shown in Figure 2. The figure shows that the value in the neighborhood of a 4×4 feature map is scanned with a 2×2 filter with a step size of 2, and the maximum value is selected and output to the next layer.

After five convolutional layers, there are three fully connected layers: fC6, fC7 and fC8. The fully connected layer can be regarded as a convolutional layer. Its convolution kernel size and input data size should be consistent with the convolution layer. The fully connected layer can be described as:

$$X_j^l = F\left(\sum_i w_{ij}^{\prime} X_i^{l-1} + w_b^l\right)$$

3. Model Solving

We need to accurately identify the Asian giant hornet. Since most of the sightings misjudged the Asian giant hornet, the image recognition model is established based on the training set results. After determining the species type on a certain photo, we can input the photo into the neural network training program. Through calculation and analysis of results, we can obtain the accuracy rate of image recognition. Accurate recognition and classification are essential to solve the invasion problem of the Asian giant hornet in Washington State. It is conducive to reduce the waste of limited resources, such as human and material resources.

Figure 3 shows an example of the accurate recognition rate of some species types, including the Asian giant hornet, Bald-faced hornet, Cicada killer wasps, Woodwasp, Native bumblebee and Woodwasp. Through the recognition of a large number of photos, we get an average recognition accuracy rate of 71.55%. This is because some photos are blurred and the shooting angle is too far. For some clear photos, the accuracy rate of image recognition can reach 100%, this shows that some of our pre-screened data sets can effectively improve the accuracy of image recognition. Under the condition of clear images, they can effectively identify the Asian Hornet, and the image recognition model is less likely to be misclassified.

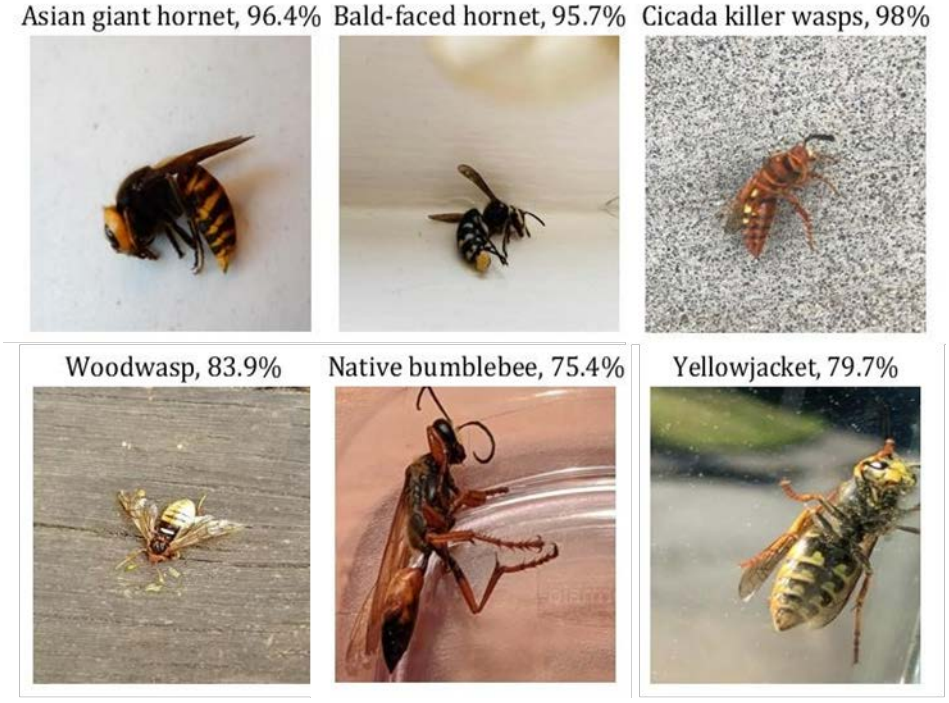

Figure 3: Accurate recognition rate of some species

4. Conclusion

In order to improve the efficiency and effect of recognizing photos, we have established an image recognition model based on deep learning. Through a large amount of data testing, the accuracy of the model's prediction is 71.55% on average. The analysis may be because some photos are too blurry or the shooting distance is too long. This leads to lower accuracy of some predictions, and at the same time the order of the investigated species can be obtained.

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