Application of Unsupervised Deep Learning in Road Image Recognition

Jingwei Xie

College of Innovation and Entrepreneurship, Dalian University, DaLian, 116622, China

Keywords: Unsupervised deep learning; Road image recognition; Application analysis

Abstract: Deep learning is to use deep neural network to simulate human brain, analyze and calculate data. Unsupervised learning algorithms based on deep trust network is also known as unsupervised deep algorithms, which have good application effects in the field of image recognition. This paper discusses the application of unsupervised deep learning in road image recognition, and summarizes the application status, application problems and development prospects to promote the development of road image recognition under the background of artificial intelligence.

Image recognition is an important content in the field of artificial intelligence. By collecting analyzing, processing and understanding image data, different objects can be recognized effectively. There are many methods for image recognition, such as back propagation, support vector machine, k-nearest neighbor classification, and template matching, but the generalization ability of these image recognition methods is limited, and the accuracy of image recognition is not enough [1]. Hinton proposed unsupervised learning algorithm based on deep trust network in 2006, which is also called unsupervised deep learning. Image classification tasks can be completed by learning large databases and automatically extracts features. Statistical data shows that the probability of unsupervised deep learning errors in large-scale image recognition is only 16.4%, which is far lower than the error rate of previous image recognition methods. It has good application value in face recognition, gesture recognition, iris recognition and road recognition [2 ~ 3]. This paper focuses on the application of unsupervised deep learning in road image recognition.

1. Unsupervised Deep Learning Network Model

In recent years, unsupervised deep learning has developed rapidly in the field of image recognition with its powerful ability of data analysis and feature extraction. In the process of development, unsupervised deep learning methods have also been optimized. Many deep network models have been proposed and applied, including automatic coder, deep belief network, deep stack network, convolutional neural networks, and recurrent neural networks.

1.1 Convolutional Neural Network

The convolutional neural network is similar to the traditional neural network structure. It belongs to a multilayer network structure, and each layer of the network structure contains a large number of neurons. It is similar to the neural structure of the human brain, and can be regarded as a simple simulation of the human brain. In general, a convolutional neural network includes three parts, namely an input layer, a combination of n-layer convolutional layers and a pooling layer, and a fully connected multilayer perceptron classifier [4]. The main component of the convolution layer is the feature plane which is composed of some rectangularly arranged neurons. These neurons share weights, which is the convolution kernel. During network training, the convolution kernel will obtain reasonable weights through learning to effectively stabilize the connections between the layers of the convolutional neural network and reduce the risk caused by over-fitting. The pooling layer includes two forms of average pooling and maximum pooling. Both of these pooling forms can be regarded as special performance in the convolution process. The existence of pooling and convolution greatly reduces the complexity of convolution neural network model and the required parameters, and reduces the required parameters. Softmax is mainly used as the convolutional neural network classifier.

1.2 Deep Belief Network

Boltzmann machines are an important part of deep belief networks. Multiple restricted Boltzmann machines can be stacked to form deep belief networks. Yu Shize [5] established an energy theoretical probability model for deep belief networks. It can be found that the training of deep belief networks includes two components, that is pre-training and fine-tuning. The pre-training requires unsupervised learning for each layer of neural network, in which the signal from the previous layer will be the input signal of the latter layer, and the initial value of the pre-training is the trained neural network parameters. Using supervised learning to train the network is fine-tuning. Because the visualization of training data has been completed before, only a few iterations are needed to complete the estimation of the model.

1.3 Recurrent Neural Network

The recurrent neural network is mainly to collect and store the information, and the collected information will also be used for the current output calculation, that is to say, there are nodes connected between the hidden layers in the cyclic neural network. The input of the same hidden layer consists of the input of the input layer and the final output of the last hidden layer connected with it. Ideally, the recurrent neural network can complete the processing of training data of different lengths. In order to adapt to different image recognition environments, it includes three types of short-term memory model, simple recursive network, and two-way recurrent neural network, all of which have good application effects [6].

1.4 Generative Adversarial Network

Generative adversarial network consists of a generator and a discriminator. The main function of the generator is to collect the distribution of real data samples. Based on the collected data, new data samples can be generated for network software analysis. The discriminator is used to determine whether the ventricle is real or sample data. After the application of generative adversarial networks in the field of image processing, more and more adversarial network models have been proposed, such as conditional adversarial networks. The remaining adversarial networks have one more constraint based on them, limiting noise and effectively avoiding the bad situation such as model training collapse, and provide a guarantee for the diversity of generated samples.

2. Application of Unsupervised Deep Learning in Road Image Recognition

In recent years, high-end technologies such as intelligent vehicles, assisted driving and mobile robots have developed rapidly. These industries have put forward higher requirements for road image recognition. Improving the accuracy of road image recognition and reducing the occurrence of errors have gradually become the focus of current research.

The road image recognition method includes two parts, namely feature-based road image recognition and road edge recognition. Road area recognition regards road recognition as an image segmentation problem, and distinguishes according to the color, brightness and other indicators of the road area. The classification method is to calculate the road image histogram, select the appropriate threshold value and perform gray-scale segmentation on the image, and then the road image is recognized by generating, splitting and merging methods. The road area identification is based on the improved distance watershed algorithm, and the main process is as follows: (1) initialize the definition of road and background minimum; (2) determine the watershed by watershed algorithm; (3) fit the road boundary by using huff transform; (4) update the minimum value according to the detection results [7]. When initializing the definition of road and background minima, the first thing to do is to grade them, find the pixels adjacent to the road and background minima, calculate the distance between the harness and the minima, and grade them and store them according to the calculation results. The expansion of water collecting basin is to expand from the selected minimum value. According to the principle of level division, pixel points are processed from the minimum value. In the process of processing pixel points, if pixel points is connected with

water collecting basins, this pixel point can be regarded as the watershed of different water collecting basins. In order to improve the accuracy of the algorithm, the minimum value should be updated in real time. If the detection result is ideal, the minimum value obtained from the previous image detection can be used as the definition of the minimum value. If the detection result is not ideal, the minimum value obtained from the previous image detection is used.

The method of road image recognition effectively identifies the road area by recognizing the characteristics of road areas and background areas and finding the edge of the road according to the changes of features. This method includes image preprocessing, edge extraction and binarization. The first thing to do is to select an area of interest in the road image, to eliminate the noise with the use of filtering, and then to enhance the edge to complete the data preprocessing. After the edge features are extracted, a suitable operator is found, and the edge image is obtained by using the algorithm of binary image. Finally, the binary edge image is transformed into a continuous road image by using the huff transform [8]. Road edge detection includes the following steps: (1) image pre-processing; (2) lane edge detection. The first step of image preprocessing is graying the road image. The RGB model mentioned above is used to collect data, and different colors correspond to different gray values. Then the spatial filtering algorithm is used to process the image. The gray value is the calculated data, and the gray value of the edge of the road image is enhanced. The road image binarization is carried out, and the method of image binarization is the method of maximum class variance. Lane edge detection includes two parts: dividing region of interest and lane line fitting.

The application of unsupervised deep learning in road image recognition is mainly completed by computer vision detection systems. Road images are analyzed and processed using unsupervised deep learning. Road areas and background areas are identified and distinguished, and then use background subtraction to input road area information as classifier and directly output road image. Unsupervised depth learning combines multiple factors, taking into account the situation of road edges, effectively reducing the occurrence of situations such as incorrectly identifying roads. The relative biggest application advantage of unsupervised deep learning and traditional road image recognition methods is the low incidence of errors, which can ensure the accuracy and effectiveness of road recognition, and has promoted the development of unmanned vehicles, mobile robots and other industries [9].

3. Conclusion

In summary, unsupervised deep learning has the characteristics of high recognition rate, strong robustness, and strong generalization ability in road image recognition. The application effect is significant. If it is promoted and applied, it can effectively promote the development of major industries that apply road recognition technology. However, the research of unsupervised deep learning in road image recognition is still in the exploratory stage, and the following aspects need to be strengthened: (1) road image recognition in rainy and snowy days; (2) road obstacle recognition and detection; (3) identification of road boundaries and road representations. Through research, we can discover the application value of unsupervised deep learning in road image recognition and determine the improvement direction.

References:

[1] Li Chaobo, Li Hongjun, Xu Chen. *Application of Deep Learning in Image Recognition* [J]. Journal of Nantong University (Natural Science), 2018, v.17; No.64 (01): 5-13.

[2] Xia Yongquan, Huang Haipeng, Wang Bing, et al. *A Self-Encoding Method Based on Improved Unsupervised Deep Learning* [J]. Bulletin of Science and Technology, 2018 (7).

[3] Yin Ruigang, Wei Shuai, Li Yan, Yu Hong. *A Survey of Unsupervised Learning Methods in Deep Learning* [J]. Journal of Computer System Applications (8th issue): 1-7.

[4] Kang Xiaodong, Wang Hao, Guo Jun, et al. *Color Image Recognition Method Based on*

Unsupervised Deep Learning [J]. Journal of Computer Applications, 2015, 35 (9): 2636-2639.

[5] Yu Shize. *Research and Implementation of Road Vehicle Information Extraction and Recognition Algorithm Based on Image Processing* [D]. 2015.

[6] Zheng Yuanpan, Li Guangyang, Li Yi. *A Review of the Application of Deep Learning in Image Recognition* [J]. Computer Engineering and Applications, 2019 (12).

[7] Xie Jiexin, Zhao Hongfa, Shao Zhenzhou, et al. *Fast Multi-Modal Trajectory Segmentation Method Based on Unsupervised Deep Learning* [J]. Robot, 2019, 41 (3).

[8] Lin Mingwang. *Application of Deep Learning in Fish Image Recognition and Classification* [J]. Digital Technology and Application, 2017 (4): 96-97.