Visibility Analysis Based on Deep Learning

Zhen Mao[1]，Xiaoyan Chen[1*]，Xiaoning Yan[2], Shuangwu Zheng[2]
[1]Tianjin University of Science and Technology, China;

[2]Shenzhen Softsz Co. Ltd., China
E-mail:1037331281@qq.com
www.tust.edu.cn

Abstract

In recent years, visibility analysis through deep learning processing and analysis of video images for different places has become a hot research topic that attracts people's attention. A new deep learning model (A-VGGNet) is proposed to evaluate the visibility of real scenes. The model is constructed on the basis of the VGG classification model, and the classification accuracy of the deep learning model is improved by adding an attention mechanism. The experimental results show that the training success rate is 97.62%, the verification set test accuracy rate is 75.05%, and the test set classification accuracy rate is 85.05%. The proposed model has a good effect on the accuracy evaluation and classification of visibility.

Keywords: Deep learning, Regression analysis, VGG network, Attention mechanism

1. Introduction

Visibility is an indicator of atmospheric transparency in meteorology. In daily life, it indicates the maximum distance that people with normal vision can see and recognize objects. The unit is usually meter. Atmospheric visibility is closely related to people's daily life. Visibility analysis has important research significance in transportation, navigation, aviation and national defense military activities. Traffic accidents caused by low visibility are 2.5 times higher than other disasters, which will have a great impact on road transportation, aircraft flight and maritime navigation[1].The main factors affecting visibility are fog and haze. Generally speaking, the diameter of fine powder floating particles in haze is less than 0.01 μ m, so they can directly enter the human body through breathing, causing harm to people's health. Therefore, the accurate prediction and prediction of atmospheric visibility plays an important role and significance in urban air pollution control, ensuring public transport safety and maintaining people's life and property safety[2].

At present, the methods of visibility measurement mainly include human eye estimation, equipment detection and video image analysis. Among them, the traditional human eye estimation has great subjectivity, with large precision error and no specific quantitative standard. Although the instrument detection has high detection precision, it cannot be used on a large scale due to its high cost, difficult operation and troublesome carrying [3].With the development of computer vision technology and artificial intelligence science, video image visibility detection based on deep learning has gradually attracted people's attention. Using video to analyze visibility has the advantages of high speed, low cost and easy access to observed image data[4]. Through the analysis and processing of video images, this paper establishes the relationship between video images and real scenes, and then analyzes and classifies the meteorological elements affecting visibility according to the image characteristics.

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2. Research Methods and Technical Routes

In this paper, regression analysis is used to study the relationship between visibility and temperature, humidity and wind speed in fog. The variables are fitted and analyzed, and the relationship between visibility and the three is described according to the visibility index. Aiming at the problem of visibility accuracy evaluation, this paper designs a new deep learning model A-VGG net to improve the model on the basis of VGG classification model. The model improves the classification accuracy of deep learning model by adding attention mechanism, and realizes the accurate classification of visibility.

2.1. *Regression analysis*

This paper studies the relationship between visibility and temperature, humidity, wind speed and other different weather conditions. In order to find the relationship between visibility and different meteorological parameters, the meteorological elements affecting visibility are analyzed by fitting MOR (Meteorological Optical Range) with temperature, humidity and wind speed, and with the help of regression idea.

Regression analysis is a predictive modeling technology, which studies the relationship between dependent variable (target) and independent variable (predictor). This technology is usually used for prediction analysis, time series model and discovering the causal relationship between variables. This study uses polynomial regression fitting. The regression function of polynomial regression is a regression in which the regression variable is polynomial, and the regression model is a kind of linear regression model. At this time, the regression function is linear with respect to the regression coefficient.

2.2. *A-VGG Net*

The model adopted for this visibility estimation is named A-VGG net improves the VGG (Visual Geometry Group) classification model and improves the classification accuracy of the deep learning model by adding an attention mechanism. The network structure is shown in Figure 1.

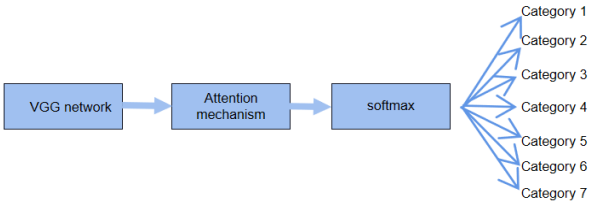

Fig. 1.A-VGG network structure

The VGG network[5] was proposed by the famous research group VGG of Oxford University in 2014. VGG is composed of 5-layer convolution layer, 3-layer full connection layer and softmax output layer. Max pooling is used to separate layers. The activation units of all hidden layers adopt Relu function. VGG network replaces large-scale convolution kernel VGG for feature extraction by stacking multiple 3x3 convolution kernels. In this way, multi-layer neural network can extract more features under a certain receptive field, and the training speed is relatively fast due to the small amount of parameters[6]. VGG16 classical convolutional neural network model is used in this model, which can be well suitable for classification and location tasks.

Attention mechanism is a data processing method in machine learning. It is widely used in natural language learning, image processing, speech recognition and other fields. Its core goal is to select information more critical to the current task goal from a large number of information. The network structure is shown in Figure 2 below.

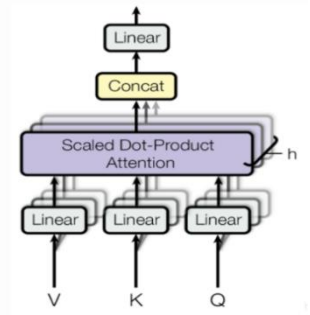

Fig. 2.Structure of attention mechanism

Neural attention mechanism can make neural network have the ability to focus on its input subset, and can select specific input. Attention can be applied to any type of input, regardless of its shape. In the case of limited computing power, attention mechanism is a resource allocation scheme that is the main means to solve the

problem of information overload. Computing resources are allocated to more important tasks. Attention is generally divided into two types: one is top-down conscious attention, which is called focused attention. Focused attention refers to the attention that has a predetermined purpose, depends on tasks, and actively and consciously focuses on an object. The other is the bottom-up unconscious attention, which is called significance based attention[7].

3. Experiments and Results

3.1. *Data processing*

Firstly, the detected video is frame extracted. The extracted videos are selected and classified. The training sets are divided into 7 categories, each training set contains 600 pictures. The verification set and test set are also divided into 7 categories, each category contains 100 pictures.

In this paper, the training data set is expanded and enhanced through image translation, rotation, mirror image and Gaussian noise, 2400 images of each type are obtained, and the training set is expanded to 15800.The enhancement of the model training data can not only improves the generalization ability and robustness of the model, but also basically overcomes the imbalance of positive and negative samples. And label the selected and classified photos. Resize the picture to 224 × 224 size pictures and then sent to the designed network for training.

3.2. *Analysis of factors affecting visibility*

In this paper, the meteorological optical range is used to fit the relationship between visibility and temperature, humidity and wind speed. After sorting out the data, 1439 input samples are counted. A single sample is composed of temperature, humidity and wind speed. The temperature, humidity and wind speed are fitted respectively. The fitting results are as follows. Figure 3 shows the fitting results of MOR and temperature, figure 4 shows the fitting results of MOR and humidity, and figure 5 shows the fitting results of MOR and wind speed.

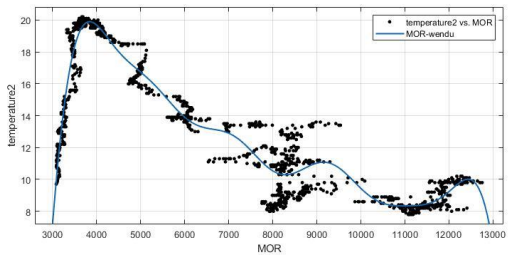

Fig. 3. Fitting curve of MOR and temperature

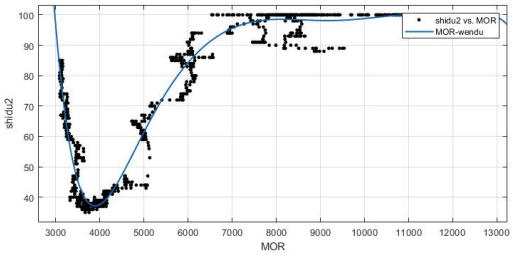

Fig. 4. Fitting curve of MOR and humidity

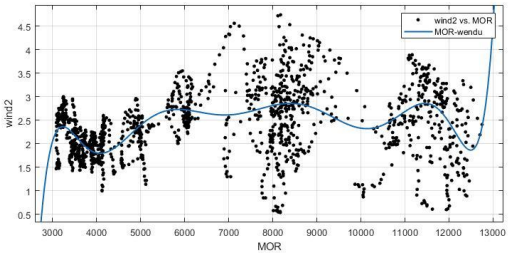

Fig. 5. Fitting curve of MOR and wind speed

From the fitting results, the fitting effect is good for the two parameters of temperature and humidity, but for the case of discrete data points such as wind speed, it cannot achieve good results, and other methods may be needed to analyze it separately. Multiple linear regression fitting combined with several main influencing factors shows that visibility is related to meteorological factors, directly proportional to temperature and wind speed and inversely proportional to humidity.

3.3. *Visibility classification*

In the process of evaluating the accuracy, the visibility is 7 classified and processed, and the improved A-VGG net is used to classify the visibility in video data. During the experiment, the training environment adopts Ubuntu

18.04 operating system, the CPU is Intel xeone5-2360, and the graphics card is two NVIDIA geforce gtx1080ti 11gb. During the experiments, the batch size is set to 16, each epoch takes 16 samples for training in the training set until all samples are trained once, that is, one epoch. 100 epochs were trained in the training process. The test environment of this paper adopts windows 10 operating system with i5 CPU- 9400F@2.9HZ The graphics card is NVIDIA geforce gtx1660 6GB. Through the training of the model, the accuracy of the training set and the accuracy of the verification set are obtained.

In this paper, the depth learning model is constructed. Based on the intercepted visibility data set, the experiment is carried out with ten-fold cross validation. Train_acc (TrainingAccuracy) and val_acc(Validation Accuracy) curves of the deep learning model were obtained according to the experiments. At the same time, train_loss and val_loss curves were obtained. The resulting curve is shown in Figure 6.

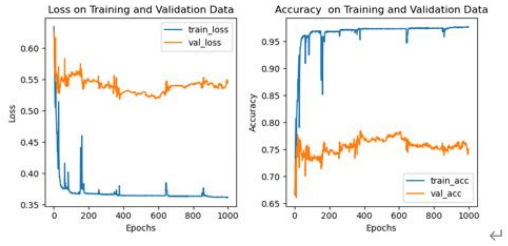

Fig. 6. Model training results

The results show that the loss curve of this algorithm decreases rapidly with the number of iterative steps, approaches 0 rapidly, and fluctuates slightly near the loss value of 0. Meanwhile, as the number of iteration steps increases, at 50 epoch, the train_ acc and val_ acc curve rises in a straight line and quickly approaches 1.0, that is, 100%. After a small shock of the validation data, the curve is basically stable at 100 epoch, the training loss value of the model is 0.3620, and the training success rate is train_ acc: 97.62%, where the validation set loss value val_ loss: 0.5445, verify the integrated power val_ acc: 75.05%, achieving an ideal training success rate, verifying the effectiveness and feasibility of the proposed network model, and maintaining a good fitting state in the process of learning the data set. The model uses one sixth of the data set for classification test, and the test score of algorithm test is 85.05%.

4. Discussion and conclusion

In this paper, the curve between visibility and temperature, humidity and wind speed is fitted through regression analysis. From the fitting results affecting the visibility mor value, it can be concluded that visibility is related to meteorological factors, directly proportional to temperature and wind speed, and inversely proportional to humidity. At the same time, the improved A-VGG network based on the VGG combines the attention mechanism to produce a good classification effect on the accuracy evaluation and classification of visibility. It can be seen that the deep learning network model designed in this paper has a good classification effect on the visibility data. By adding the deep convolution layer and adding the main force mechanism module, the distinguishability and characteristics of the data set are enhanced, which verifies the effectiveness and feasibility of the model proposed in this paper.

5. References

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Authors Introduction

Mr. Zhen Mao

He obtained his bachelor's degree from Nanjing Institute of Technology in China in 2020. He is currently studying for a master's degree at Tianjin University of Science and Technology.

Prof. Dr. Xiaoyan Chen

professor of Tianjin University of Science and Technology, graduated from Tianjin University with PH.D (2009), worked as a Post-doctor at Tianjin University (2009.5-2015.5). She had been in RPI, USA with Dr. Johnathon from Sep.2009 to Feb.2010 and in Kent, UK with Yong Yan from Sep-Dec.2012y.

Mr. Xiaoning Yan

He obtained a bachelor's degree in software engineering from South China University of technology in 2012 and a master's degree in computer science from the University of Texas Dallas in 2015 . Now he is the technical director of Shenzhen Ansoft Huishi Technology Co., Ltd

Mr. Xiaoning Yan

He is a graduate student majoring in control engineering of Tianjin University of science and technology. He is now the vice president of Ansoft Algorithm Research Institute and Ansoft algorithm engineer. He is mainly engaged in the application research of deep learning, computer vision and artificial intelligence algorithms.