Application Research on Satisfaction Evaluation of Clothing Advertising based on Micro Expression Recognition Technology

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-----ABSTRACT-----

Questionnaire is one of the most important means to collect data and make information decision. In this paper, the micro expression recognition technology of artificial intelligence is applied in the field of print

In this paper, the micro expression recognition technology of artificial intelligence is applied in the field of print advertising satisfaction collection and information decision-making. Starting with the analysis of micro expression, a new concept of satisfaction factor of print advertising is proposed and then various optimization functions in neural network are analyzed and discussed. In the following part, the Adabound optimization function is applied to the network model in the example of clothing print advertisement and the convergence speed of the loss function is accelerated in order to improve the detection accuracy of the model. Experimental result shows the satisfaction of the viewers to the clothing print advertisements, allowing researchers to judge their purchase desire at the same time.

Keywords - Clothing print advertising; micro expression recognition; satisfaction; Adabound

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INTRODUCTION

As an important means of promotion, advertising can attract consumers' attention, induce consumers' purchase interest and desire, promote consumer behavior, and predict consumers' preferences and interests. Therefore, it has certain advantages in information transmission and attracting consumers' attention. When the clothing plane advertisement is put out, the enterprise can only know whether the users like the clothing in the advertisement or not and the aspects that need to be improved through the results of the questionnaire. However, there are many disadvantages in the method of questionnaire:firstly,the making of questionnaire is troublesome;secondly,the process of collecting questionnaire and statistics is complex; in addition, the questionnaire is filled by users themselves, so the quality of the results is not guaranteed.

The concept of micro expression was first proposed by psychologists. Even if people actively control their facial expressions to hide their true feelings, psychologists can also judge their true feelings by observing the subtle movements of facial muscles subconsciously and combining the facial coding system[1]. Therefore, micro expression is considered to be a kind of instantaneous, fast and unconscious expression that appears when people deliberately hide and suppress their true feelings. Because of its short duration and small amplitude, micro expression is not easy to observe, even for psychology practitioners who have received targeted training. Therefore, the recognition and judgment of micro expression is at a low level.

In recent years, there are many artificial intelligence micro expression recognition methods. Pfister[2] proposed to use the local binary patterns on three orthogonal planes (LBP-TOP) for facial feature extraction and micro expression recognition. On the basis of LBP-TOP, Wang[3] proposed to use LBP six intersection points (SIP).Li [4] proposed a LBP-TOP like algorithm, which uses histograms of oriented gradients (HOG) and histograms of image gradient orientation (higo) in three orthogonal planes to extract the features of micro expression video frame sequence, achieving good micro expression recognition effect. Patel[5] proposed to use a convolution neural network with convolution layer, pooling layer and full connection layer to extract the features of micro expression for recognition. Li[6] and others use the deep multitask convolutional neural network to locate the key points of the face, so as to better extract the optical flow features of the micro expression frame sequence for the micro expression detection task. Because micro expression can directly reflect the mood of the people who watch clothing advertising, the combination of micro expression technology and clothing advertising recognition satisfaction evaluation can make up for the defects of questionnaire survey in the investigation of clothing advertising satisfaction.

This paper focuses on applying micro expression recognition technology to the satisfaction evaluation of clothing advertising, proposes a new concept of clothing advertising satisfaction factor and compares three optimization algorithms, namely Stochastic Gradient Descent (SGD)[7], adaptive optimization algorithm (Adam)[8] and Adabound[9].In the test, micro expression recognition technology is used to record the types and times of different micro expression of the subjects after watching the clothing advertisement. After calculating the satisfaction factor, we can know whether the subjects has the desire to buy clothes from the macro as pect.

CLOTHING ADVERTISING SATISFACTION FACTOR

The micro expression can be divided into 7 levels [10], 1 for fear, 2 for disgust, 3 for sadness, 4 for anger, 5 for nature, 6 for surprise and 7 for happiness

Table 1 level of micro expressions

M icro expression	fear	disgust	sadness	anger	M icro expression	nature	surprise	happiness
Impact score	1	2	3	4	Impact score	5	6	7

The clothing advertisement satisfaction factor is the embodiment of subjects' satisfaction with the clothing in the advertisement. Next, we count the number of micro expressions of the subjects identified in the test and calculate the weighted average of all micro expressions. The specific formula is as follows:

Clothing advertisin g satisfacti on factor

$$= \frac{\text{fear} \cdot N_1 + \text{disgust } \cdot N_2 + \dots + \text{happiness } \cdot N_7}{\text{types of micro expression } \times N}$$

Where N_i (i=1...7) is the number of different micro expressions and N is the number of micro expressions in total. Finally, the clothing advertising satisfaction factor is calculated to judge whether the subject is satisfied with the clothing advertising and his desire to buy goods.

This article is based on the level ratio of micro expressions, people with natural, surprised and happy expressions are classified as those who have the desire to buy the advertised products.We can also calculate the satisfaction factor of clothing advertising. If the satisfaction factor is greater than 0.71, we consider the subject to be a potential customer.

NEURAL NETWORK TRAINING OPTIMIZATION ALGORITHM

A. LENET NETWORK

In this paper, we design a 7-layer LENet[11] convolutional neural network as the base net to extract the expression features, which has 2 convolution layers, 2 pooling layers and 3 fully connected layers.Except for the input layer, each layer of the base network contains a different number of training parameters. The data first passes through the convolutional layer twice to the pooling layer, and then passes through the fully connected layer.



Figure 1 lenet network structure

B. RANDOM GRADIENT DESCENT ALGORITHM

Random gradient descent algorithm(SGD) randomly selects a sample from the training set to learn each time. Batch gradient descent algorithm uses all training samples each time, so these calculations are redundant given that the sample set is the same. Since the random gradient descent algorithm randomly selects one sample to update the model parameters each time, the learning speed is very high and the status can be updated online. Supposing n experimental samples in some data sets are randomly selected, we then let I=0,1..n. The parameter formula of SGD is as follows:

$$\theta_{i+1} = \theta_i - \eta \bullet \frac{\partial J_n(\theta_i)}{\partial \theta_i} \tag{1}$$

Most practical optimization methods for deep neural networks are based on stochastic gradient descent algorithm. However, as a super parameter, it is usually difficult to adjust the learning rate of SGD, especially in case of complex network such as face micro expression recognition, largely because the size of different parameters varies greatly and needs to be adjusted in the whole training process.

C. ADAPTIVE LEARNING RATE ALGO RITHM

Adamalgorithm introduces a one-step optimization method of random objective function based on adaptive estimation. This method has the advantages of small difficulty, high computational efficiency, small memory requirement and constant diagonal rescaling, which make it suitable for big data and large parameter problems. This method is also suitable for non-stationary objects and problems with noise and sparse gradient. Adam algorithm uses the momentum optimization method, because parameter θ will not affect the gradient value of the algorithm. If the gradient of the algorithm is relatively small, the change of the parameter will also become very small, so this article adds momentum to the optimization formula to make the parameter change, just like the actual object motion mode, and the gradient is regarded as the acceleration of the object motion To prevent the momentum from changing too much, we use the

parameter m as the momentum, that is, m_i is the momentum update rate.

Because of the fast descent rate, the algorithm is just local convergent instead of globally convergent.Therefore, we only calculate the gradients of recent iterations and use the exponential decay method for optimization. However, as momentum is introduced into the stochastic gradient descent algorithm, there will be new super parameters added to the model, so all super parameters need to be adjusted continuously. Therefore, different learning rates

$$\mathbf{m}_{i} = \beta_{1} m_{i-1} + (1 - \beta_{1}) \frac{\partial J_{n}(\theta_{i-1})}{\partial \theta_{i-1}}$$
(2)

$$\theta_{i} = \theta_{i-1} - m_{i-1} \tag{3}$$

$$\mathbf{s}_{i} = \boldsymbol{\beta}_{2} \boldsymbol{s}_{i-1} + (1 - \boldsymbol{\beta}_{2}) \left(\frac{\partial J_{n}(\boldsymbol{\theta}_{i-1})}{\partial \boldsymbol{\theta}_{i-1}}\right)^{2}$$
(4)

$$\mathbf{m}_i = \frac{m_{i-1}}{1 - \beta_1^T} \tag{5}$$

$$\mathbf{s}_i = \frac{s_{i-1}}{1 - \boldsymbol{\beta}_2^T} \tag{6}$$

$$\theta_{i} = \theta_{i-1} - \eta \frac{m_{i}}{\sqrt{s_{i} + \varepsilon}}$$
(7)

Adaptive optimization algorithm has better optimization performance than stochastic gradient descent algorithm. However, recent studies show that they usually have worse generalization performance than stochastic gradient descent algorithms, especially in the case of deep neural networks. In the process of micro expression recognition, on the one hand, we need to use the adaptive optimization method to realize the fast training process and give the element scale term of the learning rate; on the other hand, we need to use the random gradient descent algorithm to ensure the generalization ability. Therefore, this paper introduces Adabound optimization algorithm for micro expression recognition to improve the training effect of the model.

D. ADABO UNDALGORITHM

Adam is an adaptive learning rate optimization algorithm, which can adjust the learning rate continuously in the training process to accelerate the convergence of the loss function of the model. However, the range of learning rate in Adam algorithm is from 0 to $+\infty$, while in SGD algorithm, the learning rate is directly set to a fixed value. However, the use of Adam algorithm for training may lead to the divergence of the loss function, which means we can only get the local optimal solution instead of the global optimal solution. If we cut the learning rate based on the idea of gradient cutting technology, the learning rate will be limited to a certain range, ensuring that the learning rate will not be too large or too small. Therefore, using are set for each parameter, and the learning rate is adjusted adaptively, considering that the step of each parameter is different. Since sometimes the training samples are not balanced, the sparsity of the data will lead to the gradient sparsity of the corresponding parameters. In most cases, the gradient of the sparse parameters is 0 and the update frequency is relatively low, so a larger update step can be used, while the parameter with a higher update frequency can use a smaller step. The specific optimization formula is as follows:

Adabound algorithm instead of Adam algorithm to optimize the model can make the training effect more ideal. According to the principle of Adam algorithm, the following steps are added after Adam formula (6).

$$\eta_l = 0.1 - \frac{0.1}{(1 - \beta_2)i + 1} \tag{8}$$

$$\eta_{\rm u} = 0.1 + \frac{0.1}{(1 - \beta_2)i + 1} \tag{9}$$

$$\eta_i = \begin{cases} \eta_i & \text{if } \eta_i < \eta_i \\ \eta_u & \text{if } \eta_i > \eta_u \end{cases}$$
(10)

Use formulas (8) and (9) to limit and cut the learning rate η_i

. Finally, remove the learning rate that' s less than η_l or greater than η_u according to formula (10). By limiting the learning rate to $[\eta_l, \eta_u]$, the algorithm will not make the model unbalanced due to the adjustment of the learning rate and can further improve the training effect of the training model.

EXPERIMENTAL ANALYSIS

The hardware environment used in this article is Windows10, 16GB memory, Python3.7 software, and the simulation experiment is implemented according to the deep learning framework TensorFlow.

A. EXPERIMENTAL DATA SET

The data set used in this paper is Fer2013 data set. Fer2013 database is a large-scale and unconstrained database automatically collected by Pierre and Aaron through Google. The database consists of 28709 training maps, 3589 public test maps and 3589 private test maps. Each image is a grayscale image with 44x44 pixels. There are seven expressions in the fer2013 dataset: angry, disgusted, afraid, happy, sad, surprised and natural. Figure 2 shows some pictures in fer2013 database. There are significant differences in age, illumination, facial posture, expression, reflecting the real state of facial expression in different environments. We also classify the training set and test set of fer2013 data set according to a certain proportion.



Figure 2 some micro expression in fer2013 dataset

category	anger	disgust	fear	happiness	sadness	surprise	nature	number
training set	3995	436	4097	7215	4430	3171	4965	28709
Public collection	491	55	528	879	594	416	626	3589
Private set	467	56	496	895	653	415	604	3589

Table 2 training set and test set of fer2013

B. COMPARISON OF OPTIMIZATION FUNCTIONS

In order to compare the differences among SGD, Adam and Adabound, this paper uses SGD, Adam and Adabound to train the model. The training set and test set used are



Fig 3 Loss function of models trained by different optimization functions

As shown in Figure 3, the loss function values of SGD, Adam and Adabound optimization functions have been greatly reduced after 400 training cycles. At the beginning of training, SGD converges the fastest, Adam the second, and Adabound the slowest. When the training period reaches 100, the decline rate of SGD loss function value slows down greatly, while Adam and Adabound loss function values continue to decline. Finally, the loss function value of Adabound is smaller than that of Adam. Although the convergence speed of Adabound loss function is slow in the initial stage of training, it can keep a downward trend in training, thus the final training results are better than SGD and Adam.

C. ANALYSIS OF RESULTS

In the experiment, one subject was asked to watch a thirty-second advertisement and all the micro expressions of the subjects are recorded, as shown in Figure 4:

Fer2013 data sets. This article sets the learning rate of SGD, Adam and AdaBound to 0.1, momentum to 0.9, β_1 to 0.9, β_2 to 0.999. We can get Figure 3.



Figure 4 types of micro expressions

As can be seen from Figure 4, there are two happy faces, one surprised face, four natural faces, three fear faces and one angry face. According to the calculation method of satisfaction factor of clothing advertising, the satisfaction factor of the subjects is only 0.61, which does not reach 0.71, indicating that subject have no desire to buy the advertised clothes.

CONCLUSION

This paper puts forward a new concept of clothing advertising satisfaction factor, applies micro expression recognition technology to watching clothing print ads, and uses Adabound optimization function to improve the accuracy of training model, so as to make up for many disadvantages of traditional questionnaire survey in clothing advertising application. In the future, we will further optimize the network structure of micro expression recognition to speed up the recognition efficiency.

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Biographies and Photographs



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