Research on Physical Fitness Classification of Traditional Chinese Medicine Based on Human Infrared Heat Map

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Abstract. The infrared heat map reflects the overall temperature distribution of the human body, which coincides with the theory of traditional Chinese medicine, as an important indicator of human sub-health status identification in the field of traditional Chinese medicine, the physical fitness of traditional Chinese medicine has attracted more and more attention from the medical field and the general public. Because the infrared heat map of the human body has rich color distribution characteristics, this paper uses color feature extraction and texture feature extraction algorithms combined with SVM classifiers and convolutional neural networks to perform classification experiments. The results show that the accuracy of deep learning algorithms is higher than that of traditional machine learning algorithms, Deep learning can be combined with local subtle features for further research.

1. Introduction
The application of infrared thermal imaging technology to the identification of TCM (Traditional Chinese Medicine) physique is one of the important methods for the objectification of TCM physique identification, avoiding the shortcomings of large deviations caused by the inconsistency of individual subjective understanding and understanding of the scale evaluation method. For complex physique, the infrared heat map can clearly and objectively reflect the main problems. Zeng Dechuan and others summarized the temperature distribution characteristics of infrared heat maps of different types of physique, and concluded that the use of infrared thermal imaging technology to study the physique of Jianjia is an important topic for future health management[1]; Professor Li Hongjuan and others studied 9 kinds of traditional Chinese medicine Research on the thermal characteristics of people with physique, based on the temperature detection report of the infrared heat map, analyzed the temperature difference of different viscera and each meridian of different physique people, and analyzed the infrared heat maps of 562 cases of different physiques, and obtained different characteristics of 9 physiques[2].

At present, the research of infrared thermal imaging technology in the application of traditional Chinese medical physique is only a small sample empirical study of individuals. Whether the data analysis results conform to the principles of statistics and whether it is scientific and reasonable remains to be further discussed. This research combines computer technology to automatically analyze the characteristics of infrared images of the human body, and aims to provide a more convenient auxiliary diagnosis method and save manpower consumption.
2. Materials and Methods

2.1. Extract color features
The research object in this paper has good visual effects and rich color features, so first choose the color feature as the feature description object. The data in this study has rich color distribution characteristics and is closely related to the color space distribution. Therefore, this paper uses the commonly used color feature description method Color Moment, ColorCoherenceVector and ColorCorrelogram, which characterize the color space distribution, for feature extraction and comparison experiments.

2.1.1. Color Moment
Stricker A.M.A and Orengo M[4] proposed the Color Moment method, which is an effective method of color feature representation. It can better express the color distribution information while being less complex. It uses first moments($\mu_i$) and second moments($\sigma_i$), third moments($s_i$) to express the color information in the low-order moments. The mathematical expression of the Color Moment is as follows:

$$\mu_i = \frac{1}{N} \sum_{j=1}^{N} p_ij$$  \hspace{1cm} (1)

$$\sigma_i = \left( \frac{1}{N} \sum_{j=1}^{N} (p_ij - \mu_i)^2 \right)^{\frac{1}{2}}$$  \hspace{1cm} (2)

$$s_i = \left( \frac{1}{N} \sum_{j=1}^{N} (p_ij - \mu_i)^3 \right)^{\frac{1}{3}}$$  \hspace{1cm} (3)

2.1.2. ColorCoherenceVector
Aiming at the shortcoming that the color histogram and Color Moment cannot express the spatial position of the image color, Ravanmehr R et al. proposed the color coherence vector of the image. Its core idea is to divide the pixels belonging to each bin of the histogram into two parts: if the area of the continuous area occupied by some pixels in the bin is greater than a given threshold, then the pixels in this area are regarded as aggregated pixels, otherwise as non-aggregated pixels.

2.1.3. ColorCorrelogram
The ColorCorrelogram (CC) is another method of expressing the color distribution of an image proposed by J. Huang. The ColorCorrelogram represents the spatial distribution relationship of color pairs at different pixel distances. It not only depicts a certain number of pixels in a color accounts for the proportion of the entire image, and it also reflects the spatial correlation between different color pairs. It combines the two visual characteristics of the image's spatial position information and color information, and uses the same color or the difference between different colors.

However, if the correlation between any colors is considered, the ColorCorrelogram will become very complicated and huge. This study uses a simplified color auto-correlation graph correlogram, it only examines the spatial relationship between pixels with the same color.

2.2. Texture features
The most significant feature of the infrared heat map of the human body is the regularity of the temperature distribution in various regions of the human body. The human body is divided into regions according to the field of traditional Chinese medicine. Different physiques and regions have different temperature distribution rules, which are reflected in the infrared heat map as different color distributions. According to the law of color distribution, different TCM physiques can be distinguished. The GLCM algorithm and the LBP texture feature extraction method describe the image texture features according to the gray-level correlation characteristics of the image, this paper uses GLCM and LBP for texture feature extraction.

2.3. Classification based on SVM
SVM has good performance when dealing with small samples. Due to the small number of samples in this study, firstly, SVM was used to combine the extracted color features and texture features to identify
the physique of traditional Chinese medicine using infrared heat maps. The SVM classifier selects the radial basis kernel function as the kernel function. In the SVM classification experiment, it is considered to use grid parameter optimization, genetic algorithm parameter optimization and particle swarm optimization to find the optimal parameters to obtain relatively excellent classification accuracy.

2.4. Automatic classification based on deep network

CNN can classify images well without manually extracting features. Due to the limited data set, it is a binary classification problem. Therefore, this paper builds a relatively shallow neural network to recognize infrared heat maps. This paper uses the existing AlexNet model and fine-tunes on this basis to realize automatic recognition of human infrared heat maps, and at the same time, compare experiments with other existing deep neural networks to find the best classification network.

3. Results

3.1. Data set source and experimental equipment

The data set used in this research comes from the infrared image database of the Infrared Research Office of the Service Bureau of the State Administration of Traditional Chinese Medicine. The image size is 240*320.

Traditional Chinese medicine physiques are generally divided into nine categories. Because the research institute collects fewer data samples, the preliminary research is divided into two categories for identification, namely, Peaceful physique and Other physique. In the field of Chinese medicine, Peaceful physique is a healthy body state, while others If the physique is in a sub-healthy state, it is necessary for the patient to pay attention to the body in daily life and correct unhealthy living habits.

The experiment divides the data set into a training set and a test set. The actual data image is shown in Figure 1, and the size of the image is 240*320. The image categories are divided into peace and Other physique. Among them, there are 400 images of Peaceful physique and 572 images of Other physique in the training set, 55 images of peace constitutions and 54 images of Other physique in the test set.

![Figure 1](image1.png)

(Figure (a) shows an example of a peaceful physique image, Figure (b) shows an example of a Other physique image)

The experimental environment is CPU: i5-Inspiron15-7548, and the operating system is win10, 64-bit. The SVM algorithm is implemented based on Matlab 2017b and LibSVM, and the training and testing are all performed under the CPU. The deep learning algorithm is implemented based on tensorflow, and the training and testing are all performed under the CPU.

3.2. SVM classification results

3.2.1. Based on color features

Table 1. Classification results of three feature description methods under different optimization methods

| Color feature extraction | SVM-particle swarm algorithm | SVM-genetic algorithm | SVM-grid method |
|--------------------------|-----------------------------|-----------------------|-----------------|
| Test Accuracy(%)         |                             |                       |                 |

The experimental environment is CPU: i5-Inspiron15-7548, and the operating system is win10, 64-bit. The SVM algorithm is implemented based on Matlab 2017b and LibSVM, and the training and testing are all performed under the CPU. The deep learning algorithm is implemented based on tensorflow, and the training and testing are all performed under the CPU.
Although the ColorCoherenceVector and the ColorCorrelogramAuto take into account the spatial distribution of colors, they have not achieved a good classification effect when the number of this data set is small. There is little difference between the classification results of the Color Moment feature description scheme.

### 3.2.2. based on texture features

Table 2. Classification results of two texture feature description methods under different optimization methods

| Color feature extraction | SVM-particle swarm algorithm | SVM-genetic algorithm | SVM-grid method |
|--------------------------|-----------------------------|-----------------------|-----------------|
| GLCM                     | 65.5350%                    | 65.6379%              | 67.5926%        |
| LBP                      | 65.5350%                    | 65.6379%              | 58.8477%        |

The accuracy of only extracting texture features for classification is improved compared to only extracting color, and the experimental results show that the GLCM algorithm is more effective, which is sufficient to prove that the close relationship between the gray values of the human infrared heat map pixels has an important impact on the image category.

### 3.2.3. Fusion feature classification results

Table 3. Comparison of fusion feature classification results

| feature extraction | SVM-particle swarm algorithm | SVM-genetic algorithm | SVM-grid method |
|--------------------|-----------------------------|-----------------------|-----------------|
| GLCM- Color Moment | 58.8477%                    | 62.4486%              | 59.1564%        |

Choose the slightly superior GLCM and Color Moment feature fusion for training and classification again. The experimental results in Table 3 show that this scheme does not have any effective help on the classification results, which shows that the direct extraction of color features and texture features on this data set is very limited. The differences between the samples are weak, and more subtle features need to be added for subsequent processing.

### 3.3. Based on CNN classification

Table 4. Comparison of fusion feature classification results

| Category           | AlxNet  | GoogleNet | VGG    |
|--------------------|---------|-----------|--------|
| Peaceful physique  | 87.27%  | 67.27%    | 80.00% |
| Other physique     | 57.41%  | 24.07%    | 55.56% |

From the above experimental results, it can be seen that compared with the traditional feature extraction algorithm, deep learning has a better classification effect on this data set. After multiple rounds of training for each network, the test accuracy listed in Table 4 is the best result. Among them, AlxNet is trained for 15 epochs, GoogleNet is trained for 25 epochs, and VGG is trained for 10 epochs. Taking into account, a simple AlxNet network The training effect and test results are the best, and the next step of research can be carried out on this basis. The combination of the basic model of the Alexnet algorithm and the local features of the image can be used to further extract the depth features more accurately to improve the classification accuracy, and to solve the problem of the imbalance of the classification accuracy in this experiment.
4. Conclusions
The physical fitness of traditional Chinese medicine is used to monitor the overall health of the human body in the field of traditional Chinese medicine. However, due to the high price of infrared thermal imaging, the application of infrared thermal imaging in the field of traditional Chinese medicine is relatively small. The recognition of infrared thermal image of TCM physique mainly depends on extracting the law of human body temperature, and there is no work to distinguish categories based on the characteristics of the image itself. This research conducts preliminary research in this field, combining computing technology and the characteristics of the image itself to analyze the TCM physique categories.

In this study, we first used the color feature and texture feature of the infrared heat map of the human body to be combined with the SVM classifier for TCM physique recognition, and then used deep learning convolutional neural network for classification and recognition. The experimental results show that deep learning has better results in feature extraction. A higher classification accuracy rate has been achieved, and further adjustments and improvements based on the convolutional neural network AlexNet can further improve the classification accuracy rate in subsequent work.

Acknowledgments
This project is the preliminary research result of the sub-task of the national key research and development plan "Modernization of Traditional Chinese Medicine" research key special "Key Technology Research on Portable TCM Health Data Collection Equipment" (2018YFC1707700). We would also like to thank the project funded by the State Administration of Traditional Chinese Medicine (GZY-FJS-2018-023) for supporting this study. Finally, thank my teachers and classmates for their help and encouragement in the research process.

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