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A Review on the Classification of Traditional Chinese Medicine Tongue Images Based on Computer Technology

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Abstract: Tongue imaging in traditional Chinese medicine is one of the important indicators for diagnosis, and its research has become a hot topic in the field of traditional Chinese medicine. In recent years, with the continuous development of computer technology, more and more research has applied computer technology to the analysis and diagnosis of tongue image classification in traditional Chinese medicine, which is of great significance for the diagnosis and treatment of traditional Chinese medicine. The research on the classification of tongue images is also of great importance. This article reviews the current status and existing problems of tongue image research.

Keywords: Traditional Chinese medicine; Tongue diagnosis; Computer; Classification.

1. Introduction

Traditional Chinese medicine, as an important component of traditional Chinese medicine, has a long history and profound cultural heritage. In terms of disease diagnosis, traditional Chinese medicine focuses on syndrome differentiation and treatment, that is, by comprehensively analyzing the patient's symptoms, signs, tongue images and other information, determining the nature and stage of the disease, and formulating corresponding treatment plans. Tongue imaging is a very important indicator. Traditional Chinese medicine believes that the tongue is the mapping area of internal organs in the human body. Observing the patient's tongue can provide important diagnostic clues, help doctors determine the nature and stage of the disease, and thus develop more accurate treatment plans. Traditional Chinese medicine plays an irreplaceable role in disease diagnosis, and tongue imaging, as one of the important indicators in traditional Chinese medicine diagnosis and treatment, plays an important role.

Traditional Chinese medicine tongue diagnosis [1-4] is an excellent and exquisite diagnostic and treatment method that has been passed down for thousands of years, and has continuously developed and strengthened through long exploration and practice. The application value of tongue diagnosis is extremely powerful. It observes the shape, color, and coating of the tongue to analyze physiological conditions and explore pathological changes. It is an important component of traditional Chinese medicine. The use of various detection methods and the use of modern computer technology to achieve modernization of tongue diagnosis in traditional Chinese medicine has become an inevitable trend and a crucial approach to the modernization of traditional Chinese medicine, in response to issues such as broadening the perspective, standardizing diagnosis, and miniaturizing the four diagnostic methods of traditional Chinese medicine. In recent years, computer technology has been widely applied in the medical field, and the application of image processing and pattern recognition technology in tongue diagnosis has gradually received attention from the scientific research community worldwide. The use of modern information analysis and pattern recognition technology to address the mainstream issues in the objective development of traditional Chinese medicine tongue diagnosis is crucial for achieving modernization of traditional Chinese medicine tongue diagnosis. Based on image processing technology to extract effective information from images and perform recognition analysis, modernization of traditional Chinese medicine tongue diagnosis has made certain progress, indicating the feasibility of automatic classification of traditional Chinese medicine tongue images.

This article reviews the research progress and achievements of traditional Chinese medicine tongue image classification based on computer technology in recent years, focusing on the research of tongue image classification, including the dataset of tongue images, tongue image processing, feature extraction, classification methods, and other aspects. This article will explore and analyze the current problems and future development directions from these aspects. These research results provide new ideas and methods for traditional Chinese medicine diagnosis, and are expected to achieve more intelligent auxiliary diagnosis in the future.

2. Research status analysis

2.1. Database

The dataset used for tongue image classification plays a very important role. A good dataset not only represents the strengths and weaknesses of the model, but also serves as the foundation for data analysis. The dataset of tongue images is diverse and can be generally divided into two categories.

The first type is a self-built dataset, which is collected and organized by researchers themselves. Use professional tongue image acquisition equipment, including several important components such as standard light sources and high-definition cameras, to capture volunteer tongue images under standard light sources according to certain shooting guidelines. The process of collection requires significant effort, but research is targeted. This part of the data involves the privacy of volunteers, and confidentiality measures need to be taken during the use process.

The second type is a publicly available dataset of tongue images. This part of the data can be queried and downloaded from public databases. Currently, considering privacy, the number of publicly available datasets is relatively small. Due to the lack of indication of disease or other characteristics in the public section, it is necessary for professional physicians to assist in labeling before it can be put into use. As shown in Figure 1, this publicly available tongue image dataset only contains 300 images.

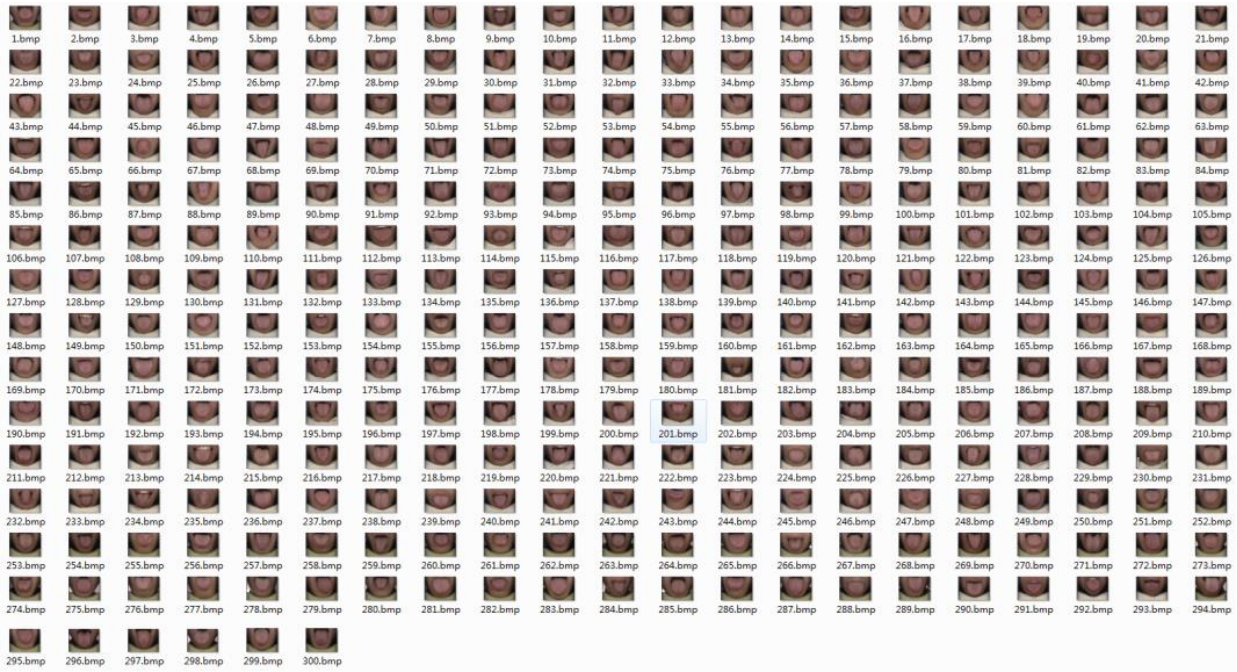

Fig. 1 Public tongue image dataset

2.2. Current situation analysis

Some studies have used traditional image processing methods and feature extraction algorithms to process and analyze tongue images, such as methods based on features such as color, texture, and morphology. In addition, there are also some studies using deep learning techniques for tongue image classification, such as convolutional neural networks (CNN), recurrent neural networks (RNN), etc. Although these methods have achieved certain results to varying degrees, there are still some problems and challenges.

Starting from the tongue image itself and dealing with non-standard tongue images, Qi et al. [5] used traditional Chinese medicine experts to correct the contour of tongue images, making the tongue images as standard as possible in the external environment, and then combined with tongue color correction to complete tongue color classification. The above method achieves classification goals by manually standardizing tongue images. Although the operation is feasible, the workload is huge and not suitable for a large number of tongue image data.

Regarding the feature analysis of tongue images, Wang et al. [6] proposed a new color recognition algorithm that can divide tongue images into multiple regions, and then classify these regions based on the color of the tongue and tongue coating, using land movement distance. Wang et al. [7] studied three features of the tongue color space: color gamut, color centers of twelve tongue colors, and color distribution of typical image features in the tongue color gamut. Using these features, a new tongue color space was defined, and a new method for extracting color features based on this color space was proposed for diagnostic classification. In addition, other researchers have also proposed methods for extracting and analyzing other key features of tongue images. For example, Liu et al. [8] used a wide line detector to extract crack features from tongue images. Wang et al. [9] proposed an improvement on the Hu moment operator to make the target image invariant to rotation, translation, and scaling. They extracted 7 Hu moment feature values of the target tomato and used these parameters to detect and classify the shape of the tomato. From the perspective of tongue image features, processing and analysis can indirectly achieve the goal of tongue image classification and recognition. Meng [10] proposed a new feature extraction framework called Constrained High Diffusion Neural Network (CHDNet) to extract unbiased features and reduce the manual labor of traditional Chinese medicine tongue diagnosis. This method learns advanced features and provides more classification information during training time, resulting in higher accuracy in predicting test samples.

Shen Lansun et al. mainly study the key technologies of tongue diagnosis analysis, including the analysis and description of basic information, such as tongue image acquisition, color reproduction, tongue body segmentation, and tongue image feature extraction. They also include fusion methods based on tongue image feature information. They proposed a fusion method [11, 12] that utilizes support vector machines as the feature and decision layers of multi class classifiers, and applies this method to clinical tongue imaging, comparing it with the judgments of traditional Chinese medicine experts to evaluate experimental results. Chiu [13] has developed an intelligent tongue imaging diagnostic system that can quantitatively analyze the surface features of the tongue. In order to reduce the interference of environmental factors on diagnostic results, they developed a standard hardware environment, which is used for lighting, acquisition, and tongue image reproduction. In addition, a structure recognition algorithm is proposed, which is based on the color and spatial texture features of the tongue body and tongue coating. And it can determine the main color of

the tongue body and tongue coating, the thickness of the tongue coating, and whether there is greasy coating on the surface of the tongue. Three traditional Chinese medicine experts will evaluate the recognition results of the system.

Regarding the research and analysis of tongue image classification methods, in general tongue color classification methods, tongue images collected through standardized devices often come with high device requirements, high resolution, and large memory datasets. Therefore, there are high requirements for hardware conditions and training time used in network training. Wang et al. [14] used the AdaBoost algorithm to classify tongues by color, and combined the algorithm with a cascading framework to analyze tongue color. This method can effectively improve the classification accuracy, but there are also some shortcomings, such as the small experimental data set in this paper, which may lead to overfitting. Shang et al. [15] applied the Otsu method to multi-channel images to remove tongue background, and used CNN to classify tongue colors. The preprocessing and data enhancement of tongue color images in the article can effectively improve the robustness and generalization ability of the model. However, for some special cases (such as changes in light, angle, etc.), this method may have certain recognition errors.

3. Summary and Outlook

This review mainly introduces the research status and development trends of traditional Chinese medicine tongue image classification oriented towards computer technology. At present, research on tongue image classification in traditional Chinese medicine mainly focuses on feature extraction, classifier design, and dataset construction. Although some progress has been made, there are still some challenges, such as a lack of dataset, insufficient feature extraction, and unstable classifier performance. In the future, research on tongue image classification in traditional Chinese medicine will develop in the following directions: firstly, strengthening the construction and sharing of datasets to improve the generalization ability of models; The second is to explore more effective feature extraction methods, such as deep learning; Thirdly, design more stable and efficient classifiers; The fourth is to combine the classification of tongue images in traditional Chinese medicine with other medical fields, providing more accurate, fast, and convenient technical support for clinical diagnosis and treatment.

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