DOI: 10.53469/jcmp.2025.07(11).06

The Application and Research Progress of Artificial Intelligence Technology in Tumor Inspection Diagnosis

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Abstract: ***Traditional Chinese Medicine (TCM) inspection plays an irreplaceable and significant role in the early screening and therapeutic effect evaluation of tumors. However, it is highly dependent on the subjective experience and judgment of doctors, which often leads to doubts about its accuracy and consistency. Moreover, the inheritance of TCM inspection faces challenges due to its high subjectivity, especially for young doctors, who find it difficult to learn and master. Meanwhile, with the increasing demand for TCM, the scarcity of senior and renowned TCM practitioners has become more prominent. Driven by artificial intelligence (AI) technology, Inspection Diagnosis of TCM is undergoing a profound transformation and demonstrating great potential clinical value. This paper summarizes the data preprocessing, classification diagnosis, and multi-modal analysis in the inspection process using AI technology, and also reviews the current application status in areas such as tongue diagnosis, facial diagnosis, eye diagnosis, and hand diagnosis. It focuses on analyzing the new breakthroughs in tumor auxiliary diagnosis and therapeutic effect prediction. The aim is to provide new ideas for tumor diagnosis and treatment and explore feasible paths for the future development of intelligent inspection.***

Keywords: Tumor, Artificial Intelligence, Inspection, Research Progress**.**

1. Introduction

Inspection diagnosis of TCM is a method of examining systemic diseases and syndromes through visual inspection, based on the "governing exterior to infer interior" diagnostic thinking in traditional Chinese medicine theory. However, the lack of objectivity in the current observation diagnosis process has become an urgent problem to be solved. With the rapid development of artificial intelligence technology, it has achieved intelligent analysis of the four aspects of information - spirit, complexion, shape, and posture - in observation diagnosis by simulating the human thinking process, thereby to some extent compensating for the deficiencies of traditional observation diagnosis, improving its accuracy and efficiency. Intelligent observation diagnosis has injected new vitality into traditional Chinese medicine. Malignant tumors, as a serious threat to human health, show significant differences in tongue appearance, complexion and other signs during their occurrence and development [1]. With the help of artificial intelligence technology, it is expected to provide new insights and ideas in the diagnosis, therapeutic effect evaluation, and prevention of tumors, opening up new avenues to solve this difficult problem.

2. Application of AI Technology in Inspection

2.1 Data Collection and Preprocessing

During the collection of inspection data, due to differences in equipment performance, color temperature, shooting distance adjustment, frame rate, etc., the error in subsequent data analysis significantly increases. Therefore, preprocessing and other operations on the collected data are particularly necessary. In terms of tongue image collection, issues such as tongue color distortion and non-standard data format have received widespread attention. Choosing an appropriate color model to build an intelligent tongue diagnosis model is of crucial importance. Relevant studies have found that the HSI color model can achieve more ideal segmentation results in clinical diagnosis of traditional Chinese medicine tongue images compared to other methods [2][3]. However, the actual collected tongue image data may have unqualified situations, such as the camera failing to successfully capture the tongue image, or the patient not fully sticking out the tongue. To address this problem, Jiang et al.[4] used the ResNet-152 deep model to analyze the tongue image data and successfully distinguished the qualified tongue image data, providing effective technical support for data screening. In the distinction between the tongue body and the tongue coating, Yuan and Liao [5] proposed a clustering analysis method based on the Lab color space. They believe that by analyzing the differences in color blocks in the Lab color space, effective distinction between the tongue body and the tongue coating can be achieved. This method outperforms traditional deep learning methods such as FCN, U-Net, and Deeplab-v3 in segmentation effect. In the collection of facial image data, the accurate description of glossiness is of great significance. Li Fengfu et al. [6] can better retain the gloss information in the image by using three color channels: Lab, RGB, and HSV, providing a more reliable basis for subsequent analysis. In data preprocessing, Mao Hongchao et al. [7] proposed an accurate segmentation method that generates a probability map of color distribution by fitting skin color, and algorithm and adaptive algorithm to achieve precise facial segmentation, providing convenience for facial image analysis. In addition, Ming Fang et al. [8] conducted in-depth research on the preprocessing of palm images preprocessing, successfully achieving complete palm segmentation through series of processing steps such as median filtering, image binarization, and palm edge extraction, laying a solid foundation for the subsequent analysis of palm images. Therefore, the data preprocessing process has become an important part of the application of artificial intelligence in inspection and diagnosis.

2.2 Classification Diagnosis

With the assistance of artificial intelligence technology, the quantitative analysis of inspection data has been achieved, enabling comprehensive collection of subtle features and completing classification diagnosis by comparing with the set threshold. In the classification of facial luster, Li et al. [9] designed a computer-aided classification model, using six feature extraction methods such as PCA and PLS to extract facial luster information. The results showed that in the Lab color space, LDA had the highest accuracy rate for discriminating luster. In the classification of tongue manifestations, Zhang et al. [10] invented a device called TDA-1 Tongue Diagnosis Instrument. In their research, the GA-SVM classifier was applied to extract tongue feature information, and the accuracy rate reached 83.06%. Moreover, Tang et al. [11] combined deep learning with traditional machine learning to identify tongue coating, using CNN to extract tongue features, and the final recognition accuracy reached 85.0%, indicating the feasibility of intelligent traditional Chinese medicine classification diagnosis. Wu et al. [12] collected tongue images of patients with 11 diseases including lung cancer and breast cancer, analyzed them using the SVM classifier, and the average accuracy rate exceeded 70%, proving the practicality of their computer method. For the classification diagnosis of sublingual collaterals, Li Wei [13] obtained color features of sublingual veins in RGB and HSV color spaces through the K-means clustering method, and used a binary classification algorithm for disease classification, with an average accuracy rate of 80.88%. Nevertheless, there are still differences in the classification diagnosis of various auscultation data, and the interpretation results lack uniformity.

2.3 Multimodal Fusion Analysis

Traditional Chinese medicine emphasizes the holistic concept. In clinical diagnosis and treatment, it is necessary to integrate information and data from various visual diagnosis methods such as face diagnosis, tongue diagnosis, and eye diagnosis, and utilize multimodal machine learning to achieve the most accurate diagnosis for guiding treatment. When using machine learning methods to diagnose diseases, information and data from different sensors in visual diagnosis can be collected. According to the data from different parts, features can be selected and fused, and ultimately combined for comprehensive diagnosis. Compared with single diagnostic data, integrating and exploring the interrelationships of data from different diagnoses can more systematically integrate and analyze visual diagnosis data, providing doctors with more accurate and rapid diagnostic references. Zhang et al. [14] proposed a multimodal model that combines deep learning and reinforcement learning to process tongue images and query data for syndrome identification. Currently, deep learning technology is highly favored mainly because it is easy to implement for the detection of traditional Chinese medicine diseases without the need for complex feature extraction processes in various collected traditional Chinese medicine data. Therefore, combining deep learning technology with multimodal traditional Chinese medicine data can improve diagnostic results.

3. Application of Al Technology in Tumor Diagnosis

3.1 Face Diagnosis

As research on face diagnosis deepens, the application of AI in this field is expanding, and it has begun to show promise in the diagnosis and treatment of tumors, presenting broad application prospects. In the "Yellow Emperor's Inner Canon" facial visual diagnosis mainly involves observing the overall shape and movement of the face to extract facial features. Ruan Ming et al. [16] collected the complexion and luster characteristics of 97 cancer patients with anxiety and depression. They found that the overall complexion of the patient group was darker and yellower, while that of the normal group was redder, suggesting that the pathogenesis of these patients was characterized by deficiency (blood and qi deficiency) and excess (blood stasis and damp-heat). Additionally, Lu Lingling et al. [17] collected the complexion of 274 patients with digestive tract tumors and depression or anxiety. This study provided more in-depth data than previous research and found that the observation group had a darker forehead, bluer left cheek, darker left eye socket, overall yellow complexion, and paler lip color, indicating the presence of both qi and blood deficiency and blood stasis. It is evident that the objective information parameters of TCM face diagnosis can be used as effective indicators in TCM diagnosis, providing new directions for the auxiliary diagnosis, therapeutic effect evaluation, and tertiary prevention of cancer diseases [18], and opening up new ideas for the development of AI in TCM face diagnosis.

3.2 Eye Diagnosis

In early studies, it was found that the upper and lower layers of the conjunctiva in the upper part of the eye of patients with digestive tract tumors might show abnormal vascular patterns, such as a U-shaped vascular course or a "straight" appearance of the lower conjunctival veins. If the area of the sclera corresponding to the liver shows abnormal manifestations such as dilated, curved, or bleeding vessels at the end, it may indicate a potential risk of liver cancer [19][20]. Other phenomena such as leukocoria, unilateral proptosis, and masses around the eye caused by ocular tumors [21] also provide new ideas for early tumor screening through changes in ocular vessels and local features. However, further research and validation are needed for their clinical application, which may offer new focus points for intelligent eye diagnosis. Nowadays, research not only focuses on static eye features, but also uses portable eye movement devices to obtain eye movement features and trains recognition models for dynamic features using algorithms such as random forests. The results prove that this model can accurately identify diseases [22]. With the application of self-supervised learning in eye diagnosis training databases, the data model can continuously adjust and optimize its weight structure, forming a visual diagnostic system. Combining AI with ophthalmic image data can increase the opportunities for clinical screening and diagnosis of tumor patients. Moreover, research on intelligent eye diagnosis in tumor diagnosis is still limited, and the development and application of eye diagnosis technology are still in the experimental stage.

3.3 Tongue Diagnosis

The research on artificial intelligence in traditional Chinese medicine tongue diagnosis is more extensive, possibly related to the fact that tongue appearance can directly reflect the condition of the entire internal organs and the rise and fall of pathogenic factors. Currently, the application of intelligent tongue diagnosis in the diagnosis process of tumors has gradually improved. Shi et al. [23] used tongue diagnosis instruments to collect tongue appearance characteristics of lung cancer, lung nodules, and healthy people, established a lung cancer early warning model, and evaluated its performance. The results showed that the tongue appearance of lung cancer patients was dark and dull, the tongue color was red, and the tongue coating was thin and yellow greasy. The accuracy rate of the lung cancer early warning model based on tongue appearance data was 70.09%. Duan Jinlong [24] studied 3883 cases of esophageal cancer patients. He assigned values to the tongue image features and gender and age of the training group, established a logistic regression model for esophageal cancer and precancerous lesions, and verified the accuracy of the model through the test group. Gholami et al. [25] compared the accuracy of 7 different CNN methods in diagnosing gastric cancer based on tongue color and its tongue coating characteristics, finally obtained the best model, and observed an accuracy of 91% in gastric cancer diagnosis. In addition, Jiang Nan et al. [26] used the artificial intelligence health status identification system to study the tongue color and tongue texture of patients with different TNM stages of gastric cancer. The results showed that the tongue images of patients with different stages were different, the tongue coating of different tumors was different, and patients with abnormal elevation of tumor markers had thick and greasy tongue coating. It can be seen that the research on intelligent tongue diagnosis in traditional Chinese medicine has become a major trend in future tumor diagnosis and treatment, which can better assist physicians in diagnosis, and judgment of patients' conditions and other functions.

3.4 Palm Diagnosis

Early clinical observations found that the changes in palm lines and different reflex zone colors of tumor patients corresponded to different conditions. For example, patients may have the disappearance of the 6th line in the palm line, which is more common in severe cases or those undergoing radiotherapy and chemotherapy; the esophageal cancer area shows irregular gray-white spots around; the liver cancer area has circular or elliptical dark blue spots in the liver region, etc. [27][28]. Nowadays, palm lines are highly combined with artificial intelligence, and big data analysis of palm lines is carried out based on disease orientation, thereby obtaining the standards of palm diagnosis and ultimately achieving the standardization of palm diagnosis. For diseases such as breast cancer, oral squamous cell carcinoma, and pituitary tumors, the palm lines of patients have obvious specificity [29]. For patients with liver depression and spleen deficiency syndrome, Shen Suze [30] used the Inception-V3 network to collect and classify hand image data, and finally achieved good classification diagnostic results. It can be seen that the participation of artificial intelligence in palm diagnosis utilizes modern digital image processing of palm images and provides certain palm line and color information, which can play a special advantage in the diagnosis process of tumor patients.

4. Expectaction

At present, the application prospects of artificial intelligence technology in physical examination are constantly expanding, the application of transfer learning is constantly breaking new ground, and research on human dynamic physical signs is also constantly being explored. In addition, during the process of clinical transformation, due to the difficulty in aligning diagnostic standards between traditional Chinese medicine and Western medicine, a complete feature mapping system needs to be established. In the future, artificial intelligence technology is reshaping the paradigm of traditional Chinese medicine tumor diagnosis and treatment, but it needs to overcome key issues such as controlling the quality of data and improving the accuracy of algorithms. Artificial intelligence has significant advantages in the combined treatment of tumors with traditional Chinese and Western medicine, and establishing a platform for collaborative innovation between traditional Chinese and Western medicine can promote the transformation of technical achievements into clinical applications, the trend of digitalization in medical care in the future, and improving the diagnostic rate, etc.

In summary, artificial intelligence technology has advantages in inspection diagnosis of tumor patients. By identifying and analyzing the external and dynamic physical signs of patients, it provides effective treatment decisions and prognosis evaluations for tumor patients.

References

[1] XIAO Wendi, ZHU Long, WANG Yang, LIN Xuejuan, LI Candong. Application and Thinking on Multimodal Fusion Technology of Traditional Chinese Medicine Inspectio [J]. Journal of Traditional Chinese Medicine, 2024, 65(17):1741-1746.

[2] Du J, Lu Y, Zhu M, et al. A novel algorithm of color tongue image segmentation based on HSI[C]//2008 International Conference on BioMedical Engineering and Informatics. IEEE, 2008, 1: 733-737.

[3] Qin X, Wang H, Du Y, et al. Structured light image enhancement algorithm based on retinex in HSV color space. Journal of Computer-Aided Design & Computer Graphics. 2013, 25:488-93.

[4] Jiang T, Hu X, Yao X, et al. Tongue image quality assessment based on a deep convolutional neural network[J]. BMC Medical Informatics and Decision Making, 2021, 21(1): 147.

[5] Yuan Y and Liao W. Design and implementation of the trad-itional Chinese medicine constitution system based on the diagnosis of tongue and consultation[J]. IEEE access 2021; 9: 4266–4278.

[6] Li Fufeng, Li Guozheng, Zhou Rui, et al. PLS and LDA for Gloss Recognition in Facial Inspection of Traditional Chinese Medicine [J]. Modernization of Traditional Chinese Medicine and Materia Medica-World Science and Technology, 2011, 13(6):977-981.

[7] Mao H C , Wu T H , Zhou C L . Segmentation of face skin oriented diagnosing in Traditional Chinese

Medicine [J]. Applicati on Research of Computers (China), 2007, 24(9): 295-297.
[8] Fang M, Liu Z, Wang H. Image Processing Technology in the Palm Diagnosis in Traditional Chinese Medicine[C]//2014 International Conference on Medical Biometrics. IEEE, 2014: 95-101.
[9] Li F, Zhou R, Li G, et al. Classification of facial diagnosis gloss in Chinese medicine based on different algorithms[J]. Chinese Journal of Integrative Medicine, 2016: 1-6.
[10] Zhang J, Xu J, Hu X, et al. Diagnostic method of diabetes based on support vector machine and tongue images[J]. BioMed research international, 2017, 2017(1): 7961494.
[11] Tang Y, Sun Y, Chiang J Y, et al. Research on multiple-instance learning for tongue coating classification[J]. IEEE Access, 2021, 9: 66361-66370.
[12] Wu J, Zhang B, Xu Y, et al. Tongue image alignment via conformal mapping for disease detection[J]. IEEE Access, 2019, 8: 9796-9808.
[13] Wei Li. The research on sublingual vein segmentation and its pathological characteristics analysis[D]. Harbin Institute of Technology, 2016.
[14] Zhang Q, Bai C, Yang L T, et al. A unified smart Chinese medicine framework for healthcare and medical services[J]. IEEE/ACM Transactions on Computational Biology and Bioinformatics, 2019, 18(3): 882-890.
[15] Liu Deguo, Li Zirong, Li bo, Chen Qihua, et al. Professor Chen Qihua's Experience in Diagnosis and Treatment of Malignant Tumors Based on "Traditional Chinese Medicine Color Diagnosis" [J]. Asia-Pacific Traditional Medicine, 2021, 17(3):110-112.
[16] Ruan Ming, Chen Jingxian, Shen Xiaoheng, et al. Observation and Objective Analysis of Facial Expressions and Tongue Images in Malignant Patients with Depression and Anxiety [J]. Journal of Liaoning University of Traditional Chinese Medicine, 2019, 21(07):140-143.
[17] Lyu Lingling, Wang Jixian, Ling Tianyou, Zhu Weirong. Objective analysis on the characteristics of face, tongue and pulse of 274 gastrointestinal malignant tumors patients with depression and anxiety [J]. China Journal of Traditional Chinese Medicine and Pharmacy, 2024, v.39(10):5151-5156.
[18] Liu Jiabao, Qiao Ya, Lu Yuan, et al. Value of Face Diagnosis and its Objectification in Diagnosis and Treatment of Tumor Diseases [J]. Clinical Journal of Traditional Chinese Medicine, 2023, v.35(04):625-630.
[19] NI Zhonggen. Exploring the Clinical Significance of Eye Diagnosis [J]. Zhejiang Journal of Traditional Chinese Medicine, 2023, 58(12):879-880.
[20] Lu Q, Wei K, Yan C. Review of eye diagnosis in traditional Chinese medicine: modernization and future prospects [J]. Journal of Traditional Chinese Medical Sciences, 2022, 9(3): 217-221.
[21] Hao Bing, Li Jia, Li Xiuhong, et al. Clinical treatment for retinoblastoma: report of 118 cases [J]. Journal of Third Military Medical University, 2020, 42(09):942-947.
[22] LU QY, DENG JY, YU Y, et al. Machine learning models for stroke detection by observing the eye-movement features under five-color visual stimuli in traditional Chinese medicine[J]. J TCM Sci, 2023, 10(3):321-330.
[23] Shi Y, Guo D, Chun Y, et al. A lung cancer risk warning model based on tongue images[J]. Frontiers in Physiology, 2023, 14: 1154294.
[24] Duan Jinlong. Analysis and Application of Esophageal cancer high-risk groups characteristics of tongue[D]. Beijing University of Chinese Medicine, 2016.
[25] Gholami E, Tabbakh S R K. Increasing the accuracy in the diagnosis of stomach cancer based on color and lint features of tongue[J]. Biomedical Signal Processing and Control, 2021, 69: 102782.
[26] Jiang Nan, Yuan Li, Wang Li, et al. Objective study on tongue features of newly diagnosed gastric cancer patients[J]. China Journal of Traditional Chinese Medicine and Pharmacy, 2023, v.38(01):427-433.
[27] Huang Zhixin. The Basic Theoretical Research of Palmprint Diagnosis [D]. Shandong University of Traditional Chinese Medicine, 2013.
[28] LüYi, Chen Cong, Hao Yiming, et al. Overview and Prospect of Research and Clinical Application of Palm Dermatoglyphics Diagnosis [J]. Modernization of Traditional Chinese Medicine and Materia Medica-World Science and Technology, 2020, v.22(05): 1559-1566.
[29] Shen Suze. A disease auxiliary diagnosis method based on machine learning [D]. Southeast University, 2022.