Proceedings of CONF-SEML 2025 Symposium: Machine Learning Theory and Applications
DOI: 10.54254/2755-2721/2025.TJ23814

Research on Application of Deep Learning in Medical Diagnosis

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Abstract. The demand for efficient and precise diagnosis in the field of medical diagnosis is currently increasing exponentially. Traditional medical diagnostic methods face significant limitations in processing vast amounts of medical data and strained medical resources. However, with the development of computer technology, deep learning techniques have been increasingly applied in various areas of medical diagnosis, significantly accelerating the processing of large volumes of medical data and effectively enhancing the efficiency and accuracy of medical diagnosis. By compiling multiple literature sources on the application of deep learning techniques in medical diagnosis, this article summarizes two different application forms of deep learning in medical diagnosis: the integration of transfer learning and deep learning, and the combination of deep learning and the Internet of Things (IoT). It also discusses the application of these techniques in medical imaging and the auxiliary diagnosis of clinical diseases, as well as their primary impacts on medical development. The article emphasizes the advantages brought by the application of deep learning in medical diagnosis.

Keywords: Deep learning, Medical diagnosis, Medical Imaging, Clinical decision support systems, Data processing

1. Introduction

In recent years, the country has encouraged technological development and proposed the integration of artificial intelligence (AI) technology with the medical field to develop intelligent healthcare, promoting innovative application scenarios for AI in the medical domain. As an advanced form of AI's core, deep learning is crucial for the development of AI technology. To further leverage the advantages of AI in medical diagnosis, deep learning models are continuously being developed and applied to various medical diagnostic scenarios.

This article reviews the application of deep learning in medical diagnosis by reviewing relevant studies, aiming to outline the main development trends of deep learning in this field. Currently, deep learning is not only applied as an independent model in medical decision-making systems but also combined with transfer learning. Transfer learning can help make up for the fact that testing datasets are often small and incomplete. This means that models can be used in more situations and helps the growth of many medical fields at the same time. As an important medium for real-time data acquisition, IoT technology is widely used in medical equipment. The combination of deep learning

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and IoT technology facilitates data processing and allows for rapid medical diagnosis based on real-time data, improving efficiency and accuracy while ensuring stable model learning. Currently, deep learning is primarily applied in medical imaging and the auxiliary diagnosis of clinical diseases in medical diagnosis. Trained deep learning models are used to predict diseases, offering higher accuracy and efficiency compared to traditional diagnostic methods, thereby assisting physicians in medical diagnosis. The application of deep learning in medical diagnosis has promoted the development of the medical industry and broadened the clinical application forms of various traditional medical treatments.

2. Application forms of deep learning in medical diagnosis

2.1. Combination of transfer learning and deep learning

The integration of transfer learning and deep neural networks can be utilized in the process of medical diagnosis using multimodal data. Compared to traditional methods, this approach extends the scope of disease diagnosis across different medical specialties for accurate medical diagnosis even when medical data is scarce. This method offers higher precision while requiring less model training time, resulting in higher generalization and reliability in medical diagnosis, demonstrating great potential [1]. When applied to models analyzing most medical imaging data, transfer learning can significantly improve model accuracy. Even for ShuffleNet models designed with specific constraints, their accuracy increases substantially when transfer learning is applied. The combination of deep learning models and transfer learning broadens the application of deep learning for clinical medicine [2].

2.2. Combination of deep learning and IoT

IoT devices integrated with deep learning technology can classify and preprocess disease data while acquiring data. An intelligent IoT model with deep learning support for skin lesion diagnosis (IIoT-DLSLD) can be used for skin lesion diagnosis in IoT environments, classifying lesion types while acquiring imaging data of patients' skin lesions. This technology can also be directly applied in the form of an application, making medical diagnosis faster and more convenient [3]. An innovative approach using a hybrid deep convolutional neural network (DCNN) trains and analyzes imaging data obtained from CT scans and data from IoT sensors, achieving an accuracy rate of up to 92.78% in the diagnosis of lung nodules. This method ensures high accuracy while enabling robust learning and classification of diseases in the model [4]. Combining TabNet with the catBoost algorithm to analyze and process data such as electrocardiograms and continuous heart rate monitoring obtained in real-time from medical IoT devices improves the accuracy and efficiency of predictions for heart-related diseases [5]. The hybrid LSTM-SVM framework can also evaluate sleep quality by capturing exceptional features from motion activity data collected by actigraphy. Testing results of this model framework on the MESA Actigraphy dataset demonstrate that its accuracy rate for sleep quality prediction reaches up to 85.62% [6].

3. Application scenarios of deep learning in medical diagnosis

3.1. Medical imaging

Deep learning models can be used for the analysis of medical images. Using the MobileNet model to analyze medical imaging samples of COVID-19 results in a diagnostic accuracy of up to 99.97%

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[7]. Deep learning-based models can perform real-time analysis of medical images, with high accuracy in detecting tumors, diagnosing cancers, and identifying cancer sub-types. In medical practice, they can also assist in organ segmentation and the detection of abnormal organ lesions [8]. A combined model of YOLOv8, convolutional neural networks (CNN), and other models has high precision in identifying abnormalities related to respiratory diseases in radiological images, with a diagnostic accuracy of 62.4% and a recall rate of 65.6% for pneumonia, demonstrating high reliability in disease diagnosis [9]. When the dataset is inherently small or incomplete, such as for rare diseases or early-stage research data, Bayesian convolutional neural networks exhibit high reliability in medical imaging classification [10].

3.2. Auxiliary diagnosis of clinical diseases

Clinical decision support systems (CDSS) can use deep learning algorithm models to analyze patients' imaging, voice, and other data to predict their disease types, disease progression, and survival periods. Combining clinical medical knowledge, these models help doctors customize medical strategies and make medical decisions in clinical diagnosis [8]. Compared to traditional machine learning methods, deep learning-based MLP neural networks can process large sample diagnostic data to obtain data features, providing precise auxiliary diagnoses to physicians during medical decision-making, thereby improving the efficiency and accuracy of medical decisions [11]. In terms of differentiating between breast cancer and benign lesions, the accuracy of the multimodal deep learning model (BreNet) even surpasses that of radiologists [12].

4. Impact of deep learning on medical diagnosis

Traditional AI-based medical diagnostic systems for skin diseases suffer from low diagnostic accuracy and interpretability due to the heterogeneity of skin images. However, the SmartSkin-XAI method, which combines a fine-tuned DenseNet121 model with XAI technology, achieves classification accuracies of 97% and 98% on the ISIC and Kaggle datasets. This makes diagnostic accuracy and readability much better, especially when diagnosing melanoma [13]. The traditional method of diagnosing glioma grading using magnetic resonance imaging (MRI) relies excessively on doctors' subjective judgments, which is not conducive to medical decision-making and subsequent customized treatment strategies. An MRI brain image retrieval pipeline that uses a CNN model for feature extraction and a clustering method to index a feature map database, on the other hand, gets an average precision rate of up to 98.15%, showing that it is very useful in the real world [14]. Compared to traditional medical diagnostic methods, deep learning algorithms can easily mark and classify lesions in early-stage melanoma skin cancer, potentially halting disease progression and reducing mortality rates [15]. Deep learning models can generate synthetic nuclear medicine images that are highly similar to real ones, overcoming the limitations of low-dose scans to significantly improve diagnostic accuracy and broaden the clinical applications of nuclear medicine imaging (NMI), thus promoting its development [16]. The application of deep convolutional neural networks to clinical imaging can not only reduce radiation exposure from preoperative computed tomography (CT) scans but also serve as an alternative to MRI in some cases [17].

In conclusion, the application of deep learning technology in medical diagnosis is of great significance for the development of medicine. Thanks to the advantages of deep learning technology in handling massive data, it can efficiently analyze a large amount of disease data, saving a great deal of medical resources. Moreover, deep learning models possess excellent generalization ability in medical diagnosis, featuring high precision and diagnostic efficiency in disease diagnosis. In the

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case of major diseases, they can assist physicians in making medical decisions and formulating medical plans. For minor diseases, they can even replace doctors in medical diagnosis, saving medical resources, improving diagnostic efficiency, and reducing the medical burden. In addition, deep learning technology can also be used to optimize some traditional medical methods, enhance their effectiveness, and popularize these methods to other medical fields.

However, there are still some challenges in the application of deep learning technology in medical diagnosis. Currently, the regulatory measures and relevant policies regarding the use of deep learning models are not comprehensive enough. Since training deep learning models requires a large amount of patient data, such as imaging, audio, and text information, to improve the model's generalization ability and diagnostic accuracy for diseases, ensuring the privacy and security of patients during this process is a major challenge. At the same time, due to issues such as a large time span and different collection regions of the acquired patient data, there is a high possibility that the data structures and formats vary, which poses a problem regarding whether the same model can be compatible with them. Therefore, unstructured data formats and poor access to health data are also significant obstacles to the development of deep learning technology in the field of medical diagnosis [18].

5. Conclusion

Deep learning models exhibit significant advantages in processing vast datasets and making predictions based on analytical results. The application of deep learning in medical diagnosis can significantly improve the accuracy and efficiency of disease diagnosis. Furthermore, integrating deep learning with other techniques such as transfer learning and the Internet of Things (IoT) can overcome limitations such as insufficient or incomplete datasets, or outdated data, thereby enhancing the versatility and accuracy of deep learning models in medical diagnosis. This integration aids in making more precise medical diagnoses with deep learning models and assists physicians in formulating medical strategies. The application of deep learning in medical diagnosis enables early detection and intervention for many diseases, reducing patient mortality rates. It also provides a more precise and efficient alternative to some traditional medical detection methods, broadening the application scenarios of various medical approaches and promoting the development of multiple medical fields. By analyzing the existing applications of deep learning in medical diagnosis, this review aims to provide theoretical and practical support for further advancing the application of deep learning technology in the medical field and medical diagnostic processes.

Currently, the application of deep learning in medical diagnosis still has certain limitations. When a large amount of medical data is used to train deep learning models, while improving the accuracy of medical diagnosis, there is also the risk of exposing patients' private information. In addition, the majority of existing deep learning models for medical diagnosis cater to specific disease type However, the diseases of patients seeking medical treatment are diverse. To truly popularize deep learning technology in outpatient clinics, it is necessary to expand the scope of disease diagnosis.

In the future, people will continue to explore the application forms of deep learning in medical diagnosis, discover more application scenarios, improve the accuracy and generalization ability of existing deep learning models, explore the possibilities of combining deep learning with other technologies, and promote deep learning to more medical fields, making greater contributions to the development of China's medical industry.

DOI: 10.54254/2755-2721/2025.TJ23814

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