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Review

Applications of Artificial Intelligence in The Medical Field

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Abstract

Medicine is an important research and application field of artificial intelligence. From basic medicine, clinical medicine, preventive medicine, rehabilitation medicine to social medicine, artificial intelligence is everywhere. In a nutshell, the research and application of artificial intelligence in the medical field has reshaped disease-assisted diagnosis, personalized treatment, disease risk prediction, precision medical services, and new medical research models, and created new models of convenient medical treatment, precision medicine, and disease prevention. This article introduces the application of artificial intelligence in the medical field, which separately elaborates the application and major contributions of artificial intelligence in medical diagnosis, treatment, rehabilitation care and prognosis prediction, and finally summarizes the application of artificial intelligence in the medical field and looked forward to the development of artificial intelligence technology in the medical field.

Keywords: Artificial Intelligence, Computer-Aided Diagnosis, Tumor Treatment, Medical Expert System.

Introduction

Artificial intelligence (AI), which simulates the logical thinking, learning, memory, and reasoning process of the human brain, aims to create an intelligence that can think and react in a similar way to the human brain with the most simplified artificial control system. It is an emerging discipline with new ideas, new concepts, new theories, and new technologies, as well as a developing frontier discipline (1). It is widely used in economics, military, medicine, and every aspect of life. With the development of science and technology, AI technology has played an increasingly important role and its status has become more and more important, which has attracted a great deal of attention.

1. Application of AI in clinical diagnosis

AI is commonly used in medical expert systems in clinical medical diagnosis. It refers to the use of computers in medical diagnosis, allowing the computer to learn the medical knowledge of expert doctors and reasoning technology to simulate the thinking process of medical experts in the diagnosis and treatment of patients. Compile a corresponding computer program that meets the actual situation. It can inherit and carry forward the valuable theories and rich clinical experience of medical experts and is easy to share. It can also be used as an auxiliary tool for doctors to diagnose and help doctors solve complex medical problems in clinical diagnosis. In this way, with the help of machines, ordinary doctors can also do the work like the expert doctors, which improves the medical level. The first AI medical expert system appeared in the late 1950s. At that time, to simulate the relationship between the patient's illness and disease, the main medical domain knowledge was integrated into the expert system. In clinical diagnosis, the expert system not only has a very strong pertinence, but also reflects its transparency and flexibility. Not only can it effectively solve the problem of insufficient doctors, but also avoid misdiagnosis or missed diagnosis. The expert system can free the doctor from some tedious tasks, which will not only help the doctor to have a more in-depth and comprehensive understanding of the patient's situation in time, but also provide a more comprehensive plan for the patient. ESDDL expert system is a set of expert system for diagnosing and treating various diseases of low back pain, which was developed by a hospital in Shanghai in the 1990s using CM technology. This system combines clinical science with rational use, which can not only put forward an effective diagnosis and treatment plan for lumbago and leg pain, but also demonstrate and guide interns and inexperienced doctors.

Computer-aided diagnosis (CAD) is an important part of AI applications in imaging. It effectively combines image processing, computer vision, medical image analysis, etc. and anomalies are marked after system processing. At present, CAD can be applied to the detection and diagnosis of diseases by a variety of imaging technologies, as shown in Table 1. The imaging diagnosis of lung, breast, heart, brain, liver, bones and other parts has high accuracy.

Most studies have shown that computer-aided diagnosis systems based on AI have continuously improved the accuracy of identifying and classifying single organ specific lesions. Some studies reported that the diagnostic accuracy of CAD for specific lesions of a single organ is not lower than or even higher than manual reading (7).

2. Application of AI in clinical treatment

Compared with clinical diagnosis, clinical treatment is the core of medical treatment. For example, radiation therapy is one of the most important tools in the treatment of cancer. Radiation therapy uses a variety of rays to treat malignant tumor cells. The process of tumor radiotherapy is complicated, including positioning simulation, plan design, plan verification, treatment implementation etc. It is very important to accurately delineate the treated lesion area to prevent harm to normal cells. This work is mainly done by radiotherapists to outline the patient's CT image, and takes about 4 hours per patient However, currently, there is short of radiotherapists nationwide. Therefore, many medical AI companies have begun to develop intelligent radiotherapy systems, hoping to improve the work efficiency of radiotherapists and alleviate the problem of lack of radiotherapists. For example, an AI target area delineation system developed by Google and the National Health Service in the United Kingdom can automatically delineate head and neck tumors through machine learning. Tencent Medical AI Lab, in collaboration with the University of California, used deep learning for rapid and fully automatic delineation of target areas for whole head and neck organs at risk. A whole head and neck CT target area delineation can be completed within 1 second, which greatly improved the efficiency of radiotherapy target area delineation.

During minimally invasive surgery, intraoperative navigation technology based on 3D image reconstruction allows surgeons to grasp the three-dimensional position of surgical instruments relative to the patient's anatomy in real time during the operation, avoiding important tissues and organs, and providing an augmented reality map for the advancement of the operation Navigation (8). Liu Sheng et al. (9) proposed an ultrasound image navigation minimally invasive surgery robot system for prostate cancer treatment. The system can perform 3D reconstruction of the tumor target area and dose planning before surgery and realize ultrasound image navigation during surgery. Real-time guidance of the motion of the surgical robot and accurate positioning of the template improve the quality of seed implantation. Similarly, intraoperative navigation based on three-dimensional image reconstruction has good results in thermal ablation of prostate tumors (10).

Robot-assisted radical prostatectomy has been used for many years at home and abroad, among which the most widely used is the Da Vinci system. The system can help the surgeon to make the intraoperative operation more delicate. The Da Vinci robot was originally designed for cardiac surgery, with the goal of minimizing the trauma and danger of the operation to the heart. The robotic heart doctor is best at surgical treatment of various congenital heart disease, valvular disease, atrial fibrillation, coronary heart disease, pericardial disease, mediastinal tumors and other diseases. So far, hundreds of heart patients have received high-tech robot treatment, and almost all of them have recovered smoothly without complications. At the same time, in weight loss metabolic surgery, the application of Da Vinci robotic surgery system is also becoming more extensive. Compared with traditional fat-reduction surgery, the safety and feasibility of the robotic surgery system have been recognized. It can reduce the occurrence of complications such as anastomotic leakage, bleeding, and stenosis, reduce intraoperative transfer and reduce discharge time etc.

3. Application of AI in rehabilitation nursing

At present, the rehabilitation nursing robots in the medical field also apply AI technology to a large extent. The rehabilitation nursing robots are mainly the perfect combination of industrial robots and medical robots. Research data showed that, after receiving computer-based cognitive rehabilitation therapy (CBCR), the reaction time, attention, language and memory functions of post-stroke cognitive impairment (PSCI) patients have been significantly improved, and negative mental symptoms have also been significantly reduced (11). Svaerke et al. (12) discussed the impact of CBCR on visuospatial neglect (VN) after stroke and summarized the current research status in this field and found that CBCR has a positive effect on VN after stroke. In addition, there is a study on the sequential combination of aerobic exercise and computer-assisted cognitive training. The results found that, compared with the control group receiving conventional training, the MOCA score and the Wechsler Memory Scale score of patients who used sequential combined cognitive rehabilitation training Significant improvement, suggesting that the cognitive function status of stroke survivors after aerobic exercise combined with computer-assisted training is significantly improved, which has positive clinical significance (13).

El-Shamy (14) used an Armeo system that combines robot-assisted technology and virtual reality technology to allow children's upper limbs to participate in the repetitive movements required for motor learning. The results show a greater improvement than traditional treatment methods. Biffi et al. (15) added Spring technology based on Armeo to measure the accuracy, speed and stability of the upper limbs. After the treatment of cerebral palsy children, they observed a significant improvement in the QUEST score and the Melbourne scale score. Chen et al. (16) invented the upper limb rehabilitation robot based on the theoretical knowledge of mechanics, sports, and rehabilitation. The robot can provide different rehabilitation modes (active mode, assisted mode, passive mode) and exercises of different intensities according to the patient's physical condition. Both patients and physical therapists commented that the robot has a positive rehabilitation effect.

With the increasing aging of the global society, the number of medical treatment groups continues to increase, but nursing human resources are extremely scarce, and high-tech intelligent nursing technology is required to meet the social demand for medical care services, reduce the labor intensity of nursing staff, and improve nursing services Level. Domestic and foreign research on AI technology in the field of elderly care began in the 1980s and has made great progress. AI technology has applications in clinical nursing, daily life nursing, and nursing education. In clinical nursing, the application of AI mainly includes disease care management, intravenous treatment optimization, patrolling and guided diagnosis, disease change prediction, and intelligent wards. In life care, AI is mainly embodied in providing life care assistance to patients. Intelligent nursing robots with different functions, such as home medical robots (17), companion robots (18), mobile robots, and walking assistance robots (19) and remote health management robots, etc. (20) are used in the daily life, entertainment life, disease management, and physical rehabilitation of the elderly. They play an important role in improving the quality of life of the elderly and promoting physical and mental health. They have become an important nursing tool in the field of elderly care. The application of AI technology has improved the physical and mental health of the elderly to a certain extent, provided more convenience to the lives of the elderly, and improved the living standards of the elderly.

4. Application of AI in predicting prognosis

Reichling et al. (21) conducted a prospective study based on patient CD3 and CD8 stained pathological slides, using machine learning random classification 32 model and VSURF algorithm to study the tumor's intrinsic prognostic variables CD3 and CD8 immunity in stage III CRC Infiltration, automatic quantification of lymphocyte density and surface area in tumor core area and infiltration marginal area (AUC=0.56). It is proved that AI can help pathologists better determine the prognosis of patients with stage III colon cancer.

Machine learning methods are also used to predict the rupture risk of small aneurysms. Kim et al. (22) used three-dimensional digital subtraction angiography (3D-DSA) to automatically identify aneurysms and build a prediction model. Finally, the model predicts small arteries in the test set. The accuracy of tumor rupture is 77%. Gupta et al. (23) constructed an intracerebral hemorrhage outcome model (ICHOP) to predict the modified Rankin scale (mRS) score at 3 and 12 months after discharge. The ROC curve AUC values of the mRS score at 3 and 12 months after discharge were predicted to be 0.89 and 0.87. Zafar et al. (24) demonstrated its Glasgow prognostic grading (GOS) model for predicting patients with aneurysmal subarachnoid hemorrhage. The ROC curve AUC values of the model predicting death and independent life are 0.92 and 0.95, respectively. Rohaut et al. (25) reported a model for predicting short-term recovery of consciousness in patients with cerebral hemorrhage, and its ROC curve AUC value for predicting the state of consciousness when leaving the intensive care unit was 0.74. Fan et al. (26) established a clinical model through multivariate logistic regression analysis, and then combined the clinical model and the imaging model to obtain the final radiomic model. The clinical model predicts the AUC value of the radiotherapy outcome and the AUC value of the imaging label. At 0.92, the AUC value of the radiomic model combining the imaging label and the clinical model was 0.96, indicating that patients with acromegaly undergoing adjuvant radiotherapy after surgery have a good clinical outcome. It also shows that radiomics is a good Prognostic judgment method of clinical application prospects.

5. Summary and Perspectives

Medical AI is a branch of AI that will provide solutions for medical diagnosis and treatment problems. The most researched and most significant achievements are in the field of medical expert systems and medical image analysis. For now, these are far from reaching expectations. Most applications at this stage concentrating on relatively simple disease areas or specific diseases, or areas that do not require communication with patients such as image recognition assisted analysis, current AI is still in the era of weak AI and does not have the function of communication. The development and maturity of some nonlinear technologies such as computer technology, AI technology, genetic algorithm, artificial neural network technology, etc., has made it a reality for us to develop new AI systems. We believe in future intelligent medical diagnosis, treatment and prognostic systems. It will become the most powerful assistant of doctors, and it will make greater contributions to the prevention, diagnosis and treatment of various diseases.

Table 1. CAD imaging diagnosis results of lung, breast, heart, brain, liver, bones and other parts

Detection site	Test purpose	Detection Indicator	Test results
Lung	Shin et al. (2) detected lung nodules and interstitial lung lesions	Accuracy	0.902
Breast	Al-Masni et al (3) detected breast cancer	Accuracy	0.99
Heart	Madani et al. (4) tested the standard observation section of echocardiography	Accuracy	0.98
Brain	Lu et al. (5) on the detection of patients with cognitive impairment	Accuracy	0.86
Liver	Yasaka et al. (6) detected liver masses	AUC	0.92
Skeleton	Tiulpin et al. (7) tested knee osteoarthritis	AUC	0.93

Declarations

1) *Consent to publication*

We declare that all authors agreed to publish the manuscript at this journal based on the signed Copyright Transfer Agreement and followed publication ethics.

2) Ethical approval and consent to participants

Not applicable.

3) *Disclosure of conflict of interests*

We declare that no conflict of interest exists.

4) Funding

None

5) Availability of data and material

We declare that the data supporting the results reported in the article are available in the published article.

6) Authors' Contributions

Authors contributed to this paper with the design (JLL), literature search (JLL and RRD), drafting (JLL), revision (JLL and CH), editing (JLL) and final approval (RRD and CH).

7) *Acknowledgement*

None

8) Authors' biography

None

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