The Application of Intelligent Robots in the Medical Field

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Abstract: With the development of technology, the research and development of intelligent robots has extended into various fields. Among them, applications in the medical field are particularly prominent. The increasing demand for high-quality medical services and the continuous advancement of medical technology have also led to the continuous expansion of the global medical robot market. From 2010 to 2018, the global medical robot revenue grew from \$1.361 billion to \$2.8 billion, with a compound annual growth rate of 9.44%; the sales volume of medical robots grew from 932 units to 5,100 units, with a compound annual growth rate of 23.67%. In China, investment in medical robots has also seen substantial growth. From 2016 to 2019, the market size of China's medical robot industry grew annually at a rate of 28.82%. In 2020, the market size of medical robots in China reached 5.94 billion yuan, and in 2021, the market size of medical robots in China reached 7.96 billion yuan. Therefore, this article studies the current application of intelligent robots in the medical field. This paper adopts the research method of theoretical analysis. The development of intelligent robots in the medical robots in the sector.

Keywords: Surgical robots, rehabilitation robots, intelligent assisted surgery, intelligent nursing robots.

1. Introduction

The application of intelligent robots in the medical field can be broadly divided into several areas: auxiliary diagnosis and imaging analysis, intelligent surgical assistance, rehabilitation surgery, drug development, medical care and service, hospital management, and logistics. As the technology continues to mature, it now spans the entire medical process, offering solutions across every stage of patient care—from initial consultation and diagnosis, through treatment and surgeries, to final rehabilitation. Medical robots can enhance precision and efficiency at each step, improving outcomes and streamlining procedures. [1][2]. This article will address two research questions: What is the current application status of intelligent robots in the medical field? And what are the future research and development directions for intelligent robots in this sector? This article will offer valuable insights for the future study of intelligent robots in the medical field.

2. Current situation analysis

2.1. Surgical Robots

In today's rapidly developing global technology, the application of intelligent robots in the medical field has become increasingly widespread, especially in developed countries, where robots are considered an indispensable part of the medical sector. Although our country started later in this area, the pace of development has been rapid. In recent years, many enterprises have focused on importing mature medical robot technologies from abroad, such as the Da Vinci surgical robot imported from overseas since 2017. The Da Vinci surgical robot integrates medical science, robotics, and engineering, offering a high-definition three-dimensional visual system and highly flexible robotic arms, allowing surgeons to perform complex surgeries with higher precision and accuracy, and reducing postoperative complications. Therefore, it is widely used in various fields such as urology, gynecology, general surgery, and cardiothoracic surgery. The use of intelligent-assisted surgery has significantly improved the success rate and accuracy of surgeries.

Alongside the importation of foreign technology, China has made significant strides in independent research and development. One example is the domestically developed orthopedic surgical robot "Honghu" knee joint replacement robot. [3] The development of "Honghu" focused on miniaturization and increased intelligence, with the goal of addressing the global challenge of balancing medical resources.

2.2. Rehabilitation Robots

Medical robots play a crucial role in patient rehabilitation, offering a wide range of solutions for improving mobility. Most patients experience difficulties with upper or lower limb mobility during rehabilitation, and specialized rehabilitation robots have been developed to address these issues. For patients with upper limb mobility issues, scientists have developed corresponding upper limb rehabilitation robots, [2] from the hardware system to the control system, to neural network evaluation and verification experiments, ensuring the performance of the robot and its support for patient mobility issues, exoskeleton robots are used to aid rehabilitation.[4] These robots has strict modeling, analysis, and verification experiments in exoskeleton structural design and dynamic simulation to ensure the safety of patients when using them. Each joint of the lower limbs is designed with specific considerations to ensure that the changes in joint angles are relatively uniform during patient walking. This uniform change in joint angles makes it safer and more comfortable for patients to walk while wearing exoskeleton robots for rehabilitation exercises.

2.3. Intelligent nursing robots

The nursing process is the most tedious and demanding part of the entire treatment process. With the rapid development of medical robots, intelligent nursing robots have also emerged for this purpose. Given the heavy workload and diverse types of nursing work, many different types of nursing robots have also been developed, including rehabilitation nursing robots, excretion nursing robots, transport nursing robots, nurse assistant robots, etc. Different types of nursing robots can perform different tasks, particularly providing detailed and comfortable services for elderly people with weaker mobility, and also saving a lot of human resources.

Intelligent nursing robots are not limited to hospital settings; they also play a vital role in elderly care [5, 6]. They can not only provide life care for disabled elderly people, but also monitor their health status in real time, predict changes in their condition, and provide accurate evidence for doctors'

subsequent diagnosis. In addition, intelligent nursing robots can assist users in sports rehabilitation training and intelligent drug management, providing assistance to patients in more aspects.

3. Future development direction

3.1. Development prospects

Medical robots have broad development prospects in the future, mainly reflected in the following aspects:

Ehchnological Progress and Innovation: With the application of technologies such as AI and big data, medical robots will enhance their diagnostic and therapeutic capabilities and become more intelligent.

Market Demand Growth: China is gradually entering an aging society, with higher demand for medical and nursing care from the elderly. Simultaneously, the application of robots will also make up for the uneven distribution of medical resources, which will drive the sustained development of the medical robot market

Growth.

Policy Support: The Chinese government has introduced relevant policies to promote the research and application of medical robots, which provides a favorable policy environment.

Segnented Market Potential: There is strong demand and broad development prospects in segmented fields such as surgery, rehabilitation, and assistive robots.

International Market Expansion: With the deepening of globalization and frequent international cooperation and exchanges, opportunities for expanding the international market of medical robots have increased. Especially for surgical robots, with technological progress and cost reduction, the popularity rate will further increase. The market size of surgical robots in China has reached 7.17 billion yuan in 2023 and is expected to maintain a high growth speed.

3.2. Development direction

Technological Progress and Intelligence: With the deepening application of technologies such as artificial intelligence and big data, medical robots will become more intelligent and personalized. These developments will enhance their diagnostic, therapeutic, and rehabilitation capabilities, making them more efficient and adaptable to individual patient needs.

Market Expansion and Demand Growth: Factors such as aging population, the uneven distribution of medical resources, and increasing patient demand are driving the sustained growth of the medical robot market, especially in the fields of surgery, rehabilitation, and nursing. The segmented markets of surgical robots, rehabilitation robots, and assistive robots have enormous development potential and will place greater emphasis on the development and implementation of personalized solutions.

Regulation and Standardization: Concurrently, improvements in government policies are helping standardize and legalize the use of medical robots. This ensures their safety, reliability, and ethical application in healthcare systems.

In summary, medical robots will evolve towards greater intelligence, personalization, precision, and legalization in the future to meet the growing demand for medical care.

4. Conclusion

The development of intelligent robots in the medical field is accelerating, with applications diversifying and expanding. Medical robots are increasingly integral to the healthcare process, providing solutions in areas such as surgery, rehabilitation, and nursing. Both domestically and

internationally, there is a strong commitment to promoting the development of medical robots, saving human resources, and improving medical quality and accuracy.

However, several challenges remain: Technological Foundations and Innovation: Domestic medical robots have not yet made significant breakthroughs in overall basic technology, such as intelligence, precision, and human-machine integration, which still face challenges. In addition, although technological innovation is a key driver for the development of the surgical robot industry, domestic research and development in new technological products such as single hole surgery and nano targeting still need to be strengthened.

Product Functionality and Regulation: Medical robots have relatively single functions, making it difficult for them to meet diverse and complex surgical needs. Additionally, the large size of many robots poses challenges for hospital adoption and use. Regulatory policies are still evolving, and product quality mainly relies on independent testing by production enterprises, making it difficult to supervise product quality in the industry.

Human-Robot Cooperation and Talent: Human robot cooperation in medical robots is difficult and requires doctors to invest time and cost in learning and adapting. In addition, there is a large talent gap in the industry, which places higher demands on doctors.

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