Medical Robot Systems Used in Clinical Practice

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ABSTRACT

Medical robot systems have revolutionized the healthcare industry, offering precise and accurate assistance to healthcare professionals in clinical practice. This thesis focuses on the use of medical robot systems in clinical practice. The thesis covers various aspects of medical robots such as their applications, advantages, and limitations. The thesis will also delve into the different types of medical robot systems, including surgical robots, rehabilitation robots, and telepresence robots. Additionally, the thesis will explore the ethical considerations surrounding the use of medical robots in clinical practice, including patient safety, privacy, and confidentiality. Overall, this thesis provides a comprehensive overview of the use of medical robot systems in clinical practice, highlighting their benefits and limitations, and ethical considerations.

Keywords:	Medical robot, surgical robots, rehabilitation robots, telepresence robots

Introduction: Medical robotics has emerged as an innovative technology that has the potential to revolutionize the healthcare industry. Medical robots can be used in a variety of applications, including surgery, diagnosis, and treatment. The aim of this thesis review is to provide an overview of the current applications of medical robots in medicine and discuss the potential implications for future healthcare practices.

Methodology: The review was conducted by searching various online databases, including PubMed, ScienceDirect, and IEEE Xplore. Keywords such as "medical robots," "robotics in medicine," "surgical robots," and "robot-assisted surgery" were used to identify relevant studies. In general, 50 studies published between 2010 and 2023 were divided into groups and 13 of them were included in the review..

Robotics in medical applications: The results of the review indicate that medical robots have been used in a variety of medical applications, including surgery, diagnosis and treatment. Robot-assisted surgery is the most common application of medical robots, with studies reporting improved surgical outcomes, reduced hospital stays, and decreased pain and discomfort for patients. Other applications of medical robots include remote surgery, rehabilitation, and drug delivery [1].

The review also highlights the potential implications of medical robots for future healthcare practices. Medical robots have the potential to improve the accuracy and precision of medical procedures, reduce the risk of human error, and enhance patient outcomes. Additionally, medical robots can enable healthcare professionals to remotely monitor and treat patients, potentially increasing access to healthcare services and reducing healthcare costs.
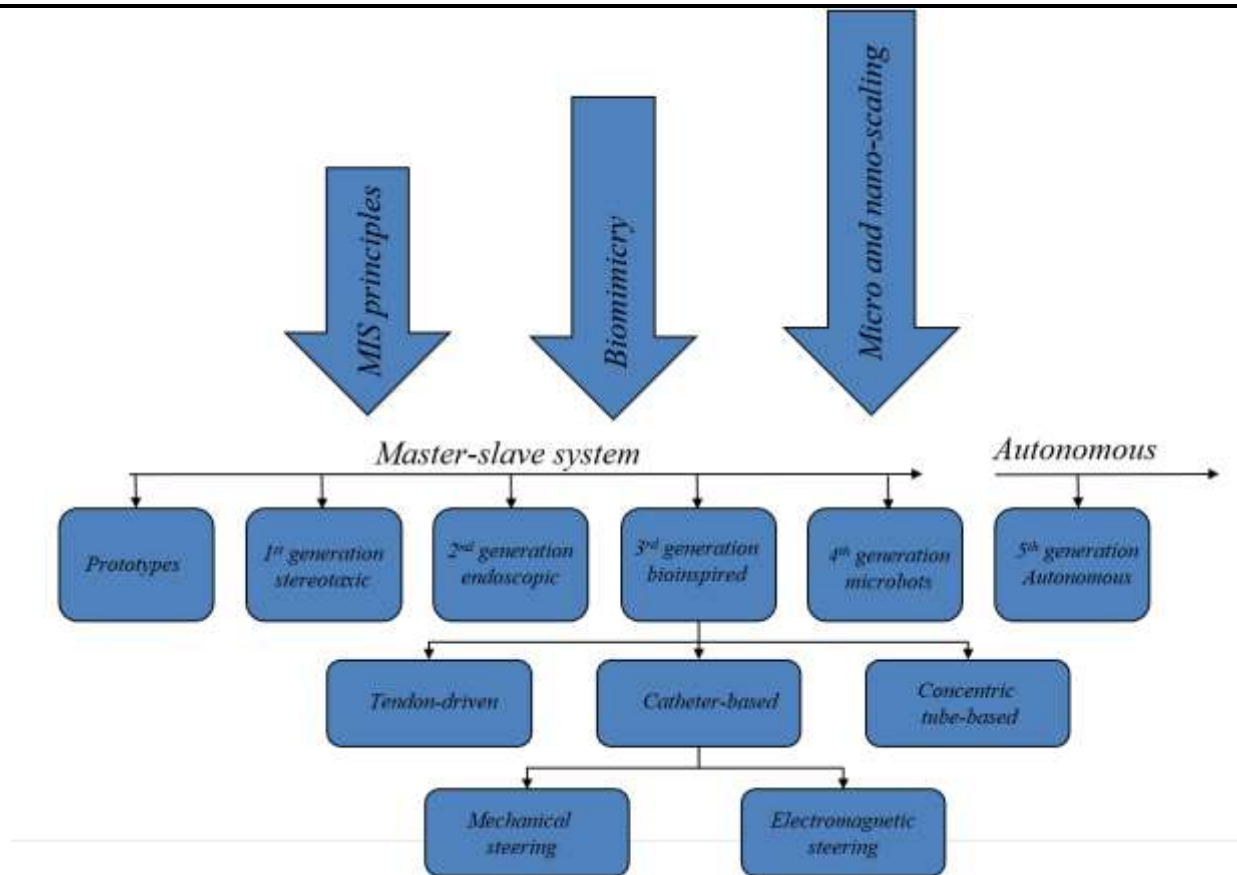
Fig. 1. Evaluation of Robotic surgery.

Robotic surgery: The introduction of robots into the healthcare system has resulted in improved clinical outcomes in robotic surgery technology. Several researchers have analyzed the evolution of these surgical robots into five generations of robotic surgery, including stereotactic, endoscopic, bioinspired, millimeter-scale microbots, and autonomous systems [2], [3]. Figure 1 below shows the evaluation of surgical robots. According to it, the evaluation of surgical robots can be divided into two large groups. The first group is called the Master-slave system, and the second is called the Autonomous system. Robots of the master-slave system generation were used to assist surgeons. Autonomous systems appeared as a result of their development. This generation of surgical robots can perform surgical operations automatically [4].

Diagnostic and Imaging Robots: Robots are gradually being used in diagnostics. This happened mainly as a result of the entry of artificial intelligence into medicine [5]. Artificial intelligence is being used to collect and analyze data from ultrasound or X-ray or other medical images [6]. Currently, many researchers are conducting research on the development of algorithms for the analysis of medical images and their further improvement.
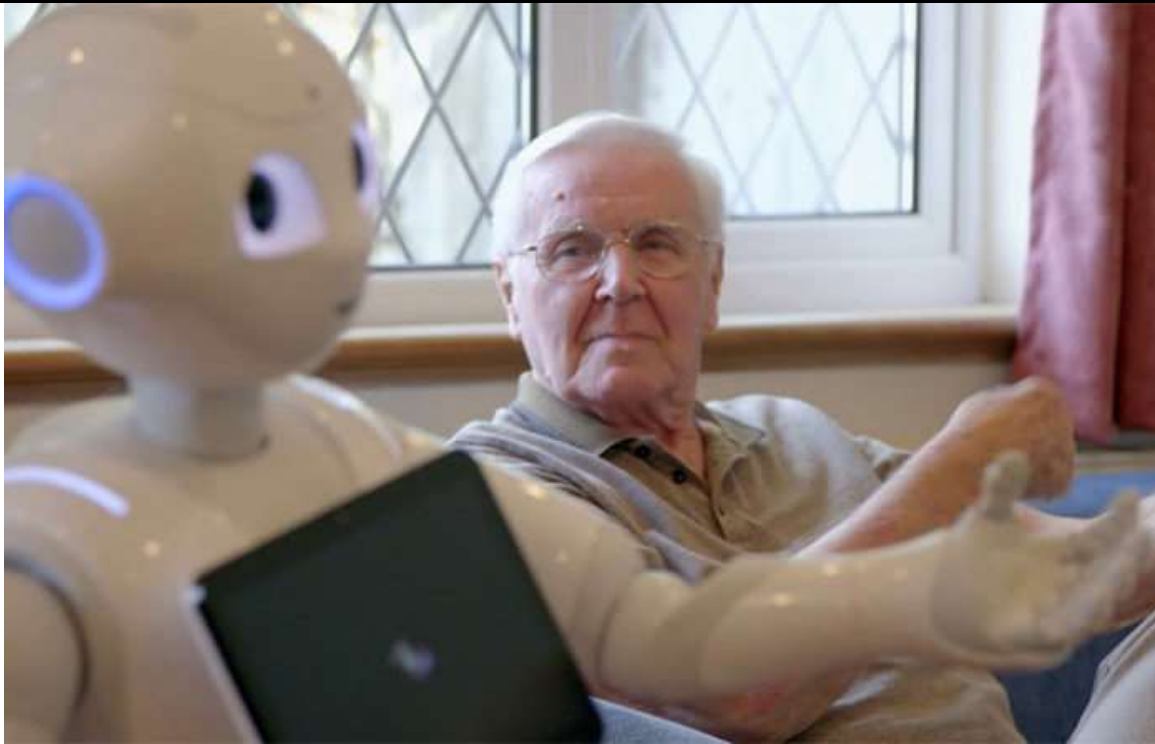
Fig. 2. Elderly care robots.

Therapeutic robots: Therapeutic robots are a category of robots designed to provide various forms of therapy and treatment to individuals with physical, mental, or emotional health challenges. These robots can assist in rehabilitation, improve overall well-being, and enhance the quality of life for patients [7]. Therapeutic robots aim to complement the work of healthcare professionals, reduce the workload on therapists, and provide consistent and repeatable therapeutic interventions. They often incorporate advanced technologies such as sensors, actuators, artificial intelligence, and machine learning to tailor treatments to individual needs and monitor progress over time [8]. Robots are also used to care for the elderly. They help elderly people to stand up, walk and do other daily activities [9]. In addition, it allows to take medicines on time and to contact the doctor or others in an unexpected situation.

Rehabilitation Robots: These robots are used to assist individuals in regaining mobility, strength, and coordination after injuries or surgeries. They can guide patients through therapeutic exercises and provide real-time feedback. Examples include robotic exoskeletons and robotic arm-assisted devices. Rehabilitation robots can be mainly divided into two groups: robots that rehabilitate upper and lower limb movements.

Upper Limb Rehabilitation Robots are used for individuals with upper limb impairments, such as stroke survivors or those with spinal cord injuries. They facilitate exercises and activities that improve arm and hand functions [10]. Examples of them are InMotion ARM, ArmeoPower, Kinova Jaco Arm robots.

Lower limb robots assist individuals with mobility impairments, including those with paralysis or gait disorders. They help with walking, balance, and lower body strength training [11]. Examples of them are Lokomat, Ekso GT, ReWalk.

Fig. 3. Drug delivery robots

Drug delivery robots: Drug delivery robots are robotic systems designed to automate the process of transporting and administering medication to patients in healthcare settings. These robots are used to improve the accuracy, efficiency, and safety of medication management and distribution. Here are some key aspects and applications of drug delivery robots [12],[13].

Conclusion: Medical robots have the potential to revolutionize the healthcare industry by improving the accuracy and precision of medical procedures, reducing the risk of human error, and enhancing patient outcomes. The current applications of medical robots in medicine include surgery, diagnosis, and treatment, with robot-assisted surgery being the most common application. The potential implications of medical robots for future healthcare practices are significant, including remote monitoring and treatment of patients and increased access to healthcare services. However, further research is needed to fully understand the capabilities and limitations of medical robots in medicine.

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