

Chapter 54

Medical Robotics

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ABSTRACT

Medical robotics is an interdisciplinary field that focuses on developing electromechanical devices for clinical applications. The goal of this field is to enable new medical techniques by providing new capabilities to the physician or by providing assistance during surgical procedures. Medical robotics is a relatively young field, as the first recorded medical application occurred in 1985 for a brain biopsy. It has tremendous potential for improving the precision and capabilities of physicians when performing surgical procedures, and it is believed that the field will continue to grow as improved systems become available. This chapter offers a comprehensive overview about medical robotics field and its applications. It begins with an introduction to robotics, followed by a historical review of their use in medicine. Clinical applications in several different medical specialties are discussed. The chapter concludes with a discussion of technology challenges and areas for future research.

INTRODUCTION

The word “robot” originated from a 1922 play called “Rossum’s Universal Robots (R.U.R.)” by Karel Capek (Capek 2001). The play was about a future in which all workers are automatons, who then revolt when they acquire souls. This idea was further proved by the introduction of Maria, the first female robot on the silver screen, in Fritz Lang’s silent science fiction movie ‘Metropolis’,

which was released in 1927. A Few years later, in 1959, John McCarthy and Marvin Minsky established the Artificial Intelligence lab at the Massachusetts Institute of Technology (MIT). The first modern robotic hand was created by Heinrich Ernst in 1961. The first industrial robot was invented in 1962 and named as ‘Unimate’. General Motors used the robot to perform repetitive or dangerous tasks on its assembly line. The year 1966 holds a special place in the history of robotics. It was during this year that the Stanford

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Research Institute came up with the concept and creation of 'Shakey', the first mobile robot ever created until that time, which could know and react to its own actions. Victor Scheinman, a Mechanical Engineering student working in the Stanford Artificial Intelligence Lab (SAIL) created the 'Stanford Arm' in 1969. In 1970 - researchers there built the Stanford cart, an intelligent line-follower robot. In order to assemble machines from small parts, Victor Scheinman invented the 'Silver Arm' robotic arm, in 1974. It made use of touch sensors. Robotics reached its advanced stage in the latter half of 20th century. In 1976, Shigeo Hirose came up with an innovative robot - the Soft Gripper - at the Tokyo Institute of Technology. It was designed to wrap around an object. In 1977, NASA launched its highly automated Voyager probe, in order to explore the outer solar system. In the same year, the super-hit Sci-Fi movie - Star Wars was released, which depicted the strongest image of human being's future with robots. On the academic side, robotics became an increasingly popular subject in engineering school and computer science departments in the 1980s. Several of the leading U.S. schools such as Stanford, MIT, and Carnegie Mellon developed robotics groups during this time. Carnegie Mellon formed a Robotics Institute in 1980 and began offering the first Ph.D. in robotics in 1989.

While many early students in the field started with the classic text by Paul (1981), several other textbooks began to appear (Fu et al. 1987; Craig 1989; Spong and Vidyasagar 1989). In 1986, automaker Honda started a humanoid robotics program, which went through 11 versions from 1986 to 2008. Towards the end of 20th century, robotics saw a sea of change in terms of the functionality of the robots. With passing of time, robots emerged as highly sophisticated machines, which could recognize their environment, distinguish sounds easily and observe moving objects. Some of the more remarkable inventions were 'RoboTuna', developed and built by David Barrett, 1996. 'Gas-trobot', a robot that digests organic mass to produce

carbon dioxide, was developed by Chris Campbell and Stuart Wilkinson at the University of South Florida, 1996 and three years later, in 1999, Sony released the AIBO robotic pet. The advent of the millennium saw further development in the field of robotics. In 2000, Honda introduced humanoid robot - ASIMO. Sony launched its third generation robotic pet in 2003. It was named 'AIBO ERS-7'. Presently, Robots can follow along with a human by holding hands. Today, with the advancement of science and technology, researchers are coming up with innovative ideas to create robots that could simplify sophisticated tasks, which are otherwise done by humans.

MEDICAL ROBOTICS

The field of medicine has also been invaded by robots. They are not there to replace doctors and nurses but to assist them in routine work with precision tasks. Medical robotics is a promising field that really took off in the 1990s. Since then, a wide variety of medical applications have emerged: laboratory robots, telesurgery, surgical training, remote surgery, telemedicine and teleconsultation, rehabilitation, help for the deaf and the blind, and hospital robots. Medical robots assist in operations on heart-attack victims and make possible the millimeter-fine adjustment of prostheses. There are, however, many challenges in the widespread implementation of robotics in the medical field, mainly due to issues such as safety, precision, cost and reluctance to accept this technology. Medical robotics includes a number of devices used for surgery, medical training, rehabilitation therapy, prosthetics, and assistance to people with disabilities.

Rehabilitation Robotics

Activity in the field of rehabilitation robotics began in the 1960s and has slowly evolved through the years to a point where the first commercially

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