# Chapter 32
# Robotics in Surgical Techniques Robotics in Surgical Techniques: Present and Future Trends

**Vassilia Costarides**
*National Technical University of Athens, Greece*

**Kostas Giokas**
*National Technical University of Athens, Greece*

**Apollon Zygomalas**
*University of Patras, Greece*

**Dimitris Koutsouris**
*National Technical University of Athens, Greece*

## ABSTRACT

*Healthcare robotic applications are a growing trend due to rapid demographic changes that affect healthcare systems, professionals and quality of life indicators, for the elderly, the injured and the disabled. Current technological advances in robotic systems offer an exciting field for medical research, as the interdisciplinary approach of robotics in healthcare and specifically in surgery is continuously gaining ground. This chapter features a review of current applications, from external large scale robotic devices to nanoscale swarm robots programmed to interact on a cellular level.*

## INTRODUCTION

Since the beginning of human history, surgical operations even in their primitive form have been on the frontier of medicine, due to the lack of non-invasive diagnostic techniques and the traumatic nature of the majority of health issues resulting from centuries of wars and battles. Surgeon, a term introduced in the 14th century means 'a person who heals by manual operation on the patient and has its roots in the Latin world chirurgiae from Greek *cheirourgiki (χειρουργική) and* more specifically their – hand and ergon – work. Surgery, the physical manipulation of the body aimed at the diagnosis, prevention and eventually treatment of diseases and traumas and from early on, the most critical factors that had to be dealt with, were bleeding, pain and infections.

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Among the first surgical operations were laceration suturing, amputations, cauterization of wounds and trepanation with evidence such as prehistoric remains in cave paintings and ancient Greek writers' descriptions. In ancient Egypt engravings of surgical tools and papyri with recipes and pharmacopeia for the treatment of numerous diseases have been discovered and in China, physicians performed surgery with the aid of anesthesia, 1600 years before it was adopted in Europe. The evolution and incorporation of anatomy in medical education in the middle ages and Renaissance provided the basis for the systematic research that established the discipline of modern scientific surgery, as a common and safe practice.

Nowadays challenges such as pain management and infections are addressed with the latest technological advances in anesthesia, antisepsis, and novel diagnostic procedures. In our never ending quest for lower mortality rates, less pain and quality services, current economic and social trends guide surgical advances to less invasive techniques that eventually lead to lower hospitalization and recovery times, thus ensuring profit and quality of life to all relevant stakeholders and patients relatively.

## BACKGROUND

In the delicate balance between minimally invasive surgery and high-cost state of the art technology, lies robot-assisted surgery, a field rapidly evolving in conjunction with other disciplines, such as micro and nano machines, wireless communications, bioengineering and information technology.

Minimally invasive procedures refer to techniques that target at limiting the incision site, so that wound healing times, pain and infection risk are controlled and minimized. It is widely used by interventional radiologists, employing imaging techniques and catheters, used as interventional instruments directed at the targeted vessel or organ, but also by general surgeons with laparoscopic procedures.

There are several techniques that surgeons use to perform minimally invasive surgery with the patient under general or local anesthesia, depending on the procedure. Usually, laparoscopic instruments either have a telescopic rod lens system that is connected to a camera, or the laparoscope is digital and the charged – couple device is placed at the end of it (Swanstrom, 2013).

The demand of robots in healthcare and specifically in surgery comes from the finite human capability to perform certain actions with adequate efficiency. As described above, latest trends in healthcare align towards automatization, robot – assisted surgery and minimization and therefore efficiency must be maximized along with patient safety, security and sensitivity. The manipulation of robotic instruments via a console, directly or indirectly that translate the surgeon movements to precision actions, was first introduced in 1983 with the Arthrobot (Paul, 1992), a bone mountable hip arthroplasty surgery robot and in 1985 the PUMA 560 (Piltan, 2012) was introduced, for a needle brain biopsy, under CT guidance. In 1988 it was used to perform a transurethral resection and a year earlier for the first laparoscopic cholecystectomy. In 1992 the Robodoc was introduced to mill out precise fittings in the femur for hip replacement (Schulz, 2007).

## IDENTIFIED NEEDS

Robot-assisted surgery originally developed to overcome certain limitations of minimally invasive procedures. Based on the analysis of sensor information, healthcare robots use systems capable of doing mechatronic actions to provide healthcare services, such as diagnosis, interventions, treatment, support