3.1 Introduction

As is the case with other surgical specialties, urologic practice has witnessed major breakthroughs throughout its history. Achievements such as the introduction of anesthesia in the 1840s and that of introducing penicillin in the 1940s have had a profound and lasting affect on the way urology is practiced. It is on this very same note that the revolution in information technology has to be seen, as current advances will undoubtedly again alter urology as we now know it. These exciting new frontiers have been made possible by the rapid expansion of the Internet, development in telecommunication infrastructures, an ever-multiplying computing power, and the increasing sophistication of robotics. Consequently, telesurgical urology became an inevitability, dictated not only by the incipient possibility but also by needs and necessities inherent to the specialty.

Urological procedures are characterized by being highly dependent on imagery and on a complex armamentarium of instruments and optics. Operations are performed in deep body cavities or confined spaces such as the pelvis and the retroperitoneum. It is because of features like these, and a rich tradition for embracing innovations, that urology lends itself to the implementation of telesurgery. The current chapter highlights the present and future roles of telesurgery and robotics in urology by addressing the following points:

- Overview of telesurgery and robotics in urology
- Master-slave robotic systems
- Remote surgery and telementoring
- Telemedicine and urology
- Future directions
3.2 Overview of Telesurgery and Robotics in Urology

The concept of telesurgery in urology is probably not new. Initial advances in telemedicine and telesurgery were however hampered by the constraints set by the limitations of computing power and lack of sufficient bandwidth to transfer the huge amounts of data necessary for such systems to be in place. It was therefore not until the last two decades, which have seen an explosion in computing power and great strides in the technology of information relay, that telesurgery emerged as a viable and practical management option. By definition, telesurgery is the ability to perform surgical procedures by means of a surgical robot actively controlled or programmed by a surgeon who is not in direct physical contact with the patient, the data being transmitted from the surgeon to the robot via telecommunication systems. The surgeon can hence be in the vicinity of the patient (in the operating theatre) or at a distance (another continent) while the procedure is being performed. Imperative to the latter situation is the integration of multimedia devices such as bidirectional (duplex) audiovisual telecommunication with robotic technologies and the existence of telecommunication systems capable of transmitting data with minimal delay.

Historically, the orthopedic and neurosurgical specialties led the way in the development of telerobotic surgery, as the nature of the tissues handled in these specialties allows for fixed anatomical landmarks that are easily imaged and can be used as reference points for image-guided procedures and stereotactic targeting [3, 25]. Contrary to this, the deformable nature of tissues and the mobility of organs in the parenchymatous specialties constituted an initial impediment to the implementation of telerobotics. Initial attempts at introducing robots in urology were therefore concentrated on prostatic surgery, owing to the prostate’s relatively fixed anatomical position in the pelvis. In 1989, at the Imperial College in London, Davies and colleagues showed the feasibility of using a modified industrial robot for transurethral prostatic resection [5]. Their concept was refined and put to clinical use in 1991, when they were able to carry out transurethral prostatectomies on five patients, marking the first time an active robot was used for resecting human tissue [6]. A second-generation robot under the name Probot was devised by the same group and also successfully applied clinically but never achieved widespread use [11]. The Probot and its predecessor were active robots in the sense that they proceeded autonomously once programmed and activated by the surgeon, working according to image-guided coordinates, which were fed to the system by the operator. Safety, which was a prime concern in the development of these systems, arose from the fact that these robots were programmed to precisely constrain motion to a predefined anatomical area marked by the surgeon, based on transrectal ultrasound (TRUS) measurements. This prevented injury to critical struc-