Da Vinci Surgical System
Vishnu Devalla, Biomedical Engineering, University of Rhode Island

The da Vinci Surgical System consists of an ergonomically designed surgeon's console, a patient side cart with four interactive robotic arms, high performance Insite vision system and proprietary EndoWrist. The da Vinci system is powered by robotic technology, the surgeon's hand movements are scaled, filtered and translated into precise movements of the EndoWrist Instruments which give rise to an intuitive interface with breakthrough surgical capabilities. Surgeon Console contains a 3-D image of the surgical field and the surgeon operates while seated at the console. The surgeon's fingers grasp the master controls below the display, with hands and wrists naturally positioned relative to his or her eyes. The system translates the surgeon's hand, wrist finger movements into precise, real time movements of surgical instruments inside the patient.

The patient side cart provides either three or four robotic arms-two or three instrument arms and one endoscope arm, that execute the surgeon's commands. The laparoscopic arms pivot at the 1-2 cm operating ports, eliminating the use of patient's body wall for leverage and minimizing tissue damage. Supporting surgical team members assist in installing the proper instruments, prepare the 1-2 cm port in the patient and supervise the laparoscopic arms and tools being utilized.

Digital surgery had to overcome many obstacles in order to be approved by the FDA. The da Vinci surgical system reduced the average 2-3% infection to nearly zero. There are four main components to da Vinci surgical system, the surgeon console, patient-side cart, endo wrist instruments and insite vision system with high resolution 3d endoscope and image processing equipment. Da Vinci surgical system costs one million dollars. The surgeon is situated at this console several feet away from the patient operating table. The surgeon has his head tilted forward and his hands inside the system's master interface. The surgeon sits viewing a magnified three-dimensional image of the surgical field with a real time progression of the instruments as he operates. The instrument controls enable the surgeon to move within a one cubic foot area of workspace. This component of the system contains the robotic arms that directly contact the patient. It consists of two or three instrument arms and one endoscope arm. The feedback as of today is limited to sensing tool-on-tool collision, so the surgeon needs to rely almost solely on the visual field when suturing or contacting soft tissue. As of 2003, Intuitive launched a fourth arm, costing $175,000, as a part of a new system installation or as an upgrade to an existing unit. It provides the advantages of being able to manipulate another instrument for complex procedures and removes the need for one operating room nurse.

The da Vinci Surgical System reduces hospital stays by about half, reducing hospital cost by about 33%. These fewer days in the intensive care unit are a result of less pain and quicker recovery. Though the size of the device is still not small enough for heart procedures in children, the minimally invasive nature of da Vinci does not leave a large surgical scar and still has some limited applications in children for the time being. Moreover, according to Intuitive Surgical, only 80,000 out of 230,000 new cases of prostate cancer undergo surgery because of the high risk invasive surgery carries, implying that more people may undergo surgery with this evolving technology. The main drawbacks to this technology are the steep learning curve and high cost of the device. Though Intuitive Surgical does provide a training program, it took surgeons about 12-18 patients before they felt comfortable performing the procedure.

References:
http://biomed.brown.edu/Courses/BI108/BI108_2005_Groups/04/davinci.html
http://www.intuitivesurgical.com/products/davinci_surgicalsystem/index.aspx
http://www.davincisurgery.com/index.aspx
The American Journal of Surgery, Vol. 187, No. 2. (February 2004), pp. 309-315.
http://www.intuitivesurgical.com/products/davinci_surgicalsystem/index.aspx