Chapter 106
Prototyping of Robotic Systems in Surgical Procedures and Automated Manufacturing Processes

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ABSTRACT

The prototyping and implementation of robotic system is a scientific and technological integrating of robotic system design, development, testing, and application. This chapter describes the recent development and applications of robotic systems to surgery procedures in biomedical engineering and automated manufacturing processes in industry. It includes the design and development, computer-aided modeling and simulation, prototype analysis, and testing of robotic systems in these two different applications.

1. INTRODUCTION

Robotic system is constructed mechanically of kinematic chains and actuators which function as muscles that transfer potential energy to body motion (Dylan, 2005, p.797 & Schreuder, 2010, p.253). The robotic mechanisms can be controlled to perform different tasks. The applications of programmable logic control to the industry bring revolution for the manufacturing techniques. It allows more sophisticated, flexible, reliable, and cost-effective manufacturing process controls (Feil-Seifer, 2007, p.425 & Kim, 2007, p.13 & Yang, 2008, p.79). Robotic system is to use control system to reduce human labor intervention during manufacturing processes and productions. It plays very important role and puts strong impact in today's industries (McComb, 2003, p.435 & Pott, 2005, p.101). Computer-aided engineering design can quickly model the robotic systems and speed the design and development cycles (Kumar, 2011, p.994 & Menzel, 2000, p.180 & Tsagarakis,

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2003, p.21). Computer aided manufacturing can improve the engineering integral processes of robotic design, development, engineering analysis, and production (Schiff, 2005, p.122 & Tapus, 2007, p.15 & Tholey, 2003, p.158). The current economic globalization requires significant labor cost reduction through industrial automation, applied robotic system, improved machine tools, and efficient production process (Ahmed, 2009, p.431 & Siebert, 2004, p.127). This chapter aims at the introduction of some robotic systems applied in surgical procedure and automated manufacturing processes. Two new research projects of robotic systems are introduced in this chapter through design analysis, computer modeling, computational engineering simulation, and prototype testing.

2. BACKGROUND

Robotic surgery has many advantages including minimally invasive surgical process, narrow incisions, decreased infection, reduced pains, and less hospital stays (Cadierre, 2001, p.1467 & Eirik, 2009, p.77 & Taylor, 2003). The development of surgical robots can improve the situation limited by current laparoscopic surgery and technologies (Backes, 2008, p.97 & Camarillo, 2004, p.188 & Hu, 2002 & Kazanzides, 2008). Also the robotic surgical system can be set up whereby the patients could be loaded into a vehicle by robotic surgical equipment and surgery can be performed by a surgeon remotely at a nearby mobile advanced surgical hospital (Brown, 2007, p.253 & Estey, 2009, p.488 & Ghomi, 2010, p.87 & Mataric, 2007, p.1). The robotic arms can be manipulated through surgeon's voice instructions to control the endoscopic cameras (Bargar, 2007, p.31 & Carigan, 2007, p.179 & Gerhardus, 2003, p.242 & Tapus, 2008, p.169). Figure 1 shows one robotic surgical application in gallbladder surgery. The gallbladder removal by robotic surgery is minimally invasive by way of robot technology permitting optimal viewing of the surgical field through small incisions with less pain and faster recovery time for patients (Gockley, 2006, p.150 & Hanna, 2011, p.761 & Harja, 2007, p.365 & Rosen, 2011). It closely mimics the surgery that is used in traditional 'open' procedures, but allows surgeon to perform the operation by da Vinci™ Surgical Systems through small incisions that are associated with minimally invasive and laparoscopic surgeries (Gortchev, 2010, p.153 & Kaouk, 2009, p.181 & Koh, 2011, p.1945 & Puntambekar, 2009, p.259).

Figure 2 shows the da Vinci robotics surgical system for gynecology, urogynecology, urology and cardiology procedures. It has flexible, safe, précised features that allows surgeon to operate the surgery with reduced trauma to the patients and a faster recovery time (Kwartowitz, 2006, p.157 & Li, 2002, p.90 & Melvin, 2003, p.33 & Passerotti, 2006, p.193 & Peters, 2007, p.179).

Figure 3 displays another robotic-assisted surgical system to help surgeon in surgery. It allows the surgeon to perform surgery with enhanced precision that reduces post-operative complications, less pain and discomfort after surgery, less scarring and a shorter hospital stay (Kypson, 2004, p.87 & Melvin, 2003, p.11 & Passerotti, 2006, p.193 & Patel, 2011, p.423).

Figure 1. Robotic surgery for gallbladder removal (Gockley, 2006)

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