Chapter 6
Robotic System Design and Development for Medical Treatment, Surgery, and Automated Production Applications

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ABSTRACT

The development and improvement of robotic system integrate the science and technology of robotic system design, engineering analysis, prototyping, and experiment. This chapter introduces the current research and development of robotic systems applied in medical treatment, surgical operation, automated manufacturing, and high-speed production. Two recent robotic researches are included in this chapter to show the technical methodologies of computer-aided 3D modeling, computational simulation, engineering analysis, prototyping, and experiment in design and development of robotic systems.

INTRODUCTION

The robotic systems mechanically consist of kinematic functioning parts including chains and actuators that similarly operate as human muscles converting its potential energy to body motion (Abbas, 2012, p.496, Dylan, 2005, p.797 & Schreuder, 2010, p.253). The robotic mechanical system can be manipulated to execute different moving functionalities (Ahmed, 2013, p.1131). The new researches of robots focus on handling various complex levels of adaptability, intelligence, intractability, efficiency, functionality, mobility, and flexibility to deal with many different complicated and non-friendly environments, and potentially offer various kinds of services to human users and society (Habib, 2006, p.449). The programmable logic control (PLC) applied in different engineering fields bring renovation to the manufacturing techniques and production technologies that allow more complicated, adaptable, well-set, and

economic-efficient production and industrial process controls (Feil-Seifer, 2007, p.425 & Kim, 2007, p.13 & Yang, 2008, p.79). By using control system, robotic system can decrease human labor involvement in production and industrial processes. The fast growing and rapid explorations in computing capability and technological renovations have brought new era for mechatronics which is a technical cross-linked interdisciplinary and intelligent paradigm that moderates, supports, interacts, and promotes modern researches, engineering technologies, control systems, and scientific practices (Habib, 2007, p.12). The robotic system plays critical role in modern industry and provides exceptional support for cost-effective business function (Kwartowitz, 2006, p.157 & Pott, 2005, p.101). Computer-aided modeling and product design can quickly simulate the robotic systems and accelerate the product development cycle (Kumar, 2011, p.994 & Menzel, 2000, p.180 & Tsagarakis, 2003, p.21). Computer aided manufacturing can flex-ibly amend and improve the engineering integration of robotic system design, development, prototyping, engineering analysis, and manufacturing process (Schiff, 2005, p.122 & Tapus, 2007, p.15 & Tholey, 2003, p.158). The globalized challenging economy needs cost-effective manufacturing production pro-cesses via automation control, flexible robotic system, better production tools, and efficient business process (Ahmed, 2009, p.431 & Siebert, 2004, p.127). This chapter focuses on the introduction and case study of robotic systems applied in surgical and automated production processes. Two current new researches of robotic system development are introduced and analyzed via modeling analysis, computer aided design, computational simulation, prototype experiment, and engineering validation.

BACKGROUND

The major advantages of robotic surgery include minimally invasive surgeries, precise incisions, minimal infection, less pains, and reduced clinic stays (Cadierre, 2001, p.1467 & Eirik, 2009, p.77 & Taylor, 2003, p.24). The surgical robot design and development can help to make better medical services that were limited by current traditional surgical technologies (Backes, 2008, p.97 & Ghomi, 2010, p.87 & Hu, 2002 & Kazanzides, 2008). In addition, the robotic-assisted surgical unit can be put in places where the patients could be placed in a medical unit by a loading robot and surgery can be remotely performed by a surgeon who is in a controlled mobile advanced surgical system (Gortchev, 2010, p.153 & Brown, 2007, p.253 & Estey, 2009, p.488 & Mataric, 2007, p.1). In robotic surgery, the robotic systems can be operated via surgeon's instructions to control the motion of surgical tools including endoscopic cameras (Bargar, 2007, p.31 & Carigan, 2007, p.179 & Gerhardus, 2003, p.242 & Tapus, 2008, p.169). Figure 1 presents one miniature robotic surgical system to remove tumor. The brain tumor removal via robotic surgery will be minimally invasive by using robot technology allowing more precise motion control and providing better view of surgical operation area for small incisions with reduced pain and less recovery time (Camarillo, 2004, p.188 & Hanna, 2011, p.761 & Harja, 2007, p.365 & Rosen, 2011, p.978). Ro-botic surgery is similar to the surgery in conventional 'open' surgical procedures, but permits surgeon to carry out the surgical operation via da Vinci™ Surgical Systems through narrow and tiny incisions that are integrated with less invasive and laparoscopic surgeries (Gockley, 2006, p.150 & Puntambekar, 2009, p.259).

Figure 2 shows the da Vinci robotics surgical system for surgical operations including cardiology, urology, urogynecolo-gy and gynecology procedures (McComb, 2003, p.435 & Li, 2002, p.90). This surgical system helps surgeon handle surgery for flexible, safe, and précised performance with minimal trauma and less recovery time (Melvin, 2003, p.33 & Passerotti, 2006, p.193 & Peters, 2007, p.179).

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