Chapter 15
Development of Bluetooth, Xbee, and Wi-Fi-Based Wireless Control Systems for Controlling Electric-Powered Robotic Vehicle Wheelchair Prototype

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ABSTRACT

In this study, multiple control systems were developed using commonly used wireless communication protocols like Bluetooth, Xbee, and Wi-Fi. Mechanical switch based control systems were initially designed using Xbee and Bluetooth protocols. Further, Android application based control systems were developed using Bluetooth and Wi-Fi protocols. A robotic vehicle was used as an electric-powered wheelchair prototype. Ultrasonic sensors and infrared sensors were integrated with the robotic vehicle for obstacle and pothole detection, respectively. The control systems were tested in an L-shaped corridor for identifying the suitable wireless communication protocol to efficiently guide the robotic vehicle through a scheduled navigational pathway. Both Xbee and Wi-Fi technology based control systems were able to guide the robotic vehicle through the corridor. But the implementation of Xbee communication protocol is economic. However, for shorter distances, Bluetooth technology may be used for cost-effective implementation.

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INTRODUCTION

In the current day world, there is a dramatic increase in the job, family and social commitments of the people. Due to these reasons, most of the people find it difficult to arrange time for their health and well-being activities. Patients suffering from neurodegenerative diseases (e.g. Amyotrophic lateral sclerosis (ALS), spinal cord injuries, multiple sclerosis, paraplegia and quadriplegia) become heavily dependent on the family members. These patients lose their muscular activity very rapidly, which results in the total body paralysis, inability in speech formation, swallowing and respiratory failure (Simmons, 2005). Hence, these patients are considered as burden to their family members (Coco et al., 2005; Zarit, Reever, & Bach-Peterson, 1980). Due to this reason, many of the families, who are economically stable, hire the services of specialized caregivers. But in developing countries like India, Bangladesh, Pakistan, Sri Lanka, Myanmar, and many African countries etc., most of the people are economically challenged to hire the services of the specialized caregivers for long period. It has been reported in literature that the care rendered to the patients on their deathbed decide whether the patients will receive a better death or a worse death (Soros & Madrick, 1999). Keeping this in mind, many researchers across the globe are trying to improve the quality of life of such severely disabled persons. The quality of life has also been related with the non-medical activities of the patients which include level of independence, social association, personal beliefs and psychological states of the patients (Simmons, 2005). These factors are highly hampered in the severely motor-disabled persons. Though mental strength and intelligence remain intact, they find it difficult to manipulate the conventional wheelchairs. This has led to the conceptualization of motorized wheelchairs, which have helped in drastically improving the self-assisted mobility of these patients. Various scientists have reported the use of intelligent sensors for acquiring information around the immediate environment of the patients (Cowan et al., 2012; Sevillano et al., 2009; R. Simpson, LoPresti, Hayashi, Nourbakhsh, & Miller, 2004; Tomari, Kobayashi, & Kuno, 2012). These sensors can divulge information about any adversities around the patients. The main disadvantage of these wheelchairs is the complex hardware architecture. The complexities can be minimized to some extent using certain wireless control systems. The simplistic nature of the wireless controlled electric-powered wheelchairs can considerably reduce the physical labor of the caregivers and enhance the autonomy of these patients. These advantages have been reported to improve the social integration of such disabled patients (R. C. Simpson, 2005).

Keeping a note of the above, in this present study, we propose a mechatronic approach for designing an economically assembled archetype (robotic vehicle). The proposed approach is helpful in realizing the directional control of a motorized wheelchair using various wireless protocols (Bluetooth, Xbee, and Wi-Fi). In addition to responding to the auxiliary controls (activation, deactivation and stop), the robotic vehicle was programmed to navigate in four different directions (forward, backward, left and right). The commands were wirelessly relayed to the robotic vehicle from the peripheral remote controllers. The remote controllers were designed using pushbutton switches, joystick and Android application. To identify the optimum wireless protocol for probable multitasking use in wheelchair control, home automation and robotic arm movement control; a comparative study was performed using the above mentioned wireless technologies.