Chapter 81
Robotic Assistive System: Development of a Model based on Artificial Intelligent Technique

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ABSTRACT

Stroke is the leading cause of disability that influences the quality of people's daily life. As such, an effective method is required for post-stroke rehabilitation. Research has shown that a robot is a good rehabilitation alternative where conventional robotic assistive system is encoded program by the robot expertise. The major drawback of this approach is that the lack of voluntary movement of the patient may affect the proficiency of the recovery process. Ideally, the robotic assistive system should recognize the intended movement and assist the patient to perform and make the training exercises more effective for recovery process. The electromyography based robotics assistive technology would enable the stroke patients to control the robot movement, according to the user's own strength of natural movement. This chapter briefly discusses the establishment of mathematical models based on artificial intelligent techniques that maps the surface electromyography (sEMG) signals to estimated joint torque of elbow for robotic assistive system.

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INTRODUCTION

Stroke is a serious global health problem which ranks as the second or third cause of death and disability of patients in many countries (Langhorne, Bernhardt & Kwakkel, 2011). Each year, about 795,000 people in America suffer from stroke. Amongst these stroke cases, relatively 610,000 people are suffered the first stroke attack and 185,000 people are suffered the recurrent stroke and from the statistics also show that 36.9% is the relative rate of stroke death from 1999 until 2009 (Go et al., 2013). In United Kingdom, approximately 152,000 stroke cases appear, and in China 1.3 million people have strokes each year with 75% of them live with varying degrees of disabilities.

A survey conducted by National Stroke Association of Malaysia (NASAM) shows that out of more than 50,000 cases of stroke reported each year in Malaysia, about four hundred stroke survivors attend daily therapy session at various rehabilitation centres throughout Malaysia. Also, the Ministry of Health reported in 2011, that with advance observant of medical care, it has successfully prevented 12-15% of death due to stroke cases per year. It is a common practice to discharge stroke patients early from the hospital and refer them to the therapist as hospital outpatients for rehabilitation training care. However, local hospitals are unable to provide good rehabilitation treatment for outpatients due to the lack of professional therapists (Nordin, Aziz, Alkaff, Sulong & Aljunid, 2012).

In other parts of the world, robotic assistive system has been introduced to maintain the consistency of rehabilitation training. With this, the human therapist is able to observe more than one patient at a time, make clinical decisions and monitor the progress of each patient (Mazzoleni, Darion, Carrozza & Guglielmelli, 2010). In addition, robotic assistive system supports intensive, repetitive and task oriented training and safety in consonant with motor re-learning program compared to conventional rehabilitation approaches which involves therapists (Harwin, Parton & Edgerton, 2006). The robotic assistive systems are designed for upper limb robots and gait rehabilitation, and offer two modes of operation namely passive and active motion. During passive motion, the system guides the patient limb movement while the patient stays in rest condition. Active motion consists of two types of motion; active-assisted motion and active resisted motion. In active-assisted motion, the system acts as an assistance, providing the external force for the patient to complete the task movement, whereas, in active-resisted motion, the patient completes the task with opposing forces (Tong & Hu, 2008).

Hemiparesis/Hemiplegia is the most common stroke that contribute to the lack of gait performance (Flansjer, Holmback, Downham, Parlten & Lexell, 2005), weakness of specific muscles, reduced mobility, loss of inter-joint coordination and sensation, and abnormal postural adjustment (Cirtea & Levin, 2000). From clinically aspect, repetitive rehabilitation training has proven best method for motor control recovery with intensive training sessions. In conventional therapy, the repetitive task of rehabilitation is time consuming and labor intensive for both the patients and therapists (Hidler, Nichols, Pelliccio & Brady, 2005). Since last decade, several studies on the use of robotic assistive system have increased for rehabilitation of post stroke patients. The utilization of robotic assistive system can easily determine repetitive and task oriented training exercise, better control of introduced force and reproduction of precise force in cyclic movement. Robotic assistive system is also more robust during therapy sessions (Kreb, 2006).

The surface electromyography (sEMG) signals provide measurement of the muscle contraction using the electrode sensor placed on the surface skin. Robotic assistive system utilizes sEMG signals as a trigger input for the system (Krebs et al., 2003) and act as proportional myoelectric control for upper limb exoskeleton (Song, Tong, Hu & Li, 2008) and lower limb exoskeleton (Hayashi, Kawamoto & Sankai,