Chapter 22
Towards Cost-Oriented User-Friendly Robotic Systems for Post-Stroke Rehabilitation

Iuliu Adrian Nadas
Technical University of Cluj-Napoca, Romania

Doina Pisla
Technical University of Cluj-Napoca, Romania

Calin Vaida
Technical University of Cluj-Napoca, Romania

Bogdan George Gherman
Technical University of Cluj-Napoca, Romania

Giuseppe Carbone
University of Cassino and South Latium, Italy

ABSTRACT

This chapter deals with robotics for assisting patients in their recovery after stroke. The first section outlines the key physiotherapist movements that are needed in post-stroke treatment. Sets of experimental data are discussed for defining the main specifications for post-stroke rehabilitation devices. Then, a detailed overview is provided on the existing key achievements and solutions concerning rehabilitation robotics for post-stroke treatment. This section is followed by a detailed critical analysis aiming at the definition of new concepts for cost-oriented user-friendly solutions.

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INTRODUCTION

In the next two decades, the current evolution in average life span and medical progress, will force a paradigm shift in the treatment of many diseases. Such is the case of stroke, a cardiovascular disease, which affects mostly the elder population (over 65) and has, as the most common consequence, a negative effect on the patient's capability of performing activities of daily living (ADL). From a medical standpoint, specific protocols exist, which attempt to correct these disabilities by performing specific drug, neurologic and physical therapy. One of the most common disabilities, which affects over 50% of the stroke survivors is hemiparesis (one side weakness) or hemiplegia (one side paralysis), namely the partial or total loss of the ability to control half of the body. This disability is treated by a physical therapist by using different techniques in a process called rehabilitation, which spreads in time up to two years after the stroke.

The Royal College of Physicians defines rehabilitation as a collaboration with limited time between a person with disabilities and professionals, plus other relevant people, to produce sustained reduction in the impact of disease and disability on daily life. The interventions are focused on the human, on the social or physical implications, or a combination of these, (RCF 2010).

In the current approach one therapist can attend only one patient at a time which limits the number of procedures that one person can undergo daily, thus having a negative effect upon the recovery process and progress. Unfortunately, based on the demographic shift estimates, the number of elderly people will increase, making it impossible for the medical system to deal properly with all of them. One possible answer here is a shift in the rehabilitation paradigm which involves the use of specialized devices to perform specific exercises with the patients, changing the role of the therapist to a supervisor which monitors and adapts the rehabilitation process for each individual, based on his/her specific needs and progress. The specialized devices which can perform these tasks efficiently are the rehabilitation robots. Currently multiple devices exist for both upper and lower limb, balance, gait and so on but there is a need for further development in this field aiming to achieve not only efficient but also cost-oriented devices that could be afforded by the medical systems of lower income countries. Rehabilitation robotics has become one of the strategic fields of research promoted all over the world in an attempt to gain sufficient knowledge and reach a good maturity level before the moment when demographics will force the shift from one-to-one therapy to personalized robotic assisted rehabilitation. If compared with conventional therapy via physiotherapists, rehabilitation robots can offer repeatable, controlled, and interactive training at a much higher intensity and pace (Housman et al., 2009).

This chapter presents a detailed overview of the current problems and progress in patient rehabilitation after stroke, illustrating some of the commercially available technologies for the rehabilitation of the lower limb, upper limb and hand, followed by on-going developments in different maturity stages. Several new solutions for the rehabilitation of the upper limb are illustrated along with an overview of the most important challenges and future research directions.

Note: performing multiple movements significantly affects the rehabilitation of post-stroke patients, as highlighted for example in (Klein et al., 2008). However, research in fully understanding the relationship between limb training and recovery is still undergoing, as pointed out for example in (Yoo, D. H., Kim, S. K., 2015). Additionally, besides existing protocols, such as (Vaida, et al., 2017), significant research