Development of a wearable assistive soft robotic device for elbow rehabilitation

Victoria Oguntosin; William S. Harwin; Sadao Kawamura; Slawomir J. Nasuto; Yoshikatsu Hayashi

Abstract:
The loss of motor function at the elbow joint can result as a consequence of stroke. Stroke is a clinical illness resulting in long lasting neurological deficits often affecting somatosensory and motor cortices. More than half of those that recover from a stroke survive with disability in their upper arm and need rehabilitation therapy to help in regaining functions of daily living. In this paper, we demonstrated a prototype of a low-cost, ultra-light and wearable soft robotic assistive device that could aid administration of elbow motion therapies to stroke patients. In order to assist the rotation of the elbow joint, the soft modules which consist of soft wedge-like cellular units was inflated by air to produce torque at the elbow joint. Highly compliant rotation can be naturally realised by the elastic property of soft silicone and pneumatic control of air. Based on the direct visual-actuation control, a higher control loop utilised visual processing to apply positional control, the lower control loop was implemented by an electronic circuit to achieve the desired pressure of the soft modules by Pulse Width Modulation. To examine the functionality of the proposed soft modular system, we used an anatomical model of the upper limb and performed the experiments with healthy participants.

Published in: 2015 IEEE International Conference on Rehabilitation Robotics (ICORR)

Date of Conference: 11-14 August 2015

Date Added to IEEE *Xplore*: 01 October 2015

ISBN Information:
ISSN Information:

DOI: 10.1109/ICORR.2015.7281291
Publisher: IEEE

Conference Location: Singapore

I. Introduction

Stroke results from damage to the vascular supply of the brain resulting in neuronal death in the brain [1]. Therefore, stroke patients have difficulty performing specific motions such as elbow flexion and extension due to damage of the motor and somatosensory cortices. Early muscle activation is critical to good recovery [2], hence the need for exercises [1], [3]. Stroke neuro-rehabilitation is therefore important to restore muscle functions to the damaged body parts and help stroke surviving patients regain the ability to perform activities of daily living. This rehabilitation is required especially during the early stage of stroke diagnosis when there is a greater opportunity to influence neural plasticity and brain recovery [4]. Stroke rehabilitation requires long, manipulative and intensive direct physical therapy sessions to improve strength, accuracy, and range of motion [5]. Recent research work on robot therapies have been shown to be safe and beneficial over human delivered therapies due to their flexibility and intensity [6]. An inexpensive, compliant, wearable and lightweight robotic device allowing patients to engage in exercises on their own, either at home or in the hospital, would make physical therapy more available to patients [3], [7].

Authors
Victoria Oguntosin
Systems Neuroscience Group, University of Reading, U.K
William S. Harwin
Systems Neuroscience Group, University of Reading, U.K
Sadao Kawamura
Department of Robotics, Ritsumeikan University, Japan
Slawomir J. Nasuto
Systems Neuroscience Group, University of Reading, U.K
Yoshikatsu Hayashi
Systems Neuroscience Group, University of Reading, U.K