Stroke is a major cause of death and disability worldwide. The damage or death of brain cells caused by a stroke affects brain function and leads to deficits in sensory and/or motor function. As a consequence, a stroke can have a significantly negative impact on the patient’s ability to perform activities of daily living and therefore also affect the patient’s quality of life. Stroke patients may regain function through intensive physical rehabilitation, but often they do not recover their original functional level. The incomplete recovery in some patients might be related to e.g. stroke severity, lack of motivation for training, or insufficient and/or non-optimal training in the initial weeks following the stroke.

A threefold increase in the number of people living past the age of 80 in 2050, combined with the increasing number of surviving stroke patients, will very likely lead to a significant increase in the number of stroke patients in need of rehabilitation. This will put further pressure on healthcare systems that are already short on resources. As a result of this, the amount of therapeutic supervision and support per stroke patient will most likely decrease, thereby affecting negatively the quality of rehabilitation.

Technology-based rehabilitation systems could very likely offer a way of maintaining the current quality of rehabilitation services by supporting therapists. Repetition of routine exercises may be performed automatically by these systems with only limited or even no need for human supervision. The requirements to such systems are highly dependent on the training environment and the physical and mental abilities of the stroke patient. Therefore, the ideal rehabilitation system should be highly versatile, but also low-cost. These systems may even be used to support patients at remote sites, e.g. in the patient’s own home, thus serving as tele-rehabilitation systems.

In this Ph.D. project the low-cost and commercially available Microsoft Kinect sensor was used as a key component in three studies performed to investigate the feasibility of supporting and assessing upper limb function and training in stroke patients by use of a Microsoft Kinect sensor based tele-rehabilitation system. The outcome of the three studies showed that the Microsoft Kinect sensor can successfully be used for closed-loop control of functional electrical stimulation for supporting hand function training in stroke patients (Study I), delivering visual feedback to stroke patients during upper limb training (Study II), and automatization of a validated motor function test (Study III).

The systems described in the three studies could be developed further in many possible ways, e.g. new studies could investigate adaptive regulation of the intensity used by the closed-loop FES system described in Study I, different types of feedback to target a larger group of stroke patients (Study II), and implementation of more sensors to allow a more detailed kinematic analysis of the stroke patients (Study III). New studies could also test a combined version of the systems described in this thesis and test the system in the patients’ own homes as part of a clinical trial investigating the effect of long-term training on motor function and/or non-physical parameters, e.g. motivational level and quality of life.
To fulfill the requirements for the Ph.D. degree, Daniel Simonsen has submitted the thesis: Tele-rehabilitation of upper limb function in stroke patients using Microsoft Kinect, to the Faculty Council of Medicine at Aalborg University.

The Faculty Council has appointed the following adjudication committee to evaluate the thesis and the associated lecture:

**Associate Professor Imre Cikajlo**  
University of Nova Gorica  
Slovenia

**Professor Jane Helena Burridge**  
University of Southampton  
England

**Chairman:**  
Associate Professor Lotte N. S. A. Struijk  
Aalborg University  
Denmark

**Moderator:**  
Professor Ole K. Andersen  
Aalborg University  
Denmark

The Ph.D. lecture is public and will take place on:

**Friday 16 June 2017 at 10:00**  
Aalborg University – Room D2-106  
Fredrik Bajers Vej 7 D2  
9220 Aalborg East

**Program for Ph.D. lecture on**

**Friday 16 June 2017**

by

**Daniel Simonsen**

Tele-rehabilitation of upper limb function in stroke patients using Microsoft Kinect

Chairman: Associate Professor Lotte N. S. A. Struijk  
Moderator: Professor Ole K. Andersen

10.00 Opening by the Moderator

10.05 PhD lecture by Daniel Simonsen

10.50 Break

11.00 Questions and comments from the Committee  
Questions and comments from the audience at the  
Moderator’s discretion

13.00 (No later than)  
Conclusion of the session by the Moderator

After the session a reception will be arranged