Robotic Tele-Rehabilitation after Stroke
Henning Schmidt¹, Robert Steingräber², Simone Schmid², Michael Schauer³, Stefan Hesse⁴, Jörg Krüger¹²

¹ Rehabilitation Robotics Group (IPK/TU Berlin), Fraunhofer-Institute for Production Systems and Design Technology (IPK), Berlin, Germany
² Rehabilitation Robotics Group (IPK/TU Berlin), Institute of Machine Tools and Factory Management, Technische Universität Berlin (IWF), Berlin, Germany
³ MEYTEC GmbH Informationssysteme, Werneuchen/Berlin, Germany
⁴ Rehabilitation Robotics Group (IPK/TU Berlin), Institute of Machine Tools and Factory Management, Technische Universität Berlin (IWF), Berlin, Germany

Abstract
The usefulness of robotic therapy devices in neurological rehabilitation therapy, especially in severely affected subacute stroke patients was proven by several clinical studies. Until now such devices are only available for inpatients receiving therapy inside rehab hospitals. A need for outpatient devices based on these proven concepts, which can be operated by the patients themselves and via tele-operation arises, since every patient should continue motor rehabilitation training on an individual basis after being discharged from the rehab hospital. This contribution describes novel concepts and therapy robot based systems for motor tele-rehabilitation which are currently being developed.

Relearning of voluntary movement capability after neurological injuries, such as stroke, is a process which takes at least several months, often years. While in the rehabilitation hospital patients receive an intensive therapy programme every day. Modern hospitals apply a combination of manual and robot based therapy, since various clinical studies showed how patients can benefit from robot based training, see e.g. [1, 2]. When being discharged from the rehabilitation hospital, severely affected patients usually have achieved a minimum level of voluntary movement control. For further improvement patients needs to continue rehab training as often and intensive as possible. Due to a reduced frequency of qualified outpatient therapy training, a lack of home therapy possibilities and motivation, the movement re-learning success seldom increases any further, it even decreases quite often [3]. Therefore there is an evident demand for high quality and motivating outpatient therapy in the patient's home environment, for which robot-based tele-rehabilitation concepts as shown in Fig. 1 may be a solution.

Audio-visual communication channels are well established in existing tele-rehabilitation concepts for outpatient care in various diseases, some solutions are already commercially available. In neurological rehabilitation the haptic modality is crucial for re-training of voluntary movement capability.

The first project to apply rehab robotics at the stroke patients home in combination with remote supervision via internet was done several years ago [4]. Other projects investigated the connection of interactive robotic training devices via network to teach physical movements [5, 6].

The integrative concept presented in this contribution aims to enhance these basic concepts by combining the following features, based on the system concept of Fig. 1: i) two modes for patient training: a) autonomous training and b) remotely supervised training, ii) audio-visual and haptic communication channels, iii) intelligent patient-adaptive therapy devices, iv) adaptive biofeedback and v) software framework for integration of arbitrary therapy devices.

The implementation (see Figure 2) was done by integration and enhancement of two well established and clinically evaluated therapy devices: Bi-Manu-Track [7] and Reha-Slide [8], Reha-Stim, Berlin. An external Embedded-PC based control unit comprises patient-adaptive "Assist-as-needed"-control algorithms for

![Fig. 1: System concept for haptic Tele-Rehabilitation based on robotic therapy devices](image-url)
autonomous patient training [9] as well as tele-operation algorithms for haptic device coupling. Patient biofeedback was designed focusing on motivational aspects and goal setting theory [10].

Fig. 2: Computer-based Tele-Rehabilitation setup with robotic therapy device Bi-Manu-Track (station 1) and Reha Slide (station 2)

References


Contact: Henning Schmidt, henning.schmidt@ipk.fraunhofer.de, +49 (0)30 39006-149