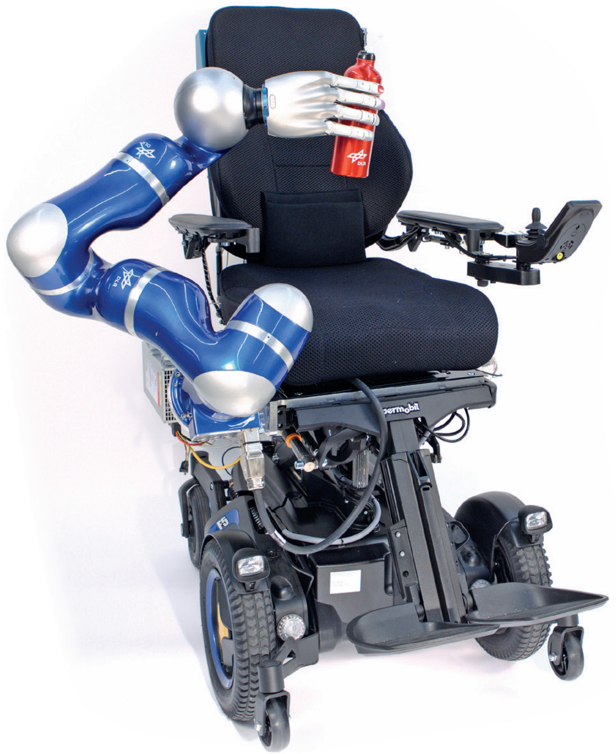
Overview

- Permobil F5 Corpus VS
- DLR Light-Weight Robot III
- DLR HIT 5 Finger Hand
- 26 Degrees of freedom
- Human-like reachability
- Compliant control strategies for safe human-robot Interaction
- Cognition-enabled intention inference



SMART Assist

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DLR at a glance

DLR is the national aeronautics and space research centre of the Federal Republic of Germany. Its extensive research and development work in aeronautics, space, energy, transport and security is integrated into national and international cooperative ventures. In addition to its own research, as Germany’s space agency, DLR has been given responsibility by the federal government for the planning and implementation of the German space programme. DLR is also the umbrella organisation for the nation’s largest project management agency.

DLR has approximately 8000 employees at 16 locations in Germany: Cologne (headquarters), Augsburg, Berlin, Bonn, Braunschweig, Bremen, Goettingen, Hamburg, Juelich, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Stade, Stuttgart, Trauen, and Weilheim. DLR also has offices in Brussels, Paris, Tokyo and Washington D.C.

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EMG-controlled Daily Assistant

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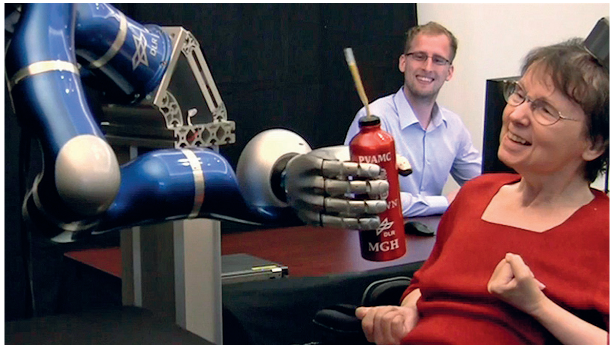
Assistive robotics

For many people with upper limb disabilities, simple activities of daily living, such as drinking, opening a door, or pushing an elevator button require the assistance of a caretaker. An assistive, robotic system controlled via a Brain-Computer-Interface (BCI) could enable these people to perform these kinds of tasks autonomously again and thereby increase their independence. We investigate various methods to provide disabled people with control over the DLR Light-Weight Robot, while supporting task execution with the capabilities of a torque-controlled robot.



Pilot study using the BrainGate2 Neural Interface System

One example for BCI-controlled assistive robotics is our pilot study using the BrainGate2 Neural Interface System. In this study, a participant with tetraplegia could control our robotic system by thinking of her own arm motion. An electrode array directly implanted into her motor cortex was used to decode robot commands from her neural signals. She finally could use the system to pick a bottle filled with coffee and drink from it independently for the first time since she suffered a brainstem stroke 15 years prior to this study.

Interfaces

The experimental sessions conducted within the BrainGate2 clinical trial represent the first scenario in which an individual with tetraplegia used our assistive framework. Another goal of our research is to develop a surface electromyography (sEMG)-based interface to allow people with movement disability to control a robotic hand arm system. This approach aims to harness the residual EMG signal stemming from atrophic arm muscles that can still be voluntarily activated but do not suffice to move the limbs.

There actually exist a number of neuromuscular diseases which lead to muscular atrophy and thereby rendering people unable to functionally move their limbs. One example is spinal muscular atrophy (SMA) in which the neural connection from the spinal cord to the muscles degenerates. Using our sEMG-based interface, we could enable two people affected from SMA to control our robotic system in order to pick up objects, or serve themselve a drink.

Adding mobility

In order to better evaluate the usability of a BCI-controlled robotic system, we combined the DLR Light-Weight Robot with a power wheelchair. On one hand, we use this mobile platform to investigate sEMG-based control of the wheelchair. On the other hand, the integrated manipulator allows for more complex scenarios of physical interaction with the environment. Users of such power wheelchairs are often not able to open a closed door or to push the button of an elevator. These every-day obstacles can be overcome with the use of a mobile robotic arm. In combination with a BCI- or an sEMG-based interface, people with severe physical disabilities can increase their mobility again.

Shared control

Using assistive robotic systems, people with paralysis can perform simple activities like grasping an object independently again. However, execution of more complex tasks, like pouring liquid from a bottle into a glass, requires very accurate control. In order to simplify the usage in these more complex scenarios, we make use of the shared control paradigm.

It is not possible to directly infer the user’s intention, for example “pouring water” from the sEMG signals. However, using a knowledge database composed of objects and their possible actions, we can estimate which activity the user most likely wants to perform. Based on this inference and the EMG-based commands of the user, the robot can than provide support in task execution.

Given the task of pouring water, the robot will first support the user in grasping the bottle. When the bottle is grasped, it can be freely moved in space, however, when approaching an empty glass, the robot can again provide support to pour the liquid into the glass without spilling it.