At a glance

The setup

Commercially available and scientific hardware
Advanced technology for building sockets
Miniaturised, unobtrusive control
Personalised care for each patient

The rehabilitation process

Control of a realistic hand and wrist model on a screen
Control of full arms in virtual reality
Tailored prosthetics
Full daily-living-like environment
Functional recovery assessed over weeks and months

Focus on the patient

Respect is key: transparent data storage and access
Possibility to be followed by a physiatrist
Continous monitoring of the progress

For the future

The patient adapts to the system...
...the system adapts to the patient...
...enforcing and exploiting **co-adaptation**

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 20 locations in Germany: Cologne (headquarters), Augsburg, Berlin, Bonn, Braunschweig, Bremen, Bremerhaven, Dresden, Goettingen, Hamburg, Jena, Juelich, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Oldenburg, Stade, Stuttgart, Trauen, and Weilheim. DLR also has offices in Brussels, Paris, Tokyo and Washington D.C.

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The Prosthetics Lab

A complete environment for multi-modal dexterous myocontrol

DLR

The Prosthetics Laboratory

The world around us is shaped to be manipulated using our hands. Cars, smartphones, electric appliances: everything works at the touch of a finger or the grasp of a hand. For this reason, even the partial loss of hand and arm functionality can lead to a degradation in the quality of social and working life, neuropathic pain and depression.
In Europe alone, about 95.000 people suffer from upper-limb amputation; nevertheless, despite 50 years of research, a seamless, immersive upper-limb prosthesis, perceived as one's own limb instead of as a tool, is still a dream. The main reasons for this impasse are to be found in the inadequacy of prosthetic hardware, in the unreliability and non-dexterity of control, and in the lack of established, effective protocols to train the disabled together with the prosthesis itself, in order to enforce a tight man-machine integration.

The Prosthetics Laboratory:
a daily-living-like space in which to perform everyday actions

At the Institute of Robotics and Mechatronics of the DLR, within the Adaptive Biointerfaces Group, we strive to reach such an integration by combining advanced sensors, material science, machine learning and a fully integrated training process. This process ranges from controlling a 3D hand and wrist model on a computer monitor to a complete daily-livinglike experimental setup. The Prosthetics Laboratory actively cooperates with orthopaedic and rehabilitation companies, academic institutions and patients, to reach the grand goal of serving the community of upper-limb amputees and, in the end, produce a significant impact on society.

Doing it for real

Upper-limb prosthetics is a typical multi-disciplinary research field. In order to provide a solution to upper-limb amputees, one must involve physicians, material scientists, mechatronic engineers, mathematicians and rehabilitation experts.

Moreover, a tight cooperation is necessary among the key players outside academia. These include, e.g., manufacturers of prosthetic hardware and bio-compatible liners and rehabilitation facilities where gait and movement after the impairment are studied and corrected for. But, most importantly, patients need to be involved from the beginning, as soon as possible after the trauma, and they must be followed for weeks and months during the rehabilitation process.

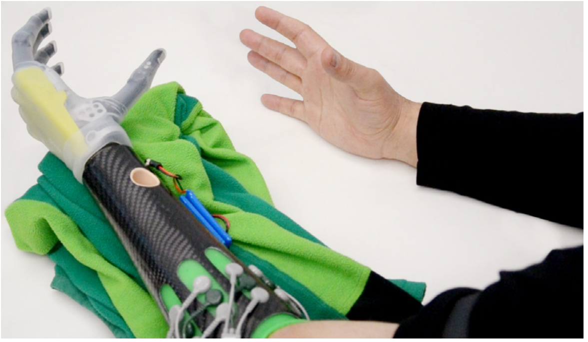
Testing prothetic control with a non-amputated person

Our Laboratory provides a research environment in which all aspects of the problem can be tackled, solutions devised, and systems tested to various degrees of "reality". On top of this, our network of external cooperations enables the targeting of our end-users to the last bit – we firmly believe that upper-limb prosthetics research must at some point leave the lab and be tested by the patients in real life: at home, outside, at work, in social life.

Our research in this field is driven by the need to deliver to the patients a solution which can be practically used at home, outside, during everyday life. Particularly, we try to make our academic results close to deployment in the market.

Sensors, silicone and maths

We pursue three main paths: sensors, sockets, control.
Sensors: Muscle activation can be detected using electromyography, force, pressure, tactile sensing and more. We explore the integration and fusion of diverse kinds of sensors to gather maximum information about the subject's intent, keeping the system lightweight and wearable.
Sockets: Sensors must be unobtrusive and placed stably on the subject's body in order to work reliably. We cooperate with orthopaedic companies to build personalised silicone sockets for each patient, in which to place the sensors.



An amputated person uses the myocontrol system devised in the Prosthetic Laboratory

Control: Turning sensor data into control commands for an upper-limb prosthesis is a major challenge. We use advanced machine-learning techniques to provide simultaneous, proportional control on all degrees of freedom of each prosthesis.

Patients come first!

Patients are trained along days and weeks, to learn to control their prosthesis in steps of increasing difficulty. They start by controlling a hand model on a screen, then a full prosthetic arm in virtual reality, and lastly a real prosthesis in a dailyliving physical setup: They must iron, prepare food, clean and so on. Particular attention is given to the assessment protocol, through which we determine both the functional recovery and the reciprocal adaptation.