To

potential R&D partners,
investors and professionals

fields:
neurotechnology, movement rehabilitation, medical device production

Dr. Jörn Rickert
Institute of Biology I
Albert-Ludwigs University Freiburg
Hauptstraße 1
79104 Freiburg
Germany

Phone: +49(0)7612032543
Email: rickert@biologie.uni-freiburg.de
Internet: www.bmi.uni-freiburg.de

The Brain-Machine Interface Initiative Freiburg

Development of a neural motor-prosthesis for movement restoration in paralyzed people

The Freiburg Brain-Machine Interface Initiative was incorporated in 2003 and is publicly financed. It consists of a team of 12 scientists and technicians working at the university- and university clinics of Freiburg, Germany

Technology

The R&D activities concentrate on the development and application of a novel medical technology: to measure a paralyzed patient's brain activity, translate it with intelligent software, and use the translated signals to drive patient-specific effectors (cf. Figure 1). The major goal of this technology, termed neuronal motorprosthesis, or brain-machine- / brain-computer interface, is to provide a better quality of life for the large patient group suffering from severe paralysis (approx. 1 Million in the US&EU[1]). Initial successes achieved in the US and EU utilized brain activity measured with electrodes placed on the scalp: paralyzed humans learned to choose between icons presented on a computer screen. The poor signal quality and poor spatial resolution of this approach make it unlikely to achieve fast & reliable control of complex prostheses though. Subsequent successes achieved in the US utilized brain activity measured with bundles of thin wire-electrodes placed inside the brain: monkeys, and recently also a few paralyzed humans, learned to move a computer cursor or a robotic arm. However, possible damage to neuronal tissue and local tissue reactions can cause problems in the long-term stability of this approach.

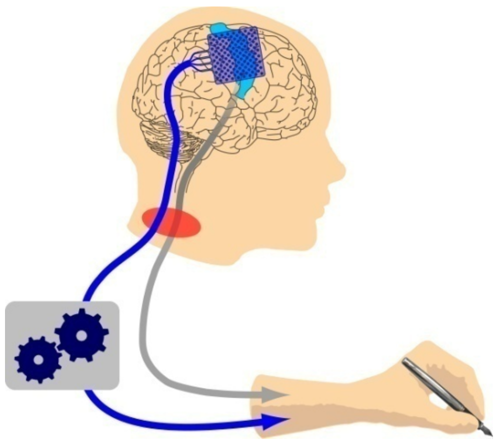

Figure 1: A neuronal motor prosthesis measures activity from the motor cortex (light blue), sends it to an intelligent software (grey box), which decodes the subjects movement intention from the activity and translates it into commands applicable to drive a wide range of prostheses. This way, a paralysis, e.g. due to a spinal cord injury (red oval), can be by-passed and the subject's capacity to act can, at least partly, be reestablished.

[1] includes severely paralyzed patients with Spinal Cord Injuries ASIA levels A&B, advanced Amyotrophia patients plus Stroke patients in need of long-term care facilities, own extrapolations.

The youngest approach utilizes electrodes placed on the surface of the brain. Recent studies demonstrated that its performance could match the two other approaches. At the same time, this approach should resolve, or at least significantly reduce, the problems of the approaches above[2].

The Freiburg Brain-Machine Interface Initiative concentrates on this promising last approach. We work on three core projects, which together build the basis of our prosthetic device: (A) the testing and improvement of human brain-machine interface control, (B) the development of a software solution for brain-machine interfaces, and (C) the development of an electrode-array to be used as an implant on the brain's surface in human brain-machine interfaces.

Development status

Core project A:
Offline analyses of our patients' brain activity showed that goal-oriented arm-movements in 2D can be derived from it. In core project A the performance of a research prototype system is tested and improved to demonstrate a reliable control of computer cursors and simple artificial limbs. The tests are performed with non-paralyzed patients undergoing a pre-surgical epilepsy-diagnosis (cf. Figure 2). The electrodes used to measure the patients' brain activity are flexible multi-electrode grids placed on the surface of the patient's brain for about one week. Cables transmit the brain activity to an amplifier which transmits it to a laptop that runs our software. The software translates the activity into movement commands presented to the patient on a computer screen.

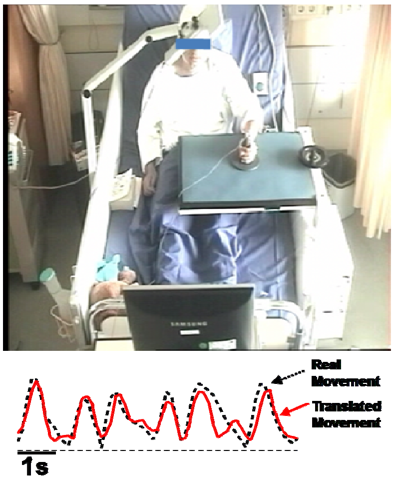

Figure 2: A patient undergoing epilepsy diagnosis has a multi-electrode array implanted onto the surface of his brain. Voluntarily he participated in our study (top). His arm movements (black dotted curve) could be reconstructed from his brain activity (red curve) (bottom).

Core project B:
Today the prototype is running in real-time and equipped with a number of advanced decoding algorithms. Core project B does focus performance and usability optimization.

Core project C:
The objective of core project C is to produce individually customizable prototypes which are optimized for the needs of a neural prosthetic device (instead of epilepsy diagnostics). A first series of those prototypes is finalized and is now tested in animals.

These key operations for the next 2 years are well funded. If successful, an additional funding in the range of € 2 million is possible. This funding is provided by federal grants in Germany.

---

[2] A survey of worldwide R&D activities on all approaches in the field performed by the US World Technology Evaluation Center organization (http://wtec.org/bci) has just been finished and is available online at http://www.wtec.org/bci/BCI-finalreport-Oct10-lowres.pdf.

Collaboration opportunities

The development is still in its early stages, and is mainly driven by scientists. Many challenges remain when it comes to commercialization and the development of medical products. Specifically, the team is looking for support in the following areas:

R&D partnership

- A brain-machine interface has the potential to drive all **electronically driven prostheses**. Thus, we look for partnerships with companies who are developing
    - alternative and augmentative communication devices
    - electronic arm- & hand prostheses
    - electronic wheelchairs
    - prostheses based on functional electric stimulation (FES)

- Currently, the decoding software is running on PCs. In medical products the software will be run on miniaturized **embedded systems**. Therefore, we look for companies with an appropriate specialization on embedded system technology.

Seed investment

- We are looking for investors to seed-finance our start-up company. The spin-off is planned for the beginning of 2010, and will be co-financed by public funds.

The Freiburg brain-machine interface team looks forward to hear from you in case you see an opportunity to support us.

Best regards,

Jörn Rickert

Partners of the Freiburg Brain-Machine Interface Initiative:

Albert-Ludwigs-University Freiburg

Bernstein Center for Computational Neuroscience

University Hospital Freiburg

Institute for Microsystem-technology Freiburg