EDAN - EMG-controlled Daily Assistant

Annette Hagengruber
German Aerospace Center
Institute of Robotics and Mechatronics
82234 Wessling, Germany
annette.hagengruber@dlr.de

Daniel Leidner
German Aerospace Center
Institute of Robotics and Mechatronics
82234 Wessling, Germany
daniel.leidner@dlr.de

Jörn Vogel
German Aerospace Center
Institute of Robotics and Mechatronics
82234 Wessling, Germany
joern.vogel@dlr.de

Neuromuscular diseases, stroke, or trauma can lead to a reduced neural function which severely inhibits limb functionality. If the disease is strongly advanced, people can't manage their daily life independently and become reliant on 24-hour care. In this situation, assistive technology, like a robotic manipulator mounted on a wheelchair, can provide help and relief. However, control of such a device is usually achieved with a joystick, which requires to have remaining functionality in hand and finger movement. This prevents many people with tetraplegia from efficient use of such assistive technology. An alternative to the joystick, is given by Brain-Computer Interfaces. It has been shown that non-invasive interfaces like Electroencephalography can be used to achieve control over low-dimensional devices like power wheelchairs [3]. More complex tasks like control of assistive robotic devices have been demonstrated with invasive interfaces, like the BrainGate Neural Interface System [1].

We investigate the use of surface Electromyography (EMG) as an interface for assistive robotic devices. It is a comparably cheap and easy to apply technology. We could show that people with tetraplegia due to a severe Spinal Muscular Atrophy (SMA), can still achieve control over a robotic manipulator (e.g. drinking from a bottle) by recording remaining muscular activity [4].

To investigate the use of EMG as an interface to assistive technology, we developed the research platform EDAN (EMG-controlled Daily Assistant). It consists of a robotic manipulator mounted on a state of the art power wheelchair. We use a torque controlled robotic arm (DLR-LWR 3), which is well suited for safe physical interaction with humans and the environment. The five-finger hand mounted on the robotic arm allows for stable grasping of a variety of everyday-objects. The focus of our research is twofold. On the one hand, we investigate the use of EMG as a non-invasive interface to provide people with control over assistive systems. On the other hand, we develop methods to simplify the usage of such systems with the support of artificial intelligence.

Manual control of robotic manipulators is rather slow and cumbersome, especially when controlled with a noisy interface like a BCI. Artificial intelligence can help to significantly improve the usability of such systems. A shared control approach, based on the combination of computer-vision, cognitive reasoning and machine learning, can provide support in task execution. In our opinion, the user should always be in control of the robot. Therefore, the actions that are performed partly autonomously by the robot need to be transparent and predictable to the user. To achieve this, we will apply task specific motion constraints based on a knowledge base, which holds information about objects and possible activities they afford [2].

Figure 1: EMG-based Human-Robot Interaction with EDAN (demonstration with non-disabled person).

This video submission showcases the current state of our research platform. EDAN is completely mobile which allows us to test it in the users home environment. The user can switch between control of the robot or the wheelchair, at any time. Using EDAN, we will test, extend and refine the capabilities of our EMG-based interface and the AI-support.

1. REFERENCES

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