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Innovative
Assistive Technology Solutions

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KI-I - Foundation and Background

Objective: Improving the life situation of people with disabilities and older people due to the use of information and communication technology (ICT)

Foundation: 2003

Form of organisation: Non-profit research organisation

Location: Johannes Kepler University of Linz

Supporting Organisations:

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Main focus and research areas

Main focus:

- Research and development
- Education and know-how transfer
- Consulting

Research areas:

- Technology for People with Disabilities
  - Information and communication technology (ICT)
  - Assistive Technology (AT)
  - Smart Environments and Environmental Control
  - Accessibility and Usability of modern IT (Web- and Software Design, etc.)
  - Design for all
- Translation into Easy-to-Read
- Quality evaluation of social service providers by peer

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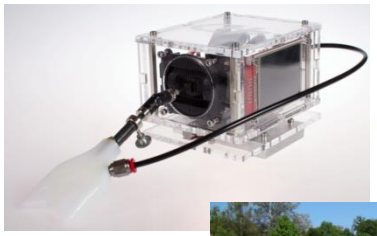
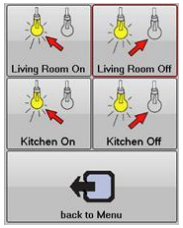
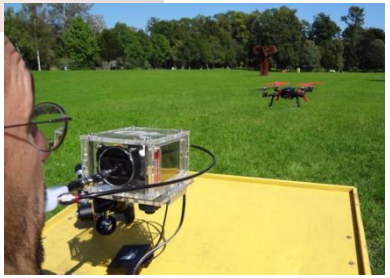
Activities and Reference Projects

- **Research and Development Projects in the Area of ICT for People with Disabilities**
  - Regional, national und international
    - AsTeRICS - Assistive Technology Rapid Integration and Construction Set — www.asterics.eu
    - Prosperity4All – Access to ICT for all — www.prosperity4all.eu
    - 4D-Joystick — www.ki-i.at/4djoystick
    - …







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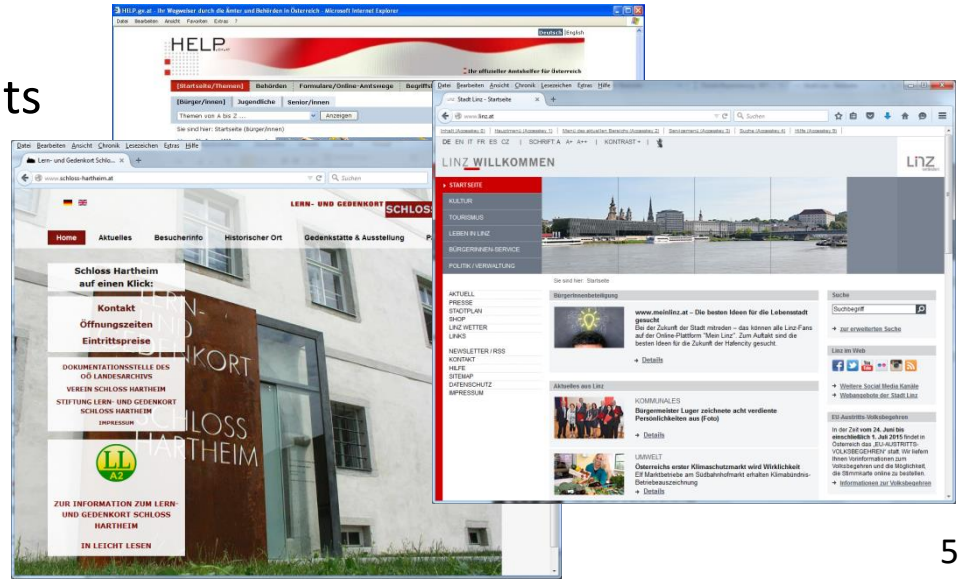
Activities and Reference Projects

- **Accessible Web-, Software- und Document Design**
  - Accessible Web Design (Consulting, Project Support and Evaluation)
    - Federal Chancellery of the Republic of Austria — www.help.gv.eu
    - Federal Ministry of Finance — www.bmf.gv.at
    - Magistrate of Linz — www.linz.at; www.lentos.at
    - Learning and Memorial Site Schloss Hartheim — www.schloss-hartheim.at
    - A-Trust GmbH — www.handy-signatur.at
    - …
  - Accessible Documents
    - Government of Upper Austria
    - capito-Network
    - …



MOUTHSTICKS

Introduction

- Persons with severe physical disabilities (limited or no hand control) often use mouth- or headsticks to handle things
  - Typing on computer keyboard
  - Handle a computer mouse
  - Using Smart Phones, Tablets
  - Turning pages of a book
  - Etc.
- Problem: Grabbing of things

Some Mouthstick Application Domains …

- Video

Project RaProErgo

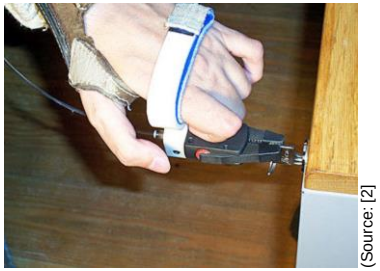
- Rapid Prototyping in the domain of Occupational Therapy
  - Use of high-tech production techniques like 3D-printing
  - Use of high-tech materials like compound-materials (GFK, CFK)
- Methodology: Participatory Design
- Interdisciplinary Team
  - Users
  - Occupational therapists
  - Polymer engineers
  - Computer scientists
  - Orthopaedic technicians
  - 3D-printer developer
  - Ethics and gender studies researcher.
- Main focus on Mouthsticks

Grabbing of Things - State of the Art

- Hand Orthosis controlled by EEG, EMG, other signals


(Source: [1])

- Hand mounted grippers (e.g. pneumatic) controlled by special switches: e.g. Gripability


(Source: [2])

- Low tech solutions mechanically handled (e.g. with tongue): e.g. Pincer Mouthstick


(Source: [3])

Grabbing of Things – The Solution?

- Small and lightweight (~ 8g) pneumatic grippers are available off-the-shelf (used in industrial production or automation)

- How can be used such grippers for mouthsticks?

The Prototype Gripper-Mouthstick

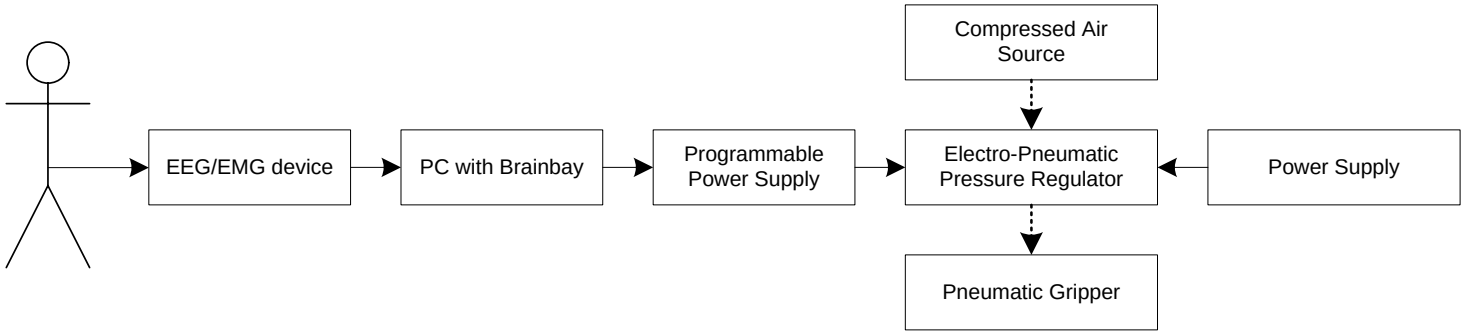
- A carbon fibre mouthstick equipped with the pneumatic gripper FIPA GR04.090
- Weight: 68g

The Prototype Control System

- Compressed Air Source: 1.5 litres 232 bar compressed air cylinder with a cheap 1st stage scuba dive regulator
- Pneumatic devices: Electro-pneumatic pressure regulator, pressure regulator, 3port solenoid valve
- EMG capturing: modified low cost EEG – *modularEEG*
- Open source software Brainbay for acquisition and processing of the bio signals
- Programmable power supply Array 3645A for controlling the pneumatic devices

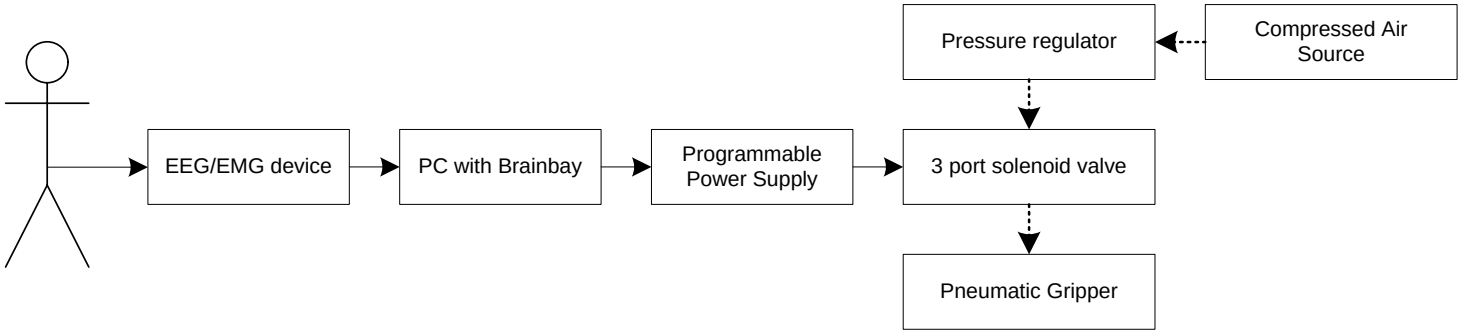
Approach 1

- Control of the gripper proportionally to the EMG signal
  - Input signal for the electro-pneumatic pressure regulator (*SMC ITV 2050*) is created proportionally to the EMG signal
  - Result: The air pressure and the closing force of the gripper directly correspond to the current muscle tension.



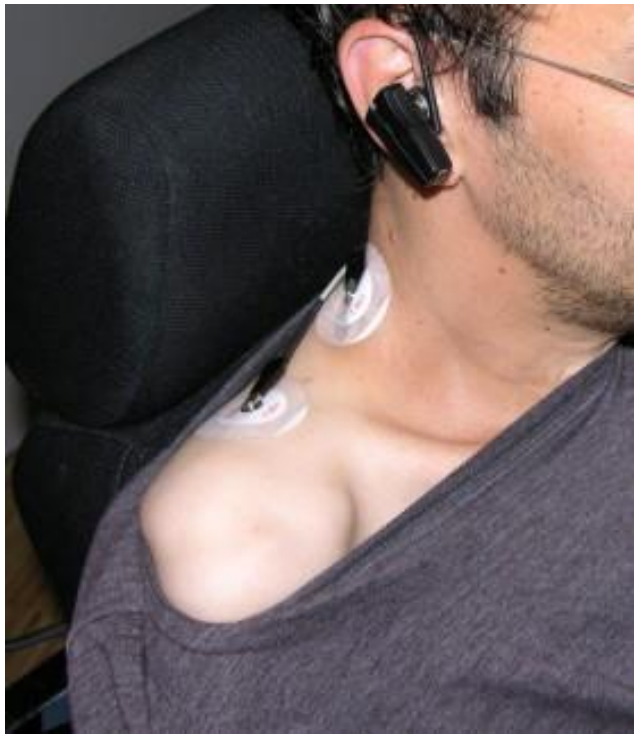
Approach 2

- Control of the gripper according to a threshold of the EMG signal
  - If the EMG signal reaches an adjustable threshold, the 3 port solenoid valve (*SMC V100*) is activated
  - Result: The gripper will close with a force which is independent from the signal and which is predefined by the air pressure (regulated with the regulator *SMC AR10*)



User Test – Test Setting

- The EMG signal was recorded using standard self-adhesive electrodes placed on the skin of the user to record activities of the musculus trapezius.
- Shielded cables were used to connect the electrodes to a *modularEEG* unit.



User Test – Signal Processing

- Raw EMG signal was bandpass filtered from 80Hz to 100 Hz using a Butterworth filter pair of order 4.
- The passband magnitude was calculated and averaged in a time window of 0,25 seconds to reduce jitter and to get a reliable control signal.

Test of Approach 1

- The amplitude of the processed EMG signal was mapped onto a millivolt-scale and transferred to the programmable power supply *Array 3645A* to control the electro-pneumatic pressure regulator.

- Advantage of this approach is full control of the gripper.
- Disadvantages:
  - Main-disadvantage is that the gripper opens slowly with a short delay of approx. 1sec, caused by the control hysteresis of the electro-pneumatic pressure regulator.
  - This approach has a slightly higher pressure air consumption than approach 2

Test of Approach 2

- With the help of an threshold a binary control signal was generated out of the processed EMG signal. By using a state machine element, the alternation from 0V to 24V and vice versa could be triggered by the binary signal.
- Advantage of this approach:
  - The possibility to close the gripper by one short muscle action and to open it with another
  - The gripper opens immediately after the muscle tonus is released
  - Less air consumption than approach 1.

Conclusion

- The experiments done have shown that the control of the pneumatic gripper via EMG signals is feasible and works well.

- → **Priming for AsTeRICS** ☺

4D-JOYSTICK

Problem/Motivation

- Playing with other children fosters social skills
- Hardly existing accessible off the shelf toys for children
- Adaption of the toys leads to warranty loss

Available Accessible Toys

- Mostly cause and effect toys using a single switch






State of the Art

- Cole Galloway adapted small motor driven toy cars with a switch
- Archimedes project Hawaii adapted toys mostly with switches
- BCI controlled quadcopter (Parrot AR.drone) by Karl LaFleur from University Minnesota

Why RC-toys

- Existing solutions not accessible
- The original product needs no adaption
- User doesn‘t loose warranty
- User can buy off the shelf toys

First Approach …

- https://www.youtube.com/watch?v=Tuob5hgLlnc

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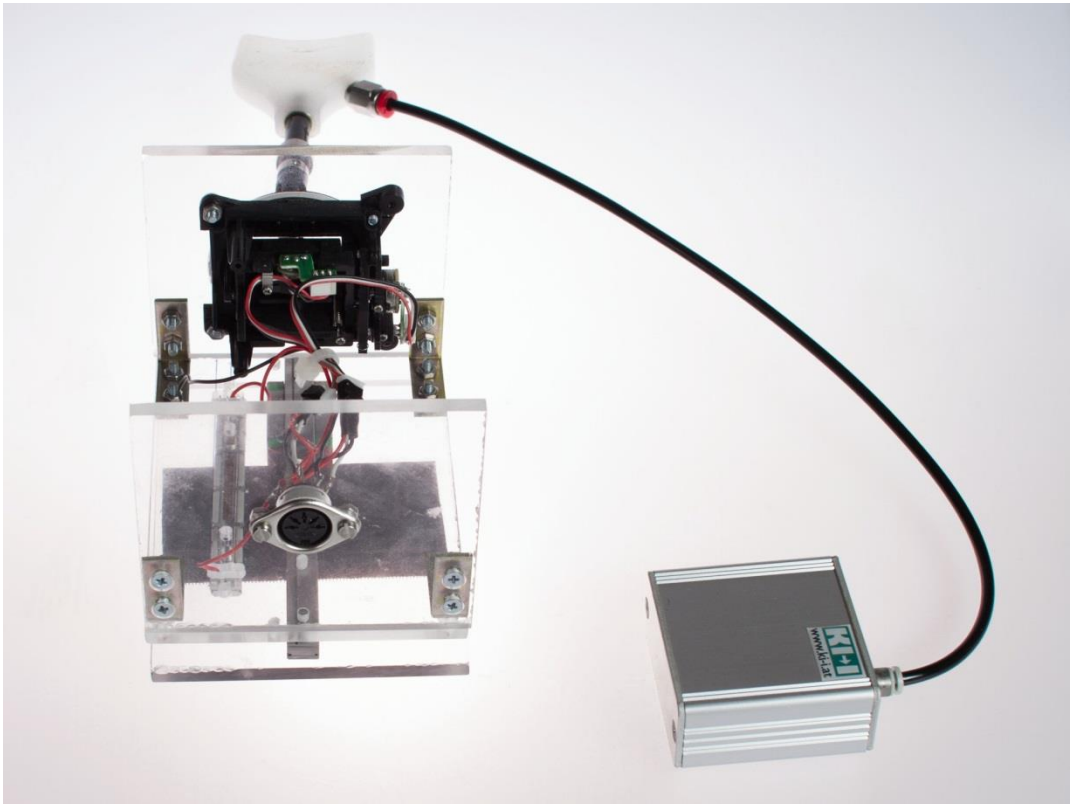
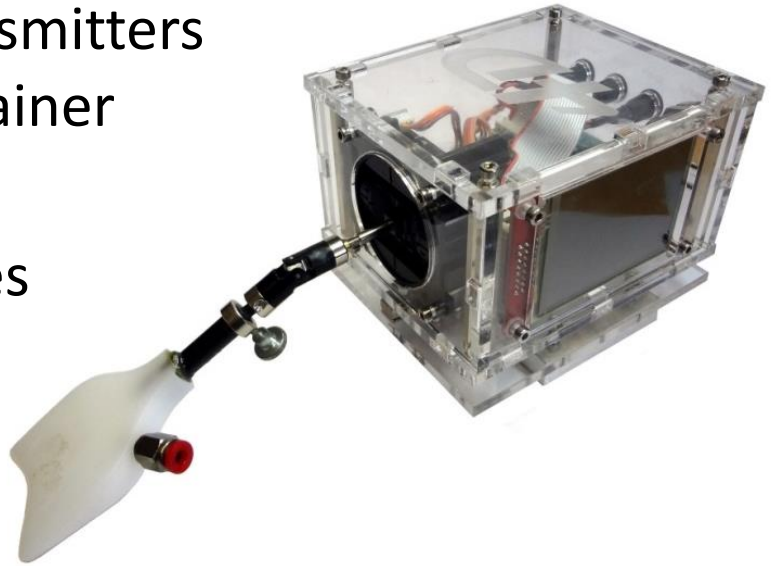
Feasibility Study – Some Impressions



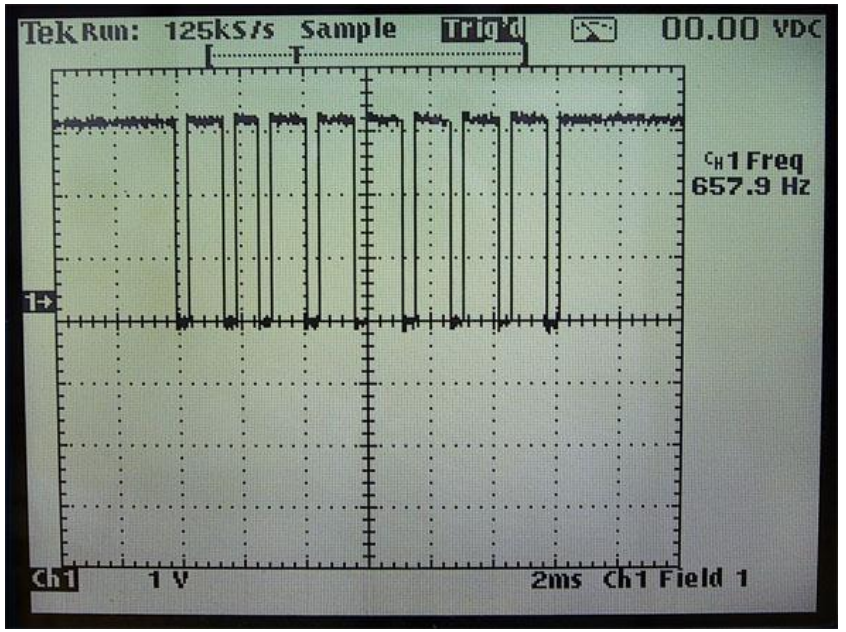
4D-Joystick: Features of the Prototype

- Full control of all kind of remote controlled models (helicopters, airplanes, multirotors, cars, boats, …)
- Up to 8 control channels (4 analogue, 4 digital)
- Compatible with PPM transmitters and remote controls via trainer jack
- Storage for 6 model profiles
- Supports dual rates, expo, dead zone, invert
- Configuration via PC software or with the touch screen
- Interface to open source software AsTeRICS



Transmitter

- µController reads sensor values and generates a corresponding PPM – Signal
- All advanced RC radio transmitters have an input for a slave transmitter (Trainer/DSC jack)



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4D-Joystick to RC-Model

Using the Prototype …

- https://www.youtube.com/watch?v=4ycVIx42yH4
- https://www.youtube.com/watch?v=2gLIylfM6uc
- https://www.youtube.com/watch?v=7BHpfYARd_g
- https://www.youtube.com/watch?v=0Xkw79xoiYg

Conclusion

- 4D Joystick allows fast and very precise input
- User has lots of fun using it ;-)
- Next steps:
  - Experiment with GPS and auto-wheelchair rotation systems
  - Creating a user group with cooperation of a big RC-vendor and local RC-club
  - 4D Joystick as PC-HID input device

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Thanks for Listening!

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