



# AsTeRICS Workshop





**Benjamin Aigner**

R&D

Embedded Systems Software  
Embedded Systems Hardware



**Veronika David**

R&D, Lecturer

Rehabilitation Technology  
Assistive Technologies



**Martin Deinhofer**

R&D, Lecturer

Rehabilitation Technology  
Software Design



**Angelina Kratschanova**

Internationalisation

Organisation Summer School  
Networking



**Christoph Veigl**

R&D, Lecturer

Embedded Systems Software  
Project Manager

# Agenda

## for the AsTeRICS Workshop in Prague, 6.5.2014

- Introduction: The University of Applied Sciences Technikum Wien
- Overview of ongoing Research with focus on the areas of Embedded Systems and eHealth
- AsTeRICS – System Overview
- The AsTeRICS Academy Project
- Ongoing engineering work and User Cooperations
- **Afternoon:**  
Hands-On workshop with tasks in small groups

# Fachhochschule Technikum Wien

## University of Applied Sciences Technikum Wien

- Vienna's first University of Applied Sciences and Austria's biggest University of Applied Sciences for technical studies
- Founded in 1994
- Austria's first University of Applied Sciences implementing the Bachelor/Master system
- Currently 12 Bachelor and 17 Master Programs
- About 4.300 graduates and 3.000 students
- Approximately 500 full- and part-time staff







University of Applied Sciences (UAS) Technikum Wien – Hoehstaedtplatz and ENERGYbase

# Bachelor's Degree Programs

## Full time & part time

### Full time

- Biomedical Engineering
- Computer Science
- Electronic Engineering
- Transport and Environment
- Mechatronics/Robotics
- Sports-Equipment-Technology
- Urban Renewable Energy Technologies

### Full time & part time

- Business Informatics

### Part time

- Electronics & Business
- Information and Communication Systems & Services
- International Business Engineer

### Distance Studies

- Electronics & Business
- Business Informatics

# Master's Degree Programs

## Full time & part time

### Full time

- Biomedical Engineering Sciences
- Game Engineering and Simulation
- Healthcare-  
and Rehabilitation Technology
- Intelligent Transport Systems
- Multimedia and Software Engineering
- Sports-Equipment-Technology

### Full time & part time

- Mechatronic/Robotics

### Part time

- Information Systems Management
- Embedded Systems
- Environmental Management  
and Ecotoxicology
- Industrial Electronics
- Information Management and IT Security
- Innovation and Technology Management
- International Business Engineer
- Renewable Urban Energy Systems
- Telecommunication  
and Internet Technology
- Tissue Engineering  
and Regenerative Medicine

# International Relations

## Knowledge is Mobile – Mobility Brings Knowledge!

- Center for International Relations:  
[international@technikum-wien.at](mailto:international@technikum-wien.at)
- 68 international partner Universities in 29 countries worldwide
- Eurasia Pacific Uninet member
- Joint Degree and Double Degree programs
  - Parts of study program at each partner
  - Distance Learning
  - Linköpings Universtet
  - Kharkiv National University of Economics (DoubleDegree: MSc + MBA)
  - RMIT Australia (Ph. D. cooperate)





# International Relations

## Multiple Degree Program with Technical University Prague and Linköpings Universitet



- Earn multiple Master degrees in less study time
- Collective development of curricula
- FHTW: Intelligent Transport Systems, Emil Simeonov
- CVUT: Faculty of Transportation Systems, Ing. Zuzana Belinová, Ph.D., Department of Control and Telematics
- Since 2007
  - Ca. 20 students of FHTW already graduated
  - 6 students of CVUT came to Vienna,  
3 students of Vienna went to Prague
- One triple degree student

# Our R&D – Main Areas

- Embedded Systems
  - Automotive Industry
  - Ambient Assistive Technologies
- eHealth
- Tissue Engineering
- Renewable Energy



# Some selected research projects

from the departments  
Biomedical Engineering and  
Embedded Systems

# Department of Biomedical Engineering

## Research focus eHealth

- Interdisciplinary R&D focus
- Cooperation between several departments: D.BME, IES, INF, ...
- Focus on standardized data communication
- Participating Test events

## Ventilation (related to eHealth)

- EL-BiK\* / Alveo PiC\* (coop. TU-Brno)

## Rehabilitation (related to eHealth & Embedded Systems)

- eSHOE\* / MISTRAAL\* (coop. SEB / NRZ / CEIT / MUW)
- AsTeRICS Academy\* (coop. ES)

\*...funded project.

# Research Focus eHealth

- The research group “eHealth” at UAS Technikum Wien emerged out of the “Healthy Interoperability” research project from the year 2009 on
  - Focus on standardized data communication in healthcare
- eHealth is an interdisciplinary R&D focus
  - Cooperation between several departments
- Development of working software prototypes
- Scientific research in **funded projects**
- R&D projects with **industry partners**
- Provide the generated knowledge for students and to industry





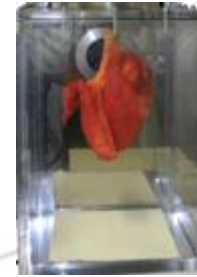
# Projects so far



CDA implementation guidelines for ELGA



Sharing of medical records across Europe



AlveoPic extracorporeal nutrition system project\*



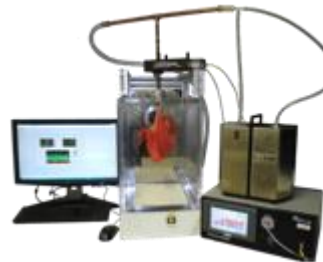
eLearning4eHealth Network (eHL)\*



OID repository for the Austrian healthcare system



EI-BiK lung simulation project\*



Terminology server for the Austrian healthcare system



\*...funded project. See next slide

# eHealth – Participating Test events

- Hosting of the Connectathon 2009
- Development of an Android App for telemedicine  
- with this App participating at Plugfest 2012
- Participating Connectathon 2013
- Monitors at connectathon 2014



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# MISTRAAL - Mobile Instrumented Stroke Rehabilitation in AAL

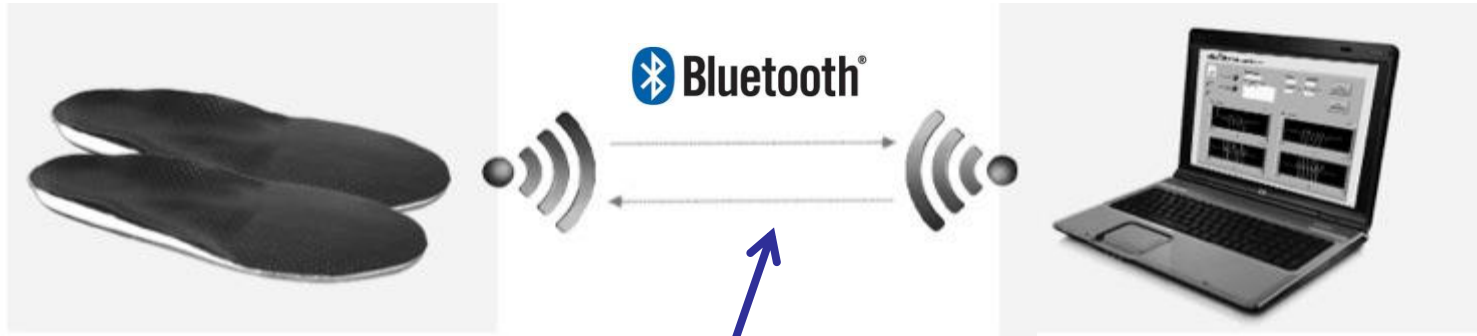
- Further Development of wearable instrumented insoles for mobile gait analysis (eSHOE)
- Aspires an automated estimation of the gait quality of stroke patients
- Support of rehabilitation in the domestic area
- Preservation of mobility and independent lifestyle
- Sept. 2013 – Aug. 2015
- Partner
- Funded by



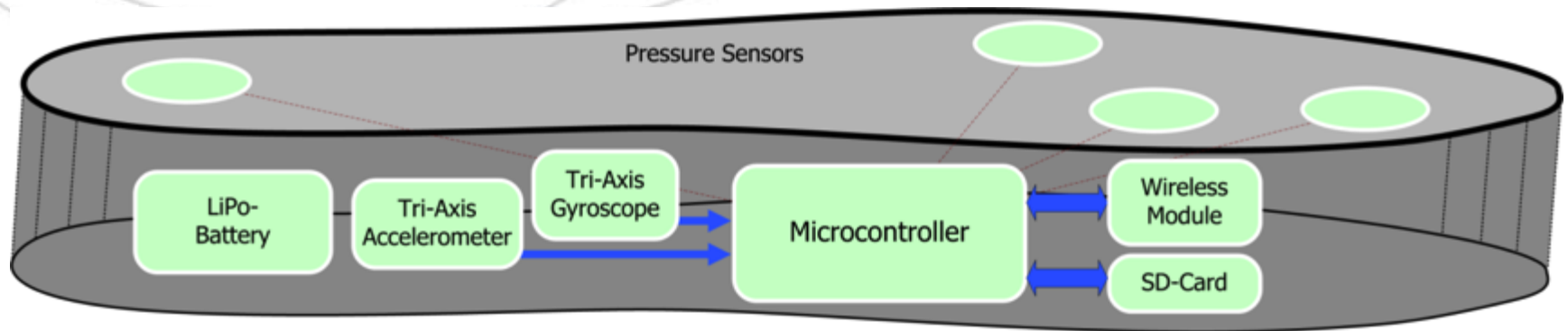
FFG

programm  
*benefit*

# Instrumented insole – concept



**Standardization**



# Department of Embedded Systems

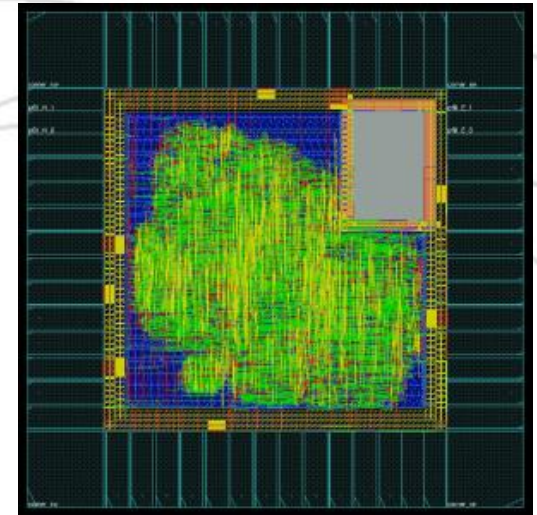
## ■ Embedded Core Topics

- Debugging of Embedded Systems and Field Bus Systems
- Formal Verification and Dependable Systems
- Time-Triggered Architectures
- MultiCore Architectures
- ASIC & System-On-Chip Design

## ■ Applications

- Automotive Electronics
- Assistive Technologies
- Smart Homes, Ambient Assisted Living

- Currently 9 national and international ongoing research projects



„TW-ASIC“: customized mc8051  
with integrated test logic



# moduLAAr

- Research project with Austrian partners
  - Austrian Institute of Technology
  - User Partner Organisations
- Combination of AAL and eHealth
- About 50 apartments for senior citizens
- One server + home automation each apartment building
- Mobile end-user devices
- Photo sharing, food order, health data records, ...

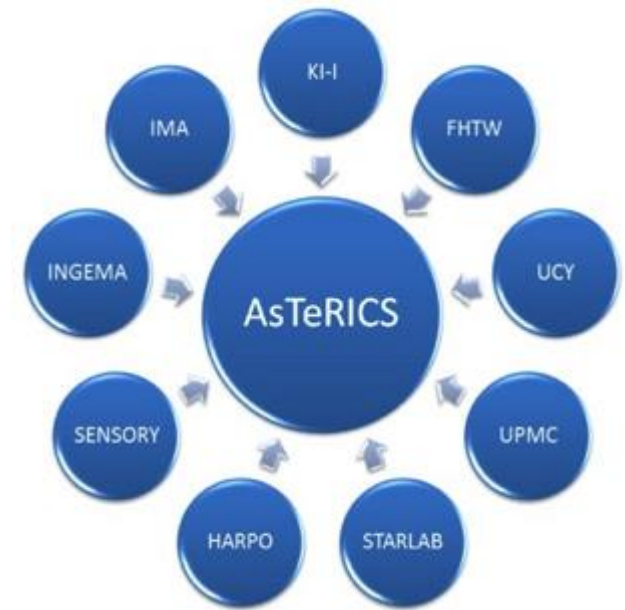


# The AsTeRICS Project

FP-7 funded EU-STREP-Project  
2010-2013

# AsTeRICS – Assistive Technology

- **2.6 million people** across Europe have problems with their arms or hands (**Eurostat 2005**)
- Several smaller groups with very severe motor conditions:
  - Quadruplegia, Cerebral Palsy, Stroke
  - Amyotrophic lateral sclerosis (ALS)
  - Multiple sclerosis, Muscular Dystrophy
- Flexible Assistive Technologies can increase autonomy and participation in the social life
- AsTeRICS Project with 9 European Partners partially funded by European Commission under the 7th framework programme (ICT, 2010-2013)

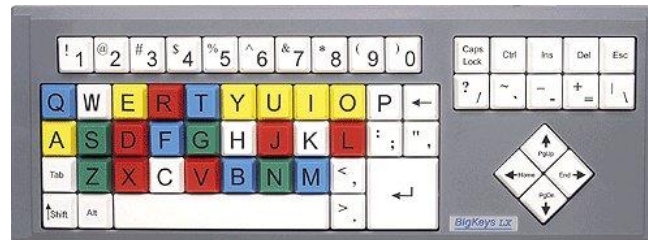


# Conventional AT input devices

- Special Buttons, momentary Switches
- Special Input Devices  
(Analog Joysticks, Trackballs, Big Keyboards)
- Augmented Alternative Communication Devices (AAC)



<http://www.gokeytech.com/>



BigKeys LX, <http://www.bigkeys.com>



[www.infogrip.com](http://www.infogrip.com)

# Problems of existing AT-solutions

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## Common problems of „off-the-shelf“ Assistive Solutions:

- **often optimised for particular application** and / or small target group, thereby expensive
- **limits of adaptability** or unaffordable costs of the necessary adaptations

## Consequences:

- Some people with disabilities are not as independent as they could be with **individually tailored** Assistive Technologies

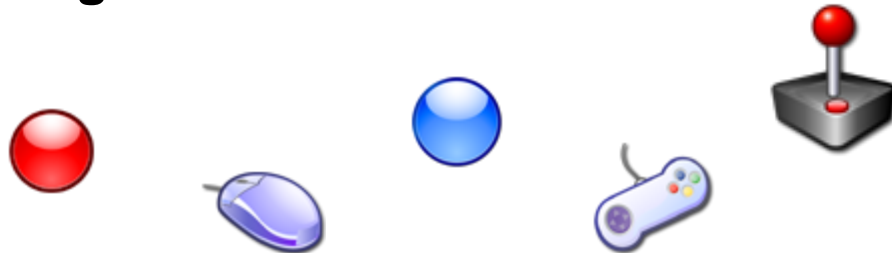


AsTeRICS provides a **flexible and affordable construction set** for user-driven Assistive Technologies (AT)



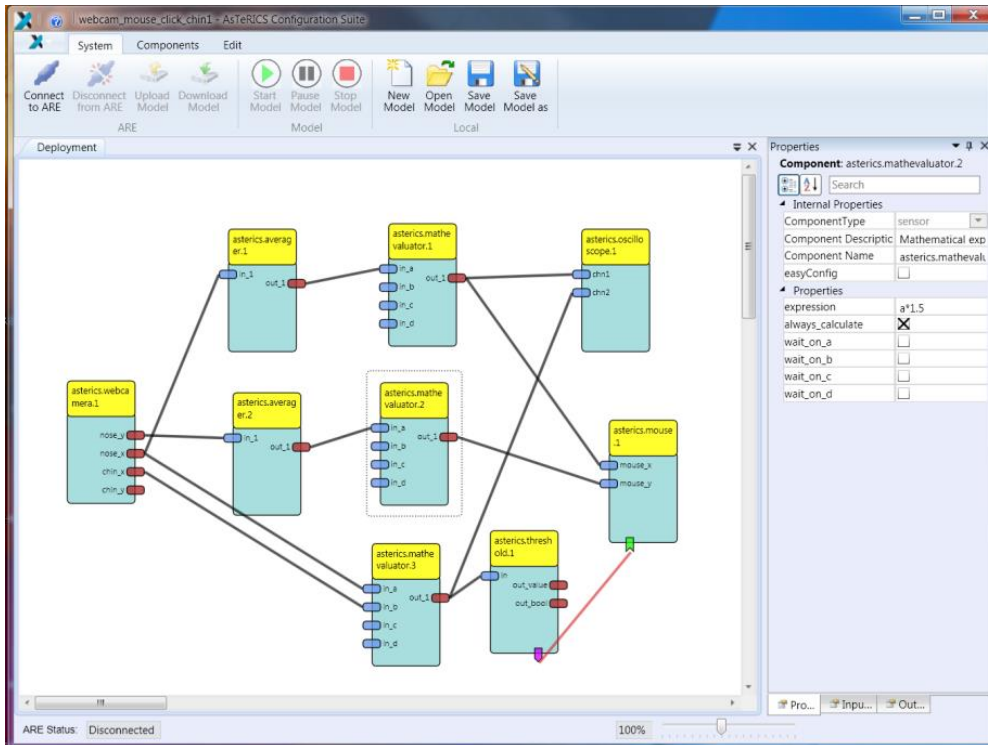
**Sensors and actuators** can be connected via an embedded computing platform

A software suite offers the interface for **graphical set-up and configuration**



## AsTeRICS Configuration Suite

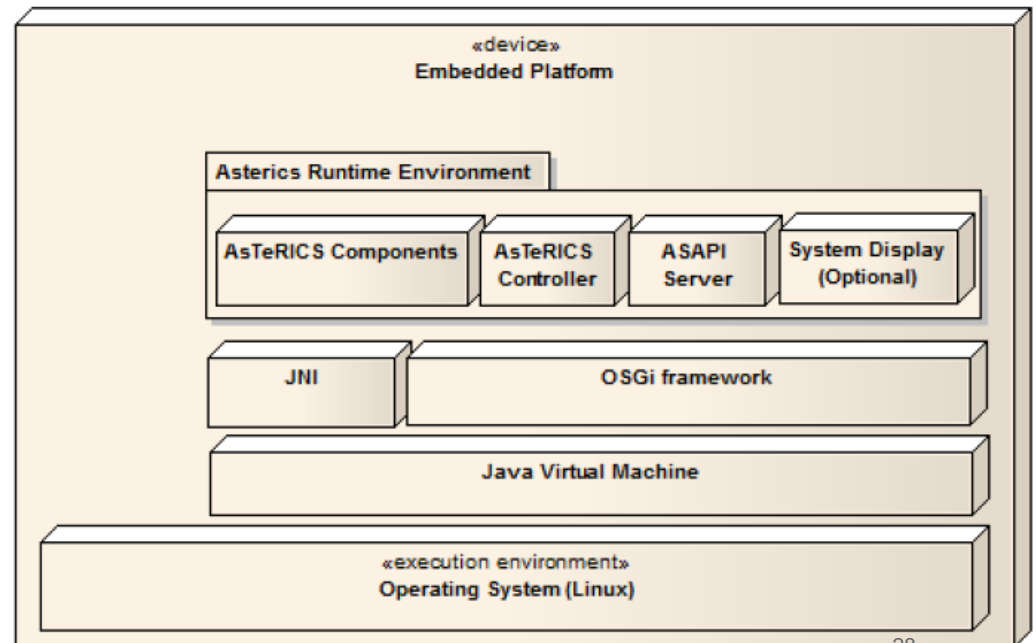
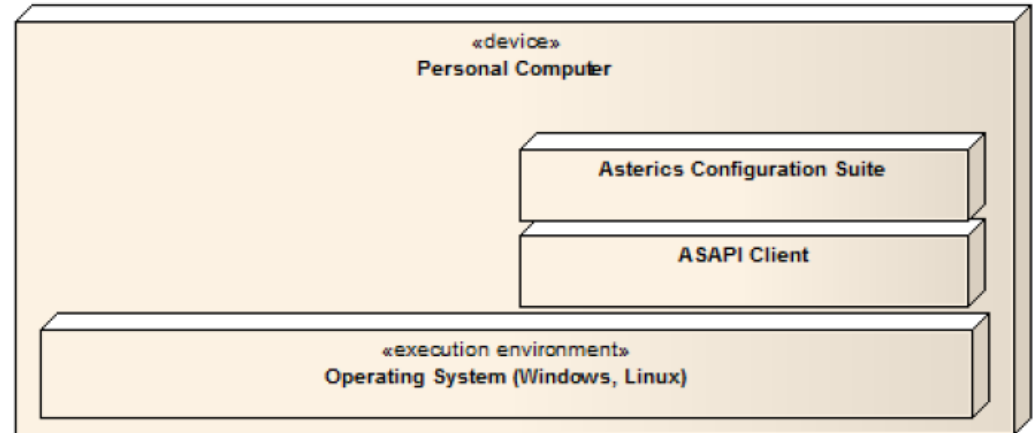
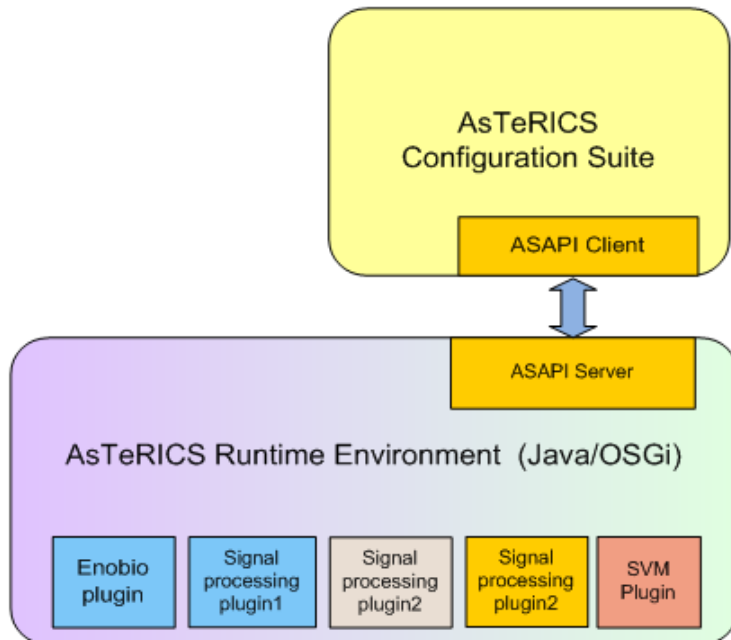
- Connection and Parameterization of plugins
- Upload / Download models to ARE (TCP)



- Cut / Copy / Paste / Group
- Integrated Help System
- GUI designer for GUI plugins

# AsTeRICS Architecture

- AsTeRICS Configuration Suite (ACS) is written in C# and runs on Windows PC
- AsTeRICS Runtime Environment (ARE) is written in Java/OSGi, uses JNI / C++ native code for OpenCV, HW access etc.



## Hardware modules for input/output:

- Digital input, digital output
- Analog Input
- GPO
  - Open collector outputs
  - Relais switch connectors
- Modules can be connected to any PC/Laptop via USB



## Hardware modules for input/output:

- Wireless 3-axis accelerometer
- ZigBee wireless modules
  - Digital output switch for AC/220V
  - Digital input (binary switches)



## Universal HID actuator

- Emulates Mouse, Keyboard and Joystick (USB HID protocol)
- Connects wirelessly to AsTeRICS ARE (via Bluetooth)
- Any input combination can be mapped to the HID device functions
- No SW-installation on target device needed (PC, Mac, Linux, PlayStation..)





## AsTeRICS Personal Platform:

- Embedded PC with small form factor
- Direct connection of Buttons, Sensors
- External Interface Modules for additional connectivity
- LCD-Touchscreen
- Module container for up to 3 modules available



## AsTeRICS Personal Platform:



All IMA-produced HW-modules are available for purchase via



[http:// asterics.harpo.com.pl](http://asterics.harpo.com.pl)



About Harpo

About AsTeRICS

Hardware

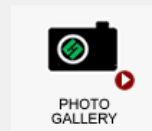
Resources

Contact

## About AsTeRICS

AsTeRICS - versatile connectivity for any person with disabilities

- ✓ control your home appliances
- ✓ control PC or mobile phone
- ✓ play games
- ✓ use one of many sensors
- ✓ use your mind with Brain Computer Interfaces
- ✓ adaptable
- ✓ flexible



AsTeRICS: Assistive Technology Rapid Integration & Construction Set

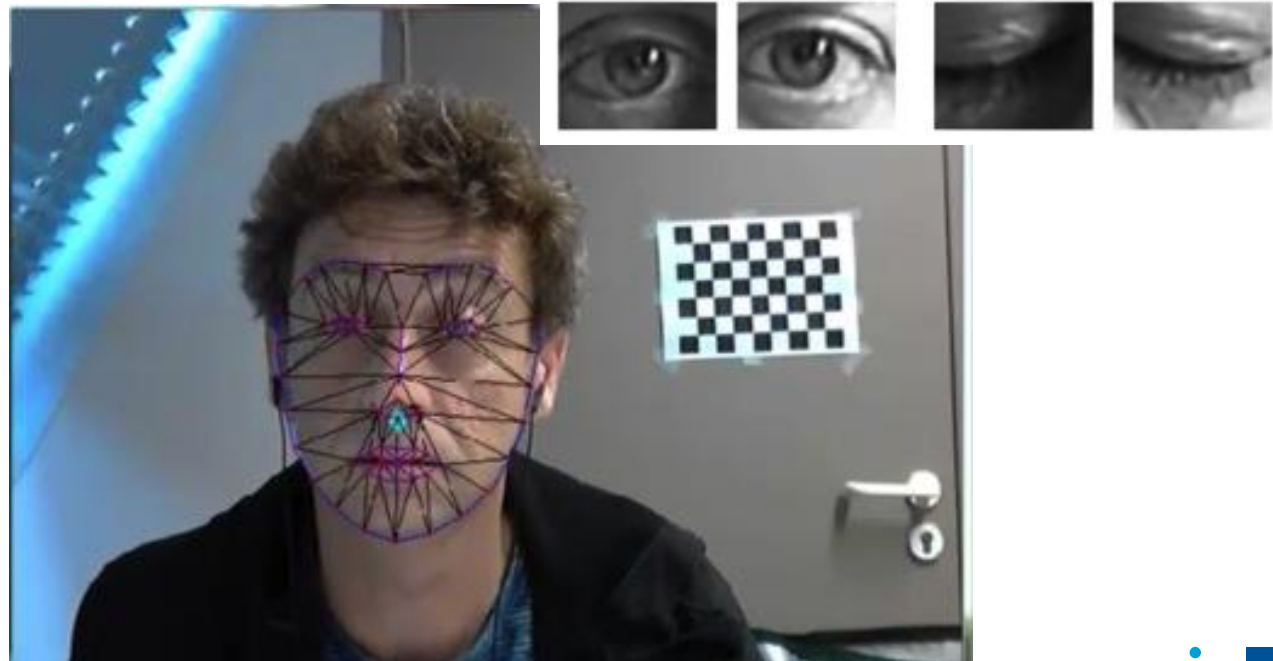


OSKA on-screen keyboard, Scanning; <http://www.oskaworld.com>

- Different Scanning variants (row/col/key)
- Selection controlled by any sensor
- Graphical Grid Editor
- Word prediction, multilingual dictionaries
- Communicator functions (speech output, mobile phone control)

## Remote (webcamera-based) and Head Mounted Feature tracking

- Face detection and feature alignment, EyeState/blink detection
- Facial feature detection (eyebrow movement, mouth open/closed)
- Constrained Local Models + Template Matching for eyestates



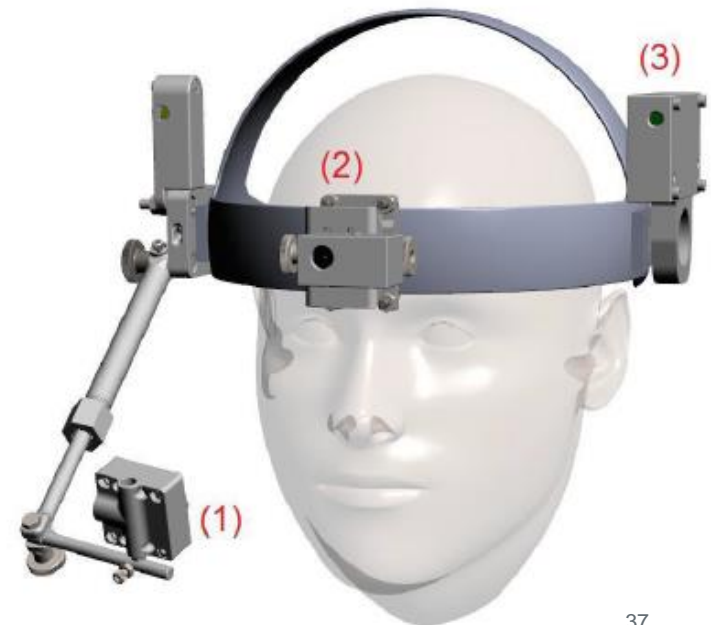


# Computer Vision Support



- Low-cost Gaze-Estimation solution
- Full mouse cursor control
- Uses IR-supported pupil-tracking and Inertial Measurement via Microcontrollers

- 1: Eye Camera (Webcamera with IR-support) uses OpenCV for pupil tracking
- 2: Scene Camera for screen tracking
- 3: Microcontroller with IMU and other sensors





## AsTeRICS-Eyetracker Accuracy evaluation:



- Abotic Door Opener Integration
- KNX / FS20 standards
- Connected via the GPIO module
- HiFi / Stereo / DVD / TV via Infrared
- Pneumatic Gripper actuator for mouth sticks



- complete input flexibility via desired sensors and on-screen-keyboard grids / scanning

# Phone & GSM Integration

- Windows Mobile and Android Smart Phone support
- Make / Accept Calls, Send / Receive SMS
- GSM USB Modem Integration
- Usage of Smart Phone as Sensor (e.g. Accererometer) or configurable Touch Pad (multitouch / gestures)
- On-Screen-Keyboard with scanning for Android



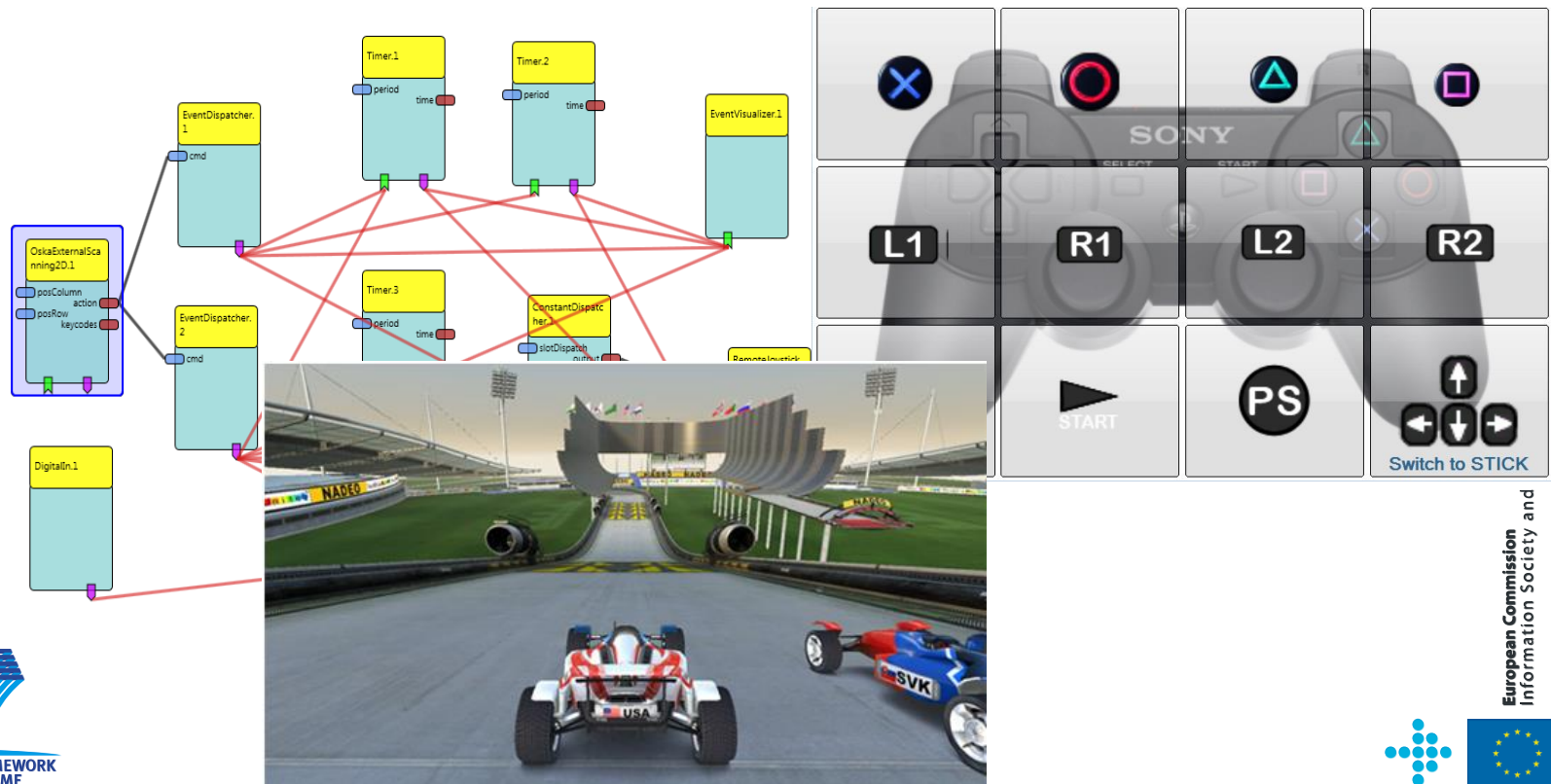
## Control of a toy helicopter by a tetraplegic user

- Infrared control command generation by IR-module
- Integration of the wheelchair's bluetooth joystick (via mouse capture plugin)
- EMG or Sip/Puff sensor for controlling up / down
- 4 degrees of freedom



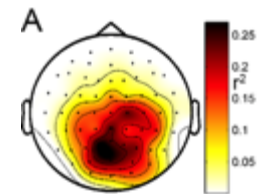
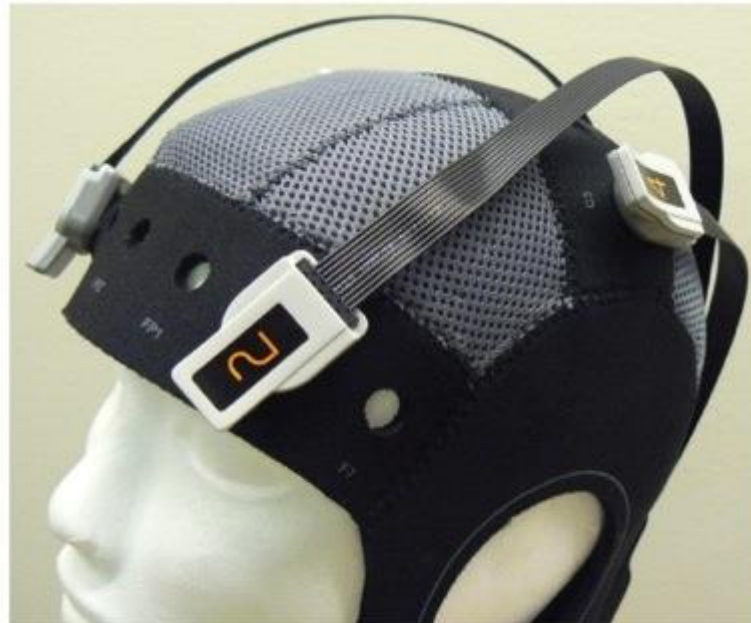
# Accessible Toys / Game Control

- HID actuator emulates Playstaion-3 SixAxis controller
- Dedicated models for controlling Racing games or Adventure games using different input modalities and devices



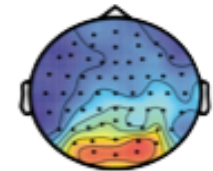
## Enobio EEG/EMG

- Wearable, wireless design (ZigBee)
- Active electrodes
- Flexible mounting cap
- Plugins for SSVEP, Eye-blink detection, EMG activity
- BNCI evaluation suite (Matlab, P300 / EPR)



p300

15.00 Hz



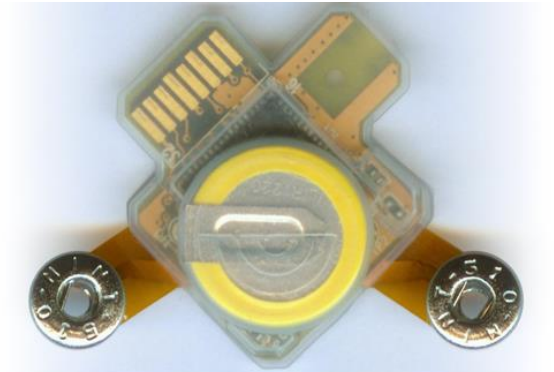
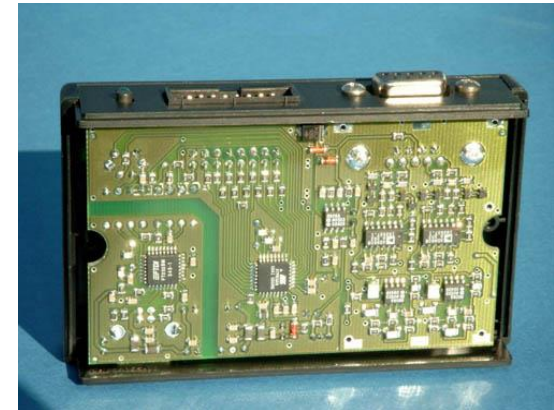
SSVEP





## LowCost biosignal acquisition

- OpenEEG / ModularEEG (6 chn)
- Small USB-powered 2 channel version (MonolithEEG)
- EMG / ECG / EOG / EEG
- OPI Innovation TrueSense Exploration Kit
  - wearable ZigBee Sensor
  - EEG, EMG, EOG, ECG
  - accelerometer
  - onboard memory (1 hrs recording)
  - realtime clock



1 cm

2 cm

3 cm

4 cm

# User Evaluations and Results

- Heterogeneity of patients
  - cerebral palsy, spinal cord injury, muscular dystrophy, spasticity, spastic tetraplegia, Friedreich ataxia, multiple sclerosis, spinal muscular dystrophy, stroke, traumatic brain injury, amyotrophic lateral sclerosis, and Parkinson disease
- Strategy for 1st prototype: As many users as possible (> 50)
  - qualitative data of user satisfaction
  - Interactions with multiple users with different diagnoses
- Strategy for 2nd prototype: less users, more time and trials
  - More time to find out suitable sensors / combinations
  - Training and model adaptations are possible
  - Quantitative results (training progress)

# User Evaluations and Results

## Smaller User groups for 2<sup>nd</sup> Prototype evaluation:

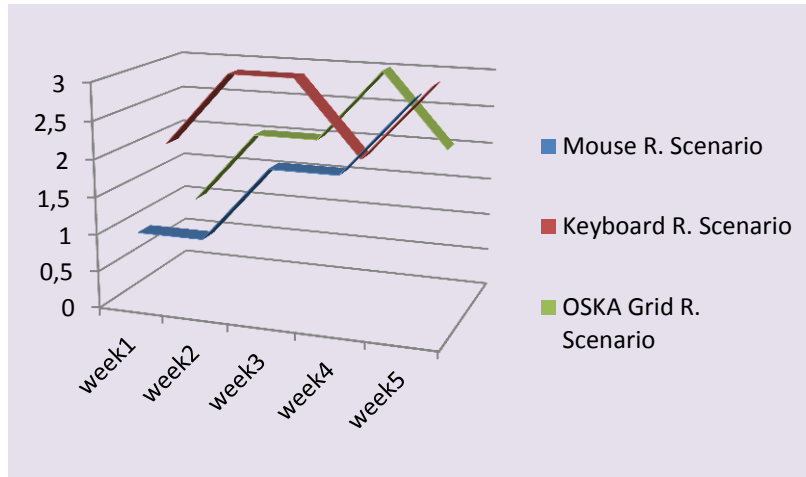
Country	Austria (n=3)	Poland (n=3)	Spain (n=5)	Total (n=10)
Profile				
Cerebral Palsy	1	1	1	3
Parkinson or similar	0	0	1	1
Multiple sclerosis / Amyotrophic Lateral Sclerosis	0	1	1	2
Spinal Cord Injury	1	1	1	3
Friedreich Ataxia and other conditions.	1	0	1	1

# User Evaluations and Results

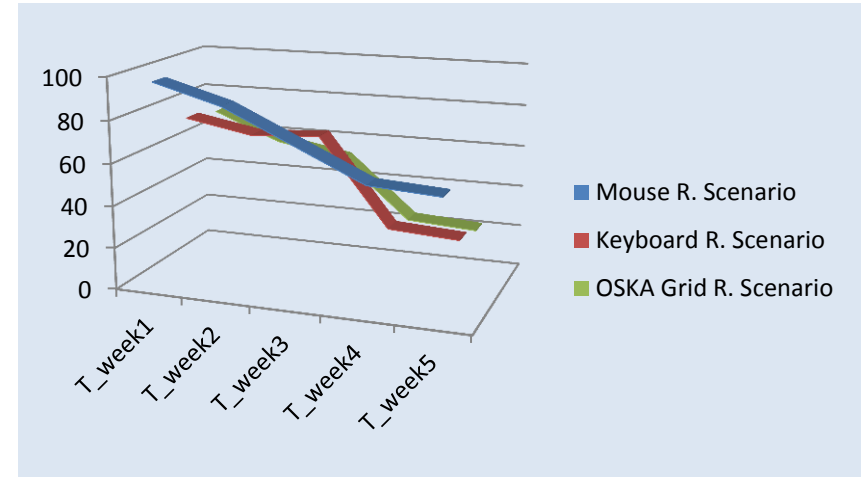
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- Based on the profile selected, several models were be created
- The user tested the system by means of specific tasks
  - Mouse control
  - Writing sentences via On-screen keyboard
  - Performance in gaming
- The models were adapted on site to optimize the usability
- In several sessions during 5 weeks, the results were evaluated with different quantitative measures (where possible)
  - Click efficiency / timing
  - Scanning / selection efficiency
  - SSVEP correct selections
- Apart from the systematic observation, the users were interviewed to gather qualitative information.
  - Acceptability and Preferences
  - Difficulties

## Evaluation results (user group from Spain, excerpt):



- Qualitative evaluation of model acceptability / satisfaction
- raised from low acceptance (1) to high acceptance (3)



- Quantitative evaluation of user interaction performance
- task times significantly dropped from ~85 sec. to ~30 sec. due to optimized models and training

# Ongoing EU-Project: Prosperity4All

- Ongoing large European Project (IP with >20 partners)
- Goal: Global Public Inclusive Infrastructure (GPII)
  - Auto-personalization of interfaces and machines (ticket machine, library computer, cash machine,...)
  - Font size, contrast, Input device,...
- Developer space: Provide tools, parts, libraries to facilitate development
- Marketplace: AT products and on-demand services (auto-translation of text, auto-captioning of videos, text to sign language,...)
- FHTW-contribution: AT-building blocks (I/O, vision, speech)

<http://www.prosperity4all.eu>, [GPII video](#)





# AsTeRICS Academy

for cross-cultural education  
in Assistive Technologies

- funded by City of Vienna  
(MA23-Project, Call 14 Internationalisation)



- International Networking, R&D
- Workshops with AsTeRICS
- Intl. Summer School (2015, 2016)
  - 10 days in Vienna
  - AT/AAL lectures
  - hands-on projects / workshops
  - free of charge
- Ph.D. - Cooperations
  - with European Universities

# Established AT/AAL Lab

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- „Showroom“ for SmartHome- and Assistive Technologies
- Project-Lab and resources for academic projects
- Demonstration of AT-solutions for interested end-users
- Playful applications, „ambient“ / embedded technologies



## (Planned) International Cooperations

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- Former AsTeRICS partners

- IMA s.r.o Prague – hardware ([www.ima.cz](http://www.ima.cz)) MobilICS
- UCY Cyprus – architecture ([www.cs.ucy.ac.cy](http://www.cs.ucy.ac.cy)) P4All, MobilICS
- KI-I Linz – user studies ([www.ki-i.at](http://www.ki-i.at)) P4All, MobilICS

- Potentially interested partners

- Technical University Prague – Lenka Lhotska
- Helmholtz Zentrum München – Claudia Hildebrand
- University Skopje – Ivan Chorbev

MobilICS

- „Far East“ – Contacts

- Tribhuvan University Nepal
- Muscular Dystrophy Foundation Nepal ([www.mdfnepal.org.np](http://www.mdfnepal.org.np))
- Royal Thimphu University Bhutan

- Contact established via cooperation with Tribhuvan University Kathmandu via EurasiaPacific Uninet
- Supports ~500 Muscular Dystrophy patients across Nepal
- 40-50 of them potential AsTeRICS users
- low-cost solutions needed -> Open Source is ideal !







LipMouse for MD-patient in Vienna; User's home: TV/HiFi/Computer control





long-term cooperation  
with Tetraplegia (C2) patient.

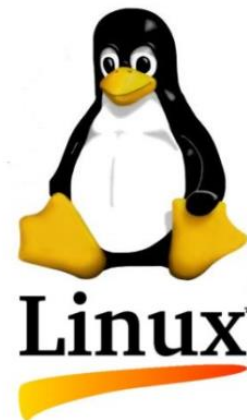
here: evaluation of input  
methods at FHTW



# Ongoing engineering work

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- ARE porting to
  - Linux (x86)
  - Raspberry Pi (Linux, ARM)
  - Android
- Due to usage of JNI / native libraries



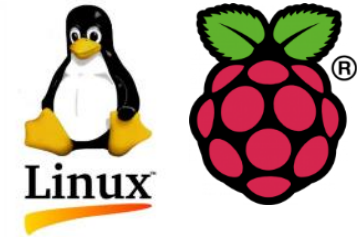
# Ongoing engineering work

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- ARE porting to Linux / Raspberry Pi

- Running

- ✓ Equinox OSGI Framework
    - ✓ Pure Java services and plugins: Processing and GUI-plugins (Swing)



- Need for Porting

- Serial communication (for CIM modules, I/O interfaces) currently RXTX win32 native lib  
Alternatives: JSSC, NRJavaSerial
    - OpenCV: Facetracker-Plugin (Camera mouse)
    - FS20 & KNX home automation interfaces
    - Speech recognition (Microsoft Speech Platform) → CMUSphinx
    - OSKA (Windows native program) → Java-based alternative

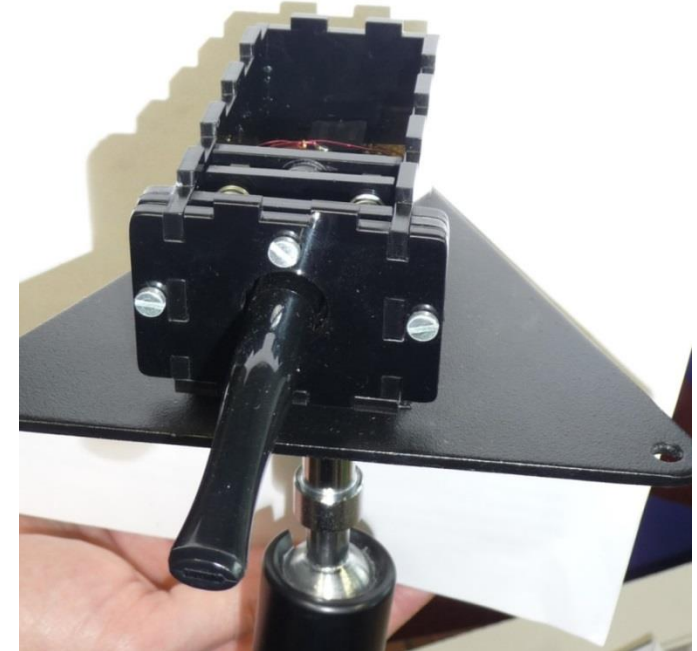
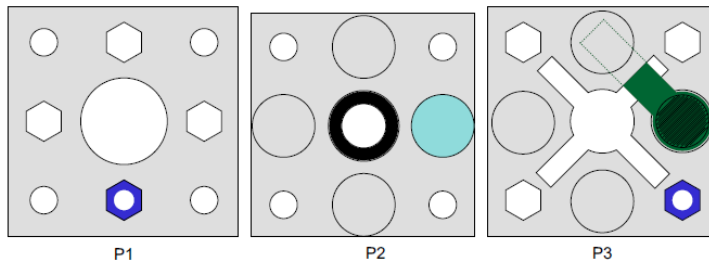
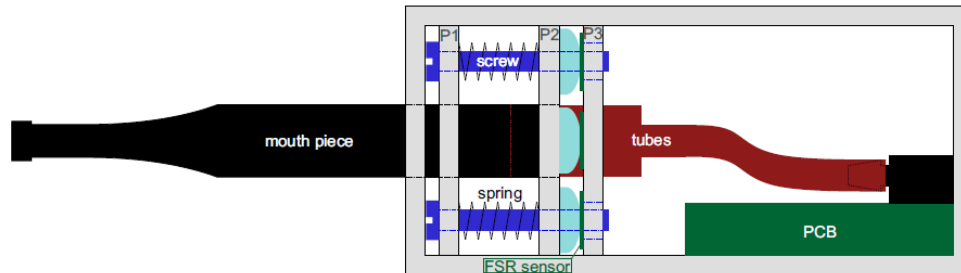
# Ongoing engineering work

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- ARE porting to Android
  - Running
    - ✓ Pure Java services and plugins: Processing plugins
  - Need for Porting
    - Equinox OSGI Framework → Apache Felix OSGI Framework?
    - Serial communication
    - GUI-Plugins (Swing) → JavaFX or HTML5/CSS/Javascript
    - OpenCV: Facetracker-Plugin (Camera mouse)

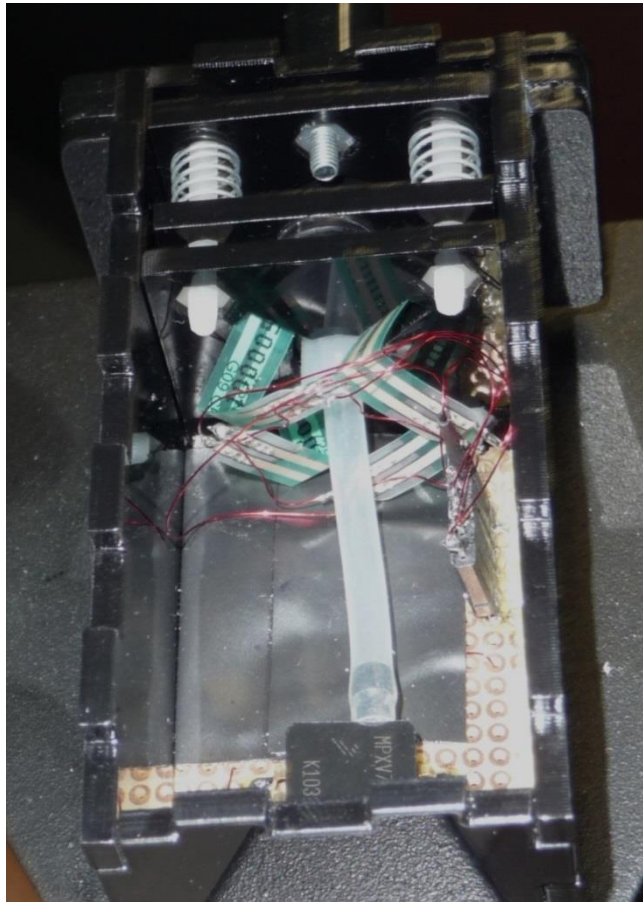


- Lipmouse – Hardware prototypes
  - Mouse emulation for quadriplegic persons
  - Mouse movement by mouthpiece
  - Clicking by sip/puff
  - Housing made of laser cutted acrylic glass
  - Battery / USB powered, Bluetooth LE

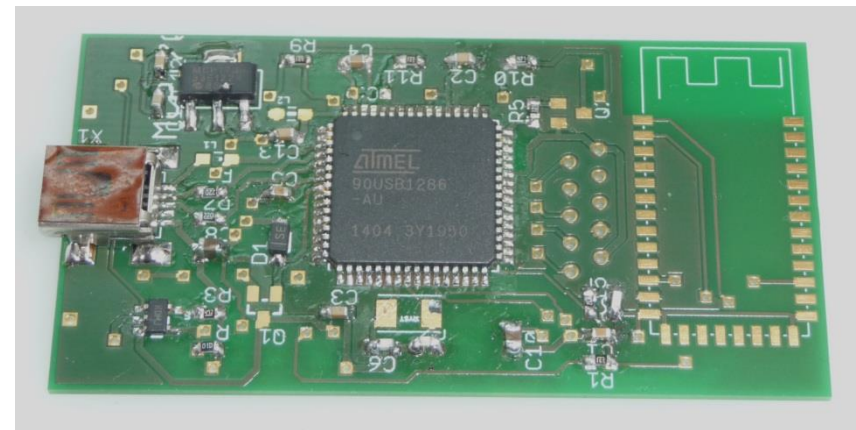
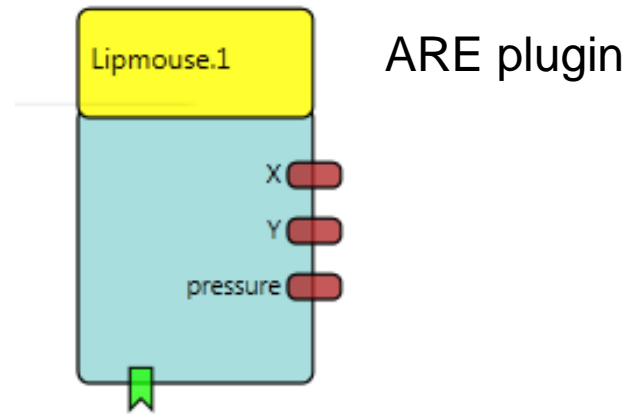




# Ongoing engineering work



Lipmouse prototype 2



Lipmouse PCB assembly



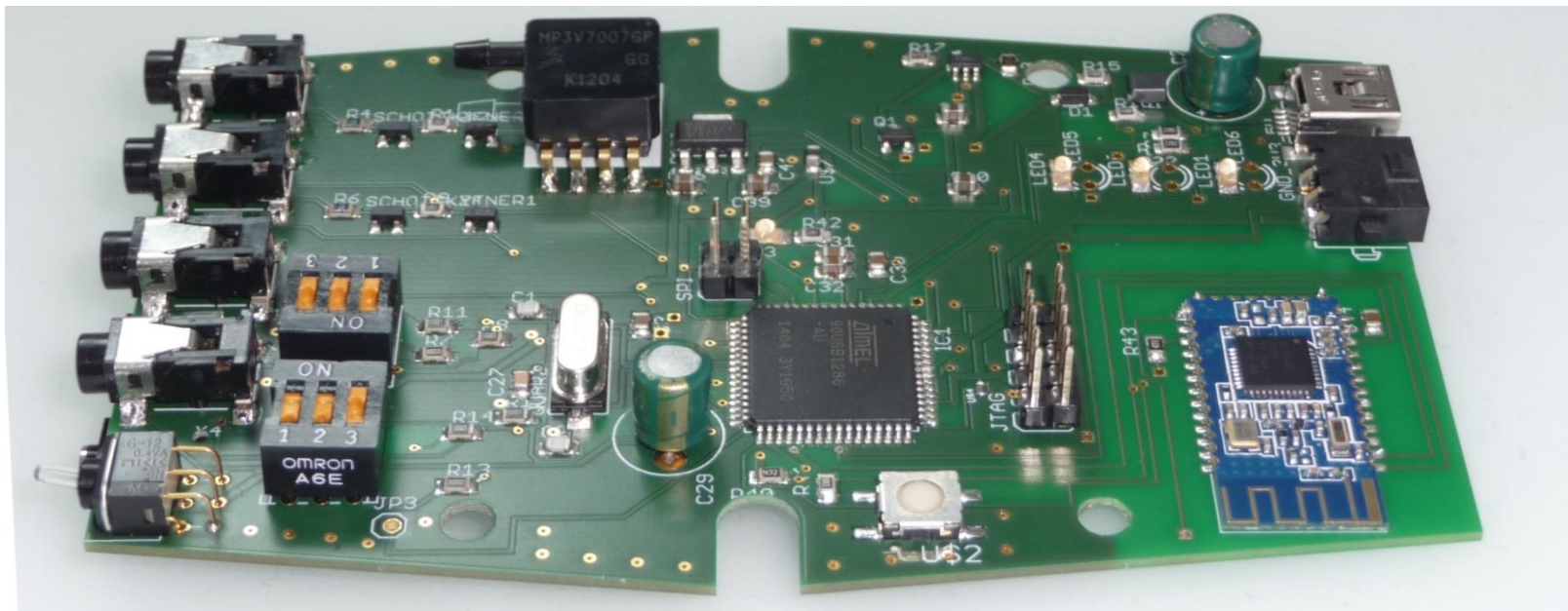
- EnOcean building automation / smart home components
  - Wireless Sensor Network (WSN) by EnOcean GmbH
  - ISO/IEC 14543-3-10
  - Ultra low power / energy harvesting devices
  - Home automation
  - Different devices for HVAC, lighting,...
  - Gateway options: USB stick / IP gateway
  - Priscilla library developed within moduLAAr project
  - Master thesis: EnOcean security/encryption evaluation

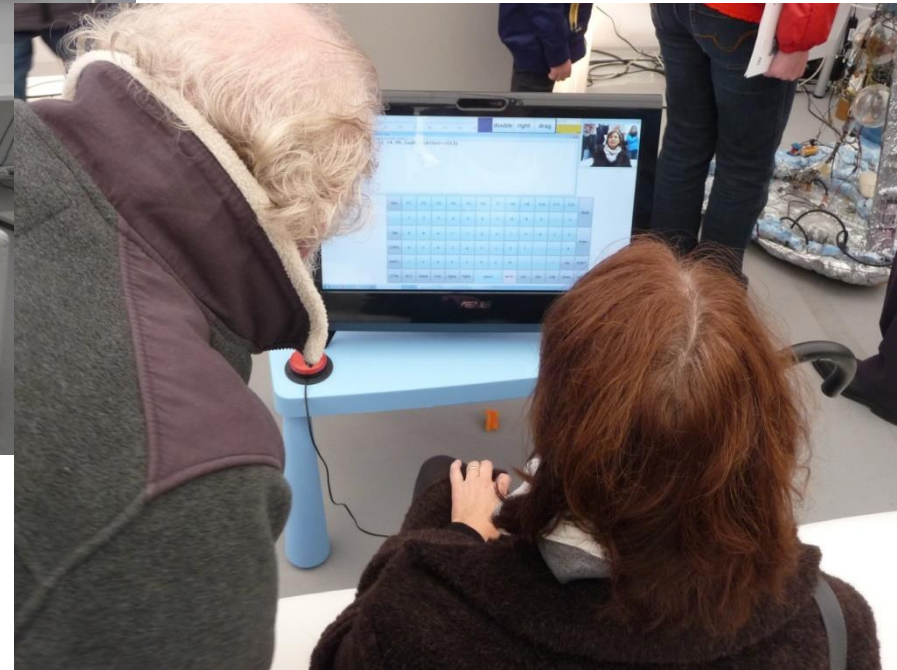


EnOcean module,  
source: [www.enocean.com](http://www.enocean.com)

# Ongoing engineering work

- AsTeRICS I/O module (Bachelor Thesis)
  - Analog inputs: resistor/voltage measure
  - Digital inputs/outputs
  - Bluetooth 4.0 interface
  - LiPo battery or USB powered
  - Optional: analog pressure sensor





AsTeRICS presentation  
at Vienna Research Fair, 2013

Facetracker-Mouse,  
Environmental Control (TV, Stereo, Lights, ...)

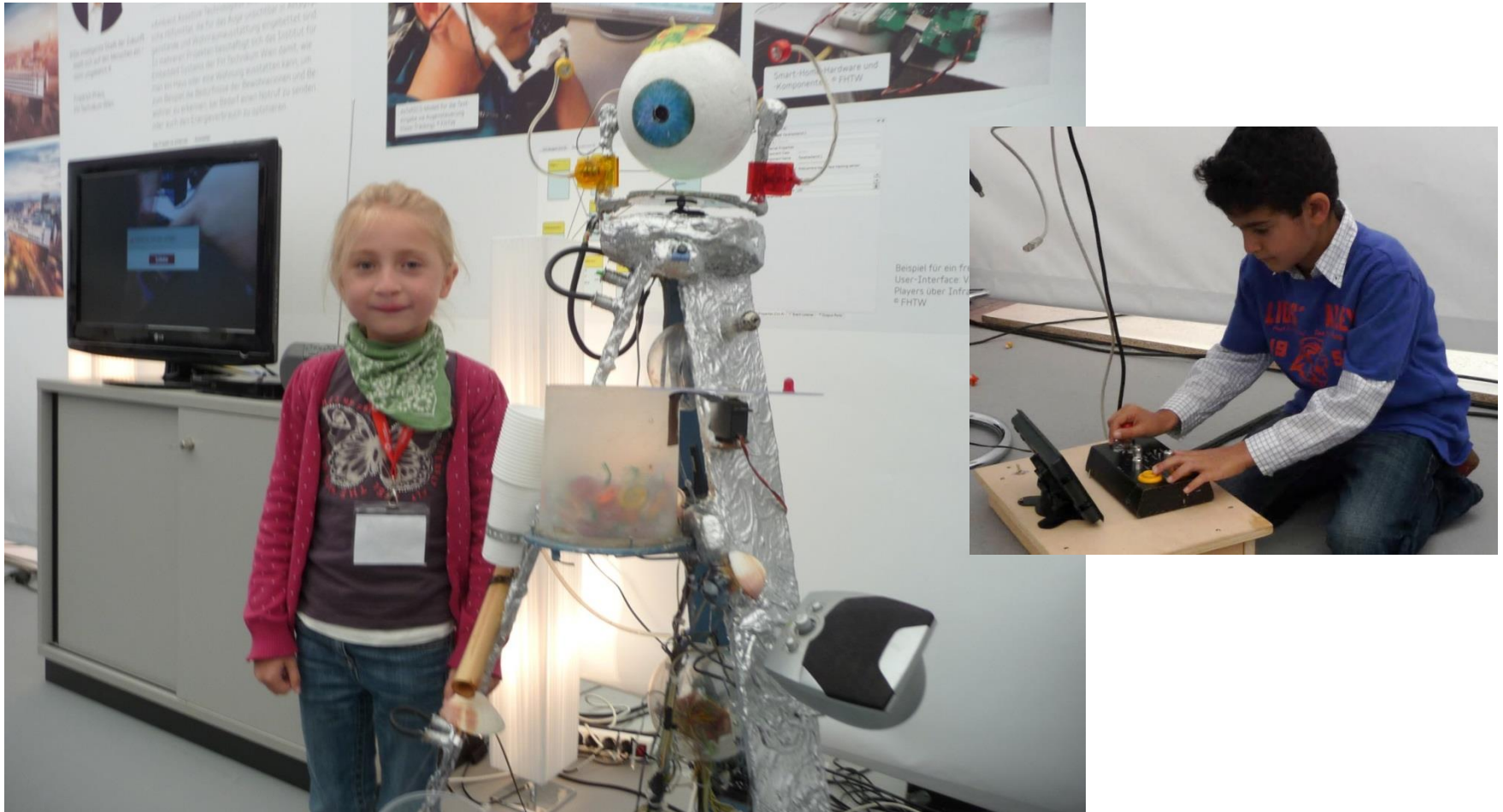


# Public Relations / Exhibitions



Vienna Research Fair 2013

“EnergyPong” –  
AsTeRICS-enabled Bike-Pong-game with calculation of calories



“Alan”: Telepresence and Snack-Robot