Improving and accelerating AT development and applicaton

AsTeRICS – Assistive Technology Rapid Integration & Construction Set

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1 Introduction

Assistive Technologies have improved considerably over the last years. In this, the situation is comparable to the general progress in information technology (IT). But there are still two main issues which seem to develop much less compared to the general IT trends:

- There is only slow and often no decrease in prices for AT
- ATs are still often not capable of addressing very special individual needs of end users and do not adapt accordingly.

Both aspects first of all originate from the diverse set of motor disabilities and the according diverse needs and environmental contexts which make ATs very much individualised solutions. This leads to according increased efforts necessary for tailoring AT as well as to a very reduced potential of “economic of scales”, of producing high quantities of the same products. At a glance we might outline this contrast by saying: *Progress in IT is based on generalisation of devices and services. Progress in AT is based on specialisation and individualisation.*

Studies (e.g. MEAC study) outline a strong demand and recommendation that AT R&D should follow the route of the general IT market to allow employing AT at a broader and more affordable scale.

But how could we reach this goal without neglecting the specialities of AT? This presentation will focus on R&D related to the implementation of a “Assistive Technology Rapid Integration & Construction Set” (AsTeRICS) which should allow

a) an easier and more efficient adaptation/tailoring of AT to individual users by non-technical specialists (e.g. therapists, care givers or even end users themselves),

b) a more efficient and cost effective implementation of AT and/or assembling of AT solutions, also as much as possible by non-technical specialists and

c) more efficient and targeted research by providing a “playground” for researchers based on reusable and easy to integrate modular components.

It is the ambitious goal of this R&D to make AT tailoring and even implementation a part of service provision to allow a more efficient and cost effective use of the AT potential. Thereby, respecting the individual needs is not diminished or neglected when focusing on the obvious economic challenges. In contrary: by allowing and improving the integration of AT tailoring or even implementation into established user centred service processes, both contradicting objectives should become easier to reach.

Recent technical developments in sensor and actuator technology form an enhanced basis for addressing these objectives. a) Sensor technology allows using very special individual activities of users (muscle ... brain) and b) mapping them with special actuator functionalities to support interaction and communication. As Human-Computer Interfaces (HCI) are used in almost all areas of our live, a more efficient access to HCI is of course at focus, which today also includes areas like mobile and embedded devices. To allow finally c) the integration into the service provision process the biggest challenges lies within the development of an easy to use construction set based on non-technical interaction principles.

By orienting as much as possible towards a) modularised AT development based on b) reusable components and c) open source and community building AsTeRICS should impact both on the R&D field and on the AT market.

2 AsTeRICS – Assistive Technology Rapid Integration & Construction Set

AsTeRICS addresses this issue by providing an **affordable construction set for building assistive functionalities** which can be highly adapted to individual user needs. The system will be scaleable and extensible, so that new functions can be integrated without major changes. Furthermore, AsTeRICS will open access for people with severe motor disabilities to various embedded devices and mobile services, which did not offer highly specialised user interfaces before.

These features are made possible due to a system architecture which is composed of **modular functional hardware and software components** perfectly suited for utilisation in various Assistive Technology applications:

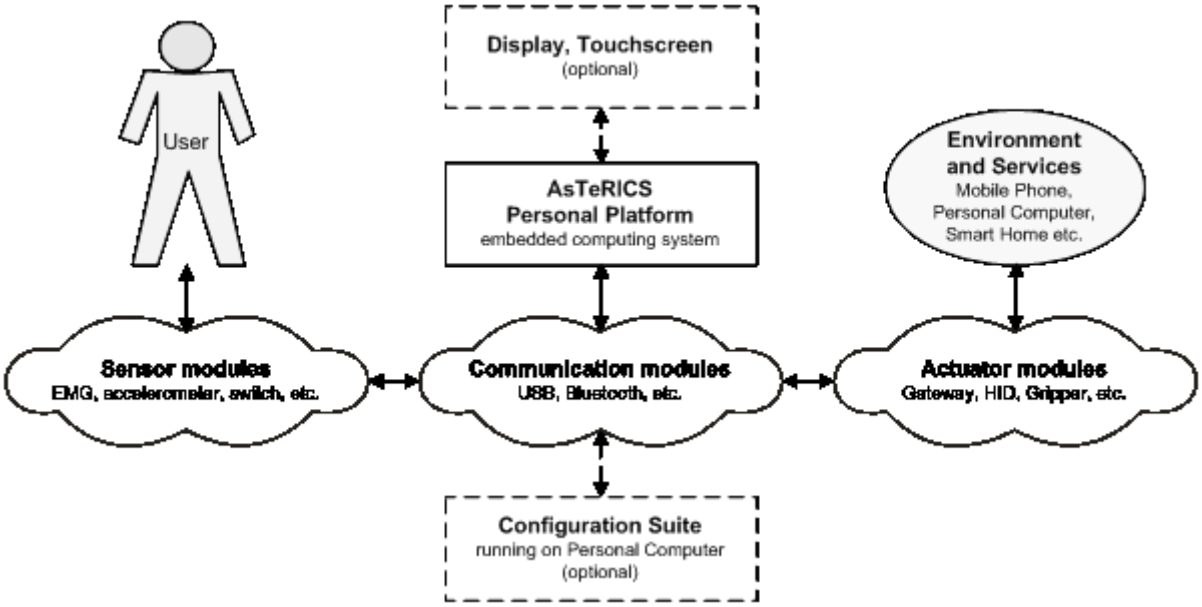

Figure 1: Concept of the AsTeRICS modular Assistive Technology system

Figure 1 outlines the concept of the AsTeRICS construction set, which contains several modules and a software suite for configuration of the system. The core element of the AsTeRICS system is the **AsTeRICS Personal Platform**, an embedded computing system which **processes data from input modules and controls output to actuator modules**. Configurations can be designed using a graphical software suite and downloaded into the AsTeRICS personal platform to perform the desired functions.

AsTeRICS is designed to extend the possible input- and output modalities as far as possible. In the course of the project, several modules which support a wide range of use-cases will be developed, including **biosignal acquisition for BCI operation and neural interfaces, computer vision based user interaction and utilisation of environmental control systems** via an off-the-shelf gateway. These diverse use-case implementations will help to highlight the flexibility and potential extension of the system.

As individual users will not need the complete set of sensors and actuators, particular applications will only use appropriate modules. In this way, AsTeRICS can provide **cost-effective alternative AT-solutions which are highly customisable** to the individual requirements of each person. The graphical configuration editor gives therapists or caregivers the opportunity to change or adapt system settings without deep technical knowledge. The user will therefore benefit from a tailored AT device which will result in it being used more effectively, efficiently and with more user satisfaction. AT adaptation or implementation will become affordable and has never been so easy even for "extreme user needs".

On the other hand, IT-professionals and rehabilitation engineers can extend the system to work with new input or output modalities. This is made possible by using a **standardised Service Oriented Architecture** and component based software approaches (e.g. OSGi),

and by keeping the interfaces to the open source AsTeRICS software framework clear and well documented.

In the following, the main AsTeRICS system components and their functionality will be described.

3 The AsTeRICS Personal Platform

The AsTeRICS Personal Platform is the central module of the AsTeRICS stand alone system which allows the interaction of (body-near or embedded) sensors and actuators and makes assistive functionalities possible.

Sensors and actuators are connected to this embedded computing platform by wire or wirelessly. The incoming signals from the sensors are processed (e.g. filtered, transformed etc.) and used to control the actuators. The OSGi-based system architecture enables dynamic pluggability of (new) processing components and the integration both of (new) sensors and actuators. This can ensure that only the software components necessary for the desired system configuration are selected and used.

4 The Communication Interface Modules

The Communication Interface Modules (CIMs) support the information transfer between the main system components: they link together the AsTeRICS Personal Platform, the sensor- and actuator modules and the Personal Computer for system configuration. The CIMs are put in place using mechanical sockets of the hardware platform. Furthermore, the CIMs can connect the AsTeRICS system to existing standardised solutions for environmental control, e.g. a home automation gateway.

5 The Sensor Modules

The sensor modules will make classic solutions for AT available - e.g. mini joysticks, accelerometers, strain gauges or sip/puff-switches. In addition to these off-the-shelf sensors, two multi-purpose input modules will be developed and integrated into the AsTeRICS system:

- The *Smart Vision Module* is a configurable VLSI computer vision sensor which will be developed by the consortium partners UPMC and CEDO. It can be used to extract special features from live image frames and to detect movements of the user.
- *Enobio*® is a wearable, modular and wireless electro-physiology sensor system for the recording of EEG (electroencephalogram), EMG (electromyogram) and EOG (electrooculogram). *Enobio*® can be used as sensor for Brain Computer Interfacing (EEG-BCI) or muscle triggered interaction.

Due to the openness of the construction set, also other sensors or biosignal amplifiers can be readily added in the future. It is one of the core goals of AsTeRICS to demonstrate extensibility and sustainability by including further modern sensor techniques which might become available during the project.

6 The Actuator Modules

The actuator modules provide the AsTeRICS system with an effective interface to the environment or to other ICT devices. One class of actuators will implement standard Human Interface Devices (HIDs), i.e. standard keyboard and standard mouse. These modules can directly be connected to a Personal Computer via the USB port and will emulate a mouse and/or a keyboard without requiring special driver software. Other actuator modules will enable access to embedded services like a home automation gateway or mobile phones.

7 Optional Display with Touchscreen

The display with touchscreen can be seen as special actuator/sensor module which will present AT interfaces to the user (e.g. UI of a virtual keyboard or mouse which supports scanning). If desired, the touchscreen can be used to select different system modes, start or stop a configuration, etc. The display will also be useful for adaptation of the AsTeRICS runtime parameters. The display and the Communication Interface Modules can be plugged onto the AsTeRICS Personal Platform and extend its features if required.

8 The AsTeRICS Configuration Suite and AsTeRICS runtime system components

The Configuration Suite provides the interface to set up and configure the AsTeRICS framework. The sensor and actuator modules are represented by graphical symbols with input and output connectivity. Additionally, an extensive set of signal processing components, data analysis functionalities and specialised user interface components is provided by the Configuration Suite. Desired components can be put into a design window and linked together simply by drawing a connection using the computer mouse and/or keyboard. A connection of two modules in the design window generates a physical data flow between those two modules in the real word. By using the configuration suite, the following characteristics of the overall system can be defined:

- The functionality (mapping sensors with actuators)
- The behaviour (calibration, reaction time, accuracy, tremor reduction)
- The look & feel of the user interface (e.g. symbols or letters on the display/touchscreen)

Using the Configuration Suite, prototypical AT-solutions will be set up either by experts or by those having proper expertise in tailoring AT for end users. As the graphical user interface will follow an accessible Design-For-All approach, people with disabilities or their related parties can “self configure” and finely adjust the system parameters according to advancements of the user or changing needs.

The Configuration Suite is connected to the runtime system via a TCP/IP connection. Therefore it is also possible to configure an AsTeRICS system from a remote PC connected via the Internet. This opens up the possibility for remote support of users and/or carers who are setting up the system and should help towards keeping maintenance cost down.

9 Participating Partners

Organisation	Country
Project coordinator : Kompetenznetzwerk Informationstechnologie zur Förderung der Integration von Menschen mit Behinderungen (KI-I)	Austria
Fachhochschule Technikum Wien	Austria
University of Cyprus	Cyprus
Université Pierre et Marie Curie (Paris 6)	France
Starlab Barcelona SL	Spain
Harpo Sp. z o.o.	Poland
Sensory Software Ltd	United Kingdom
Fundacion Instituto Gerontologico Matia – INGEMA	Spain
Institut mikroelektronickych aplikaci s.r.o.	Czech Republic

10 Co-ordinator Contact

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