PROVIDING TELE-SUPPORT AND TELE-TRAINING TO SEVERELY DISABLED PERSONS USING IP-BASED NETWORKS

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Abstract. This paper describes the experiences and results of the European Union funded RESORT project which has developed a prototype system for remote service provision for rehabilitation technology (RT) products. RESORT stands for Remote Service of Rehabilitation Technology. High-end Environmental Control Systems (ECS), Alternative and Augmentative Communication (AAC) devices and devices used for therapy and training are gaining an increasing importance in the daily life of disabled and older people and their carers. The authors have extended such an assistive system by integration of a remote control interface based on a protocol defined by the DE-4208 RESORT project. In these areas the crucial point for user satisfaction is not only the price of purchasing the equipment but also to an even greater extent the costs of personal adaptation and ongoing service and updating according to changing user needs. The RESORT prototype provides a multimedia and remote interaction link between the RT-user and a service provider. Updating the user software, carrying out adjustments, training primary and secondary users, answering questions of the user and trouble-shooting will now no longer require the personal presence of a specialist but will be carried out via telematics. Additionally, the RESORT protocol has been defined in order to allow other manufacturers to make their products RESORT compliant.

1. Introduction and Aim

Severely motor and speech impaired persons are using electronic aids for communication and for controlling the physical environment. In order to reduce existing barriers in using electronic aids the EU-supported R&D project RESORT [12,22] was launched. RESORT stands for "Remote Service of Rehabilitation Technology" (RT). The objective of this project was to develop a telematic link (Fig.6) between the user or the care person on one side and a service provider (technician, therapist, other experts) on the other side. The link not only provides video-telephony capabilities but also remote supporting the user's PC and provision of remote training. This paper describes the concept of the RESORT tele-support system, its implementation, the on-going field trials and the experiences from daily life usage in combination with our AUTONOMY system.

2. Background – The Technical Assistance System "AUTONOMY"

For several years now, our research group has been active in the development and field-testing of a combined ECS and AAC system we named AUTONOMY [3,5,6,7]. It is based on a PC hardware platform (notebook or handheld computer) and on the MS-Windows operation system. The input/output hardware can be chosen from a wide range of standard and special devices to meet the

specific needs of the disabled user. A set of peripheral hardware components links the system to the physical environment.

As a main innovation AUTONOMY offers three different user-interfaces for the three distinctive user groups [7] working with the system (Fig.1):

- The disabled end-user (the person with special needs, who is using the assistance system).

- The facilitator / care person (e.g. a therapist, pedagogue or family member) responsible for the configuration and adaptation of the user-interface.

- The integrator / administrator carrying out the technical set-up of the system.
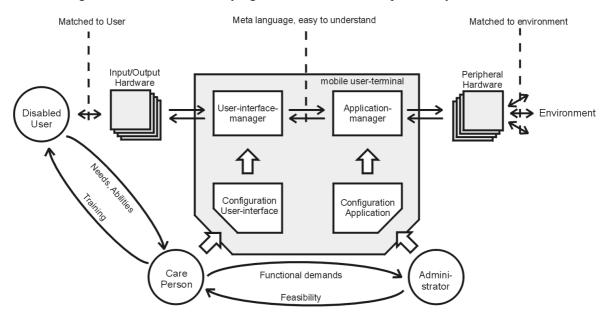

Fig. 1: Block diagram of the AUTONOMY system showing interaction
between system components and user groups [5,6,7].

The co-operation between these three groups of users is essential for optimisation and successful use of the system. The three interfaces/tools (user-interface, configuration tool and setup/test tool) are tailored to the very specific needs and abilities of the three different user groups according to the specific roles they play in setting up, configuring and operating the entire system.

Figure 1 shows the interaction between the system components and how the different user groups utilise dedicated user-interfaces. The user-interface-manager and the application-manager are internally linked with one another by an easy to understand meta language. This ensures that after the integrator (= system administrator) has set up the application configuration and the peripheral hardware the facilitator (= care person) can refer to non-cryptic (non-technical) terms when configuring the user-interface.

The task of the facilitator is to enable the impaired person to discover and exploit new areas of self-determination and independence. He/she will need a versatile and easy-to-use tool which enables him/her to create not only various user interfaces but also creative procedures for working with the communication and environmental control functions in a didactic and therapeutic manner.

Up from a certain degree of impairment motor- and multiple disabled persons rarely are able to use conventional environmental control and augmentative communication systems. To attain this ability, in many cases customer tailored user-interfaces plus a long-time training process is necessary. Even learning the relation between reason and effect and experiencing self-effectiveness (being able to make something happen in the environment and to recognise the results) is the first big challenge and often an entire new experience.

Hence, a technical system capable to meet the needs of these users has to fulfil three criteria: (1) give optimal support to the training-process; (2) support the facilitators with a tool to easily adapt the

system to the rapidly changing user needs; (3) be capable to grow from first experiencing self-effectiveness up to a multi-functional multi-purpose technical aid.
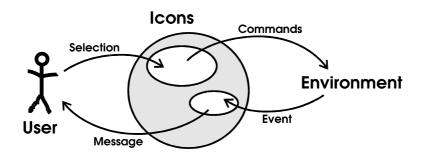

Fig. 2: Concept of interactive, bi-directional icons used in the AUTONOMY system [7].

The user-interface of the AUTONOMY-system is based on the concept of multimodal icons (Fig.2). An icon is a structure which combines methods of multimodal representation (e.g.: graphics, background colours, sound-cues, text,..) with commands to control the environment respectively with messages from the environment or with communication methods (e.g.: BLISS, synthetic speech,...). If the user wants the system to do something, he/she selects one of the icons using one of the input devices and one of the input methods mentioned above. After the selection the icon itself interacts with the environment. The icon, therefore, can be considered as the actual link between the user and the environment.

In the opposite direction, events (e. g. like „telephone is ringing") trigger the selection of an icon and are presented to the user in the same multimodal way as a message.

2.1 Smart Rooms

AUTONOMY was implemented into a smart-room at the Elisabethinum, a support centre for severely and multiple impaired children at Axams (Tyrol, Austria) and at a public school in the south of Vienna. By using the EIB (European Installation Bus) for the electric wiring and infra-red remote control technology, nearly all appliances in the room can be remote-controlled via the system. When operating AUTONOMY as an ECS the teacher or therapist will create a dedicated system-configuration. The icons on the user's screen directly correspond to environmental commands: switching on the lamps, starting the CD-player, get the toy-train running, switch off everything (Fig. 3). For AAC purposes configurations showing communication symbols on the screen can be created. Activating an icon by direct selection or scanning will result in a spoken or printed message.
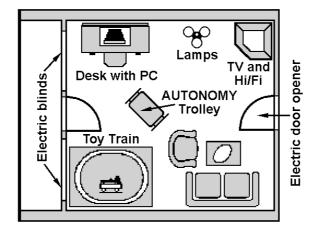

Fig. 3: Smart Room at support centre Elisabethinum in Axams near Innsbruck. Equipped with EIB Twisted Pair and the AUTONOMY system in 1995.

The smart training rooms in Austria have been equipped with:

- Mobile platform for running the AUTONOMY user interface for the disabled person
- EIB (Twisted Pair or Power Line) for lighting, blinds, fan, door opener, emergency call, etc.
- Infra-red transmission for consumer electronic (VCR, TV, CD-Player, Tuner, ...)
- Emulation of keyboard and mouse for controlling a standard PC
- General input / output facilities for controlling electric toys
- Video door control
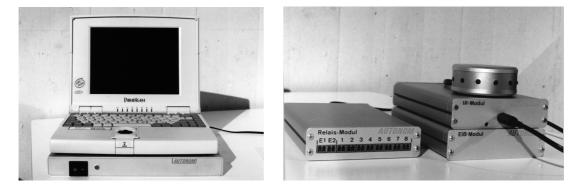- Telephone and internet connectivity

Fig. 4: Autonomy user interface implemented on MS Windows based laptop, below Busmaster of Autonomy fieldbus system (left picture). Three peripheral modules for input/output, infrared and EIB-Link (right picture).

The first room, located at Elisabethinum was operational in 1995 using EIB Twisted Pair (TP) technology, the second, located in a public school in the south of Vienna, was operational in 1998 using Power Line (PL) as transmission medium. At the Elisabethinum a single room apartment was completely re-furnished (Fig.3). It consists of four dedicated areas: one area for living, an area for TV/HiFi, a working area with PC, Modem, FAX and an area for playing with electric toys. An EIB system was installed for controlling lamps, window-opener and blinds.
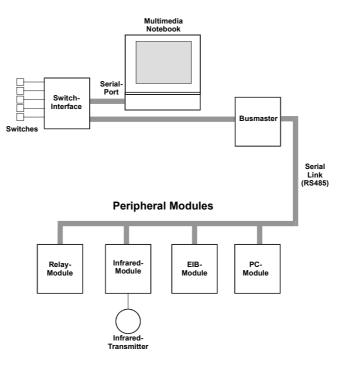

Fig. 5: Structure of Autonomy prototype system used at smart room at Elisabethinum. Twisted Pair EIB is connected via RS-232 link to EIB-Module which itself is part of a RS-485 based Autonomy field bus system.

The prototype of the assistive system was installed in October 1995. It consists of a mobile user-terminal (Fig.4 - left) and several stationary peripheral hardware modules (Fig.4 – right). The user-

terminal serves as platform for running the dedicated software tools for all three user-groups (end-user, facilitator, system-administrator). It uses MS-Windows 3.11 (later upgraded to Windows 98 SE) as operating system and offers a multi-user environment. For each user of the system an individual set of configuration properties can be stored. The peripheral hardware covers modules for generating infrared codes, for controlling the EIB and for general input/output facilities (Fig 5).

An interdisciplinary team of teachers, therapists, carers and researches was set up to carry out a field study (1996-1997). The general strategy has been to introduce the system as a new flexible tool to implement the therapist's own ideas in a creative way.

2.2 Discussion

One of the main goals in developing AUTONOMY was to provide a configuration interface which enables even complete computer illiterate persons to create client tailored user interfaces and applications. The concept received perfect acceptance from teachers and therapists and meanwhile several hundred different configurations were set-up at the test site [24,27]. The extensive use of AUTONOMY at the support centre in Axams also showed that the system offers additional therapeutic benefits beyond pure AAC and ECS [24].

Especially cognitive and motor impaired children encounter severe problems in experiencing the principle of reason and effect. As their possibilities to handle objects by themselves and perceive what will happen ("...will it drop to the floor and crash when I release it?") are restricted they encounter a deficit along these lines.

The smart-room can help to teach these basic principles. Properly configured, accessing an icon by hitting a switch can cause to start a firework of sound and light. It occurred that children needed such experiences to conceive the concept of reason and effect for their first time.

A next step in therapy can be basic communication training for non-speaking children. The usage of an AAC system is often hard or impossible to explain to severely impaired children. The therapists at Axams, therefore, started to combine AAC with ECS. This has been easy to achieve, as AUTONOMY integrates both function in one platform and under the same user interface.

3. Motivation for Remote Support

The response from the field tests on the one hand led to the development of a low-cost version of AUTONOMY [3] which is also suitable for private applications. On the other hand it motivated the launch of the EU-supported R&D project RESORT [21,22].
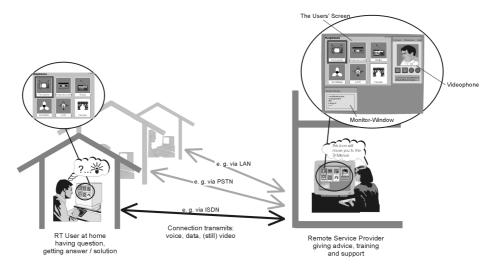

Fig. 6: Remote service provision for PC based RT systems designed by EU funded RESORT project.

The objective of this project has been to develop a telematic link (Fig.6) between the user or the care person on one side and a service provider (technician, therapist, other experts) on the other side. The

link does not only provide video-telephony capabilities but also remote supporting the user's PC. Training and supporting the user, solving problems with the system, updating of software or changing configurations can be handled in this way. Following the AUTONOMY philosophy the telematic linking will be as easy as clicking on an icon.

An increasing number of disabled people are using RT systems that help them to live more independent and self-determined lives. Analysis of the provision process shows that buying and installing an up-to-date RT system is definitely not the end, but much more the starting point of a process of continuously tailoring the system to the ever changing needs of the individual user.

In many cases the carers (teachers, therapists, family members) are the key agents in this process. Often a lack of experience in using and configuring RT systems causes a resulting lack of adaptation and frequently the total abandonment of Rehabilitation Technology. Generally spoken, it is anticipated that the actual use of RT systems is much lower than the real need. Currently support is a complicated and expensive procedure due to high travel efforts and to frequent hands-on involvement of professional support personnel.

A number of research and pilot projects have explored the potential for providing remote support for RT systems and the users. Examples include the work of Burns et al. [4], Cole et al. [9], and the CATCHNET Project [2]. Support, specifically for the rehabilitation professionals, is being piloted by Nelms and Colven [19]. All these systems either provide communication tools or freely available application sharing tools. The RESORT project recognised that these approaches did not adequately address the time critical aspects of the use of RT systems. For example, where scanning arrays are used in the user interface, conventional remote application sharing cannot provide the time critical synchronisation between actions taking place at each end of a remote link.

The RESORT project team, therefore, developed a PC-based system which provides on-line support for the carer and the handicapped person by establishing a videophone connection and synchronisation of the RT applications at both ends of the links. Whenever a problem arises the carer (or the disabled person) can establish such a multimedia link to a RESORT service centre (RSC) and ask questions, get oral explanation and support, can demonstrate what seems not to function correctly or can learn by watching the RSC operator solving problems on the remote PC via the multimedia link.

3.1 User Needs Analyses

Having analysed the responses of several series of interviews and questionnaires, the consortium drew the following conclusions:

- There is a distinction in the life of disabled people between primary and secondary carers. The "primary carers" have intensive interactions with and/or responsibilities for an individual and a small caseload. The "secondary carers" have a more specific input into the lives of a wider caseload.

- The RESORT system, therefore, focuses on assisting primary carers in the process of providing RT, including access to information and the management of cases and case conferences. A key element of the RESORT provision should be an improvement of on-going after-care for RT users.

The consortium constructed a model that shows the actual interactions of professionals involved in the life of a disabled person. In many cases, whilst these professionals interact with the disabled person directly, their involvement is filtered, controlled or monitored by a primary carer. This primary carer is often either a professional or a member of the disabled person's family.

In addition to the professionals with a responsibility for general areas in the life of an impaired person, another group of professionals has responsibility for dealing with the disabilities that arise from the individual's impairment. These disabilities affect a range of activities and may require assistance from a specialist with a very focused set of skills. Again, the involvement of these professionals may be filtered, controlled or monitored by a primary carer. The RESORT concept was developed acknowledging this significant roles of primary and secondary carers.

3.2 Concept of a Remote-Service and Tele-Training Add-on over IP Networks

The RESORT system provides the following functionality: (a) RCI (Remote Control Interface) for "real time synchronisation" of RT systems (b) easy-to-use scaleable User Interface (c) real time communication and interaction: audio and video, H.323 compliant (d) database access (e) file transfer (f) synchronisation of file systems (g) text communication (h) platform in-dependency (i) security. It offers three different modes of operation:

- In the communication mode RESORT provides hands free communication between user and service provider. If the bandwidth is large enough an additional video link can be established.

- In the student-teacher mode an additional data-link is established. The service provider will load exactly the same RT application as the user is running. The two applications - at the user's site and at the provider's site - will be synchronised via the data link. This is the mode of operation most useful for tele-training and tele-teaching. Control of the application running can be given either to the teacher or to the "student" (in our case the disabled person or the primary carer). After having demonstrated a certain topic the teacher can hand over control to the student and ask him or her to reproduce what has been demonstrated and monitor the results.

- In the tele-service-mode the service provider has the possibility to down- and upload files from and to the user's PC, modify configurations and test the changes he/she has made.
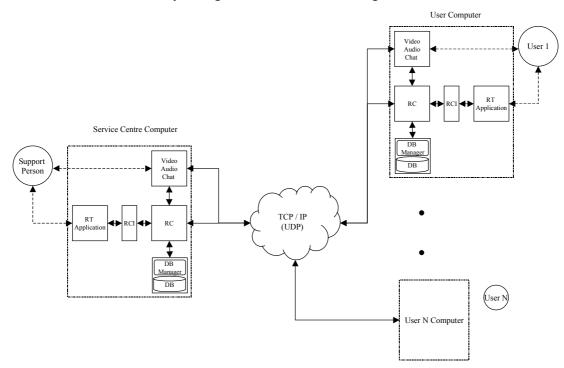

Fig. 7: RESORT system structure: On the left hand side the RESORT Service Centre, on the right hand side the RESORT Client PCs (at special schools, residential areas or private home). In between the Network.

4. Methods

At the end of year 2000 the prototype of the RESORT system was released, additionally the AUTONOMY system was equipped with a RESORT compliant interface. The core of RESORT was implemented in Sun Java 1.3. The system exploits existing technologies for tasks like video / audio transmission according to H.323 specification and desktop/application sharing according to T.120. The user interface of the Resort controller can be tailored according to the needs of the users. Although the full functionality is always available, the degree of complexity of functions and information shown to the individual user can be varied within a wide range.

The RCI (Remote Control Interface) and the RESORT protocol allow synchronisation in real time. This is possible as only small data messages are transferred instead of changed screen contents. This method dramatically reduces the required bandwidth [2] and enables the RESORT system to provide real time monitoring of single switch users. The Resort controller module (RC) is linked to (a) communication modules for video, audio and chat, (b) to the database, (c) to the RT system and (d) via network interface to the remote RC. IP is used for the network protocol. TCP/IP for control messages, UDP mainly for audio and video. In order to test and demonstrate the benefits of the system 2 existing RT systems [3,18] have been equipped with Resort interfaces.
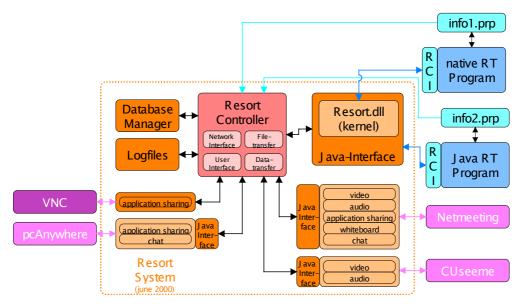

Fig. 8: Modules and interfaces of the RESORT prototype system. Different available third party products for audio, video and data conferencing can be used. The current prototype uses H.323 and T.120 implemented by Microsoft Net-meeting v3 product. For RCI specification refer to [12,22].

In order to ensure a high level of flexibility several internal interfaces were introduced. The out-come is a highly modular system which allows to exchange specific parts without the need of adapting other parts. This increases the independence from 3rd party products for audio, video, application sharing, desktop sharing, etc.

The prototype system was demonstrated in 15 workshops organised for care persons, disabled users, manufacturers and service providers in Austria, Germany, The Netherlands and Scotland. Additionally real life tests have been carried out [22].

Fig. 9: Screen Shot of client's screen during a RESORT Tele-Help session (left picture). Non speaking head stick user in front of her PC running the commercial version of AUTONOMY for communication in synthetic speech and for environmental control equipped with RESORT tele-help module. The subject is studying biology at Vienna University.

5. Results

The results from the real life tests showed that the system was usable by disabled people and their primary carers. Furthermore, both primary and secondary carers consider the system a viable tool for the delivery of support for users of RT systems.

In general, the results of the demonstrations and trials endorsed the need for the RESORT type architecture, but recognised that it would cause operational changes in the care services. When demonstrated to care service providers, they were particularly interested in the potential for rapid access to engineering and technical support. They also saw great potential for on-line conferences involving a group of different care providers involved with an individual client.

The RESORT prototype system demonstrated a multitude of benefits which will help to overcome existing barriers in the field of RT service provision. Additionally to the RESORT prototype software, the RESORT protocol has been developed and documented. This allows other manufacturers to adopt the RESORT protocol for their products in order to strengthen their position in the market [22].

6. Discussion - RESORT Interest Group (RIG)

RESORT not only aims at technical service delivery but also at pedagogic and therapeutic support via the telematic channel. In order to ensure ongoing research and development a RESORT Interest Group (RIG) was set up. The RIG provides a framework for disabled users, care persons, manufacturers, service providers, and researchers to continue the engagement in the area of remote service provision. Interested parties are invited to watch the progress of RIG by visiting the RESORT home page [12].

In mid of year 2001 first part time service centres have been set up at TU Wien and at an Austrian SME. An evaluation version of the RESORT software package is available from RIG home page [12]. Currently our group is heavily engaged in providing technical support to a disabled student of our university (Fig. 10). Tele-Support and Remote Service Provision is an encouraging aspect which will improve significantly the quality of life of disabled persons.

Fig. 10: Wheelchair-using IT studentat Vienna University of Technology (left picture) Photo taken in one of the Internet rooms of TU Wien. The student is using AUTONOMY system (right picture) for writing Modula-2 source code.

7. Acknowledgement

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