

# **A SYSTEM FOR TELE-REHABILITATION OF PROFOUNDLY DISABLED PERSONS WHO ARE USING PC-BASED COMMUNICATION AND ENVIRONMENTAL CONTROL AIDS**

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*Abstract: The DE-4208 RESORT Tele Help prototype provides remote support for disabled users of PC based Rehabilitation Technology (RT) and their care persons in order to reduce existing barriers in daily usage and service of RT. The current RESORT prototype and its interface specification support also synchronisation of single switch non-speaking motor impaired users over narrow bandwidth network channels in order to contribute to the emerging tele-rehabilitation field. The IP based RESORT system with its scaleable user interface is described explaining also the remote service API which allows to make already available RT software products ready to benefit from RESORT's tele help functionality. Experiences from two real life tests in Vienna with severely motor impaired non-speaking subjects are reported and an outlook of current and future activities is given.*

## **1. Introduction**

An increasing number of disabled people is using Rehabilitation Technology (RT) systems which help them to live more independent and self-determined lives. One example is the Technical Assistance System called AUTONOMY [13], [15], [17] which was developed at our institute. This PC-based system is a communication and environmental control aid. It assists severely motor and multiple impaired (often non-speaking) patients by providing synthetic speech, symbol communication, environmental control (infrared, radio frequency, smart home busses), access to phone and to standard PCs etc. It can be controlled via very small movements of a part of the patient's body and runs also in an automatic scanning mode. Based on experiences collected from successful field tests in private homes, special schools, rehabilitation centres and hospitals a commercial version of the Technical Assistance System was developed and additionally our research group had a closer look on existing barriers in applying this innovative technology in daily life.

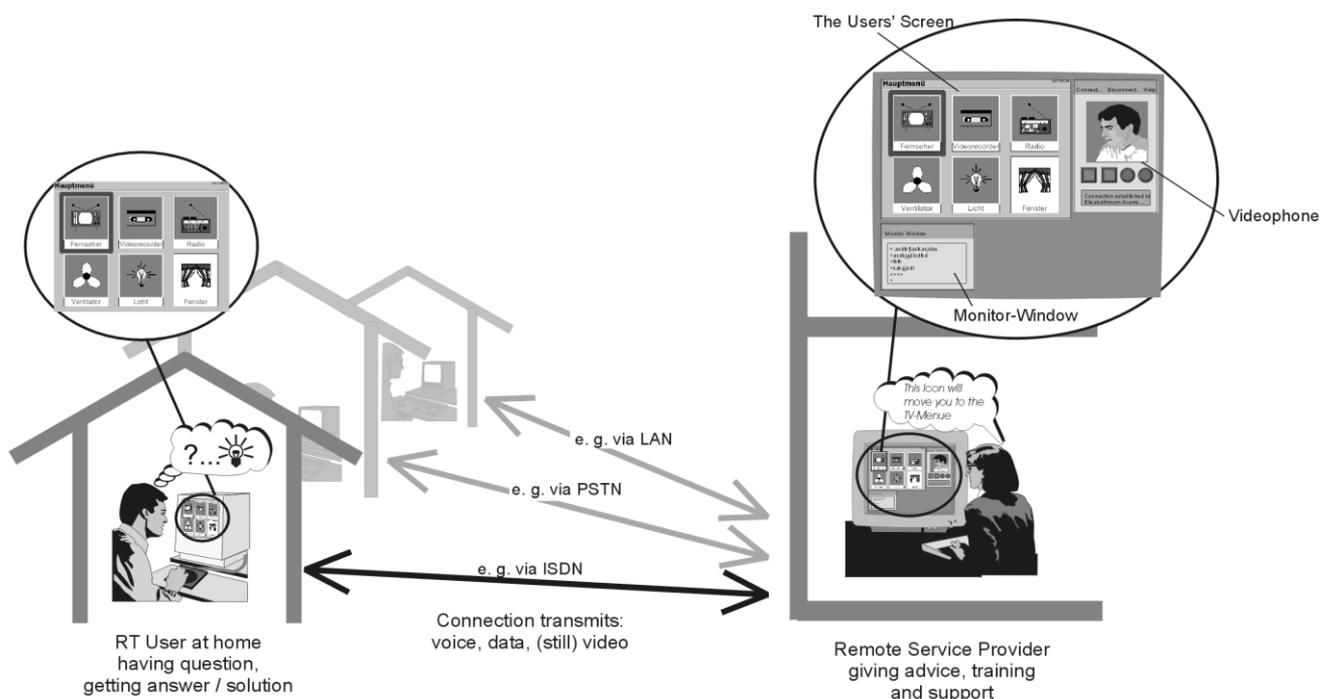
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Analysis of the provision process shows that purchasing and installing an up-to-date RT system (as e.g. the AUTONOMY system) is definitively not the end, but much more the starting point of a process of continuously tailoring the system to the ever changing needs of the individual patient who is the user of the RT device. In many cases the carers (nurses, therapists, teachers, 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, the actual use of RT systems like communication aids and environmental control devices 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. This was the motivation for launching an R&D project called RESORT (Remote Service of Rehabilitation Technology) aiming at the design and development of a prototype tele help and tele support system especially tailored to the needs of disabled persons and their carers. In this way the RESORT project contributes to the emerging area of tele rehabilitation.

## 2. Methods

### 2.1 Concept of RESORT System



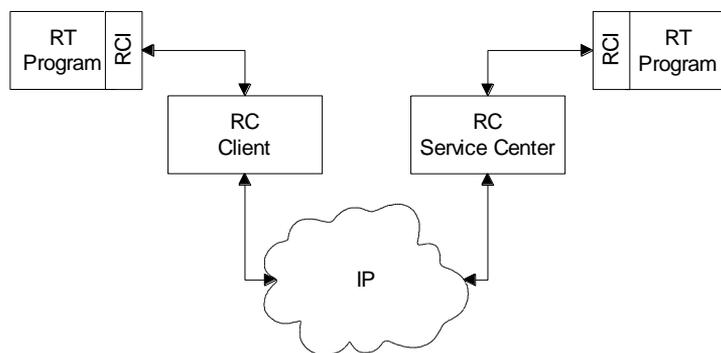
**Figure 1. Remote service provision for PC based RT systems. Overview of RESORT system structure: On the left hand side the RESORT Client PCs (at special schools, rehabilitation centres, at residential areas, private home, ...), on the right hand the RESORT Service Centre. In between the Network (LAN, ISDN, cable,...).**

The RESORT prototype system developed by the EU's DE-4208 RESORT consortium 1998-2001 consists of a service centre software and a client software connected by an IP based network. RESORT provides the following functionality: (a) RCI (Remote Control Interface) for "real time synchronisation" of two RT systems, one with the disabled user and one at the location of the service provider, (b) easy-to-use scaleable User Interface, (c) real time communication and interaction: audio, video and text, (d) database access, (e) file transfer, (f) synchronisation of local and remote file systems, (g) platform independency and (h) security. It offers three different modes

of operation: (1) hands-free audio communication between user and service provider with optional video link, (2) student-teacher mode for real time synchronisation of RT systems which is important for single switch users over links with narrow bandwidth and (3) tele-service-mode for technical maintenance.

## 2.2 System Design

The RESORT 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 interactions can be varied within a wide range.



**Figure 2. Remote Control Interface (RCI) between RT software application and RESORT Controller (RC) software running on client side and on Service Centre side. The specification of remote service API [14] allows to integrate an RCI into already existing RT software products**

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 [11] 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 text-chat, (b) to the database, (c) to the RT system and (d) via network interface to the remote RC. IP serves as network protocol. The RESORT system 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, etc. More details can be found in [4], [14]. Two different but compatible RESORT prototypes were implemented. The first one was written in Sun Java 1.3 and was released in 2000. In 2001 a second prototype was written in Delphi and now is downloadable as evaluation kit [4]. In order to test and demonstrate the benefits two already existing RT systems [10], [15] have been equipped with RESORT interfaces. The prototype system was demonstrated in several workshops, additionally real life tests have been carried out [14].

## 3. Results

The results from the real life tests have shown 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.



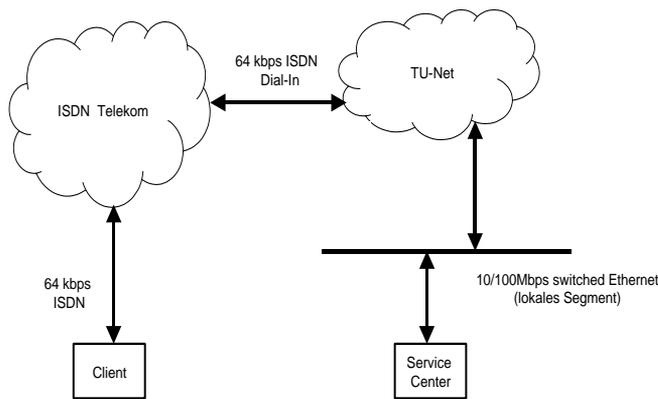
Figure 3. Screen Shot from a RESORT Client during a Tele-Service session in Vienna. A non-speaking head stick using person runs an environmental control and communication system called AUTONOMY [15], [17] which is equipped with a RESORT Interface. The service centre can be called from inside the AUTONOMY system



Figure 4. Screen Shots from RESORT Service Centre during a Tele-Service Session. Left picture shows controls for video and text communication, right picture contains controls for remotely starting and terminating RT applications at the client side

During trials with the Resort system features like the live video and the audio link gave most of the potential users a feeling of security. Getting a picture from the person who is actually helping me to fix my problem is a very important point for the client but also vice versa it can be helpful for the

operator at the RESORT service centre to see the client. It can be recognized if the user is perhaps confused or makes an impression of being stressed by the current situation. Certainly the user has to be able to decide himself or herself if the video is transmitted to the service centre. The default mode is that the video from the service centre is enabled and the video to the service centre is disabled.



**Figure 5. Network structure (64 kbps uplink from client to university network) of a long term real life test setting. Different versions of the RESORT prototype software have been tested with a head stick using non-speaking person in Vienna. This real life test started end of year 2000 and is still on-going using the latest RESORT software version which can be downloaded from [4]**

Especially for novice or not so experienced computer users application sharing could be very helpful but is certainly one of the most risky features of the system. Abuse could cause serious damage to a clients system or private information could get to not admitted persons. At the other hand a problem on the computer may be solved in a few minutes what usually would take a technician some hours to travel to the customer (certainly charging for the travel costs). The users also experienced a very good learning effect: While the operator in the service centre modified settings of the RT software they could follow the actions on their own display. In the case the problem was fixed by a technician on location this effect was not so good. Generally, as final conclusion it could be said that tele-help and remote service systems would get more and more interesting (especially trough the new high speed network systems) and have several advantages for the users. The feedback from the users also shows that such systems are really requested by them.

**Table 1. Field Trials carried out in December 2000 with RESORT Prototype System I (Java based version v3.13.) A non speaking severely motor disabled person using an AAC and environmental control system was remotely supported via RESORT (see Fig.5). Network: 64 kbps ISDN dial up to university network.**

| # | Date     | Duration [Minutes] | Successful Completion | Problems                                    |
|---|----------|--------------------|-----------------------|---|
| 1 | 11.12.00 | 45                 | no                    | major                                       |
| 2 | 11.12.00 | unknown            | no                    | major                                       |
| 3 | 13.12.00 | 20                 | yes                   | none  |
| 4 | 13.12.00 | 25                 | partly                | instability occurred and terminated session |
| 5 | 13.12.00 | 15                 | no                    | major                                       |
| 6 | 15.12.00 | 45                 | yes                   | none  |
| 7 | 21.12.00 | unknown            | partly                | instability occurred and terminated session |
| 8 | 21.12.00 | unknown            | partly                | instability occurred and terminated session |

**Table 2. Field Trials carried out in December 2000 with RESORT Prototype System I (Java based version v3.13.) A motor disabled wheelchair bound person using an environmental control system was remotely supported via RESORT. Network: cable.**

| # | Date     | Duration [Minutes] | Successful Completion | Problems |
|---|----------|--------------------|-----------------------|----------|
| 1 | 11.12.00 | 30                 | yes                   | minor    |
| 2 | 11.12.00 | 45                 | yes                   | none     |
| 3 | 12.12.00 | 5                  | no                    | major    |
| 4 | 13.12.00 | 50                 | yes                   | none     |
| 5 | 15.12.00 | 20                 | yes                   | none     |

**Table 3. Five Sessions (between December 2001 and Mai 2002) from an on-going field trial with RESORT Prototype System II (Delphi based version 0.5.x.x) over 64 kbps ISDN dialup link. This long-term trial (see Fig.5) is still on-going. Currently, August 2002, the version number of RESORT tele-help system is v0.6.1.2. An evaluation software is available on <http://www.fortec.tuwien.ac.at/resort>.**

| # | Date     | Duration [Minutes] | Successful Completion | Problems | System Version |
|---|----------|--------------------|-----------------------|----------|----------------|
| 1 | 24.10.01 | 48                 | yes                   | none     | 0.5.1.2        |
| 2 | 12.12.01 | 9                  | yes                   | none     | 0.5.1.2        |
| 3 | 12.12.01 | 11                 | yes                   | none     | 0.5.1.2        |
| 4 | 18.03.02 | 5                  | yes                   | none     | 0.5.3.10       |
| 5 | 03.05.02 | 13                 | yes                   | none     | 0.5.4.15       |

Table 1 and Table 2 show the results of first tests end of year 2000 reflecting severe instabilities due to early prototype status of the software. The reliability of software could be improved and therefore the amount of successfully completed increased which allowed to come up with an operational version in year 2001, test results are documented in Table 3.

#### **4. Discussion**

The RESORT prototype system demonstrated a multitude of benefits which will help to overcome existing barriers in the field of RT service provision. One important aspect is security and data protection. It is absolutely necessary for the user to have the possibility to decide what he/she allows or not and that the tele-help session could be terminated immediately if there is the impression that something is going wrong. Another point is the education of the service center operators and maybe the usage of network encryption technology to ban attacks by thirds. In parallel to the RESORT prototype software the RESORT protocol has been developed and documented. A remote service API allows other manufacturers to adopt the RESORT protocol for their products in order to benefit from tele-support functionality [4], [14]. An evaluation version of the RESORT software package is available from RIG home page [4]. Ongoing research and development is done under the umbrella of the RESORT Interest Group (RIG). 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 and tele-rehabilitation. Interested parties are invited to visit the RESORT home page [4]. In mid of year 2001 first part time service centres have been set up at TU Wien and at an Austrian SME. RESORT not only aims at technical service delivery but also at pedagogic and therapeutic support via the telematic channel. Tele-Support and Remote Service Provision is an encouraging area in the field of RT and tele-rehabilitation which will improve significantly the quality of life of disabled persons.

## 5. Acknowledgement

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