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Robotics for rehabilitation — a European (?) perspective

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SUMMARY

Rehabilitation Robotics (RR) is a challenging field with a high potential to support people with severe disabilities in their daily life. In the past years this field developed in Europe with a European dimension. European consortia have been supported in technical development and investigations. Also, several robotic aids have been sold and installed in Europe and support end users in their daily life. However, the breakthrough on the market is still outstanding. This paper tries to draw a picture of the RR situation in Europe and discusses aspects to move forward. Particular reference is given to TIDE (Technology Initiative for Disabled and Elderly people of European Union) and the special interest group on RR (SIG-1) of the AAATE (Association for the Advancement of Assistive Technology in Europe).

KEYWORDS: Rehabilitation robotics; European aspects; TIDE; Robotic aids.

BACKGROUND

The use of robotic devices in rehabilitation by persons with disabilities is one approach to solve indivdiual ADL (activities of daily living) problems. The objective is to support people to perform tasks in their daily lives at home or at work. Their aim is to gain more independence and control with considerable improvement of quality of life. It has been on the agenda for a certain time and stepped over from pure vision and imagination to reality, though initially with a lack of appropriate technology. Meanwhile experiences from the field of industrial robots, space robotics and service robots demonstrate the actual power of robot technology today and industrial robots are in widespread use. Only two rehabilitation robots have reached noticeable sales numbers on the market: the Handy I, and the MANUS,[1–3] both developed and manufactured in Europe. The Handy I was originally designed as a support to eating with 5 DOF operating at desk level. The MANUS is a wheelchair mountable arm with 6 DOF (or optional 7 DOF) anthropomorphic design and a workspace from the floor up to a standing person's reach. However, rehabilitation robotics (RR) is penetrating the market very slowly and still is seen to be a future technology by many people, at least in Europe. Obviously, other aspects and factors besides technology need to be considerd to implement good robotic solutions for real life situations. Rehabilitation robotics has to compete with a manifold of approaches, both technical and assistance based, to solve the ADL problems of people with disabilities and elderly people. The rehabilitation robotics field in Europe, although technically well advanced, suffers from being quite an isolated group of developers and users, with no infrastructure for presenting their results to a wider audience of potential beneficiaries. In the scope of TIDE one area of R&D is concerned with manipulation and control systems including rehabilitation robotics. Projects in RR are seen particularly critical in terms of outcomes and results for the end-users.

RESEARCH AND DEVELOPMENT OF EUROPEAN DIMENSION

As research results are presented in various contributions in this special issue, this paper presents just a brief summary of the current research with European dimension. The R&D in RR received some stimulation through the European research and development programmes ref.[4,5] Many of the national activities joined to form consortia with a European dimension. This is of particular relevance in looking for markets and economy of scale. Other stimuli came from the technology side, where people from the robotics area just searching for grants, stopped at the RR application. Of course it is a positive development to catch the edge of technology in this application area. On the other hand it might be a certain danger losing credibility towards end-users and payers. Some of the technology projects indeed suffer in the eyes of end-users from using expensive machines and technologies, being very much technological resarch oriented, and being not affordable in real life in the next 5–10 years. We are still waiting for mainstream robotics companies or traditional rehabilitation technology industries to foster this application.

The main R&D projects of European consortia in this area (excluding smart wheelchairs and automated guided vehicles) are listed in the table:

Table 1 Examples of European Projects in Rehabilitation Robotics

Acronym	Programme	Status	Robot
EPI-RAID	TIDE	finished	RTX
FOCUS	TIDE	ongoing	MANUS
Hospimaid	Value	finished	new
Immediate	Sprint	finished	MANUS
M3S	TIDE	finished	MANUS
MARCUS	TIDE	finished	robotic hand
MOBINET	TMR	ongoing	diverse
MOVEAID	TIDE	ongoing	new
RAID	TIDE	finished	RTX
RAIL	BIOMED	ongoing	Handy 1

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RAID[3] and EPI-RAID dealt with a robotic workstation for office tasks. The work was influenced mainly by the French MASTER and English CURL[6] development. M3S,[5] FOCUS,[7] and Immediate deal with the integration of a MANUS with other aids such as wheelchairs, input/output devices etc. MOVEAID[3] and HOSPIMAID are closely connected to the Italian URMAD[8] project. RAIL deals with improvements and new applications for the English Handy 1. MOBINET,[9] is a networking activity which tries to bring together researchers from different European countries and backgrounds for the improvement of the multidisciplinary understanding of the RR area. Many of the European RR actors are involved, but also some researchers from mainstream robotics.

Of course many national, mostly University based activities[10] are on the way which focus on technical improvements and transfer of mainstrteam developments. They are often connected to theses work of students.

MARKET OF RR

Rehabilitation robots can be applied for vocational rehabilitation in sheltered workshops as well as in normal offices or factories. They can also be used at home, for supporting daily living tasks or for assisting teleworking. Robots can be combined with assistive devices for personal mobility (e.g. electrical wheelchair) and thereby can enhance the benefits of personal mobility. Furthermore they can be used in educational or clinical applications. There are about 70 million people with disabilities in the EU. Assuming that 1% are potential robot users, and 1% of these buy a robot each year, this would lead to a total sales of about 7,000 robots per year. However, there are established alternatives to robotics: environmental control systems, smart homes, dedicated assistive devices, human carers and assistants do tasks or services that could be performed by rehabilitation robots.Therefore, in contradiction to the simple calculation above, the number of rehabilitation robots currently in service in the EU is estimated less than 200 (less than 10 manufacturers). A much more detailed demographic estimation is required where an exmaple for the USA is given (for example, reference [11]).

Many other factors limit the current market success. The potential users and also most of the rehabilitation advisors do not know the capabilties of robots or are not even aware of the existence of rehabilitation robots. Elderly people are often afraid to use technology personally and do not think that they can cope with a high-tech device. The notion “robot” has a negative image to some people and suggests an automatically working machine (science fiction). Despite the compex and high tech nature of RR often the human-machine interaction is the subject of criticism[12] (and consequentlly the subject of many development activities[4,13]). On this background the purchase decision is influenced mainly by the expected value of the solution. This can for example by estimated by the hours of independence gained by its usage, expressed in perceived utility or in perceived costs saving. Several quite different people or organisations have to come to an agreement before a rehabilitation robot can be bought. The reimbursing organisatinos are usually not familiar with this kind of new technology and therefore they are not convinced of the benefits of medical/rehabilitation robots. It is in general difficult to get new products to the list of technical aids. The costs are perceived as too high. Furthermore the high service level is usually a problem for the providers of rehabilitation robots because they are small companies with limited focus on service and support. Mostly they cannot sustain a wide service network.

Therefore, in public RR is recognized overall as a technology playground for university and academic people. The RR community was not at all able to correct this distorted picture. Too much technology enthusiasm and too little evidence for usability and benefits have been provided and disseminated so far. Instead to just concentrate on further – certainly needed – technical developments the RR field would be better supported by a systematic and user oriented market analysis. Although some evaluations and studies have been undertaken (for example referes [14, 16]), we still need to analyse the real benefits and disadvantages of systems in service, we need to better understand who our users are and what they actually need. We need to make clear and disseminate in which cases robotic solutions are superior to other solutions and explain why. And we need to define the rehabilitation robotics market in terms of technical options, number of units, sales and after-sales service structures, business and profits. (Many of the issues are comparable to the situation of general service robots.)

NEW EUROPEAN INITIATIVE

With FERR (Forum for European Rehabiltiation Robots)[3] European players started to intensify discussion of non-technical issues of RR. Objectives of FERR have been to promote information exchange and co-operation between existing development teams and users, to provide a forum for a wider cross section of industrial organisations, rehabilitation specialists and users, to increase public awareness of the availability of this technology, to reduce barriers to wider dissemination, including issues of pricing and reimbursement, and to promote the development of infrastructure for service and support. The following issues have been addressed during the 1st FERR workshop:

- market infrastructure for distribution, service and training,
- training of users and professionals,
- usability of existing systems,
- awareness and public image,
- priorities for the future and future co-operation.

The FERR exhibition, where most European systems have been presented, clearly provided evidence that joint actions can support the rehabilitation robotics market development. The reaction of the public was very positive. The aim to transfer a realistic picture of current rehabilitation robotics was obviosly achieved. To keep the momentum of FERR, in 1996 the special interest group on RR was established under the umbrella of AAATE (Association for the Advancement of Assistive Technology in Europe). As AAATE is a non-

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profit organisation and only personal membership is possible, the objectives do not focus on commercial issues, but on usability, market, education, and R&D. The SIG-1 as a whole wants to concentrate on horizontal issues and foster information exchange and partnership amongst the members. As a platform a homepage[17] of the SIG-1 was installed (AAATE SIG-1 homepage: http://homepages.enterprise.net/dallaway/aaate-sig1/) and decided to link to SIG-1 member pages through the Rehabilitation Robotics Jumpstation (http://homepages.enterprise.net/dallaway/rrjump). The AAATE SIG-1 will take responsibility for a robotics events on future AAATE conferences, with the main emphasis being to disseminate information about rehabilitation robotics to people from the assistive technology field in general.

Looking at the active RR community as a whole we recognise that it is just a small number of universities, research institutes and companies dealing with the subject world-wide. Aslo we notice that only a few hundred installations in service exist up to now. It is not likely to face a major breakthrough in the market soon. So the question arises, whether we would act more efficiently by adopting a more global view on rehabiltiation robotics.

SUGGESTIONS TO MOVE ON WITH RR

During FERR the participants developed a scheme of collaborative action (see Figure 1) as a starting point for future action in Europe.[3] We all hope to implement parts of the scheme in future phases of TIDE on European scale. However, probably some of the ideas could be also considered with a more global view.

- rehabiltiation robot reference/demonstration centres covering EU to measure economic benefits of the robots, to demonstrate applications, and to identify suitable users
- building up of a sales network for all rehabilitation robots
- building up of a service network for all rehabilitation robots
- organising seminars on: state of the art presentations, user needs, ergonomic design, user training
- performing robot road-shows of all rehabiltiation robots
- organising of a “Rehabilitation Robotics User Group”
- identifying funding agencies and methods in different states
- bulding up a simulation system of rehabilitation robots for assessment of potential users by means of virtual reality.

Further a number of discussion points have been brought up with potential to improve the situation fo RR in the market.

- It could be emphasised that “rehabilitation robots” are aids under the full control of the user. This might help to overcome the initial threshold to consider this type of technology as a solution. A formal validation of rehabilitation robots could also help to inform potential users about applicability and usability. In this context it is recommended to link with existing users of rehabilitation robots to permit peer counselling and improve individual benefits.

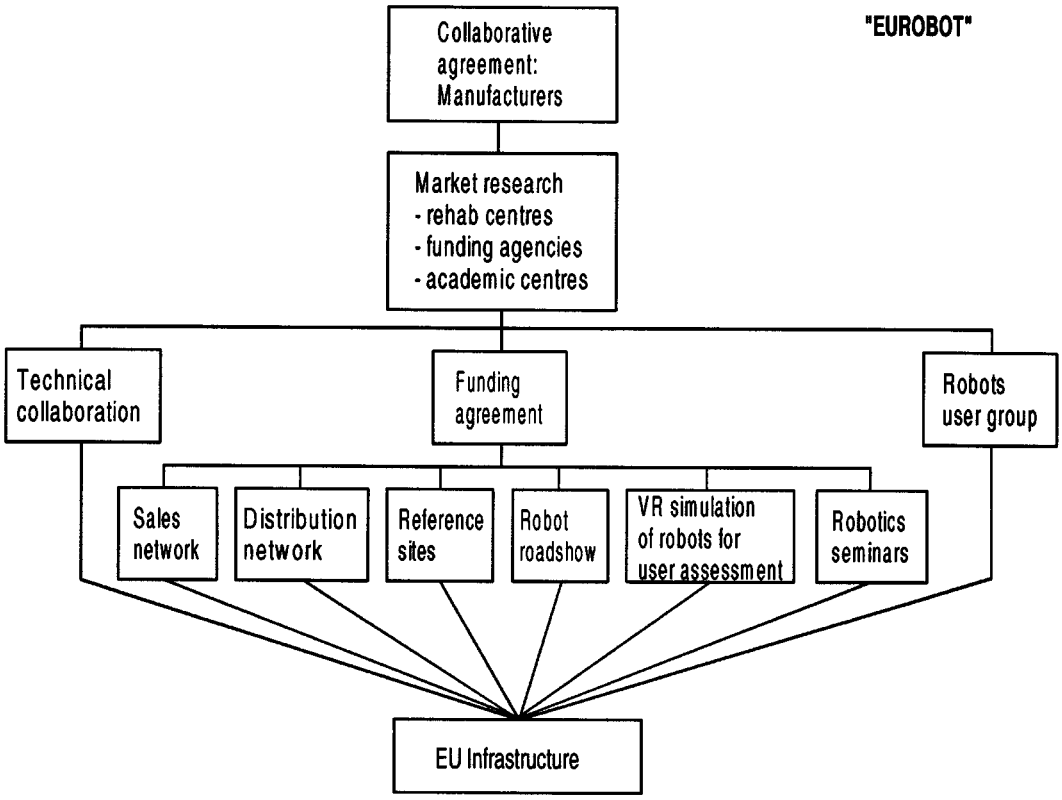

Fig. 1. Eurobot, ideas for collaboration action.

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- So far robots have usually been sold. However, leasing can be a good alternative for a customer to approach this new and widely unknown robot technology with less commitment. Renting instead of buying could help to decrease the risk that a rehabilitation robot cannot be used effectively in the long run by a person. In order to increase the market, also people with temporary impairments and elderly persons should be recognised as customers. Of course they may have distinctive needs. The cultural differences in rehabilitation support certainly should influence the approach for marketing in the respective country.
- When introducing new technologies to customers, it is important that the providers are close to the users to give them the feeling of safety and confidence. This implies that rehabilitation robots have to be sold and maintained by local or regional companies or by companies with good service networks. Reference partners could serve to demonstrate the usefulness of rehabilitation robots to potential users. A well-known "good name" of a (big) company could help to introduce rehabilitation robots in a country. Another approach could be to create joint ventures of large companies and small to medium size enterprises (SMEs) to build up a network for development, sales and service. Possibly a big company could be created from several small companies.
- There is much experience and technology in the mainstream robotics field. The main emphasis should therefore be invested to transfer existing technology into the RR area. The development of sound and usable applications seems to be a promising strategy.

CONCLUSION

From a user-oriented point of view it is time to bring the benefits of RR into practice: proven RR needs to come out of the research labs. Technology transfer from the areas of industrial and service robotics needs more attention. We also should move to a progressive strategy to approach the public opinion and convince decision makers by providing evidence of the value of robotic solutions. Only this transition can justify RR research funded by disability grants. Without this transfer disability reserach money will fund other areas and RR will need to be funded from pure technological resources.

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