Robot and Play – from Assistance to Mediation

Gernot Kronreif
PROFACTOR Research and Solutions GmbH
Advanced Service Robotics
A-2444 Seibersdorf, Austria
Tel: +43-7252-885-970
gernot.kronreif@profactor.at

Barbara Prazak-Aram
Austrian Research Centers GmbH
Smart Biomedical Systems
A-2700 Wr. Neustadt
Tel: +43-2622-69290
barbara.prazak@arcsmed.at

ABSTRACT
Playing is an important part of daily life interactions as well as a substantial and joyful part in the life of children. It can be relaxing, exciting - children can play a role and it is an important possibility to get in touch with other children. In a long term field study the authors have evaluated a robot system which supports severe physically disabled children when playing with LEGO-bricks. The very positive feedback of this study and the promising results of related work at other institutions set the basis for a new research study on the use of robotic systems as mediators during playing activities. The paper describes the motivation of this work, gives a short description of the previous work with the PlayROB system developed by the authors as well as of the new research project IROMEC.

Keywords
Assistive technology, human-robot-interaction, robot-assisted playing

1. INTRODUCTION
Play is then considered one of the most important aspects in a child's life, a parameter to be considered for assessment of children's "Quality of Life". On the other hand, children with cognitive and/or physical disabilities only have limited possibilities for interaction with social and material environment.

Based on a related study accomplished by the authors [1], the question arose whether a remote controlled robot system could be able to assist severe physically disabled children when playing with toys. The main opinion derived from interviews with therapists and parents was that children with physical disabilities cannot have the same interaction experiences which able-bodied children have. In most cases they are not able to manipulate real objects – they very often need a person who can complete actions through the child's orders. Resulting from this lack of experience the disabled children often have to suffer from a second handicap – in most cases a developmental delay. Most of the therapists and parents are in complete agreement that the use of new technology (for playing and learning) offers benefits for this target group. However children should play and learn – at least in the early stages of development – in real environments, as this is seen as the basis for a good performance in the virtual world (PC-based play and learning) as well. A main wish expressed during the interviews is that the target group should receive more opportunities for doing activities independently. Technical toys can be a reasonable solution for this user group. Such a setup should give the experience to move objects and initiate actions in their own environment.

2. RELATED WORK
For the (robot) toy market several systems are commercially available, e.g. AIBO robot dog from Sony Inc., MyRealBaby from Hasbro, or MINDSTORMS from LEGO Inc. These systems are moderately successful as toys and also sometimes used for educational purposes. Previous experience however has shown that these kinds of systems are limited for the intended use in a playing scenario with severe disabled children.

Other ongoing research projects are investigating different setups and interaction possibilities between robot and human(s) in the framework of "personal robots", like the NEC Research laboratories developing the personal robot PaPeRo to become a "family member". Similar work – but more related to Human-Robot-Interaction (HRI) – can be observed in different research laboratories world-wide. MIT Media Lab – for example – is working on the interaction aspects for sociable robot systems in a laboratory setting; a recent study is aimed for weight management for people who have lost weight and want to keep it of. The published results demonstrate that this kind of HRI work with typically developing children or adults cannot be directly applied to the area of assistive technology. For example, work at ATR with Robovie, as well as other work, has shown that interaction levels with children decrease over repeated exposure.

Other related research by Takanori Shibata at AIST and collaborators (seal type robot PARO) has shown first promising results in using an interactive robot in therapy for children and support for the elderly [2] – a similar approach is by Omron with their NeCoRo robot system, and Michaud et al. who are designing robots for child-development studies [3]. Dautenhahn et al. has investigated since 1998 the role of robotic toys in therapy and education of children with autism [4] demonstrating that a robot can potentially play a useful therapeutic role encouraging basic social interaction skills (e.g. joint attention and imitation), as well as using the robot as a social mediator facilitating interaction with peers and adults.

In the area of robot-assisted playing early research was done by Cook et al. [5]. In a series of experiments they analyzed how children with significant physical disabilities could use a robot arm to interact in a play and exploration activity. Smith and Topping [6] reported about commanding a robot for a playful scenario using single switch scanning. Howell et al. [7] presented a robotic system installed at an elementary school utilized for science instruction. Davies [8] described a prototype for a "playing robot" which aims to give assistance during either a painting or a building scenario. The common theme for all of these scenarios is to use the robot for improved interaction with and exploration of 3D objects. The robot assisted playing interaction with a standard toy presented in the present paper can be seen as further extension of that concept. As the main focus of the playing/ learning setup is on spatial ability, LEGO™ bricks were selected as toy.

3. ROBOT SYSTEM "PLAYROB"

"PlayROB" is a remote controlled robot system which aims to assist the severe physically disabled child during play (Fig. 1). The main idea behind this system is that – different to many other approaches - the robot should serve as an assistant only. The way of playing is defined by the child which ensures maximum autonomy. The robot is not the toy – but the robot assists in using the toy, which leads to a "Robot Assisted Playing" setup. Using the functionality of such a robot system, the user is now in the position to manipulate real objects (toys) in the real world, despite of her/his impairment.

Figure 1. Robot system "PlayROB".

For a long-term field study, six PlayROB systems have been installed at selected schools and therapy institutions in Austria since winter 2004. At each of the three sites, about 5-10 children are using the PlayROB system on regular basis. All of the users are showing significant physical handicaps – in most cases together with different degree of mental retardation. Most of the pupils are not able to speak.

For the desired evaluation of learning effects the following parameters are being recorded for every playing session:

- Duration of playing session
- Number of used bricks and number of different brick types
- Time required for brick placement (bricks/min)
- Utilization of the playground area (%)

The results obtained during this field study are very convincing. Most of the children show significant advancement in terms of endurance and concentration, but also of spatial perception. Furthermore general improvement of motivation during the lectures is been identified as result of the work with PlayROB. The robot system also is turning out as optimal tool for training with input devices – children are learning different features of the particular input device in a playful environment and with high motivation. To sum it up: using the robot is recognized as "learning with great fun"!

4. RESEARCH PROJECT "IROMEC"

Similar to the PlayROB project described above, IROMEC targets children who are prevented from playing, either due to cognitive, developmental or physical impairments which affect their playing skills, leading to general impairments in their learning potential and more specifically resulting in isolation from the social environment.

A novel framework for robotic social mediators will be developed and evaluated by means of a dedicated robot setup in the context of therapy and education. The research focus of IROMEC is on the user oriented definition of appropriate play scenarios, development of evaluation methods, and finally on the definition of robot behaviours and interaction modes. IROMEC will investigate how robotic toys can provide opportunities for learning and enjoyment. The developed robotic system will be tailored towards becoming a social mediator, empowering children with disabilities to discover the range of play styles from solitary to social and cooperative play. Robustness, dependability as well as "plug&play" operation of the robot system are specially addressed.

One of the major aspects of IROMEC is the study of the role of a robot as an enjoyable toy and a social mediator which is widely unexplored and has so far only be demonstrated in very small-scale pilot studies. Further, the project is emphasizing on the development of a dedicated framework encompassing a wide range of children with different kinds of disabilities, rather than purely focusing on specific user groups. Results of IROMEC will aim to generalize research on robot mediated play in a social context across different scenarios and user groups. The research focus of IROMEC is on the user oriented definition of appropriate play scenarios which cover all phases of play, the definition of robot behaviours and interaction modes resulting from these scenarios, integration of appropriate communication and control technology, and consequent application of a "plug&play" strategy.

Partners in IROMEC project are PROFACTOR Produktionsforschungs GmbH (AT), University of Hertfordshire (UK), Robosoft SA (FR), Institute for Rehabilitation Research (NL), University of Siena (IT), University della Valle d'Aosta (IT), Toy Research Institute (ES), Risoluta SLL (ES) and Austrian

Research Centers GmbH (AT). More information is available at the project homepage www.iromec.eu.

5. ACKNOWLEDGMENTS

Realization of the six “PlayROB” systems mentioned in this paper was partly funded by Austrian charity organisation “Licht-ins-Dunkel”. The authors also acknowledge the contributions of Andreas Hochgatterer, Michael Meindl and Wolfgang Ptacek as well as of the three participating institutes “Waldschule” (Wiener Neustadt), “Institut Keil” (Vienna) and “Vereinigung zu Gunsten körper- und mehrfachbehinderter Kinder und Jugendlicher” (Vienna).

EU project "IROMEC" (Interactive Robotic Social Mediators as Companions) is being co-funded by the European Commission in the 6th Framework Programme under contract IST-FP6-045356.

6. REFERENCES

[1] G. Kronreif, et al., “Robot Toys for Severe Physically Handicapped Children”, Proc ICORR 2003, Daejon, Korea, pp. 282-286, April 22-25, 2003

[2] Marti P., V. Palma, A. Pollini, A. Rullo, T. Shibata “My Gym Robot”, Proceedings of AISB05 International Symposium on robot companions: hard problems and open challenges in human-robot interaction, April 2005.

[3] Michaud F., Laplante, J.-F., Larouche, H., Duquette, A., Caron, S., Masson, P. “Autonomous spherical mobile robot to study child development”, IEEE Transactions on Systems, Man, and Cybernetics, 2005, 35(4): 1-10.

[4] Robins B., K. Dautenhahn, R. te Boekhorst, A. Billard “Effects of repeated exposure to a humanoid robot on children with autism”, in S. Keates, J. Clarkson, P. Langdon and P. Robinson (Eds.) Designing a More Inclusive World, Springer Verlag, London, 2004, pp. 225-236.

[5] A.M. Cook, K. Howery, J. Gu, M. Meng, “Robot enhanced interaction and learning for children with profound physical disabilities”, Technology and Disability 13, pp.1-8, 2000

[6] J. Smith, M. Topping, “The introduction of a robotic aid to drawing into a school for physically handicapped children: A case study”, British Journal of Occupational Therapy, 59 (12), pp. 565-569, 1996

[7] R.D. Howell, S.K. Damarin, E.P. Post, “The use of robotic manipulators as cognitive and physical prosthetic aids”, Proc RESNA 1987, pp. 770-772, San Jose, June 19-23, 1987

[8] R.C. Davies, “The Playing Robot: Helping Children with Disabilities to Play”, Proc DARS 1995, pp. 71-76, Vienna, Austria, September 19-20, 1995