Interdisciplinary research collaborations and learning processes of engineers and social scientists during the development of a robot for seniors in Europe

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ABSTRACT: In a Europe-wide project called Adaptable Ambient LIving ASsistant (ALIAS), engineers and social scientists have been working together to develop a robot that guarantees improvement in the quality of life for seniors. The seniors have been part of the development process from the very beginning. Feedback processes between seniors, social scientists and engineers, have assured that the wishes and attitudes of seniors were included in the development of the robot. This permanent user-inclusion ensures that the needs and preferences of seniors are being integrated during the process. Furthermore, the engineers and social scientists obtain an added value through the interdisciplinarity of the project. In addition, learning effects are being generated because of the close cooperation between the various working groups. The project, in principle, and the interdisciplinary work, in particular, have been built in to this article.

INTRODUCTION

The development of demographic change is closely connected to changing social demands. In general, the average age of the population in Germany and Europe is increasing [1]. At the same time, there is a singularisation in age, especially for women [2]. This means that the number of older people, especially women, living alone (at home) is increasing. Technical solutions may support their quality of life in old age.

The objective of the Adaptable Ambient LIving ASsistant (ALIAS) project is the product development of a mobile robot system that interacts with senior users, monitors and provides cognitive assistance in daily life, and promotes social inclusion by creating connections to people and events in the wider world. The system is designed for people living alone at home or in care facilities such as nursing or senior care homes.

The function of ALIAS is to keep the user linked to the wider society and in this way to improve her/his quality of life by combating loneliness and increasing cognitively stimulating activities. ALIAS is embodied by a mobile robot platform with the capacity to monitor, interact with and access information from on-line services, without manipulation capabilities. ALIAS is not designed to replace human-human contacts, but rather, to enhance and promote these through the proposed wide range of integrated services. By serving as a monitor, a cognitive-prosthetic device and a facilitator of social contacts, the ALIAS system will significantly improve the daily life of seniors [3].

DESIGN AND GOAL OF THE PROJECT

To account for the acceptance of a mobile robot system by seniors, one focus of the project relates to questions of social acceptance of robot systems in general and in specific within the named user groups. Therefore, the authors used specific methods of open innovation processes to integrate the users from the very beginning [4]. Several aspects of men and women, and similarities and differences between different age groups, lifestyles and life stages have a relevant impact on the development of products and their implementation. From the scientific view of gender relations, the analysis of causes and backgrounds of gender differences and their impact on social phenomena is highly valued. *Role models and social sanctions influence the cognitive processes of learning, learning motivation and success. These processes usually continue unconsciously for the individual person* [5].

Gender affiliation qualifies life situation, lifestyle, attitudes and action-guiding knowledge and, thus, differences in consumption patterns and, therefore, must be considered and integrated into the product development [6]. Depending on their recent personal way of life, the lives of humans vary considerably; for example, a few already have some experience with social media, others will never have [7]. Elderly people cannot be seen as a homogenous group, even if *the elderly* are usually addressed in public debate often as one group with common goals and interests. This is insufficient. Therefore, gender mainstreaming has been taken into account in the process of user integration from the beginning. Furthermore, women live longer than men. Life expectancy for new-born girls in Germany is now 82, of the new-born boys 77 years [8]. Retirement-age men still live predominantly in a partnership, while steadily amongst women, the proportion of living alone increases with age. This is a direct result of the significantly increased life expectancy of women [9].

Therefore, the consortium of the project consists of a well-balanced mix of highly experienced researchers, developers, business partners and one key user-group. The researchers of this project come from a range of disciplines. They range from computer science, electrical engineering and information technology to sociology, gender studies, pedagogy and so on. The interdisciplinary composition of the team not only ensures a high quality development process for the robot, but also contributes to learning effects within the team.

The link between engineers and social scientists also represents the added value of interdisciplinary projects in higher education. In this case, interdisciplinary refers to the use of approaches, attitudes or methods of different disciplines [10]. Due to the on-going collaboration and feedback provided by empirical results, the different employees gain insight into different sciences. In particular, this also has a positive impact on the qualification of PhD students and graduate students within the consortium. Thus, a permanent linkage and feedback within the team is ensured and can be seen in Figure 1, which depicts the design of the project ALIAS.

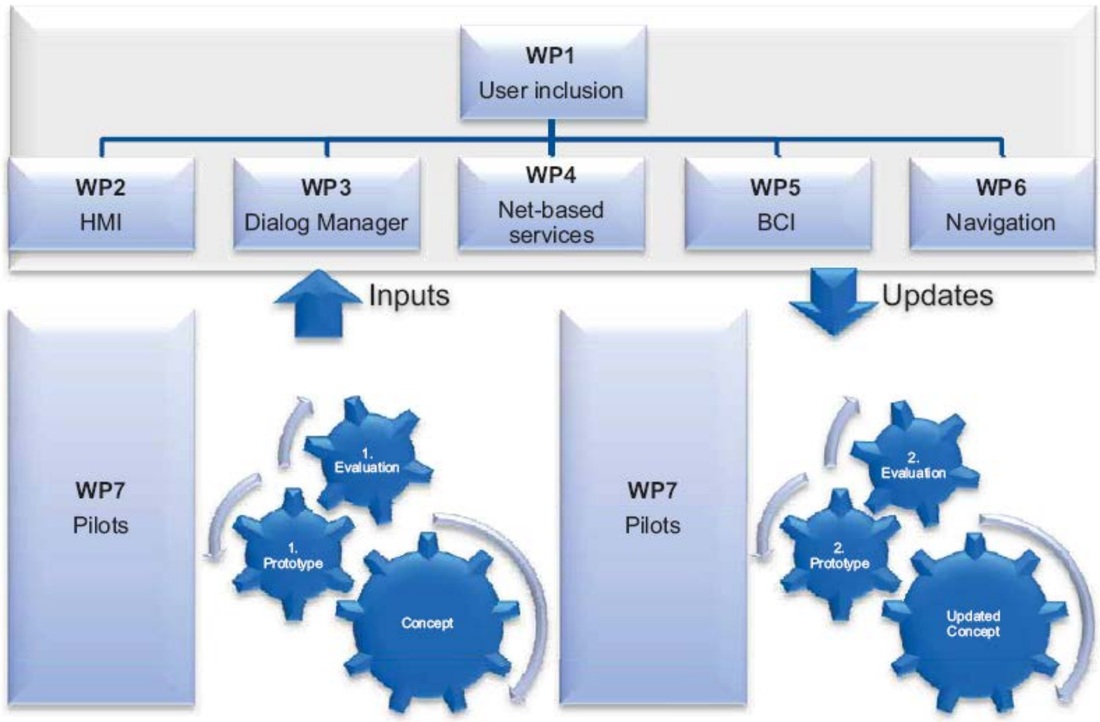

Figure 1: Design of the project ALIAS.

The consortium aims to integrate a commercial pilot that includes all state-of-the-art communication media, i.e. (video-) telephone with answering machine, television set, radio, music box and modern on-line services, e.g. chat tools, Skype, and Internet-browsing in the ALIAS robot. On top of the integration of existing solutions, three novel situations will be introduced:

1. A novel cognitive user interface concept is introduced to ensure a good usability and to avoid people fearing to do harm to the robot.
2. Proactive behaviour from the robot platform will ensure that the user stays in contact with his or her surroundings and gets mentally stimulated.
3. The third unique selling point is a Brain-Computer-Interface (BCI) that will be included in order to train and preserve the mental functions of the user.

By offering a fault tolerant, flexible and mobile communication gateway, including a user-adapted interface, ALIAS can preserve communication abilities between friends and relatives for a long time, which is essential for seniors' well-being. ALIAS will accompany the user over a long period and can be continuously adapted to the user’s needs caused by the ageing process. The hardware of the pilot will consist of already available hardware components, its design and software components will be elaborated with very close end-user inclusion in two practical phases. The time schedule of the project ALIAS can be seen in Figure 2.

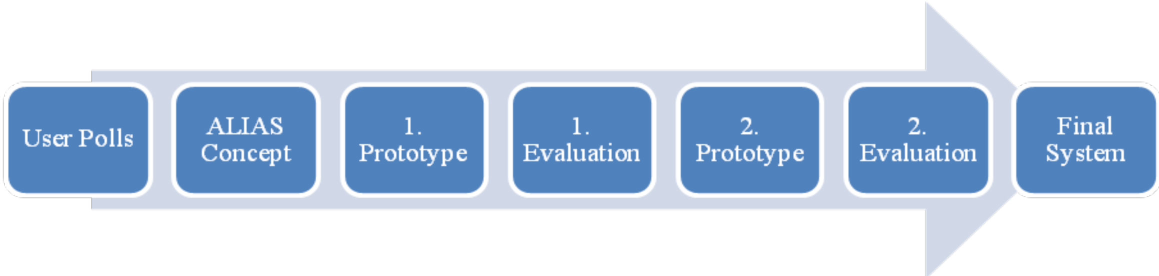

Figure 2: Time schedule of the project ALIAS.

From the start, user polls were used to help define the requirements and preferences of the senior target groups. The user polls took account of the diverse groups of seniors and the relevance of gender. Then, a proof of the concept to assess project vision was done, based on preliminary results. A first integration (first running prototype) with all components at reduced functionality if necessary, was submitted to a first end-user validation in summer 2011. Gender aspects were integrated (e.g. in speech recognition). This prototype was evaluated in field trials with seniors to identify the weaknesses and improvable components of the ALIAS architecture. With these results the second integration (second prototype) with all components and the user-feedbacks was developed and will be submitted to a second end-user validation, probably in October 2012. This prototype will also be evaluated in field trials with residents of a nursing home to identify the weaknesses and improvable components of the ALIAS architecture. The final step will be the development of the technical platform (final system) with all the results that were gained during the project.

THE INTERDISCIPLINARY APPROACH OF THE PROJECT

The consortium consists of several working groups and follows a two-fold iterative process. The working groups are staffed by employees from various scientific disciplines. The main task of the working group *User-Inclusion*, so called WP1, is the identification of the different preferences and requirements from seniors and their social environment, as well as providing scientifically support for the first and second user trial. In particular, gender aspects related to technical solutions are being considered. The feedback from users during the evaluation phases has a direct influence on the properties of the pilots and the final robot prototype. Another crucial point is that WP1 must deal with is the determination of the accessibility towards the seniors getting them in touch with the new kind of service robots. Here, gender is an important point, which needs to be regarded in order for an appropriate solution to be reached.

Therefore, secondary analyses, surveys and interviews with seniors and evaluation of the prototype of ALIAS were performed. The results of empirical studies (e.g. needs and preferences of female and male seniors towards a robotic system) were continuously fed back to the technical partners. All partners are informed of these results and they use them to set the robot to meet the needs and wishes of the heterogeneous groups of seniors, and develop and enhance the prototypes. The results of the further technical development again were reported back to the partners of the user inclusion team of WP1. With these results, tests (e.g. polls, workshops, information events and field trials) with the seniors were planned and conducted. These tests were also scientifically evaluated and gender aspects considered. The linkage between the various partners can be seen in Figure 3.

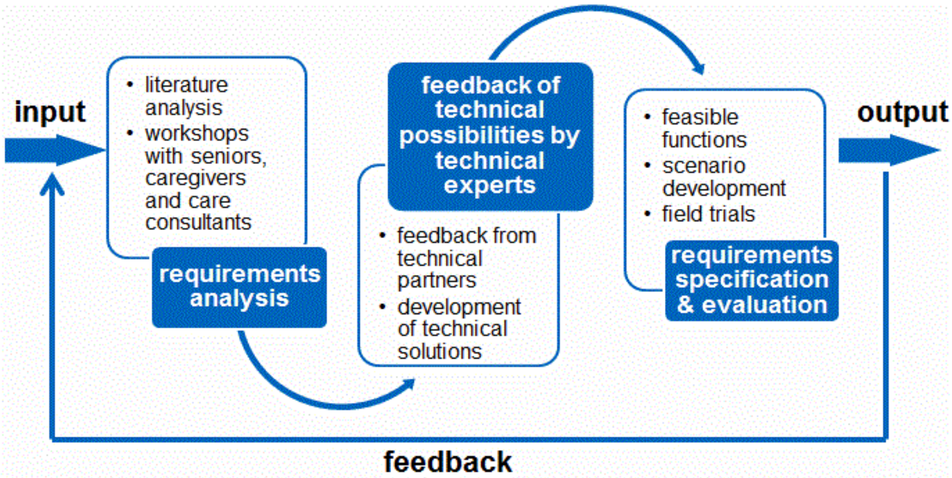

Figure 3: Connection and feedback between social scientists and engineers in the project ALIAS.

In general, a heterogeneous primary group (elderly people) was divided into relevant sub-groups. For example, the authors took into account the needs of people interested in technology, as well as people who never came into contact with any kind of technology, women and men, etc. After the completion of the pilot definition, all user wishes and preferences were fed in to the technical working groups as requirements. Table 1 shows an overview of the users' perspective.

Table 1: Design and functional requirements of the robot platform ALIAS.

Tasks	Specification
Support	Reading and writing support functions; ground lighting in the night, gentle night light
Health	Motivation to live healthily, health monitoring; information on health topics
Events, Hobbies, etc.	Information on cultural and leisure event; receiving and performing tips for entertainment from relatives; learning/teaching functions; TV-function, music (player), gaming
Communication	Telephone, e-mail, easy-to-use contact list; support of intergenerational communication; cross-lingual chat support
Usability and Design	Adjustable display; situational choice between voice, gesture and touch screen control; choice between female and male voices, etc
User Contact	Independent perception and recognition of the user, being a friend

THE ADDED VALUE OF INTERDISCIPLINARY PROJECTS IN HIGHER EDUCATION AND LEARNING EFFECTS AMONG ENGINEERS AND SOCIAL SCIENTISTS

Interdisciplinary learning in projects is a practical method for acquiring knowledge, skills and abilities from many disciplines [11]. An interdisciplinary environment may also awaken interest in other subjects [12]. Effects of synergy are also stated in other projects.

The interdisciplinary approach of the project also provides continuous development for the scientists involved. In ALIAS many PhD students and graduate students from different disciplines work together. They learn from each other at different points. The processes are not strictly separated but are linked. The development of the robot cannot happen without the feedback and incorporation of the results of the evaluation. Furthermore, the evaluation cannot be performed separately from the mobile platform. In the development of surveys and evaluations, the target group, as well as the technical side must be considered. For this reason, permanent close cooperation exists. The technical partners also provide input to the interviews. In addition, the engineers are becoming familiar with the technique of participant observation, as this research method is used for the evaluation of the field trials with the robot and the seniors. The engineers, in turn, provide input on how to run field trials and how the participant observations can be performed best with respect to the robot and the scenario. This ensures that the individual scenarios are designed for both the technical processes and how well they suit the target groups.

The engineers are also becoming familiar with the social science perspective in the development processes. This also helps the technical side in the understanding and interpretation of the available data and, thus, in the technical realisation of the results. On the other hand, social scientists get an insight to the development process with an engineering perspective. This is very important because evaluations could never be considered separately from the relevant field. In particular, the close collaboration between different professional cultures creates added value for everyone who is involved.

The field trials are one important aspect in the development and evaluation of the robot platform. In the first field trials the three different scenarios of the robot (e.g. call-scenario, games-scenario, event-scenario) were tested with 14 seniors, six caregivers and care consultants. Both engineers and social scientists prepare and accompany the field trials [13]. By using written surveys, all test persons were asked about their attitudes, prospects and wishes before the test started and their impressions and suggestions for improvement after the test. The test phase normally took 20 minutes and the authors always tested pairs. Every scenario started with asking ALIAS for help (e.g. *ALIAS come to me!*). After the robot goes to the senior who asked for help ALIAS greets the user. Then, the senior could choose one of the three provided scenarios. For example, by saying *Please call Britta,* a telephone call via Skype could be started. The control could be performed by speech, as well as via touch screen. The robot platform performed all of its tasks during the test autonomously [14]. Impressions can be seen in Figure 4 and Figure 5.

Figure 4: Seniors testing the different scenarios of the robot at the field trials.

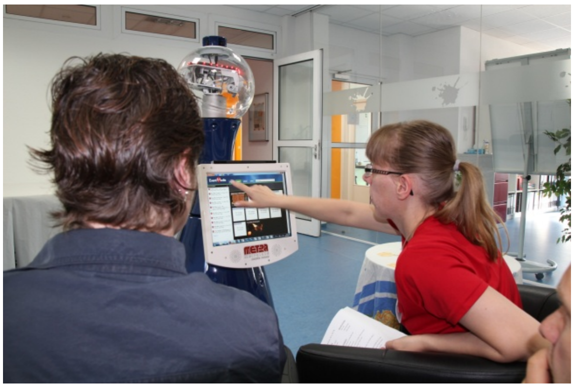

Figure 5: Seniors testing the ticket-scenario of the robot at the field trials.

The effect of heterogeneous disciplines on the participants in groups is one of the most studied factors [15]. The diverse cultural backgrounds in the professional teams has been analysed in many fields, e.g. gender, status, introversion versus extroversion, motivation, status, etc [16]. Group analysis is not in itself a guarantee of high or higher performance. Rather, a specific degree of difference and an optimal heterogeneity must be present [17]. But even with optimal heterogeneity, one-dimensional causal attribution is impossible. Interdisciplinary groups are better suited to certain tasks than homogeneous groups, but worse for others.

A possible explanation for why interdisciplinary groups are more effective in appropriate circumstances is that homogeneous groups refer to the knowledge base in heterogeneous groups [18]. The knowledge and skills of each participant in heterogeneous, interdisciplinary groups is in contrast with homogeneous groups of varying quality and quantity. Interdisciplinary groups are a special case of a heterogeneous group. In heterogeneous groups, participants have divergent knowledge, skills or abilities. It is essential, however, for the same knowledge base to exist among the participants in each case, but to varying degrees. This is mainly due to individual skills, which also affect the status, that is, for example, due to recognition and acceptance of individuals affected in the group.

In interdisciplinary groups, however, the knowledge in each discipline is often distributed differently. When the level of competence in traditional, heterogeneous groups varies in one discipline, it is divergent in interdisciplinary groups in several disciplines. This multiple divergence effect that the participants can take both the role of the teacher, as well as of the recipient. In principle, this independence of status and equal cooperation should, therefore, be even more effective. It remains to be seen whether the differences are considered to be too great so that the interaction is impeded. Interdisciplinary projects should be designed in a way that they can only be solved with the cooperation and the coordination of intensive collaboration. This interdependence should be realised in a way that the tasks are divided internally so that cooperation is essential. A satisfying result can be achieved only if all group members participating in solving the problem.

CONCLUSIONS/FUTURE WORK

So, what are the educational consequences out of this interdisciplinary project? The experiences and results are incorporated into university teaching. The interdisciplinary contents are included into the courses at the departments of Gender Studies in Science and Engineering (e.g. in the seminar *technical design* or the lecture *non-technical demands for engineers*). Also, doctoral theses were written concerning the added value of interdisciplinary projects in higher education, and learning effects among engineers and social scientists. Synergy effects also occur through joint publications and presentations by members of the consortium. In general, the collaboration of the project members and the primary and secondary users is already good. Through the regular exchanges within the project, the employees also learn from other disciplines. The result is a permanent exchange of knowledge and skills beyond the professional boundaries.

This represents an added value for all persons involved. Since most employees are PhD students, the interdisciplinary exchange also guarantees a high level of quality in their education and further training. Members of the ALIAS consortium stay in regular contact by the consistent use of mailing lists, regularly telephone conferences within and between working groups and project meetings. These activities ensure that no information is lost and that all members have the latest news. In addition, the project partners normally benefit from joint work. This applies particularly to the many young researchers in this team because they can learn from experienced colleagues, including those from different disciplines. Of course, further improvements could be always made.

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