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THE ACCEPTANCE OF ROBOTIC SYSTEMS BY ELDERLY PEOPLE - FIRST EMPIRICAL FINDINGS

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ABSTRACT

This Paper presents the methodical approach and early findings of the project SEN-TAF (Technology-Acceptance by the Elderly to Increase Independence). The project aims to examine the acceptance of robotic systems by elderly people and make early recommendations of necessary features those systems should contain. Based on theoretical approaches of technology acceptance and an empirical study to examine the general need of support of the elderly we developed several scenarios of robot applications. These scenarios are then visualized in animations and simulations to check the preliminary defined acceptance model. Beside these scenarios we survey several other factors which might have an impact of the overall acceptance, e.g. the appearance of the robotic systems (humanoid vs. technical appearance) and the interaction 'mode' (speaking vs. non-speaking). In addition to these animations and simulations we survey the acceptance of the robotic dog AIBO as early placeholder for future developments in animal robotic systems which could serve as a resource against boredom.

Index Terms – Service Robot, Human-Robot-Interaction, Acceptance, Elderly People

1. INTRODUCTION

The increasing obsolescence of the society [1] leads to a rising need of new offers of help and support for elderly and humans in need of care, which cannot be yet adequately taken off by existing institutionalized utility systems.

Service robot could close this gap in the future. Already soon they could be present in our everyday life. They could cook our meals, clean our rooms or serve as companions.[2] Although the demographic change poses some degree of risk, it also offers opportunities to use the potentials of an aging society. Service robot could close this gap in the future.

In 2007, 6.5 million robots were worldwide in use. According to the "World Robotics 2008" it is expected that 18 million robots will operate in various fields, such as working in dangerous environments, in public facilities but also in private households.[3] Already today, 3.5 million service robot are used by private households.

However, it is to be stated that the formulated hopes for a fast developing market in the service robotics did not fulf ll themselves. The systems implemented so far are not practice suited to meet the requirements of a dynamic everyday life environment. [4]

The question arises how such robot systems should be designed to be accepted by the market. The abstract construct of the market is made of human decisions. Users work gladly with a technical system or refuse it. This is exactly the same for AAL-specific applications as well as for all technical systems.

While technology assessment (TA) examines the acceptance of already developed technology, the still new approach of "promoting acceptance" investigates all conducive factors during the development of technology. Since the technology is not developed, hindering factors can be largely avoided and the product can be developed with other properties. [5]

2. ACCEPTANCE OF ROBOT

The research of robot acceptance is a relatively new field with growing need for theoretical and methodological framework.

The Robot often takes a different role as ordinary home appliances. It can be stated that the better the service robot is implemented with behaviors that users are familiar from human interaction partners, the less control problems and fears are expected by the user.[6]

This leads to the presumption that the more human-like those robots are designed, the more intuitive will be the use and handling and thus the overall acceptance.

However, this external effect of the appearance is not infinite. It was shown that the acceptance depends on the appearance of the robot, but does not increase linearly with the anthropomorphism of the robot. More precisely, in a given range the acceptance suffers a strong break. This phenomenon is explained by the fact that while machines are classified by observers as technical artifacts, humanoid robot are regarded as humans, and are blamed for deficiencies in the non-verbal behavior. [7], [8]

In addition, there is a need to define other factors that may affect the overall acceptance of robotic systems. Bartneck et al. aimed to develop a standardized measurement tool for the users perception of the robot systems. Based on an extensive literature research, they identified five factors: anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety.[9]

The project Robot@CWE and in particular the research group of Manfred Tscheligi hit the frame of reference with the factors: usability, social acceptance, user experience and social influence (USUS) for the declaration of cooperation between robots and humans.[10]

For the following study mainly the work of the dutch research group of Marcel Heerink are interesting. The group focuses on the further development of the UTAUT--model for Human Robot Interaction (HRI) for older people. They consider factors such as pleasure, social presence and social skills. Their goal is to develop a framework for the acceptance of robotic agents by the elderly.[11], [12] , [13]

3. THE PROJECT SEN-TAF

The project Sen-Taf aims to explore the acceptance of robotic systems by the elderly.

Based on theoretical approaches of technology acceptance and an empirical study to examine the general need of support of the elderly we developed several scenarios of robot applications. These scenarios are then visualized in animations and simulations showing robotic systems operating in the household. By means of these animations we explore whether such systems are already accepted by seniors.

Additional studies with the robot dog Aibo will provide insights into the interaction behavior of the respondents.

3.1. Methodical Approach

3.1.1. Need of support-Study

At the beginning of our study, we conducted a needs analysis (N = 175) to determine the need for assistance. To exclude a socially desirable response behavior, the study was designed as a general analysis of the need of assistance, not in particular of robot assistance.

Either way, it was found that the highest support needs are desired for those activities, which can be easily delegated, such as gardening, carrying heavy loads, cleaning the floor, doing laundry and ironing, as well as dusting.

For the more personal activities such as personal hygiene, adherence to the diet plan, visiting friends and relatives, and walking-assistance the desired support was the lowest.

Also we found out that the age of the respondents had little influence on the required support of need. Similarly, there was no evidence that older people are less technologically affine than younger ones. It was stated openness to technical issues among the respondents, but with some skepticism, which is mainly due to the threat of isolation.

Based on the results we have developed four different scenarios for a service robot:

1. Serving
2. Recognition of dangerous situations
3. Typical household work
4. Robot as play partner

3.1.2. Applied Model of Acceptance

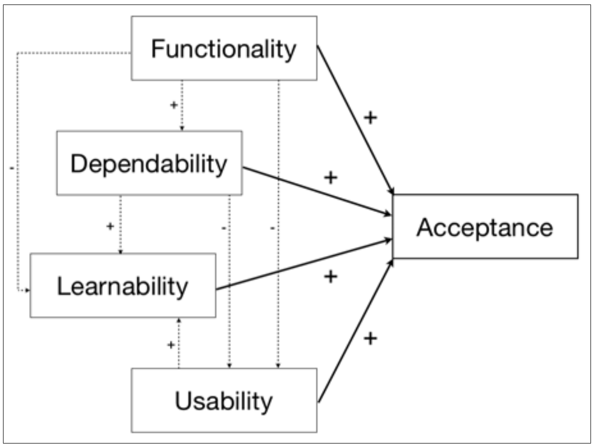

Figure 1: Model of Acceptance

Our model of acceptance [5] consists of four factors:

- Functionality
- Dependability
- Learnability and
- Usability

The factor functionality represents the properties and services of a technical system. These properties were identified through our need-of-support-analysis and translated in robot application scenarios.

The factor dependability includes the perceived reliability of the system, viz. does the services run safe, fast and accurate.

These two factors together correspond to the factor performance of the UTAUT-model [14], but have the advantage to measure more accurately.

The factor learnability expresses how easily the user expects to learn the correct and efficient use of the technical system. Learnability is influenced by a number of factors: the complexity of the application, the prior knowledge, personality and learning preferences of the user, as well as the internal locus of control. [5], [15], [16]

The factor usability finally is kind of a residual factor with such heterogeneous features like user interface, compatibility with other technical systems, operating environment, etc., generally the quality of use of the system.

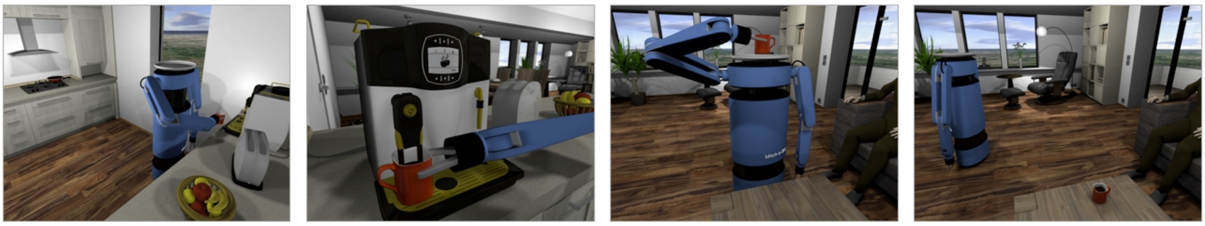

Figure 2: The "technical-looking" robot prepares a cup of coffee and brings it to its User. (screenshots from animation)

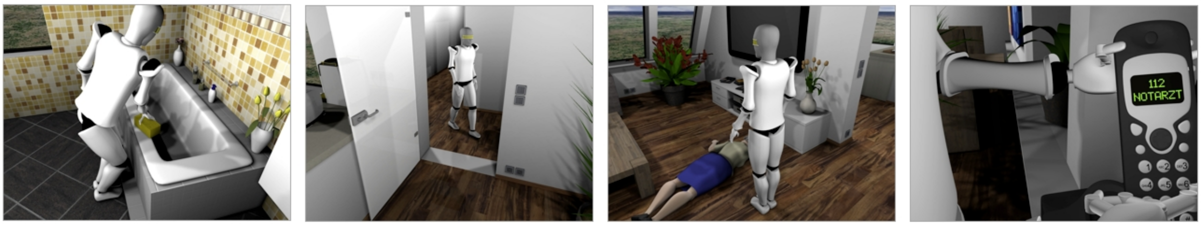

Figure 3: The "humanoid-looking" robot recognices a noise while cleaning the bath. It is looking for the sound source and discovers the resident lying unconscious on the floor. The Robot calls immediately an emergency. (screenshots from animation)

We suspect that functionality and reliability will have the largest effect of the overall acceptance.

3.1.3. Acceptance testings with animations

The four scenarios were implemented using the 3-D graphics software Blender. We created four one-to two-minute animation (see Figure 1 and 2) that serve as the basis for the acceptance tests. The animations demonstrate the robot cleaning a window, bringing a cup of coffee, playing chess and recognizing a life-threatening situation (the robot detects the user lying unconscious on the floor and calls an emergency).

The once created animations now allow it with comparatively little effort to make such changes from which we expect it could affect the acceptance. The ongoing intended changes refers to the appearance of the robot (humanoid vs.. technical) and the control of the robot (voice-vs. remote control).

Thus we now have four animated films, each in four different versions, which serve as the basis for the acceptance testings. These tests take place in selected senior residences in the region Cologne-Bonn. The respondents see one version of the animation and are questioned in a subsequent qualitative interviews. One goal is to evaluate our acceptance model and to identify differences of acceptance between the four animation.

The results will then show what type of robot (humanoid or technically) and what type of service (spoke-or remotely) is preferred by older people.

3.1.4. Acceptance testings with robot dog "Aibo"

Since the acceptance testings with animations give us valuable insights into the desired range of functions and the perceived reliability of these functions as well as of the overall system, but they only give us partially valid results with regard to the actual interaction behavior.

For this reason we conduct additional studies in the senior residences using the robot dog Aibo. We were interested in how the elderly will interact with an intelligent robot that can speak, understand and respond.

Fist pretests in a nursing home showed indeed that most residents responded positive and open-minded to Aibo. Because of Aibos limitation in speech and understanding (Aibo understands only a few english commands), we decided to conduct a Wizard-of-Oz experiment. In this experiment Aibo was – not obvoous to the inhabitants - telecommanded by an assistant sitting in another room. The experiment setup was as follows: Aibo was sitting straight to the respondent on a table (see Figure 4).. Aibo spoke to the respondent and replied to questions and tried to engage the respondent in a conversation (because of the telecommand, Aibo was able to speak and reply to questions).

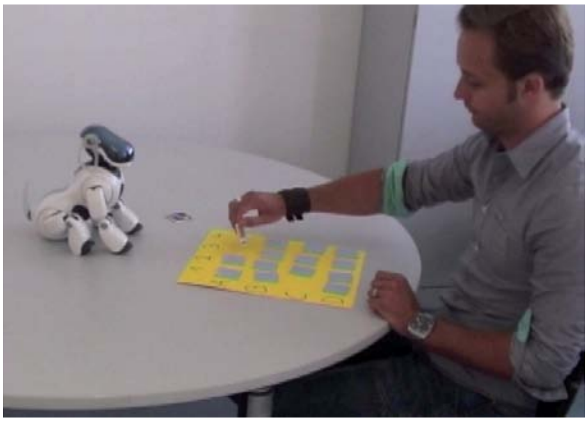

Figure 4: Respondant playing "Memory" with AIBO

Above all, we were interested to what extent would Aibo be accepted by the elderly. Studies in american nursing homes showed that regular interaction with Aibo was able to reduce loneliness of the residents [17]

For this reason, we let Aibo play Memory with the respondents. We were interested in whether the respondents would change their attitude toward a robot after their first interaction with an intelligent robot.

To measure the change in attitude, we used the NAR-Scale developed by Nomura et al. [18], which we translated into German. The NARS consists of three sub scales: 1. Attitude toward the interaction with robots, 2. Attitude towards social influence of robots and 3. Attitude towards emotions in interaction with robots.

4. FIRST RESULTS AND FUTURE PROSPECTS

The pretests for the acceptance testings with animations are still going on. First empirical findings will be presented at the IWK-Conference in Illmenau in September.

The pretests for the acceptance testings with robot dog Aibo have recently been completed. Initial evaluations (N = 15), which are only a preliminary result and can only be interpreted as a trend, shows a slight positive attitude change after the respondents first interaction with Aibo. However, the change is too small to be significant.

This could be referred to the fact, that the respondents had initially a very high positive attitude to robot. The often postulated skepticism of the elderly to robot and technology can also not be determined.

We were interested in particular, whether the respondents would use Aibo even if he has skills that go beyond the simulated characteristics.

Based on the results of our study of need, we therefore determined some "scenarios" for Aibo and evaluated them by the respondents.

It showed again that those capabilities and skills of Aibo, which are well-delegable ("Aibo guards the apartment", "Aibo detects accidents and calls emergency", "Aibo finds misplaced objects") would be used certainly, while those skills, which require more personal involvement ("Aibo as intelligent diary", "Aibo as game and sport partner") will be less used. This results surprised us so far, as we have seen a high degree of interaction willingness by the elderly in the tests.

Further tests will show whether this is due to a general lack of willingness to interact with a technical artifact or whether the respondents do not believe in the capability of a robot operating reliably in complex interaction situations.

Specifically, we also asked, how much the respondents would spend on maximum for an Aibo capable to carry out all these skills. On average, respondents mentioned a price of 1500 Euro (lowest mention: 100 Euro, highest mention: 5000 Euro).

Summarizing the first results from the pretest, Aibo seems to be accepted by older people but the willingness to pay for such a robot is comparatively low (in 2006 the year when Sony stopped production, Aibo was offered at a retail price of 2099 Euro).

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