# Touch-Screens and Elderly users: A Perfect Match?

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***Abstract*—This paper discusses some challenges in use of touch–based screens by elderly adults. We are focusing primarily on touch-based interactions with personal artifacts such as smart phones and tablets or touch-screens embedded in the home environment. We have conducted several small studies as a prequel to a larger study of "smart home" package designed and employed in "care residences" for elderly. We report here on findings from these studies and extend them into more general discussion on the use of touch interfaces by elderly. We discuss challenges related to diversity of elderly as a user group, progressive changes due to aging and their effects on the use of touch-screens. How to use technology to support mastering of daily life tasks and at the same time easy to use, touch-based solutions that support mastery (usually requiring some level of skills)? How to select other modes of interaction when the touch is not enough? Elderly people constitute a challenging and vulnerable user group that we want to strengthen and empower in the spirit of participatory design.**

***Keywords—Touch Interfaces; Design Method; Elderly Users; Multimodal Interactions.***

## I. INTRODUCTION

We are experiencing dramatic trends in the diffusion of information and communication technology (ICT). A persistent increase in the ageing population is seen as both a challenge and an opportunity for ICT. Elderly adults are a diverse group, diversity further augmented by the nature of ageing. Gradual decline in visual and auditory perceptions, motor skills and cognitive abilities make elderly into a highly non-homogeneous user group in terms of physical and cognitive abilities. This has implications for interface design [7, 15].

Changes associated with ageing make elderly adults, as an ICT user group, more challenging and vulnerable than younger adults. The term '*vulnerable*' indicates that they may experience difficulties in raising their voice or getting their voice heard. The term '*challenging*' refers to the difficulties for designers to empathize with their experience of the world [11] given their gradual decline in physical ability.

### A. Coming of Age

An important aspect of ageing is the process of losing physical and cognitive abilities over time. The process starts early (in the 20ies), but it is not until too much of the ability is lost that we see it as a problem. Progressive changes, in many cases, lead to increased need for care and loss of independence in later years. Most elderly prefer to live independently in their own homes as long as possible and postpone moving to senior communities or care centers [10]. The main indicators for having to move to a care unit are fall accidents, cognitive decline and loneliness [12]. Maintaining everyday physical and cognitive activities are crucial for not losing them and for counteracting these three problem areas. Technologies can replace or enhance lost abilities e.g. by smart home technologies (safety alarms, fall sensors, stove alarms) and by easy-to-use communication devices (video calls (skype or similar), easy-to-use phones such as the one shown in Fig. 1).

European Union has a large research initiative on Ambient Assisted Living [1]. Many national research-funding agencies all over the world invest into similar projects concerned with various aspects of designing technological solutions for and with elderly that are intended to provide assistance in their daily lives, increase the quality of life and prolong their stay at home (see [2, 3, 5, 8, 10, 13, 20]).


Figure 1. The phone designed for elderly, DoroS1, popular with elderly.

### B. Touch Interfaces

There is a common perception that touch interfaces are intuitive, natural and easy to use, even for elderly [23, 28]. Smart phones, tablets and large multitouch surfaces are now commonplace and affordable. Thus, they are often the interface of choice for assisted living research and design.

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However, there is very little systematic research undertaken on if and how these interfaces may enable and help elderly in interacting with their technology rich home environments [2]. On the other hand, there is an increasing amount of literature on principles and frameworks for touch interaction in general. Hornecker and Buur [14] present a framework emphasizing the interweaving of the material/ physical and the social, contributing to understanding social user experiences of tangible interaction. Similarly, Challis [4] discusses tactile interaction and its general principles. Wang and Quek discuss [28] how touch screens enable (intimate) contact and communication, and encourage exploration.

### C. Do Touch Screens Fit Elderly Users?

In a newly started project: *'technology@home'*, we aim at studying and designing for elderly people living in their own apartments in a "care residence" (offering some services like a 24/7 reception desk, a restaurant, a gym to the inhabitants). The care residence offers a basic 'smart home' package to its inhabitants and we will study how the technology solutions are used and how they can be improved or enhanced through participatory design (PD). One of the apartments is reserved as a 'living lab' where inhabitants, relatives, carers and health care workers can get information, try out and learn about available technologies. In addition, the 'living lab' is an arena for PD experiments for new technical solutions.

We have used touch interfaces in earlier research with "challenging" users [6]. The 'smart home' package we will work with includes a touch screen that can be hung on the wall or be taken down and used as a tablet pc. Since there already are a number of apps for health care on tablets, we see a potential in evaluating relevant apps as a part of the process of designing new apps.

We are committed to work, starting in January 2013, on development of novel interfaces and services utilizing touch screens and tangibles, with users' mastery as a key design principle [3]. Elderly users (and their relatives and carers) will be recruited for collaboration and engagement in the (PD) design activities and evaluation sessions aimed at novel products and services (see [16, 19, 20]).

In this paper, we report from a set of small studies concerning the use of touch interfaces by elderly. These studies were carried out in preparation for the larger study described above, *technology@home*. The studies aimed to identify challenges and opportunities of touch technology for elderly people, as a basis for designing usable systems for and with this vulnerable user group.

## II. OUR STUDIES WITH ELDERLY AND TOUCH-SCREENS

This section presents our short studies of use and design on touch –based platforms with and for elderly people. The first example is a small study testing touch screen-based phones on a small set of elderly users. The three remaining examples are all semester long student projects [18, 25, 30], illustrating important challenges: how to balance simplicity and mastery, and how to make a good choice of interface when touch alone is not enough and multimodal interfaces may be called for.

### A. Smart Phone Experience

For this experimental study we contacted a small sample of elderly with the aim to discuss and, if possible, observe their use of touch interfaces. Surprisingly, none of our participants have used touch interfaces, not even on a smart phone. Most of the elderly were using phones like the one shown in Fig. 1, designed with large buttons and straightforward functions. Friends and family often recommend the phone to them. It is sold in specialized stores targeting people with special needs.

None of the elderly we talked with liked this phone. The phone is bulky and heavy. Elderly, just like youngsters, like certain kinds of technology. Their tastes may be more along side of practical, but they do retain the sense of what is cool as a piece of technology and what is certainly not. However, they were familiar with them and liked the simplicity of use.

In order for them to become familiar with the new technology, they received touch-based phones and got some instructions for using them (see Fig. 2).

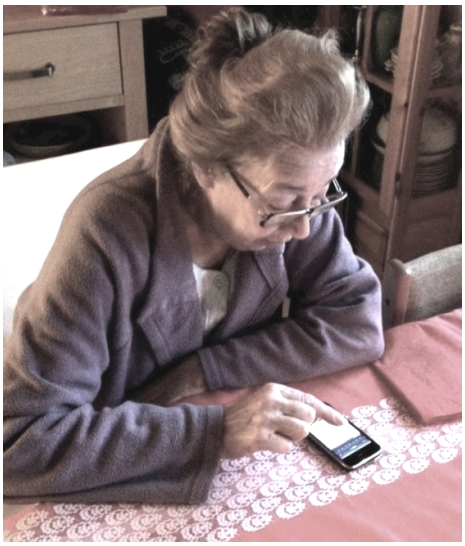

Figure 2. An elderly learning how to use a smart phone.

At the follow up meeting, the SIM card from one of the smart phones was back in the old phone. The elderly woman was very proud that she has managed to take it out of the new phone and place back into the old one. The explanation was that she does not need all the fancy stuff, she only uses the call functionality, does not feel like having Internet access, or any other features. When asked if the interface was too complicated on the new phone, the answer was that it was not difficult, it was easy and intuitive, but at the same time the smart phone was not needed. She was used to her old phone and attached to it emotionally, but had rational reasons for continued use. She argued that her old phone was smaller and lighter then the smart phone she got to try (android based one). The two functions that she uses, call and receive call, were very simple to use. She does not use

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the SMS feature. At first it was because there were three letters per small button, thus hard. She now does not wish to learn how to do it on the touch phone. If she did, SMS could become a new communication channel for her friends and family and she did not want to engage in that.

This example illustrates how important it is to listen to the users' reasons for using the technology or not (see also [17, 21, 23]). The use practices and habits are very important to consider when designing with elderly, and may be hard to break even when new solutions are easy, fun and intuitive. The design challenge is to provide space for users to keep the technology they use and like, but offering at the same time the possibility to master new devices and encourage an organic change of the established habits enabling them to master tasks and do things in easier ways.

Similar to the attachment to the old phone, many elderly still enjoy walking to the bank to pay their bills. Learning how to do it online may become a necessity at some point, as many banks already have only net-based solutions.

### B. *TV control on the iPad*

Our next example is a student project [18] that studied how elderly people use their regular TV remote control, and aimed to design a touch-based solution based on knowledge about use practices. Four elderly people were involved in the project, but interesting challenges were encountered even within such a small sample.

The design team quickly found out that the remote control was used to a minimal extent. The elderly people had a choice of 21 basic channels that they could watch; however, all four of them were regularly watching 4 channels or less. Apart from that, only the 'on button' was regularly used. The volume button was used occasionally. The first design suggestion for this user group was to make a very simple interface, with just a few (four) choices for channels, an 'on/off button' and a 'volume button.' Here, the affordances would be very clear, but so would the limitations. The question that presented a challenge was *how to take the step from the ease of use towards actual mastery* of an interface that could open for more possibilities if needed. The suggested design is shown on Fig. 3, where the possibility to choose more channels (the '*Flere kanaler* button' on the bottom right) or to perform some basic system functions (the '*Innstillinger* button', bottom left). A display of the time was also added.

Testing this new prototype brought another challenge: one of the participants had hand tremors and it was difficult for the participant to touch only the desired area since the buttons were too small. Adding some physics, so that more pressure needed to be applied by this participant than by other users on their interfaces was a way to resolve this challenge for the purposes of the project.

This is, however, not an easy task [13, 26, 28, 29]. A light, accidental touch should not activate a wrong channel. There are many ways to solve this problem, e.g., combining the touch with tangibles and/or sound.

Since the variation in the elderly population is so vast, a possible approach to a more general design solution could be through multimodality, configurability and personalization.


Figure 3. The second prototype implemented on an iPad [18].

### C. *Video conferencing on the iPad.*

Our last two examples are student projects [30, 25] both focusing on the feeling of being alone, which is so common among elderly [12]. Both projects were concerned with providing easy access to video conferencing, in order to enable easy access to friends, family of caretakers. The solutions were developed on the iPad, using open source software whenever possible. The focus was on the closer understanding of touch functionality for elderly. Therefore, in case of the project [30], Fig. 4, a heat map was developed to show how wide is the range of places where elderly apply touch, while trying to press the green phone icon. This is contrasted to the heat map showing a group of students who had the same task. It is easy to see that, while the students are always on the target icon, the elderly touch everywhere, including empty spaces.

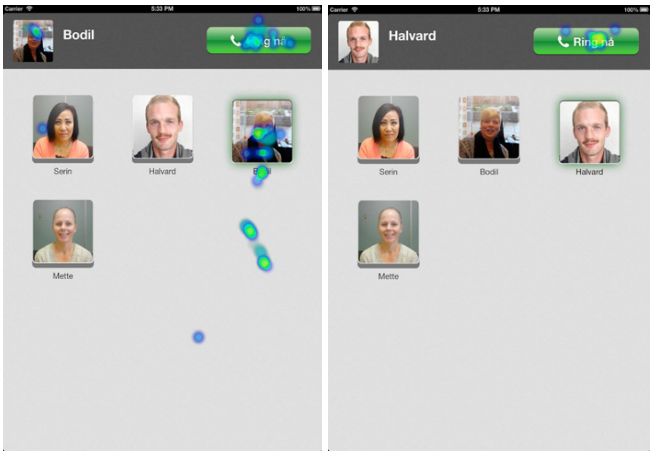


Figure 4. A heat map showing where elderly touch the screen when trying to reach the call button (left) vs. students (right) [31].

In [25], the students have focused on providing a large area where the touch may be applied; combining this with large icons similar to those of phone in Fig. 1; see Fig. 5.

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Figure 5. Simple interface for calls [25].

## III. CHALLENGES IN DESIGN FOR AND WITH ELDERLY

We face three major kinds of design challenges in the 'technology@home' project. The first is concerned with our choice of PD as design approach, the second stems from the loss of abilities that elderly people experience as they grow older, and the third is our focus on touch interaction.

### A. *Participatory Design Challenges*

A challenge specific for PD with vulnerable users is how well they can represent themselves and have a say in the design process. Vulnerable users' interests (e.g., children, disabled or elderly people) are often represented by those whose task is to work with and for them (case handlers, nurses, teachers, etc.) potentially leading to conflict where the two have differing interests. It is therefore of interest also in design of touch interfaces to explore ways in which less articulate groups of users can be given a stronger position as a PD participant. Thus, the first design challenge is concerned with arranging the participatory design process in ways that accounts for potential vulnerabilities and challenges that participants are meeting and at the same time enable active and creative engagement in the design process [3,16, 19, 20].

### B. *Challenges from Loss of Abilities*

An important set of challenges in design for and with elderly people stems from their loss of physical and cognitive abilities. Such impairments often do not originate from one source only. In design, it is important to see how the elderly people themselves perceive their impairments and how these affect their everyday life [5]. For example, reduced vision and dementia are both frequent among those over 70 years. Clearly, both may affect a significant percentage of elderly population. But each elderly individual see him/herself differently and the way these two impairments play out in a person's life would most likely differ from one person to another. It is understandable that because of the complexity of issues, designers often choose participants with only one impairment, such as dementia [20]. In-depth studies of the more complex composition of health issues normally present for elderly people suggests that technical solutions must be seen as parts of a system – an evolving system – and fit together. A basic infrastructure (like the 'smart home' package) can be a first step in the design of a set of technology tools that can be combined as needs change and appear.

### C. *Touch Interface Challenges*

The third challenge concerns touch interaction and how this kind of interaction addresses bodily changes stemming from old age. Hornecker and Buur [14] introduce a conceptual framework for characterizing tangible interaction with four themes: 1) tangible manipulation, 2) spatial interaction, 3) embodied facilitation, and 4) expressive representation (Fig. 6). All four themes introduce limitations and possibilities based on the challenges posed by elderly users. For themes 1 and 2 the loss of abilities will directly limit the technical solutions, while new technologies offer new possibilities for themes 3 and 4.

**Tangible Interaction**

| Tangible Manipulation | Spatial Interaction | Embodied Facilitation | Expressive Representation |
|---|---|---|---|
| Haptic Direct Manipulation | Inhabited Space | Embodied Constraints | Representational Significance |
| | Configurable Materials | | |
| Lightweight Interaction | Non-fragmented Visibility | Multiple Access Points | Externalization |
| | Full Body Interaction | | |
| Isomorph Effects | Performative Action | Tailored Representations | Perceived Coupling |

Figure 6. Tangible interaction framework [14, p. 440].

The tangible interaction theme introduces challenges concerned with haptic direct manipulation, where age-related changes constitute challenges of touch and grip. We need to explore whether the interpretation of lightweight interaction and isomorph effects is consistent for different age groups. Isomorph effects may turn out to be very important for people with cognitive impairment. The second theme, spatial interaction, seems particularly relevant for the home environment where the technical things should be integrated and fit in. Many elderly people arrange their home space in order to help them remember things (letters by the door, bills on the fridge, etc. [22]). The three remaining elements of this theme (non-fragmented visibility, full-body interaction and performative action) seem to not be particular for elderly users. The theme embodied facilitation concern how we move in space. Here, we focus on how the physical arrangement ease or delimit activities – and where the particular needs of elderly people are important to address. We are concerned with tailoring the representations to this particular user group and to offer multiple access points. The fourth theme concerns expressive representations: how the digital functions and data are represented physically. Here,

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we focus on the representational significance [24] conveying the state of the system to the user, the externalization as well as the perceived coupling between the physical object and the digital representation it embodies.

The *'technology@home'* will explore these themes from the perspective of the elderly user. Possibilities for tailoring the technology to the needs of each individual seems to be necessary for supporting elderly in their (technology-filled) homes. However, this is not possible to do neither practically nor economically. We will explore ways of customizing or individualizing a general solution as a easy-to-do part of the solution itself.

### D. Implications for Design

Design grounded in the characteristics of elderly users may have to reconsider some design issues. One important issue is ethics. Ethical considerations concern the PD process and how the research and development is carried out [16] as well as the technical solutions resulting from the process [9]. Connected to the question about ethics is the announced aim to "improve quality of life" through technology – an aim that makes sense if we see technology as a support for and replacement of lost abilities. Mastery and autonomy of their own life is a basic element of social and emotional well-being. Home automation should be designed as something complementary to human care, not as a replacement. Interestingly, there are many initiatives to solve social problems and fear of loneliness with another series of technological solution falling under the category empathic design [2, 25, 31].

The major implication for design is that current touch screen designs rest on some assumptions that are often not present for elderly users: they are sometimes not able to see what to do on a small screen, nor are they able to push a small area in a way which is not too hard or soft, or too long or short. The elderly users' abilities are different from person to person and they change over time. It therefore seems necessary to include in the design an automatic customization procedure where the system gets to know the particular user and her/his particular way of touching the screen.

## IV. CONCLUDING REMARKS

Designing with and for elderly carries a complex set of issues ranging from ethical considerations and methodological challenges to the choice of interaction styles and modalities. Many challenges are related to their vulnerability, decline in physical and cognitive abilities and diversity in manifestation of this decline among elderly. A smart home can be viewed as ecology of devices, potentially interacting with each other and/or with the outside world. If the elderly are to be supported by these devices, they need to be willing to, and know how to use them for their own well-being. Everything they use needs to be customizable for them, as well as adaptable to their changing abilities. Mastery and autonomy are among basic ingredients needed for the feeling of well-being. If the technology can help elderly to accomplish greater degree of independence through mastery and autonomy, its promise and opportunity is fulfilled. To approach that goal, we believe PD is a good methodological approach for evaluation of use of existing solutions and designing new solutions for elderly. When it comes to the naturalness and ease of touch-screens for elderly, we cannot conclude that they are an optimal choice. However, with customization and adaptation strategies, they may become a better match. This is also a direction for our future research.

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## REFERENCES

[1] Ambient Assisted Living joint programe http://www.aal-europe.eu/ [retreived: January, 2013].

[2] M. Asboe, J. Fernandes, and E. Grönvall, "C-HUB: a communication and network platform targeting the Generation Plus and their social and care networks," *DHRS2010*, pp. 7, 2010.

[3] T. Bratteteig, and I. Wagner, Beyond the smart home. Designing multimodal environments to support mastery design, *4S conference*, Denmark, September 2012.

[4] B. Challis, Tactile Interaction. In Soegaard, et al. eds. *Encyclopedia of Human-Computer Interaction* (2012). Available online at http://www.interactiondesign.org/encyclopedia/tactile_interaction.html [retreived: January, 2013].

[5] K. Cheverst, K. Clarke, G. Dewsbury, T. Hemmings, S. Kember, T. Rodden, and M. Rouncefield, "Designing assistive technologies for medication regimes in care settings," *Universal Access in the Information Society*, vol. 2, no. 3, pp. 235–242, 2003.

[6] A. Gasparini, A. Culén, Tablet PCs – An Assistive Technology for Students with Reading Difficulties? ACHI 2012, Fifth International Conference on Advances in Computer-Human Interactions (2012), pp. 28–34.

[7] A. Dickinson, J. Arnott, and S. Prior, "Methods for HCI research with older people". *Behavior & Information Technology, 26, 4,* 2007, pp. 343-352.

[8] W. K. Edwards and R. E. Grinter, "At Home with Ubiquitous Computing: Seven Challenges," in *Proceedings of the 3rd international conference on Ubiquitous Computing*, London, UK, UK, 2001, pp. 256–272.

[9] A. Essén, The two facets of electronic care surveillance: an exploration of the views of older people who live with monitoring devices". Social Science & medicine, 2008, 67 (1), pp. 128-136.

[10] S. M. Golant and J. Hyde, Eds., *The Assisted Living Residence: A Vision for the Future*, 1st ed. The Johns Hopkins University Press, 2008.

[11] J. Grudin, "Groupware and social dynamics: eight challenges for developers," *Commun. ACM*, vol. 37, no. 1, 1994, pp. 92–105.

[12] Helsedirektoratet. Welfare technology. Report on implementation of welfare technologies in the municipal helath and care services 2013-2030, 2012.

[13] T. Hirsch, J. Forlizzi, E. Hyder, J. Goetz, C. Kurtz, and J. Stroback, "The ELDer project: social, emotional, and environmental factors in the design of eldercare

technologies," in *Proceedings on the 2000 conference on Universal Usability*, New York, NY, USA, 2000, pp. 72–79.

[14] E. Hornecker and J. Buur, "Getting a grip on tangible interaction: a framework on physical space and social interaction," in *Proceedings of the SIGCHI conference on Human Factors in computing systems*, 2006, pp. 437–446.

[15] D. Howthorn, "Possible implications of aging for interface designers." *Interacting with Computers. 12*, 2000, pp. 507 – 528.

[16] S. Jesper, and T. Robertson. *Routledge Handbook of Participatory Design*. Routledge International, 2012.

[17] M. Kobayashi, A. Hiyama, T. Miura, C. Asakawa, M. Hirose, and T. Ifukube, "Elderly User Evaluation of Mobile Touchscreen Interactions," in *Human-Computer Interaction – INTERACT 2011*, vol. 6946, P. Campos, N. Graham, J. Jorge, N. Nunes, P. Palanque, and M. Winckler, Eds. Springer Berlin / Heidelberg, 2011, pp. 83–99.

[18] K. Larsen, G. Gahnstrøm, K. Matyja and J. P. Nilssen. Student project "Team Old School": http://www.uio.no/studier/emner/matnat/ifi/INF2260/h11/prosjekter/inf2260-team-old-school-rapport-v2.pdf [retreived: January, 2013].

[19] S. Lindsay, D. Jackson, G. Schofield, and P. Olivier, "Engaging older people using participatory design," in *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems*, New York, NY, USA, 2012, pp. 1199–1208.

[20] S. Lindsay, K. Brittain, D. Jackson, C. Ladha, K. Ladha, and P. Olivier, "Empathy, participatory design and people with dementia," in *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems*, New York, NY, USA, 2012, pp. 521–530.

[21] D. López and M. Domènech, "Embodying autonomy in a Home Telecare Service," *The Sociological Review*, vol. 56, 2008, pp. 181–195.

[22] L. Palen & S.Aaløkke Ballegaard. Of pill boxes and piano benches: "home-made" methods for managing medication. CSCW, 2006, pp. 79-88.

[23] M. Rauhala and P. Topo, "Independent living, technology and ethics," *Technology and Disability*, vol. 15, no. 3, 2003, pp. 205–214.

[24] B. Ullmer and H. Ishii. Emerging frameworks for tangible user interfaces. IBM Systems Journal 39 (3-4), 2000, pp. 915-931.

[25] A. Voje, H. Eggen, T. Gabrielsen, T. Vitikka and L. Bech Student project "Kamfer": http://www.uio.no/studier/emner/matnat/ifi/INF2260/h12/projects/elderly/Kamfer/ [retreived: January, 2013].

[26] C. Wacharamanotham, J. Hurtmanns, A. Mertens, M. Kronenbuerger, C. Schlick, and J. Borchers, "Evaluating swabbing: a touchscreen input method for elderly users with tremor," in *Proceedings of the 2011 annual conference on Human factors in computing systems*, 2011, pp. 623–626.

[27] R. Wang and F. Quek, "Touch & talk: contextualizing remote touch for affective interaction," in *Proceedings of the fourth international conference on Tangible, embedded, and embodied interaction*, 2010, pp. 13–20.

[28] F. Werner, K. Werner, and J. Oberzaucher, "Tablets for Seniors – An Evaluation of a Current Model (iPad)," in *Ambient Assisted Living*, R. Wichert and B. Eberhardt, Eds. Springer Berlin Heidelberg, 2012, pp. 177–184.

[29] X.J. Zhao, T. Plocher, and L. Kiff, "Touch screen user interfaces for older adults: button size and spacing". In: *HCI International 2007,* Beijing, China, July 22–27, 2007.

[30] V. S. Åmdal, K. Klette, H, L. Simonsen and S. Ahmedov "Selskap": http://www.uio.no/studier/emner/matnat/ifi/INF2260/h12/projects/elderly/Elderly-aid-app/ [retreived: January, 2013].

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