TV Remote Control for Elderly

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ABSTRACT
In this project the design of a TV remote control for elderly was approached taking into account their needs and their visual and motor deficiencies. Following the iterative design process preliminary user interviews were conducted and an easy to use TV remote control was designed as well as evaluated. The device is equipped with the basic controls for volume and changing channels and it also introduces four e-ink screens placed on the favorite channels buttons, in order to provide an intuitive interaction that substitutes the traditional numeric keyboard. The final prototype was tested and highly appreciated by the users.

Author Keywords
TV remote control, design for elderly, interactive devices, gerontechnology

ACM Classification Keywords
HCI

INTRODUCTION
Seniors are the fastest growing population worldwide.The United Nations projected that by 2050, people over 60 will account for 21% of the world population (UN, Social Policy Report, 2002). Taking into account that people spend on average around 20 hours per week watching TV and seniors probably a lot more (www.nationmaster.com), the interaction between elderly and television is a challenging field for designers. The means of communication between the seniors and the television is in most cases the TV remote control.The main trends in the design of remote controls for seniors are oversimplified devices (as showed below) with big buttons with the basic functions (on/off, changing the volume level and channels). In our approach, we focused on ergonomics and on keeping the complexity of the remote control low, but we also added the fuction "set favorite channel" and "mute" as it will be described in the following sections.

Remote
Although research on the needs and problems of elderly is expected to be a vast field of interest in the future with

Picture 1. The ACCENTA Remote Control

Picture 2. The Tek Partner Universal Big Button Remote Control

various applications, the literature on this subject is limited. A number of design examples are presented briefly here.

Innotech Systems Inc., (http://www.innotechsystems.com) a company that designs and builds remote controls and remote control systems for leading OEMs (the initials for Original Equipment Manufacturer that is a company which manufactures products or components that are purchased by a purchasing company and retailed under the purchasing company's brand name) worldwide, designed the ACCENTA remote control. ACCENTA offers the choice of completely hands-free voice or hand-held operation and additionally a unique voice-feedback system that tells users what button they have pushed in order to eliminate guessing and minimize the usual difficulty associated with learning to operate the remote control.

The Tek Partner Universal Big Button Remote Control (http://www.hytekmfg.com) is a universal remote designed for those with low vision and dexterity issues. Its large size enables more buttons on its surface and makes it difficult to lose. The oversized buttons lit up when they're touched. The Good Housekeeping Research Institute (http://www.goodhousekeeping.com/product-testing/reviews-tests/about-good-housekeeping-research-institute), the product-evaluation laboratory of the magazine "Good Housekeeping", tested the Tek Partner remote for durability and found that it still was operating properly after being dropped repeatedly.

In (Massimi et al., 2007) current mobile phones are evaluated by seniors and some considerations for choosing a mobile phone for seniors are listed. For instance, the seniors felt that large buttons were extremely important to any device they would use . Moreover they were worried about being unable to grasp the phone properly and securely and they generally preferred rugged phones that could withstand drops and scratches, but did not want them to be too heavy.

Health problems of the elderly

It is common knowledge that most human capabilities degrade more or less significantly through aging. Research shows (Goldstein, 2002) that changes affecting human cognition, motor behavior and memory become noticeable around the middle of the fifth decade of life. Specifically, changes in visual acuity, flexibility of joints, hearing capability and physical strength were the most important characteristics taken into account for the suggested design. These facts introduce different needs in a potential product design.

Muscular weakening suggests a less strong grip of objects, which along with the low flexibility leads to the need for a solid body design of tangible devices, that are difficult to slip or drop. Moreover, loss of visual acuity increases the need for surrounding light to complete tasks, while hearing difficulties introduce the need for a sound feedback of actions.

Concerning cognitive functions, the age of the aforementioned target group suggests a technological maturity that took place around the beginning of the 1990's, which means that the technological background and symbolisms of that era should be respected and taken into account.

The term "elderly" is given in the present work, after the person has reached the seventh decade, when developmental changes are assumed to have become more obvious. Moreover, a decay of these factors that is not higher than expected is assumed. This means that organic changes and more severe body conditions do not have to be accommodated, resulting in a product that focuses on elderly people without severe problems in vision, hearing and movement.

LIMITATIONS AND CONSTRAINS

During the design of the remote control, we faced several difficulties that influenced the final result of our design. First of all, the two-weeks time constraint set by the instructor influenced all stages of the design. Our original plan was to conduct a field study and observations of potential end-users i.e. elderly people at the age above 60 when using the remote control at their home. Since we are non-dutch native speakers and also due to time constraints of the project this was not feasible, and thus we aimed at visiting several elderly houses in the city of Eindhoven, the Netherlands. This plan was also abandoned since we were unable to get permission to visit these houses for the aims of our project. We fully understand that observation sessions with the potential end users of our product would probably be the most appropriate method to use for the gathering of product requirements. Since this method was impossible to apply, we consider the interviews we conducted over the phone or in person successful and the best ones to use under these constraints. After making a low fidelity prototype, we moved on to the first evaluation session, for which we had access to only one english-speaking female dutch subject at the age of 72. Although

Picture 3. Prototype no. 1: Clay

we considered our subject's observations and arguments informative, it would be more valuable to base the final design on more subjects' opinions.

DESIGN PROCESS

Due to limited time we had to choose a process that was compound and possible to follow in 2 weeks. We have decided to split our work in five main stages. Stage one was researching what is known about designing for elderly. We referred to literature Goldstein, 2002) describing what physical limitations we should take into account while designing for this specific group of users. In the second stage, having all the theoretical knowledge we conducted a brainstorm session about the TV remote control - we discussed what are the current designs, what are their limitations, why are they bad for elderly people. After that we came up with first ideas about what our new remote should be like and which needs and elderly people limitations it should accommodate. A this time we also conducted two phone interviews and we designed a persona. Third and fourth stage were repeated several times. Stage three was prototype design, stage four - its evaluation. We went three times through this cycle. The first time we have developed a clay prototype (Picture 3) and we performed an evaluation of it.

Picture 4. Prototype no. 2: Paper interface and clay shape

Picture 5. 3D model of the final prototype.

We have discovered problems it might have and we have decided to develop the second prototype that consisted of two elements: the paper prototype of the interface and the clay part to test the ergonomics of our design (Picture 4).

This prototype was tested with a user. The test led us to yet another redesign and eventually we developed a 3D model of the final design (Picture 5). The model has then been built out of wood and therefore transformed into the non working prototype, that resembles the final product. In the end we tested our remote, what is described further on. The last, fifth stage was documenting our design process.

Interviews

Due to the limitations explained above, we decided to conduct semi-structured interviews with potential end users for the purpose of gathering product requirements. Semi-structured interviews were chosen over others since they encourage the two-way communication between the designers and the interviewees and help them built a rapport through the conversation-like nature of the interview.

Five persons aged between 61 and 79 years old were interviewed. Four of them were male whereas one was female. Due to us not being able to access three of the persons, interviews in these cases were conducted over the phone.

The interview questions chosen regarded their way of holding and using the remote control in their own TV (e.g. with 1 or 2 hands, laying down or being seated on a sofa/ armchair, etc), what functions they use more and also what they like in it or what would they change.

After the evaluation of the gathered interview data we extracted the relevant information that helped us in designing the persona and later on our first prototype.

During those interviews we learned that elderly people have several favorite channels that they regularly watch and the way they keep track of them is to memorize (or sometimes write down on a piece of paper they have glued to the remote) which numeric button on the remote corresponds to which channel. This is problematic for them, since they are not able to reprogram the remote themselves and therefore their favorite channels often end up on two digit positions (like 27). Choosing a two digit

Picture 6. Persona: Sophie van Aangenaam

channel is a difficult task for them, since it requires specific timing and good motor skills of fingers.

We have also learned that the most important functions for our users refer to volume - changing the volume level and muting the sound when needed.

Some of our interviewees pointed that their way of watching the TV is to zap constantly between channels or switch between several of them (e.g. when one is showing a movie, but it has an advertisements break and the other is showing the news in the same time).

Persona

In order to focus our design procedure on a specific target group, we created a persona (see Appendix A). The persona was created based on the data taken from the interviews that we conducted. Cooper (Cooper, 2007) mentions "Personas provide a powerful tool for understanding user needs, differentiating between different types of users and prioritizing which users are the most important to target in the design of function and behavior."

Name:	Sophie van Aangenaam (Picture 6)
Age:	75
Occupation:	Retired teacher
Location:	Zwolle, The Netherlands
Description:	Widow since 7 years, lives alone. Has minor hearing problems and arthritis. Some sight problems (uses two pairs of glasses). Has TV as company. Cannot cope with complex devices.
Goals:	To enjoy life despite her age. To be able to use devices she used when being younger with ease. Accomplish common tasks fast / without effort.

First prototype design and user test

After defining our persona (Mrs. van Aangenaa) we conducted a brainstorming session that was focused on designing a remote control that will enhance her television watching experience. Lots of ideas were generated and evaluated with the general concept of keeping the remote simple, having only the most used buttons (according to the interview data we collected) on the remote, having backlit buttons that will make the interaction easy under low-light conditions, taking care to keep the shape and size comfortable for our persona to use with both one and two hands and make the information on the buttons legible.

The result was the design of a paper and a clay prototype of a remote control. These lo-fidelity (lo-fi) prototypes were chosen over a high-fidelity (hi-fi) one since in this early stage of the development phase we were in, they would give us useful feedback about refining our design until we build a more realistic prototype that would be hard to change. Also we preferred them because they are fast, cheap and would allow us to try far more ideas than when testing a hi-fi prototype (Rettig, 1994).

The paper prototype (see: Picture 4) was created so that we could get feedback about the interface: our design ideas, if the icons used in the remote were easy to understand and if there were any interaction problems with the interface. The clay prototype (see: Picture 4) was created so that we could test the shape and size of it.

A user evaluation of the prototypes was conducted. For this reason we recruited one potential end user. The participant was a 72 years old female with some motor and sight problems typical for her age. Together with the prototype evaluation, a brief semi-structured interview was conducted that regarded her opinion about our design and the new ideas that we thought of implementing (see Appendix B). The user testing was conducted in the living room of her home where she watches TV and lasted for 35 minutes.

The reason why only one participant was recruited for the evaluation of the prototypes was that this solution would give us quick feedback on our design so that we could redesign the remote control and change the parts that were the least understood or the hardest to use for our potential end users.

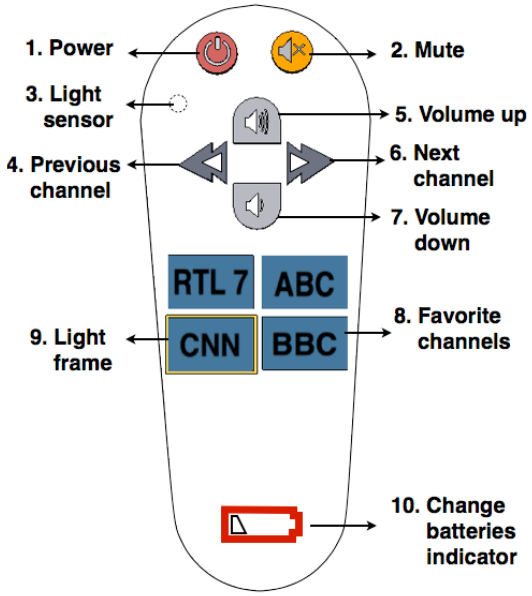
The results of the evaluation session showed that the choice of the icons was successful, the concept of the favorite buttons was understood and welcomed and that having the buttons lit up in low light condition was a good and useful idea. On the other hand, the participant complained that the remote control was too wide to use with one hand and that she would not like the addition of the acoustic feedback since it would be too much for her to hear sounds each time she was pressing a button too many times at the remote (e.g. when zapping through the channels).

Picture 7. The final prototype: wooden model of the product.

Final prototype

After receiving feedback about the paper and clay prototypes, a 3D non-working model of the final product has been created and the decission to make the final prototype out of wood has been taken (Picture 7).

This prototype is the result of all the design decisions that we made. The remote is simple, minimalistic, with big, clear buttons. The numeric keyboard has been removed, what redefines the way a remote is used. It operates on the concept of favorite channels. The device is designed in the old fashioned way, the interaction is based on traditional buttons, because that is what users are used to and given their age, they are not likely to change their habits. However, it is equipped with several solutions that make it more user friendly and well adjusted for elderly people. Picture 8 shows all the functions of the device.



Picture 8. Final product functions.

No.	Name	Description
1	Power button	Red backlit button that turns the TV on and off.
2	Mute button	Orange backlit button that allows to turn the sound on and off. This button also has a light frame (9).
3	Light sensor	Light sensor is not visible for the user. It measures light conditions in the room and adjust the brightness of all backlit buttons, screen buttons and light frames.
4 6	Next and previous channel buttons	Backlit buttons placed vertically that allow to zap and navigate between channels.
5 7	Volume up and down buttons	Backlit buttons that allow to turn the volume up and now according to user preference.
8	Four favorite channels buttons	Four buttons with e-ink screens on top of them. Screens display the name of the channel that is programmed under the button. Buttons have the same physics as regular buttons. The screen is built in them. It is a high contrast backlit screen that allows to read from in both in low and high light conditions.
9	Light frame	Light frame around four favorite buttons has a feedback function. The light in the frame turns on only when the channel programmed under the button that the frame surrounds is being watched. Otherwise there is no light around the button.
10	Change batteries indicator	A battery shaped LED that is built in the remote body. It is not visible unless it is ON. It turns on when the batteries have less than 10% of their power and might start causing lower performance of the remote. The LED turns OFF when new batteries are put inside the remote.

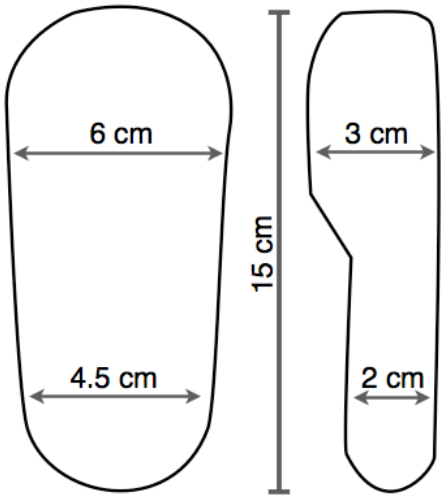
Table 1. Description of remote functions

Table 1 (previous page) describes all the functions of our TV remote control. The most innovative feature of the remote are four screen buttons that allow to preset favorite channels and have instant access to them. While the idea of having such preset buttons is not new, so far they figured on remotes as unlabeled colored buttons, which in our opinion is not good enough for elderly people, as they might have difficulties remembering what TV stations they had preset under which button. This is why it have been decided to build little displays into the buttons.The e-ink (electronic paper) displays have been chosen because they consume very little energy, have high resolution, high contrast and good performance both in good and poor light conditions.

Shape and size

Since the participant of the evaluation session we conducted in the previous design iteration complained that the remote was too wide to operate with one hand, we decided to redesign the shape of it. Thus, we made it narrower, keeping in mind that users who prefer to use it with two hands will still be able to do it in a comfortable way. This fact made it impossible to fit 6 favorite channels buttons, so they had to be taken down to 4. Moreover, making the device narrower made also the most frequently pressed buttons uncomfortable to reach for people with problems in their joints. For this reason, we placed the favorite buttons on the bottom part of the remote and the channel/volume level buttons in the middle.

The remote is considerably smaller (Picture 9) compared to most remote controls for elderly people. The shape and size of the remote were chosen so that it fits nicely in the hand of an elderly person allowing the use both with one and two hands. Therefore it is small enough to reach the buttons with one hand, but the buttons are well spaced and designed in a way that the use with two hands is also possible and comfortable.



Picture 9. Dimensions of the remote.

Forms of feedback

During the interviews users indicated that they do not receive good feedback about actions they perform with the remote control. And although most of the feedback should be displayed by the TV itself, the remote control device can also provide some useful feedback about specific functions. Therefore, it has been equipped with buttons that cannot be pressed by mistake and force required to press a button is selected in a way that maximizes both comfort of use and perception of pressing the button. Moreover, four favorite channels buttons has been equipped with a light frame, that lights up once the channel programmed under the pressed button is selected and being watched. The mute button is also equipped with the light frame. Light frame is a simple and useful feature that allows the user to see with one glance at the remote what channel is he watching and if the mute is on.

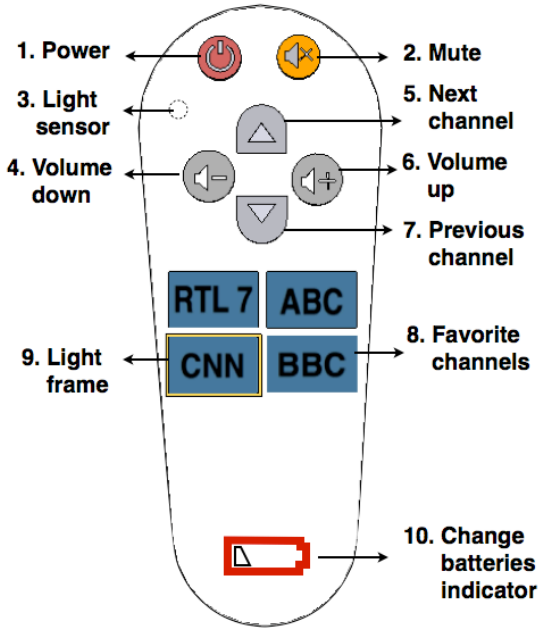
A special form of feedback has also been chosen for informing the user about the need to change the battery in the remote. As the batteries discharge, the performance of the remote is getting worse, therefore it is very important to inform the user about the need to change the batteries in the right moment and in an effective way. This problem has been addressed by placing a strong red LED battery symbol on the remote that turns on when batteries have less than 10% of their original power. The symbol is visible as long as user doesn't change the batteries in the remote. After it has been done, the battery LED turns off.

Light sensor and accelerometer

Remote controls are used in different light conditions - in the morning the room where the TV is located might be very sunny and bright, while in the evening it can be totally dark, unless the light has been turned on. It is important to provide that users can see what is on the remote while using it. Therefore, all the buttons on the remote are backlit. Since lightning conditions might change, the built in light sensor detects the light intensity and adjusts the brightness of the backlit buttons and screen buttons accordingly. To ensure that the buttons are lit up only when the remote is being used it also has a built in accelerometer that detects if the remote moves. This way, when it is being hold steady or simply put down on the table, the lights on it would dim after 10 seconds. Once picked up again, it would detect the movement and turn the lights back on again.

User evaluation and results

After building the final prototype user tests were conducted. A group of six users (3 males and 3 females, 60 - 80 years old) were interviewed and asked questions about the remote (see: Appendix C). Since we had a non-working prototype that was not possible to evaluate with at least 5 potential end-users in their home environment given the constraints that we discussed before in this report, semi-structured interviews were conducted. The questions used concerned the size and shape of the remote, the size and placing of buttons and their labels, how to perform key actions and also general questions about the look and feel of the



Picture 10. Final prototype with redesigned placement of volume and channel changing buttons.

remote. The test took approximately 15 minutes per user and was conducted in a shopping centre. Participants found the remote simple and easy to use. They liked the limited number of buttons and their size and placing. The idea of having preset buttons with screens was highly appreciated and well understood by all the participants.

The shape and size of the remote was perceived very positively. It was easy to hold and comfortable to operate with one and with two hands. The font and symbols on the buttons were a big advantage, as well as backlit buttons.

Participants had problems with distinguishing between volume regulation and channel changing buttons. Most of them understood that buttons that were intended to change the volume (vertical, buttons 5 and 7, see Table 1) change the channels and the horizontal ones (4 and 6) are responsible for volume. Some users didn't understand that any of those buttons change the channel. They thought that all four buttons are responsible for the volume.

After conducting the test and finding that vertical and horizontal buttons were poorly understood, the remote was slightly redesigned - the volume buttons were placed horizontally and the channel buttons vertically. Also the labels have been changed, to make it more clear what the buttons represent (Picture 10).

After the redesign a set of 7 user interviews was conducted to evaluate new buttons placement and labels. This time, functions of the buttons were identified correctly and users didn't have problems with understanding which buttons correspond to which function.

CONCLUSIONS

Designing a remote control for elderly people is a task that should engage and apply acquired knowledge relevant to their needs and special characteristics. Following an iterative process, consisting of user tests, interviews and by applying the results of each phase to the final product, we created a prototype for a remote control that offers the most frequently used functionality and aims in simplifying the interaction when completing the tasks related to it. By introducing the use of e-ink screens to store the favorite channels and the manipulation of tangible backlit buttons that provide visual and sound feedback, we feel that an effective user experience is provided, that meets the aforementioned needs.

FURTHER RESEARCH

Further research should aim in the minimization of energy consumption for the remote control, so that no frequent changing of batteries or recharging will be required. Also, research concerning the customization of the location of the buttons on the remote control according to the user's size of hands or way of interaction (1-2 hands). Redesigning well known devices to accommodate the needs of a specific social group is an interesting and challenging task. The task that can be approached from different perspectives. This paper shows one of them, it follows the path of interaction design that says that users, especially elderly have their habits and are not willing to change them. Though, it might be interesting to investigate if elderly people would adopt new solutions and to what extend. Is that a question of elderly people not willing to change their habit? Or maybe simply the devices that require from them those changes are poorly designed?

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APPENDIX A: PERSONA DESCRIPTION

Sophie van Aangenaam, 75

Ms. Sophie is a 75 year old retired teacher. She lives in a small house with a garden, that is located near the big cathedral in Zwolle. She was mar- ried to a teacher, but unfortunately Mr. Aangenaam passed away seven years ago. She has two sons and three adorable grandchildren. Currently Ms. Aangenaam lives alone and enjoys the company of some elderly lady friends now and then, as well as her sons' and gradchildren's, that visit her at least once a month. Ms. Aangenaam is quite healthy for her age, with some minor hearing problems and some reading difficulties. She wears a big pair of glasses, that help her covering a bigger visual field as she claims, and she has a special pare of them for when she watches tv. What bothers her the most is the difficulty to move around, due to her arthri- tis. She doesn't use any moving aids, but she is not as flexible as she used to be and she finds it difficult sometimes to walk for long distances. Her memory though is quite strong and she is proud to receive positive com- ments by her sons about her clear mind, despite her age. In the afternoon, when she has finished the housework, she likes watching her favorite pro- grams on tv in her favorite armchair. She sometimes leaves the tv open for several hours, just to hear the sound of it. She complains though about the small size of the buttons of the remote control and the difficulty she has in realizing whether she actually pressed a button or not. Her favorite buttons are "1", "4", "9" , "2" and "7". With the last two she is able to go to the channel "27", when she feels like it. She also likes to turn the volume off, when somebody calls her or rings the doorbell, but the button that does it is quite hard to spot, as she claims. Moreover, she complains that she often loses the remote. "It would be nice if you could call the remote and hear it ring, like my mobile phone", she says joking. When she feels more adventurous, Ms. van Aangenaam zaps throught the chan- nels, to see what is on, so as to take a break from her favorite tv shows.

APPENDIX B: FIRST INTERVIEW QUESTIONS

Interaction questions:

- What would you do to turn on the TV?
- What would you do to go to your favorite channel?
- How do you think you can set the favorite channel?
- How would you turn off the volume?
- How would you make the volume louder?
- How would you change the channel? (Is there another way?)

Interface questions:

- How do you like the buttons with favorite channels?
- How does the remote feel like? Is it comfortable to hold?
- Do you happen to lose the remote? Would it be useful for you to have a feature that would allow you to find the remote easily?

We are proposing some new features in the remote. What do you think of them?

- Buttons that display the name of a channel - Favorites
- Find the remote
- Shape adjustable grip
- Light and audio feedback while pressing the favorite buttons

APPENDIX C: EVALUATION QUESTIONS

1. Age:
2. Sex:
3. Interviewee uses the remote with 1 hand YES NO
4. What do you think that these buttons do?
5. How would you set your favorite button?
6. What do you like about the remote?
7. What you don't like?
8. How does the remote feel like? (size / shape / size of buttons / placing of buttons)
9. Do you happen to lose the remote? How often?
10. What do you think of the new functions that are introduced in this remote?
11. Do you want to add something?