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FULL PAPER

Ergonomic design of user guides in multimedia environments with remote controls and onscreen displays

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Abstract

During a project period of three years a new type of remote control and onscreen display was developed after a process of compares and analysis of present remote controls and multimedia devices. This project was initiated by a German producer of consumer electronics. The usability and user acceptance was tested and added by questionnaires. The characteristic of this system is a remote control with only one control element and an according concertedly developed onscreen display. This new onscreen display is marked that the motion of the thumb on the surface of the sensor pad produces a conformable motion inside the display. All operational functions are integrated in 4 menus at both sides, top and bottom of the screen. The user testing had shown that haptic elements are well suitable to fulfil the requirements of supporting the user by imprinted user routines and avoidance of visual control of the usage.

Keywords: remote controls, haptic input elements, design criteria, onscreen display, user acceptance

1 Initial situation

Due to the technical development and other reasons led to a change of the basic thinking about remote controls at the end of the nineties. The range of functions, which had to be accosted by a suitable control device, were increased highly. But it did not resulted in better usable or user-accepted remote controls. Only the scale of control elements was permanently growing up. The use of this “multi-functional” remote controls with a lot of sequential operating steps and (coupled with this) multiple menu levels at the screen display could not be handled by the users without a long-term training or a special knowledge background. This naturally led to an increasing scepticism and respectively negative evaluations of the operating convenience in tests of independent magazines (e.g. Stiftung Warentest, VIDEO).

As per description above the onscreen displays broadened continuously at different consumer electronics in this period at the end of the nineties. From investigations about the quality of configuration of workplaces with visual display units (and also from

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evaluation of displays and their OSD) the idea came up, to apply the basic software-ergonomic design rules also to the design of OSD's as a base for the valuation of their design quality.

The initiative for the accomplishment of a research project was given by the commitment of the German company LOEWE, a big producer of consumer electronics. LOEWE came into criticism several times, that their remote controls can not keep up with the quality of their devices (e.g. (test 1996) and (test 1997)) and executed own preliminary investigations about the possibly new design of remote controls. (Ginnow-Merkert 1997) Hence it was among others deduced, that a new development in compliance with the given assumptions by (Ginnow-Merkert 1997) absolutely contain positive chances at the market.

The project aim was the development of a remote control based on a new sensor. The use of this new sensor should combine haptic input elements with the ability of an intuitive function control by usual motor movement of the hand respectively the fingers by visual tracing for different users like children, adults and elderly people.

Thereby just as broadly bsed user groups should be accosted by the design as, at the same time, be imparted of the usage by a suggestively to the system of remote control and OSD adapted user guidance.

For reaching this aim it was tried to abide ergonomic design rules consequently, especially following basic principles:

- Information about the "Where" and the "How to do?" of an input have to be imparted over two sensory channels. This is especially important for elderly and persons with sensory limitations (Poulsen 2001) and it is also helpful for all other users.
- For the outer formation, the weight and the actuating forces the recommendations for manually operating actuator components get the base of the design. (e.g. in (Schmidtke 1993))
- The prospective users may not be disadvantaged or debarred by any of the design features.
- The outer formation should consider the median measures (50th percentile) of the prospective users.
- The manner of usage should be conveyed intuitively by the hand-sized outer formation of the remote control and by a perceptible and distinguishable shape and location of the input elements.
- The remote control should be usable also for persons with different handicaps (visually, motor), for elderly and for children in the same range. These different deficits should be supported useful and helpful.

2. The enforcement to use haptic input elements

Basically it is not a new approach to use input elements with haptic sensory supporting components. But the explicit focusing towards these design goals could not be realised

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before. What are the benefits of this concept? The decision to use haptic input elements for the new remote control was based on two advisements. The haptic sense as a combination of somatosensory and sensomotor system (see in fig. 1) is the first developed information channel in the human ontogenesis. In the Embryonic stage the skin including its senses evolves together with the central nervous system early from the outer germ layer (ectoderm).

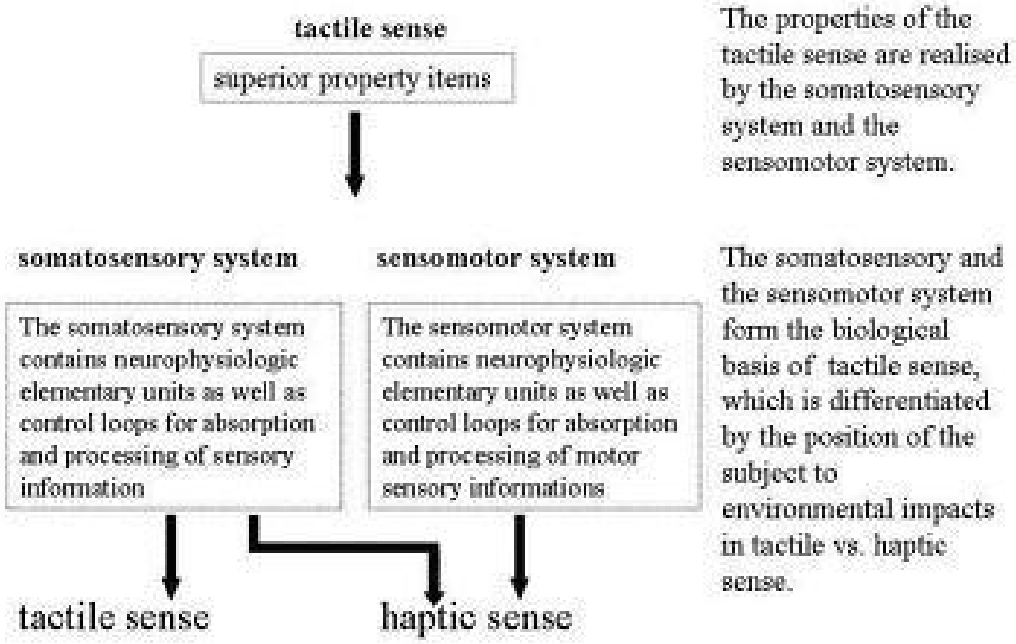

Figure 1: Diagram of the connection between haptic and tactile sense (after Grunwald 2001)

On one hand the reaction on tactile charms is one of the first options from the fetus and embryo answering to stimuli from the environment. (Ettrich 2001) Also postnatal the active information acquisition of the environment starts hapticly by the neonates. The baby tries to touch, feel and pick up objects and surfaces. There are examples how much this even is reflected in common linguistic usage (see (Grunwald 2001) for some German examples). On the other hand the visual system develops later as the primary information source and so the other senses do. Because of this early infantile imprint it is possible to acquire spatial respectively material-related knowledge like the visual system delivers by means of haptic exploration. (Zimmer 2001) In the same manner a haptic information brokerage is advantageous if there is a large amount of information on the visual system and if the visual ability is limited respectively missing as in case of persons with visual impairments.

In the common life of (human) adults the haptic sense does not have the same level of importance like in the early childhood. The use of this “buried” sense effects more intuitively and on a second way additional to the main sensory channels like vision and hearing. But it is always present and can be used to support or unload of the other channels.

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To reach a higher acceptance of newly designed devices, it is important to strengthened the use of positively identified memorised patterns. Thereby the learning effort at the confrontation with new action algorithms will be reduced. That means e.g. for remote controls the retaining of positive input user's habits by button-like elements and a shape similar to a baton. Intercessional for baton-like shapes is also that people often use a remote control (e.g. radio remote controls for cars) to point intuitively at the object that is to be controlled as a kind of nonverbal communication with the receiver. Technically this is not necessary in the most cases (e.g. by the use of radio waves).

It can be summarised that haptic charms and information can be well recognised and processed parallel to audio-visual stimuli. Over the haptic information level so called "tactile stereotypes" can be drilled. These stereotypes subserve to a faster sequence control.

At the potential range of application exists a stronger constraint to self-explanation by simplification and the support of the inner model as in work environments. Because in leisure time and recovery situations a longer familiarisation and training phases will not be accepted. This is also a consequence of the postulated task-oriented design of user interfaces to the standards ISO 13407, ISO16071 and ISO 9241. By the abovementioned haptic based experiences at the explorative investigation of the environment, useful supports for the learning process can be given. By this "haptic memory support" a inner mental model of the functionality and operations can be created faster and more extensively as by standard elements (e.g. circular buttons). In fig. 2 some simple examples of this differences are shown. It is also noticeable that "haptic elements" as a design requirement are not really new but not very often in the focus of research and development.

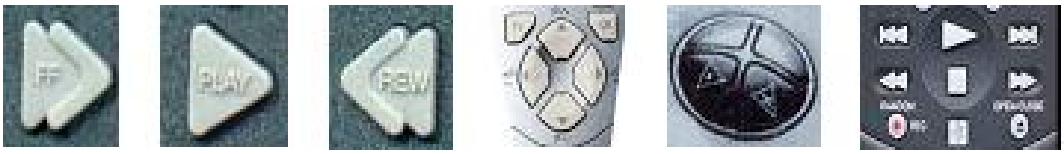

Figure 2: examples for input elements with a good haptic support

3 Analysis of the design quality of remote controls

For reaching the setting aims an extensive analysis and evaluation of multimedia remote controls available on the (mainly European) market had been accomplished. Till to the determination of the design rules 157 remote controls of different producers and device categories have been appraised. Because there are no (common) design rules for such input elements, first of all the following questions should be cleared with this analysis:

- Which formational configurations positively support the user habits or disturbing them?
- Are there any common features like form and location of input elements in spite of the different producers and device categories?

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- Are the proportions of the remote control and the input elements concordant with the requirements given by the ergonomics literature?
- Is it assumed that defined elements have such a strong distribution, that users require it on a remote control?
- Which elements are needless or cause problems with the realisation of the aims?

For a better comparison and to give the ability for objectifying these analyses which is comprised prior on visual expertises and evaluation of the of the available technical data, an own database for remote controls was built. Thereby it was possible to accomplish a specific request of features with the common database functions to realise a fast localization of the question. Belonging to an internal system points are given after each data input for the occupied fields automatically. These points can be used for evaluation too.

After a 3-year period of using the data base it is still in expansion and enhancement. But it is already possible to conclude that the abovementioned aims could be reached by the data analysis. A statistic interpretation of this analysis is consciously not be given because it is not possible to make a predication about the population and type and scale of the sample. Otherwise these conditions persistent changing by the technological development. The following results are derived from the analysis and was made to the basics of the configuration process of the new remote control together with the so called "Ruelberg-criteria" (Buchheim & Lutherdt 2001):

- Remote controls often have baton-like shape.
- Input elements for essential control functions are always present.
- These essential functions are:
- Power on/off of the controlled device
- Program up/down or title forward/back
- Volume +/-
- Mute
- Numerical buttons for direct choice of a program or title
- Most of the control devices are disposing of a menu button to activate more functions.
- Displays or touch screens have not putted through, and if they are available they are not configured to user conformable display.
- A lot of the remote controls enacted a switch-rocker or mini-joystick which combines the functionality of switching a program and setting the volume.
- At all of the analysed the principle was considered that an adjusting movement upwards or to the right side increases the particular property and to the other side decreases it.
- At all of the devices the input action was represented by pushing on buttons or software-cloned buttons on a touch screen.
- It was possible to identify some determined "quasi-standard" input elements

(Lutherdt 2002)

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As a matter of course these identified “quasi-standards” for remote controls (in multimedia environments) have to found a representation in a new design of such a control device.

4 Evaluation of the determined design criteria

Figure 3: Performing the user tests with video recording

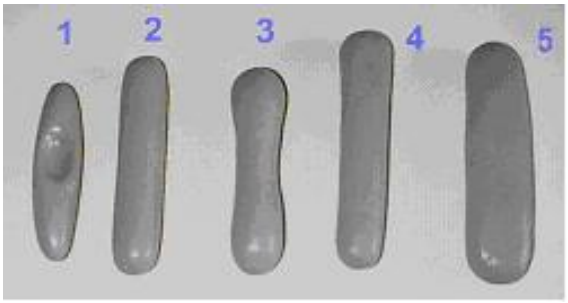

Figure 4: 5 shape models of remote controls to choose by experimentee in the user tests

To compare the results of the described analyses with the opinion of potential users a test sequence with 20 persons (male/female, age between 13 und 30 years) were performed. (see fig. 3). Thereby the experimentees had to pick one of 5 shape models (see fig. 4). This chosen model they had to use like a real remote device to control the TV set by their own thoughts and wishes. No restrictions were made for interacting with the remote control in view of the way of effectuation, the number of the used fingers and hands and the type and count of the control elements. To reach a realistic situation the requested inputs were executed by the test performer with the TV belonging remote control. Thus the test persons could concentrate to the test situation and also had an apprehend feedback. The whole test sequence was proceeded under supervision of a tutor, a second test performer in an other room and a video-based recording for later analysis. Additional the tests were combined with a questionnaire which had the experimentees to fill out after the test sequence. At least some basal anthropometric data of the test persons were taken (see fig. 6).

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Figure 5: During the tests the experimentees had to execute a given scenario (here: choice of a menu item in the OSD)

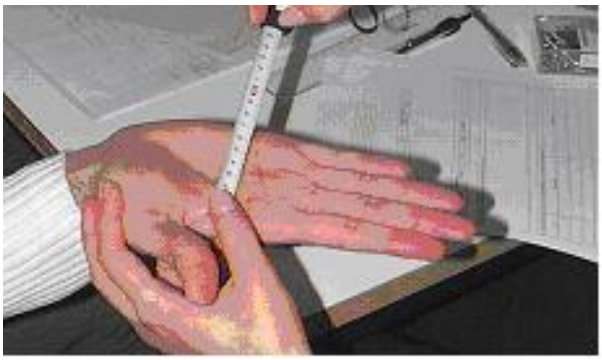

Figure 6: Taking the measures of the hands of a test person (necessary to determine the correlation between the hand measures and the choice of a specific shape model)

To determine the exploration strategies by using an unknown remote control also user tests were performed. Thereby was detected that the users tried to apply their knowledge about their own or other controls instead of reading the operating manual before the use. If they came to a situation where none of the common strategies was helpful they tried to get a help function in the main menu. Additional could be observed (like at the tests with shape models too) that during a lot of input actions a obvious changeover of the look took place from the display to the remote control (location of the input action) and back. [Lutherdt 2002] As shown in the fig. 7 and 8 these changeovers are obviously discernible on snapshots of the recording tapes. But a changeover of the look always means a shifting of the control of the human attention and an unintentional move of the head jointed with a temporal lost of the option to control the successful input action. With the new unity of remote control and OSD this unintentional move of the head should be minimised.

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Which action is expected? **Where the input action has to be made?**

Figure 7: The necessary changeover of the look by execution of unknown functions on remote controls lead to temporal lost of the option to control the successful input action (Lutherdt 2002)

What action is to do? **Was this the right action and had it given an adequate result**

Figure 8: The necessary changeover of the look by using a unknown remote control (here: using a unknown model) for later control of the effect of an input action (Lutherdt 2002)

5 Implementation of the results into a connected system of remote control and Onscreen Display (OSD)

By derivation of the results the new remote control should comply with the average of the common controls in size and weight. The shape should be a cylindrical baton fully covered by a sensory foil. (shown in fig. 9) But this concept did not followed up until a first tests stage because of the problems with this sensory foil. It does not met the requirements of the releasing force, the reproducibility and the needed resolution. Furthermore the cropping counterforces by holding the baton could not be eliminated or compensated.

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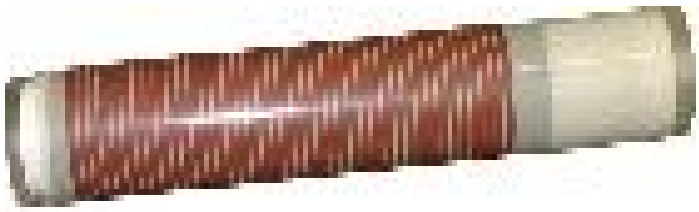

Figure 9: Remote control in baton shape with a fully covering sensory foil (Lutherdt et.al. 2003)

After this approach was not successful the extracted wishes of the user test and the other design criteria should be united in a remote control with a single sensory pad. The place and the size of this pad was determined by the measures of the hands and the average of the measured thumb-position on one of the shape models. In the fig. 10 and 11 are shown a detailed view to the sensory pad and a top view of the whole remote control (manufactured by LOEWE®).

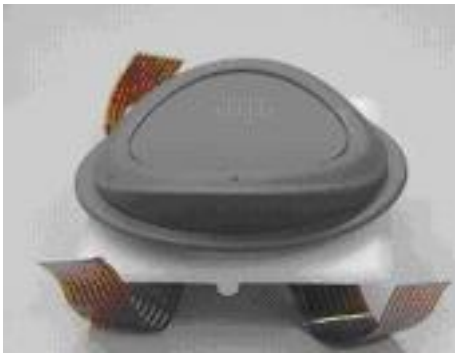

Figure 10: Sensory pad of the remote control with the carrier and electronic connections (Lutherdt et.al. 2003)

Figure 11: Top view of the new remote control with sensory pad (Lutherdt et.al. 2003)

Like shown in the fig. 10 and 11 the user's wishes were respected to extremely reduce the input elements. Size and weight is comparable to other existing remote controls. A LED on the top shows the operating readiness and gives an additional visual feedback of an detected input action on the sensory pad by flickering. In addition this sensory pad offers an auxiliary haptic orientation support by small pimples at the outer torus.

The reduction of functional elements of course means that the remaining functions have to integrated into the OSD. There is not much contrary to this concept because modern multimedia devices increasingly possessing an own display or forming a system compound with other devices like TV, video-beamer or PC. To reach an optimal solution for OSD design similar analysis were executed as for remote controls.

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Furthermore the software-ergonomic principles were applied given by the ISO 9241 and the EU-compliant developing process for software ("EUKOS" (Sievers 2002)). A special attention was pointed to a menu structure with a less depth (maximum 2 sublevels), to a motion compliant mapping of the thumb motion on the OSD and to a contrast rich representation.

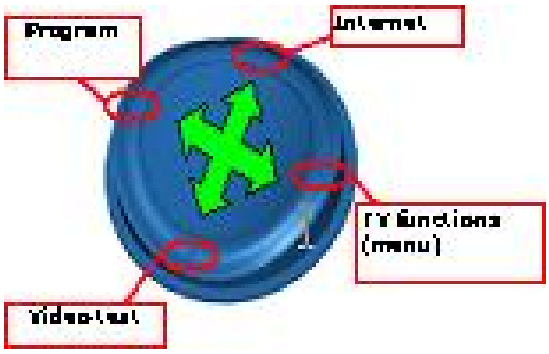

Figure 12: Schematic image of the sen-sory pad with the specific input areas. (Lutherdt et.al. 2003)

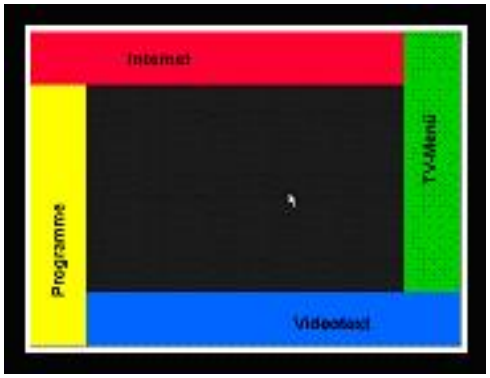

Figure 13: The displays areas belonging to the input areas (Lutherdt et.al. 2003)

The fig. 12 and 13 illustrate the wanted conformity of the directions in the OSD and at the sensory pad. At conventional TV's the OSD appears unexpected anywhere at the screen, and by the moving background images the spectator is deflected additionally. Other concepts use the whole to represent the OSD. At the above shown layout only appears the wanted menu item at that side of the screen compliant to that side of the pressed edge of the pad. In the inner areas of the sensory pad can be executed the navigation within the menus by stroking up and down or from left to right with the thumb. The curved line of thumb moving causes by the physiological degrees of freedom of the thumb ankles are considered in the detection software. The selection can be executed by pressing at the centre of the pad. In the fig. 14 (next page) an example is shown for such a navigation in this OSD. By pressing the right edge of the sensory pad the menu "Picture" (German: "Bild", the menu for all settings of the screen) was opened. By stroking downwards the item "colour" was selected and by that time the actual value is shown underneath. This value was set to 50% by stroking to the right side on the pad.

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Figure 14: Example of the new OSD on a TV of LOEWE.® (Lutherdt et.al. 2003)

All settings have to be confirmed explicitly. I there no happened a confirmation of new values the menu closes self-acting after a settable delay. The system continues working with the previous values. All settable values are displayed as numbers (in percent) and graphical as a beam (like shown in fig. 14).

6 Valuation of the developing results and outlook

Both the performed tests at the institute (14 experimentees) and the experiences during the presentations had shown that the combination of remote control and OSD achieves a wide acceptance. This is only limited true for the stand-alone remote control. Thereby occurs that the users could not imagine (without briefing or some attempts) that it is possible to control all the functions of the TV set only by one input element. The feedback of the formation features themselves was positively, esp. the reduction of the input elements, the location of the sensory pad, the accessibleness of the pad, the size and the shape of the remote control. After some functional tests the experimentees corrected their primary reserved and critical opinion about the formation of the remote control. In the fig. 15 are seen the presentation of the system at the stand of LOEWE at the fair IFA 2003 (world of consumer electronics) at Berlin in September 2003 (implemented at LOEWE TV Xelos®).

Figure 15: Impressions from the presentation of the remote control and the OSD at the international fair IFA 2003 by Mr. Schedel (company LOEWE)

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Up to now the haptic feedback about an executed action has to be assessed as insufficient. This results by the unsatisfactory yieldingness of the silicon surface of the pad and the missing pressure point. Similar problems are well-known by the use of laptop touch pads. This lack should be removed by further developments. By this the sensor foil underneath the silicon hood should be replaced or added by micro pushbuttons. The outer formation and the general functionality should be obtained.

The OSD was developed priority for TV's and will be entranced in LOEWE products at the end of the year 2005. Now this OSD has to adopted to smaller screens and displays with less colours and pixels (e.g. for PDA or portable DVD- and video players). After this new user tests have to be performed and from the valuations of these tests design solutions have to be derived.

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