Interactive TV User Interfaces: How Fast is Too Fast?

Mitja Golja
Iskratel d.o.o.
Ljubljanska c. 24a
SI-4000 Kranj, Slovenia
+386 4 207 3529
golja@iskratel.si

Emilija Stojmenova
Iskratel d.o.o.,
Tržaška cesta 37a,
SI-2000 Maribor, Slovenia
+386 4 207 2154
stojmenova@iskratel.si

Iztok Humar
Laboratory for
Telecommunications,
Faculty of Electrical
Engineering,
University in Ljubljana
Tržaška 25, SI-1000
Ljubljana Slovenia
+386 1 4768 806
iztok.humar@fe.uni-lj.si

ABSTRACT
The analysis, presented in this paper, is searching for an optimal speed of user interface for intractive TV navigation. Pleasant navigation technique for browsing through user interface usually incorporates scrolling. The latest set-top-boxes have enough processor power to support very fast scrolling not only for texts, but also photos and other elements. We designed and performed an experiment to measure optimal scrolling speed for different activities on user interface. We found out that optimal speed depends on type of navigation elements (text or graphics). The results of this study can improve the usability of horizontal and vertical navigation techniques in modern interactive TV navigation.

Keywords
User interface, navigation, scrolling, speed, interactive TV

INTRODUCTION
Navigation techniques provide an easy way for accessing large quantity of information on a limited screen space. Scrolling is a fundamental technique for moving in two-dimensional continual space. Scrolling user interface feels more alive, fluid and less abrupt.

In interactive TV and IPTV (Internet Protocol Television), users can navigate and select among vast of content (hundreds of TV channels, thousands of movies, pictures, etc.) therefore user experience is one of key issues for successful offering such services.

Many analysts [18] predict that the greatest barrier to the development of IPTV and interactive TV would be consumers. In the ever-changing technology environment, consumers must be convinced to adopt IPTV. Customers are questioning whether IPTV offers better features, such as content, price, user experience, and search or other unique applications.

Form the first introductions of interactive TV and IPTV the user experience has changed quite a lot.

First generations were base on simple set-top-boxes with low processor power, which were very limited in performance perspective. Typical architecture was based on client-server model, where client was typically implemented as simple limited web browser.

User interface was built as a web page with Java script functions were used for navigation. Consequently the user experience was rather low because of slow request-response model. End users had to wait while navigating through the menus.

The developments in set top box - STB chipsets with more powerful processors and entry of new players in this segment such as Intel have brought a shift in architecture of latest generation of IPTV and interactive TV solutions. Latest architecture typically uses fat client approach rather than thin client in the past. These implementations cache the necessary meta-data in the background. Consequently, user interface can provide fast and responsive user experience.

With this new architecture and highly performing hardware we have come to the point where set-top-boxes and user interface can work faster than the users can percept.

Figure 1: The problem of too fast scrolling on user interface. The user becomes disoriented when the menus and content are moving too fast. Source: Iskratel Innbox HD30 user interface with vertical navigation [12]

Because we at Iskratel are involved in development of such devices, we have met an important question for scrolling in user interfaces: how fast is too fast? How fast navigation on user interface at TV can ensure wide user segment with comfortable and acceptable user performance?

RELATED WORK

In the past, several studies already addressed similar problems related to perceived user experience.

Shin [19] explored the factors influencing the adoption of IPTV, and tested predicting user acceptance of IPTV. The analysis showed importance of perceived system quality. The higher the quality of content and responsiveness of the system, the more positive the attitude toward IPTV was confirmed. System quality is especially important in the context of IPTV, as many people become reluctant to use services when they experience frequent delays in response, disconnection, lack of access, or poor security [1]. Similarly, Lin and Lu [14] examined information quality, response time, and system accessibility. They argue that these three variables are useful predictors of perceived ease of use and perceived usefulness. Because response time and system accessibility, and other factors such as system reliability and security can be understood as attributes that explain system quality, information system quality can be comprehensively identified by system quality and information quality.

Scrolling is one of the most fundamental activities when interacting with computer, IPTV and interactive TV use. Igarashi & Hinckley [11] identified the problem that scrolling too fast results in the motion blurring. Motion blur can cause disorientation, and reduces the user's ability to determine whether they have reached their target. They analyzed scrolling issues in personal computer – PC environment for web browser, map viewer, image browser, dictionary and sound editor. Igarashi & Hinckley proposed speed-dependent automatic zooming (SDAZ) as a solution to the problem of motion blur when scrolling rapidly. SDAZ automatically alters the zoom level, based on scrolling speed. The document was smoothly zoomed out when the user's scrolling speed exceeds a predefined threshold.

Wallace et al. [20] analyzed scrolling and zooming for documents with text and graphic and determine metrics of visual flow to answer the question "how fast is too fast" on personal computer. Presented empirical results show maximum acceptable document speed at 2,68 pages/s and comfort speed at 1,52 pages/s. However they didn't measure any horizontal scrolling.

Human visual perception was analyzed by Card [7], Burr [5].They found that the human eye summates signals over a period of 120-125 ms. Visual accuracy can usually tolerate an image retinal velocity of up to 3 degrees per second [15]. However, the introduction of smooth-pursuit eye movement allows movement in excess of 9 deg/s [8], perhaps even up to 100 deg/s [3], as the tracking of the target reduces the retinal image velocity to a manageable level.

Based on previous results and through empirical study, Wallace et al. [20] recommended comfort scrolling speed for documents with pictures on PC as 1.52 pages per second.

The perspective tilt dynamics in zooming and scrolling techniques on mobile devices such as smart phones with tilt and accelerator sensors were the focus of research of Eslambolchilar & Murray-Smith [9]. The issues of small screen and specific navigation were closely observed and an optimized SDAZ model for mobile devices was proposed.

SCROLLING iTV USER NAVIGATION

Latest studies with qualitative methods confirm that most suitable navigation models and its unified user interface for application running on the TV, such as electronic program guide, are based on scrolling techniques [18]. This concept is also implemented in Iskratel's commercial set top box – media center Innbox HD30. Beside standard IPTV services such as live TV, video on demand, electronic program guide, personal video recording, more advanced services and applications are also supported e.g.: presence monitoring, messaging, call control, media exchange, recommendations, etc. Common to all those services is the usage of scrolling navigation. Since all necessary meta-data are locally cached, the system response is practically instant.

Implementation of User Interface

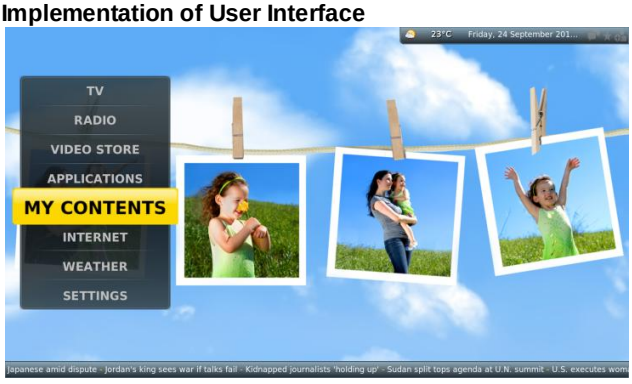

Figure 2: Main menu of Iskratel Innbox HD30 user interface [12]

User Interface is designed in two levels with rotating menus. On the main menu the user selects basic services and applications.

The second level is used for selecting the content (e.g. TV channels or movies in video store). For selecting TV channels, a vertical menu is displayed with seven neighboring listed channels. Each channel is accompanied with the following information displayed: channel name, number, logo and the name of current show. When pressing up or down button on the remote control, channels are scrolling up or down respectively. For video store, the

navigation pane is designed horizontally as presented at Figure 3.

Figure 3: Video store menu of Iskratel Innbox HD30 with horizontal navigation [12]

USABILITY STUDY

Wallace et al. defined metrics with *document speed* as the rate at which navigation through the information space is occurring. The speed is measured in units such as pages/second or lines/second. It is this value that it is desirable to maximize in order to acquire the target more rapidly. Alternative units that might be used include cm/s, pixels/s and degrees/s. These alternative units can be calculated as functions of screen resolution, physical screen size, and viewer distance from the screen.

In IPTV graphical user interface we are dealing with items such as channel lists, video on demand movie items or content titles in electronic program guide. Typically seven to eight content items are displayed on the screen at once. The metrics should be defined in clicks/second.

Nielsen [16] recommended user testing with 5 test users, to get the best result, especially when the user tests are an iterative process. This is shown in Figure 4. Also Hwang & Salvendy [10] confirmed that 10±2 participants is enough for usability evaluation.

In our research, 16 users participated in the test to achieve better statistical pattern.

Evaluation

The objective of the experiment was to obtain empirical data on the rate of information flow that humans find comfortable and tolerable when scrolling rapidly. Usability tests were conducted over a 2-month period in 2011.

Sixteen volunteer participants (13 male, 3 female) ageing from 19 to 57 years took part in the experiment. All participants had basic computer skills.

To assure proper test environment we set up a room with optimal lightning condition and viewing distance to TV set according to SMPTE (30 degree field) recommendation [22].

For evaluation we used graphical user interface based on Iskratel's media center product Innbox HD30. Navigation screens are presented on Figure 1 (vertical navigation) and Figure 3 (horizontal navigation).

Procedure

An important part of the experiment lay in the participants' understanding of the meaning of the task. Participants were individually advised to consider the task of scrolling vertically through TV channels and horizontally through video store menu with the goal of target acquisition in mind. They were instructed not to try and read all the channel data, but rather look for the locations of specific channel. They were asked to imagine they were scrolling through the menus with the intention of navigating to a known channel or movie.

The "most comfortable" speed was defined to be the speed at which they felt provided the optimal trade-off between acquiring the target quickly and maintaining an understanding of their location in the menu.

First we adjust 5 different vertical speeds in random order (presented in Table 1) and each participant was asked to rate the speed on a seven-point Likert scale [Figure 4], where too fast experience was rated one, and too slow experience was rated seven. Speeds were empirically chosen on pilot tests (from annoying slow, doubling the speed rates with focus on optimal speed, to much too fast). Those tests also indicated that different speeds for vertical and horizontal scrolling should be chosen.

vertical text speed (click/s)	2	7	17	31	62
horizontal graphic speed (click/s)	1	2	4	9	22

Table 1: Adjusted speeds for textual and graphical navigation.

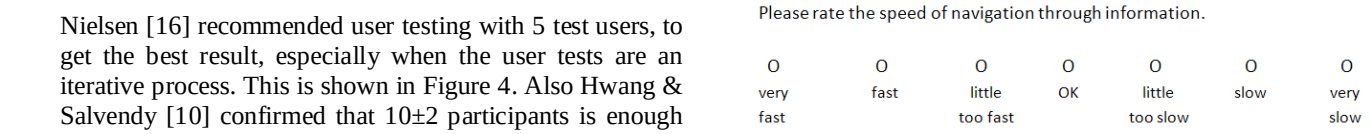

Figure 4: Likert questions for rating the speed for navigation

After evaluating 5 speeds participants were asked to choose optimal speed for them. The test was repeated for horizontal navigation again.

Results and discussion

Obtained results for vertical scrolling of TV channel list are presented in Figure5. Most of test participants marked 17 click/s as an appropriate speed. Other speeds were marked either too slow or too fast.

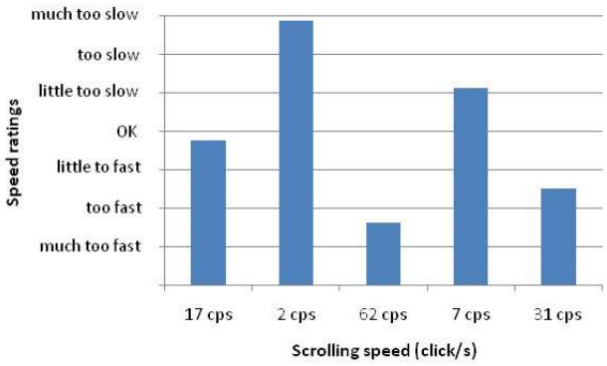

Figure 5: Results for vertical text scrolling in random order as were conducted on the test

Before participants moved to the next task, they were asked which speed (in sequence) they remembered as the most optimal for navigation. The answers of the question confirmed the previous results as shown in Figure 6.

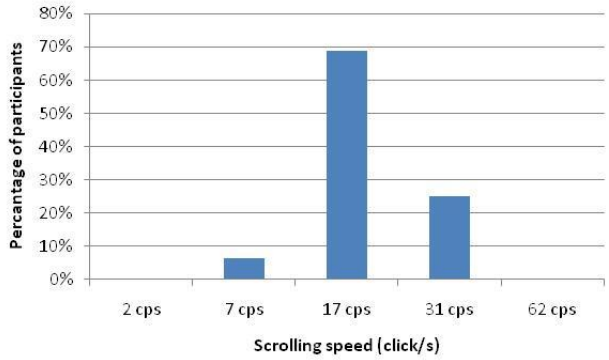

Figure 6: Optimal vertical text speed chosen by participants

Eleven participants selected vertical speed 17 click/s as most appropriate, three choose 31 click/s and one 7 click/s. We can conclude that on average 19.9 click/s (2.84 pages/s) is the optimal vertical scrolling speed for text based items (e.g. TV channel list). This result is higher compared with personal computer results (1.52 pages/s) of Wallace et al. [20]. We see main reasons in larger viewing distance, smaller screen view angle, nature of content – TV menus (less complex than document) and different type of navigation with remote control.

On the other hand ten participants selected horizontal speed 4 click/s as most appropriate, four choose 2 click/s and two 9 click/s. On average 4.1 click/s (0.59 pages/s) is the optimal scrolling speed for graphic based items such are movie posters in video on demand menu.

Summarized results shown in Figure 7 indicate that most optimal rated scrolling speeds for text and graphic based items.

We can convert these results into pages/s or screen time. For horizontal text based items the optimal screen time 350ms and for vertical graphic 1.71 s respectively. This differs from the results measured on other devices such as personal computer (900 ms [19]) and horizontal document scrolling.

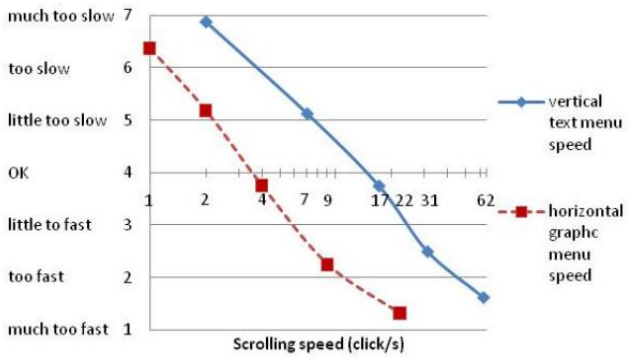

Figure 7: Scrolling speed rated by participants

The analysis of the results obtained from the conducted user evaluation study showed that we have to carefully select optimal navigation speeds in interactive TV user interface. Since it is strongly desirable that it is not too fast for any users we suggest that viewer speed should be less than 99% of people indicated as too fast.

CONCLUSION

The task of scrolling involves a rapid movement through the information space. This movement can cause blurring or disorientation if it occurs too rapidly. We conducted an evaluation to determine an optimal threshold value on the speed rate for Interactive TV navigation.

According to Kinchla et al. [13] human eye perception indicates no consistent difference in sensitivity of or vertical and horizontal movement. The only reason for different result is therefore in the content of a moving object. Text reading or recognition is also not highly dependent on vertical or horizontal movement [4].

We discovered that the optimal navigation speed depends mainly on wherever simple text or graphics is used in the navigation elements. Empirical results show's that optimal speeds in such case are up to 4.8 times slower. This is due to the fact that graphic recognition (e.g. movie poster) is much more complex and takes much more time than channel number - name or position recognition.

Optimal speed for TV navigation also differs from optimal speeds measured on other devices such as personal computers (document or browser scrolling) and mobile phones. Main reasons besides content are larger viewing distance, smaller screen view angle and type of navigation (remote control). We believe these result will help to improve future user interfaces of Interactive TV in terms of users experience and usability.

Future work

Future plans include testing the navigation speed in some other applications, such as electronic program guide or multimedia library. Although physiological attributes do not expect differences between for recognition at horizontal

and vertical scrolling [13], we plan to prepare in-depth statistical analysis and evaluate both vertical and horizontal graphic and text scrolling. More precise measurements of optimal speed will be conducted. Additional demographical data of participants (e.g. the amount of time user evaluation study participants spend on watching TV daily) will be correlated with results.

Acknowledgments

Authors thanks to Gregor Fuis and Sergej Eržen for their help with testing environment preparation and participants who took part in the evaluation study. The research work was partly performed in the scope of research programme P2-0246 - Algorithms and optimization procedures in telecommunications, financed by the Slovenian Research Agency.

REFERENCES

1. Aladwani, A., Palvia, P. Developing and validating an instrument for measuring user-perceived web quality. *Information and Management*, (2002) 39, 467–476.
2. Anderson, R.E. Social impacts of computing: Codes of professional ethics. *Social Science Computing Review 10*, 2 (Winter 1992), 453-469.
3. Blohm, G. & Schreiber, C. The smooth pursuit system, *http://www.auto.ucl.ac.be/EYELAB/neurophysio/perception_action/SP.html*. (2002)
4. Bowers, A. R., Woods, R. L., Peli, E. Preferred Retinal Locus and Reading Rate with Four Dynamic Text Presentation Formats. *Optometry and Vision Science*, (2004) vol. 81, no. 3, 205–213.
5. Burr, D. Motion smear, *Nature* 284, (1980) 164–165.
6. Byrne, M., John, B., Wehrle, N. & Crow, D. The tangled web we wove: A taskonomy of WWW use, in *Proceedings of CHI'99 Conference on Human Factors in Computing Systems Pittsburgh*, May (1999), 15–20', 544–551.
7. Card, S. K., Moran, T. P. & Newell, A. The Psychology of Human-Computer Interaction, *Morgan Kaufmann Publishers Inc*, (1987), chapter 2, 23–97
8. Eckert, M. & Buchsbaum, G. The significance of eye movements and image acceleration for coding television image sequences, in A. Watson, ed., *Digital Images and Human Vision*, M.I.T Press, (1993), chapter 8, pp. 90–98.
9. Eslambolchilar, P., Murray-Smith, R. Control centric approach in designing scrolling and zooming user interfaces. *International Journal on Human-Computer Studies 66* (2008) 838-856
10. Hwang W., Salvendy G. Number of people required for usability evaluation: the 10±2 rule. In *Communications of the ACM* (2010), 53(5), 130-133.
11. Igarashi, T. & Hinckley, K. Speed-dependent Automatic Zooming for Browsing Large Documents, in *Proceedings of the 2000 ACM Conference on User Interface Software and Technology*, (2000) San Diego, California., ACM Press, pp. 139–148.
12. Innbox HD30. http://www.innbox.net/
13. Kinchla, R. A., Loraine G. A. Visual movement perception: A comparison of sensitivity to vertical and horizontal movement. Attention, *Perception, & Psychophysics*. (1970) Volume 8, Number 6, 399-405,
14. Lin, J., Lu, H. Towards an understanding of the behavioral intention to use a web site. *International Journal of Information Management*. (2000) 20, 197–208.
15. Morgan, M. J. & Benton, S. Motiondeblurring in human vision, *Nature* 340, (1989), 385-386.
16. Nielsen, J. Why you only need to test with 5 users. Alertbox: Current Issues in Web Usability. Retrieved from http://www.useit.com/alertbox/20000319.html (2000).
17. Nielsen, J. Usability engineering. *Boston: Academic Press*, (1993).
18. Obrist, M., Moser, C., Tscheligi, M., Alliez, D. Field evaluation of a cross platform 6 key navigation model and a unified user interface design. *EuroITV '10 Proceedings of the 8th international interactive conference on Interactive TV&Video*. (2010)
19. Shin, D., H. An empirical investigation of a modified technology acceptance model of IPTV. *Behaviour & Information Technology*, (2009): 28:4, 361-372
20. Wallace, A., Savage, J., Cockburn, A., 2004. Rapid visual flow: How fast is too fast? *Proceedings of the Fifth Australasian User Interface Conference* (AUIC2004). Australian Computer Society Inc., Darlinghurst, Australia, New Zealand, 117–122.
21. Wikipedia. Nettop. http://en.wikipedia.org/wiki/Nettop
22. Wikipedia. Optimum HDTV viewing distance. http://en.wikipedia.org/wiki/Optimum_HDTV_viewing_distance