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UNIVERSIDADE ESTADUAL DE CAMPINAS

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Control as Artifact for Interaction with Television

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Technical Report   -   IC-09-22   -   Relatório Técnico

June   -   2009   -   Junho

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Abstract

This technical report presents the results of an experiment whose objective was to observe users' interactions with television using the remote control. We believe that a culture mediated by the new media of Interactive Digital Television (iDTV) will depend directly on the artifact for physical interaction available to the user. In the work reported here we made an *in loco* observation of barriers related to the use of remote control in the television context and identified project requirements that should be considered in the design of new physical artifacts of interaction with iDTV.

1 Introduction

Based on previous results of our research on digital artifacts and interaction languages in the scope of Interactive Digital Television (iDTV) [7,8,9], we set an experimental scenario with users, aiming at identifying barriers that this new media could present, more specifically, with the use of the remote control. The main physical artifact of interaction with the television system – the remote control – is not enough, in its current formats, for users to have a more constant and dynamic interaction with iDTV, having in mind the problems already identified and discussed by several authors (e.g., [1,2,3,4,10]).

The e-Cidadania research Project[1] investigates solutions for the interaction design of systems that make sense to the Brazilian citizens, to facilitate the constitution of a culture mediated by Information and Communication Technologies in our society. This Project addresses one of the grand challenges in Computer Science research in Brazil for the next years, the "Participatory and Universal Access to Knowledge for the Brazilian Citizen" [11]. In this sense, our research regarding physical artifacts of interaction with iDTV acts in synergy with the mentioned Project, since we believe that a culture mediated by this new media will depend directly on the artifact for physical interaction which the user will have.

Thereby, this experiment was conducted during the 6th Workshop from e-Cidadania Project. In this Workshop, two activities were conducted. The first one had the objective of eliciting requirements for communication tools to be used in Inclusive Social Network systems [5]. In the second activity, participants were invited to individually interact with a TV in a scenario where various remote controls were available.

The objective of this technical report is to present the results obtained in this second activity which aimed at better understanding how users interact with television using remote controls; results achieved corroborate the existence of usage barriers in concrete interaction activities with these artifacts. Some of such difficulties were previously described by those users in interviews made during the 4th Semio-Participatory Workshop of the e-Cidadania Project [6].

This technical report is organized as follows: Section 2 introduces the methodology used and the experimental setting for the activity with the remote control; Section 3 presents the experiment, as well as its quantitative and qualitative results, and based on those results, we propose guidelines to the design for new physical artifacts of interaction with iDTV; and Section 4 presents our final considerations and further work needed in the continuity of our research.

2   Research Scenario and Methodology

The practice with the remote control that took place during the 6th Workshop of the e-Cidadania Project was planned to be executed individually, with concrete activities of interaction with TV. This activity was recorded in audio and video – with the participant's acknowledgement and consent – in order to facilitate the post activity analysis.

This experiment was motivated by the necessity to confirm some points that had been highlighted by some users themselves during the interviews that took place during the 4th

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[1] A Microsoft Research – FAPESP Institute for IT Research funded Project.

Workshop, regarding the difficulties in the use of remote controls. Some examples mentioned in that interview are as follows:

- ❑ Initial confusion due to the presence of different remote controls in the same room;
- ❑ Most of the interviewed users had no knowledge about the function of all the buttons of the remote control from their TV set. They use the remote to perform only daily functions (turn the TV on/off, change the channel and the volume);
- ❑ In general, remote controls have many buttons and most of them are not frequently used;
- ❑ Buttons used to change the channel and adjust the volume are in different positions in different models;
- ❑ Users stop looking at the TV screen in order to look at the remote control, searching for the buttons they want to push;
- ❑ The texts written on the remote control have a reduced size;
- ❑ There are texts in English (in this context, a foreign language for the users).

Besides the goal of confirming the aspects commented by the users, our intention with this experiment was to identify the barriers that users with different abilities and competencies might still have. These barriers in the interaction with TV via remote control were not evident, but they were observed during the users' interactions with the artifact. The identification of these barriers in concrete tasks of interaction with TV is essential for our research. Table 1 presents information that characterizes the diversity of the ten users that participated in the experiment.

Table 1: Ethnographical data regarding the participants

User	Age	Gender	Schooling Level	Occupation
U1	32	M	Ongoing bachelors or associate degree	Course coordinator
U2	22	M	Bachelors or associate degree	Informatics instructor
U3	55	F	High school	Art teacher
U4	55	F	Fundamental education	House keeper
U5	46	F	High school	Handcrafts woman/ cook/ Brazilian waxing stylist
U6	49	F	Some fundamental education	House keeper
U7	55	F	Some high school	Handcrafts woman/ elderly nurse
U8	58	F	Bachelor or associate degree	Handcrafts woman
U9	51	F	Fundamental education	Handcrafts woman/ embroidery
U10	57	F	High school	Retired

According to the survey answered during a previous Workshop, all of the ten participants had at least one TV set at home, and three of them do not use the remote control (either because it is broken, the person likes to move around and use the buttons on the TV, or because the channel is never changed). These participants came from different

regions of Brazil (namely south, southeast, north and northeast regions – no one from the central area) and their relationship with technology varied from experts (instructor) to digitally illiterate (never used a computer before, difficulty in using ATM, cell phones and other technological device).

The scenario to run the proposed experiment used the following equipment:

- ❑ 01 (one) TV set with remote control;
- ❑ 04 (four) extra remote controls with different designs. 03 (three) of the remotes used were from TV sets and 01 (one) from a DVD player;
- ❑ 01 (one) table to put the TV on;
- ❑ 01 (one) table to place the 05 (five) remote controls;
- ❑ 01 (one) measuring tape with 3.0 meters long;
- ❑ 01 (one) camera;
- ❑ 01 (one) MP3 recorder;
- ❑ 01 (one) video camera;
- ❑ 01 (one) stopwatch;
- ❑ 10 (ten) observation forms.

The following items concern the method used for the accomplishment of this experiment (grouped for better contextualization):

- ❑ **Tasks (to be made in the presented sequence)**
  - o Task 1: Turn the TV on;
  - o Task 2: Turn the volume down until it is pleasant to the user;
  - o Task 3: Change the channel: from channel 2 to channel 12, which in the region of Campinas (SP), where this Workshop took place, means Rede Record and Rede Globo/EPTV, respectively;
  - o Task 4: Access the equipment's configuration menu;
  - o Task 5: Turn the TV off.

- ❑ **Human Resources (roles and functions)**
  - o Facilitator: Responsible for explaining to the users how the remote control practice would be performed. He was also assigned to the general flow of the dynamics and for the audio recording;
  - o Observer: The observer had the task to fill the evaluation form for the tasks, including the taking precise timing for each task in the stopwatch;
  - o Video Recording: Responsible for taping the users' interactions.

- ❑ **Preparing the room**
  - o Before starting the experiment, the five remote controls were placed in a table. This table was set in front of the chair where the users would sit during the experiment, being placed 2.0m far from the TV screen. Figure 1 presents the setting where the experiment was conducted;
  - o All remote controls had their batteries on so that they would not be too light and, potentially, facilitating the identification of the "correct" remote.

Furthermore, in a real use setting with more than one remote control, all of them would have batteries.

Figure 1: Part of the experimental setting

❑ **During the tasks**
- o Before the starting of each task, the facilitator – the first author of this technical report – read aloud the tasks to the users. It is important to mention that, before the experiment, the facilitator had explained to the users all together, the structure and sequence of the tasks, without much details of their configuration such as, for example, the existence of five different remote controls in the table and the elevated level of the TV sound when turning the TV on;
- o After the conclusion of each task, the user would put the remote control back on the table – anywhere he/she wished – before continuing to the next task.

❑ **Between each task performed by different users**
- o Before the entrance of a new user in the experiment room, the table with the remote controls had to be set again, so that the remotes would be in the same initial position for every user. This initial position in represented in Figure 2;
- o Leave the TV set on Channel 2 (Rede Record);
- o Turn up the volume to "level" 60;
- o Turn the TV off.

❑ **Decisions**
- o No user should have previous access – before his/her turn – to the room where the experiment was being conducted;
- o Besides the TV remote control, other three TV controls and one DVD control were chosen. This happened because, after the analysis of the

interviews from the 4th Workshop, it was observed that the most popular remote control in the residencies, after the TV's, is the DVD's (44%);

o   The text that stated the brand of the TV in the remote control and in front of the TV set were not removed since in real situation of use this could be one of the approaches adopted by the users to try to identify which one would be the TV remote control. It is worth pointing out that the other remote controls were generic, having no text with brand identification.

Before presenting the analysis of the experiment results *per se*, we will analyze the remote controls used in the activity (Figure 2). Table 2 shows the description of some characteristics of these remotes. The remote control from the TV used in this activity is presented in Figure 2b.

Table 2: Characteristics of the remote controls used in the experiment

Item	Remote controls used in the experiment				
	Figure 2a	Figure 2b	Figure 2c	Figure 2d	Figure 2e
Application	TV	TV	DVD	TV	TV
Number of buttons	9	27	51	32	32
Power On/Off button	Yes	Yes	Yes	Yes	Yes
Volume button	Yes	Yes	Yes	Yes	Yes
Channel button	Yes	Yes	Yes	Yes	Yes
Menu button	Yes	Yes	Yes	Not identified	No
Language and acronyms	English	English and Portuguese	English	No text	English
Number of words or acronyms	3	13	27	0	18

A preliminary analysis of these artifacts allows us to corroborate some barriers in the interaction with the remote control in the context of TV, as reported by users during the interviews from the 4th Workshop. Similar results were achieved by Nielsen, using other remote controls [10]. Some considerations on the artifacts used in this experiment are as follows:

❑   100% have a button to turn the TV on, which is the same button used to turn the TV off. In each remote this button is on a different place;

❑   100% have buttons to change the volume. All of them make use of two buttons: one to turn the volume up and the other to turn it down;

❑   100% have buttons to change the channel. All of them make use of two buttons: one to advance and another to go back one channel;

❑   60% have words or acronyms only in English;

❑   20% have words or acronyms in two languages, i.e., some functions are described in Portuguese and others in English;

❑ 20% have no text written in the artifact. The solution make use of symbols and due to this fact, we were not able to identify whether the remote has a button to access the equipment's configuration menu without consulting the manual;

❑ 60% have a button to access the configuration menu.

Our hope in the experiment was that the great variety of users' profiles as described above, would enable us to observe other barriers to interaction, not reported yet.

(a)   (b)   (c)   (d)   (e)

Figure 2: Initial setting of the remotes on the table

3   Results on the Remote Control Experiment

The activity with the remote control was divided in two parts. In the first, a quick explanation about how the experiment would be conducted and how each user would participate was presented to all the users together. Still in this moment, it was mentioned that this activity was motivated, among other factors, by the necessity of deepening some questions related to the answers that these same users had given before in the interviews during the 4th Workshop. After this quick explanation, the second part of the experiment took place, with the interaction with TV via remote control.

This quick explanation was necessary in order to guarantee that all participants would actually know the five tasks to be performed via remote control as well as to offer additional information regarding how they should proceed during the experiment. In this first part, it was emphasized that the tasks should be performed using the remote control, and that they

were not allowed to use the buttons on the TV set. We also warned them that, before starting each task, the facilitator would tell them what to do, and that, by the end of each task the remote control should be placed back on the table, before beginning a new task.

3.1   Quantitative Results

Table 3 presents quantitative data related to the time each user needed to perform each task. The order of the users that is presented in this table was the same that took place during the experiment and that these users are identified in this technical report as U1, U2, ..., U9, U10.

Table 3: Users x Tasks (times in seconds)

User	Task 1	Task 2	Task 3	Task 4	Task 5
U1	5.62	9.75	7.25	5.72	1.84
U2	6.81	6.84	6.22	2.50	2.56
U3	**20.50**	4.23	3.00	**12.31**	1.35
U4	12.06	19.38	**38.69**	**20.93**	1.46
U5	9.25	**15.15**	7.19	4.28	5.84
U6	7.56	**13.72**	**11.47**	n/a	1.60
U7	**14.32**	2.94	2.72	4.69	1.47
U8	**26.47**	5.12	8.06	5.00	**54.66**
U9	9.85	6.31	2.56	3.75	**+12.00**
U10	19.16	10.78	6.25	5.50	3.24
Average	13.16	9.42	9.34	7.19	8.60

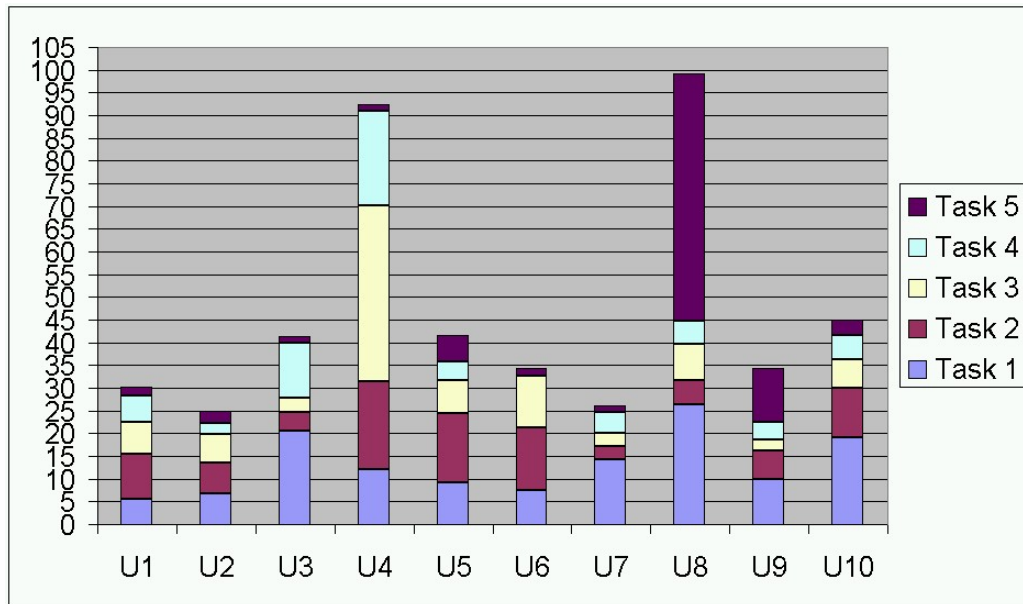Figure 3 presents a graphical synthesis of data from Table 3.

Figure 3: Time that each user needed to perform the tasks

3.2   Qualitative Observations

After the activity, relying on audio, video and the data collected by the observers, an analysis of the data was made. Some considerations and findings regarding the five tasks that the users performed are presented as follows. From this qualitative analysis we are able to better understand the quantitative data extracted from the experiment (Table 3):

- ❑ **Task 1: Turn the TV on**
    - o U3 did not try to identify the remote control by comparing the text referring to the name – brand – of the artifact to the one in the TV set. This user adopted the "trial and error" strategy in order to identify the remote. First, she tried the remote presented on Figure 2e, pressed the red button – which, in this remote, would be exactly the on/off button – and, as the TV presented no response to the command, she skipped to the remote control of the TV used in the experiment. After the conclusion of this task, to begin all other tasks, the user went straight to this remote;
    - o Before starting Task 1, right after U9 sat on the chair, when she saw the table with the five remotes, she said: "Jesus!". To start the task, this user first grabbed quickly the DVD remote and then she went on to the remote from the equipment used in the experiment.
- ❑ **Task 2: Turn the volume down**
    - o When performing this task, U1 migh have pretended that he hadn't understood what he was supposed to do. Therefore, the timing might had been shorter;
    - o It seems that U3 and U10 felt uncomfortable with the volume of the TV;
    - o U5 was bothered by the volume of the TV, probably due to the noise; this user pressed the button to change the channel. When that happened, U5 said: "Oh my God!"[2]. Then she changed the channel back and said: "I'm lost"[3]. Then she was able to turn the volume down, but right after she ended up hitting the button that turns the TV off. When the TV was off, she said: "Now I am curious"[4]. At this moment, the facilitator had to interfere to let the TV in the correct status so that the user would be able to start the next task (Task 3);
    - o One of the participants showed some doubts about which remote control to pick up. Figure 4d shows this situation. It is worth mentioning that this user

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[2] In Portuguese: "Ah! Meu Deus!".
[3] In Portuguese: "Me perdi".
[4] In Portuguese: "Agora eu fiquei curiosa".

performed Task 1 before Task 2 without any troubles, being Task 1 accomplished in a short time, below average. Once concluding Task 2, for all following tasks, the user searched directly for this remote;

o   In order to change the volume, U10 used fingers from both hands.

- **Task 3: Change the channel**
    - o   80% of the users – U1, U2, U3, U5, U7, U8, U9 and U10 – changed the channel by pressing the numbers until they had formed the number corresponding to the channel asked (direct access to the channel, by pressing 1-2);
    - o   U6 changed the channel using the buttons for zapping (going the channels one by one);
    - o   U4 adopted the same strategy as U6 – she changed the channel using the arrows –, but U4 went as far as channel 55 first, and then she went back to the channel asked (channel 12).

- **Task 4: Access the equipment's configuration menu**
    - o   After U2 had finished Task 4, he continued pushing the buttons to configure the TV. The facilitator signed that this was not necessary. This user was the fastest to accomplish the task (2.50s);
    - o   After U3 had heard from the facilitator that Task 4 was about accessing the configuration menu, she said: "Configuration menu, my God, this is getting ugly"[5]. It is worth noticing that this user was able to complete the task and that, at the end, she dropped the remote control on the table, in an expression of despair/relief. This reaction was different from those after concluding other tasks;
    - o   Before starting Task 4, U4 put her glasses on and picked the DVD remote (Figure 2c), which worked for this task. That is, when she pressed the menu button on the DVD remote, the TV menu was displayed. This fact caused, as it will be further detailed, confusion until the end of the tasks. The data presented on Figure 3 about the time that this user took to complete the five tasks shows that her interaction was damaged due to the inconsistency of the design solutions of the remotes.

- **Task 5: Turn the TV off**

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[5] In Portuguese: "Menu de configuração, papai do céu, agora vai ficar feio o negócio".

o U8 said: "On, off, ah! And now? [...] is it, isn't it? [...] it is not the same button? Help, I don't know"[6], because she was no sure if she had concluded the task successfully. This user was not sure if the same button could be used to both functions: turn on and off. This was the only remote control to have a text related to the on/off functionality, but the text was only "On". We imagine that the users doubt was due to this text, which had no "off" written on it, but it should be used to turn the TV off. As shown on Table 3, this user took longer than 54s to turn off the equipment. Maybe she had lost time searching some button with the text "off" related to it. When finishing this task, the facilitator asked the user: "Which button did you push to turn the TV off?"[7] and the user answered: "On"[8].

❑ **In General**
o At the end of each task, 100% of the users placed the remote control back on its original position. The facilitator had explained that they were supposed to place the remote control back on the table, but nothing was mentioned about the position;
o The remote control shown in Figure 2a was not even touched by any of the users. This was the smaller remote control used, and the one with the least number of buttons (nine). At a closer look at this remote control, we realize that this artifact looks likes sound systems' remote controls. Maybe that was the reason why this remote was not even touched by the users;
o The control for DVD (Figure 2c) is the one to have more buttons (fifty one), as well as the highest dimensions;
o The sum of the time to perform Task 1 was higher than the sum of the other tasks. This was probably due to the fact that the users needed some time in their first interactions in order to identify the remote that controls the TV;
o The time required to perform Task 5 was much lower in most cases. The average time of this task was significantly higher due to the fact that U8 took more than 54s to turn the TV off. This was probably due to the fact that the users had already acknowledged which was the remote control for the TV and that they know that the same button used to turn on is also used to turn off. This justifies that the average time to turn the TV off was lower that to turn it on;

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[6] In Portuguese: "Liga, desliga, ah! e agora? [...] é, não é? [...] não é no mesmo botão? Socorro eu não sei".
[7] In Portuguese: "Qual botão a sra. apertou para desligar a televisão?".
[8] In Portuguese: "No liga".

- o The sum of the times to perform Task 4 was less than the sum for the other tasks;
- o In the sum, Task 2 and Task 3 are very close. This was probably due to the resemblance of the interaction language with both tasks;
- o 90% of the users used the right hand during most part of the experiment;
- o 100% of the users looked at the TV to press a button.

Figure 4: Moments of the experiment. (a) User observing the remote control; (b) User commenting on the button that got stuck; (c) user puts the glasses on in order to use the remote control; (d) User in doubt about which control to use

3.3   Discussion

Next we present a discussion based on situations that took place during the experiment, which allowed us to identify the barriers in the interaction that sill exist and that are not clear.

By the quantitative results of this experiment it became clear where problems of interaction lay. After this identification, a qualitative analysis of the facts took place. Based on this analysis and on observations, we identified possible origins for the issues and we propose some design guidelines. The purpose of these guidelines is to provide one more

instrument to support the design of a new physical artifact for interaction with iDTV, aiming at minimizing the chances for a design to carry the same problems of interactions identified in this work.

Situation 1: Specifically on the interaction of U4, we could observe how the interaction might be complex, even when performing tasks that are fundamental and apparently simple: first, in order to turn the TV on (Task 1) this user successfully tried to use the remote control presented in Figure 2c. Although this remote was from the DVD, it turned the TV on. Probably, imagining that this was the "correct" remote, in order to start Task 2, U4 grabbed the same remote, but this time the TV did not answer to the command from the button supposed to turn down the volume. In the sequence, the "correct" remote was chosen, and therefore the task of turning the volume down was accomplished. It must be mentioned here that the facilitator did not expect that the TV would turn on with the remote from the DVD. The facilitator then interfered in the experiment for U4 in this task (2), showing U4 the "correct" remote. After listening to what she was supposed to do in Task 3, U4 took the remote from Figure 2e. As she was not able to perform the task with this remote, in the sequence she took the remote shown in Figure 2d. As this control did not work either, she tried another one. This time, the option was the "correct" one. Using the arrows to change the channels in sequence, the user browsed until channel 55, passing channel 12 (which was the goal of Task 3) unnoticed, and then went back to the correct channel (12). After explanation about what the user was supposed to do in Task 4, U4 picked the control shown on Figure 2c and said: "Hum, what now?"[9]; then she put her glasses on and kept staring at the remote for 16 seconds before pressing one of its buttons. Even using the remote control from the DVD, the TV showed its configuration menu. After explanation of Task 5, the user went straight to the remote from the DVD and pushed the red button to turn the TV off, and the TV went off.

Issues identified: As seen, the existence of many remote controls in the same place causes confusion. Though, worse than that is the fact that some physical artifacts works sporadically for multiple devices, which makes it more difficult for the user to identify which artifact is the one for the interaction with the TV. Observing the interaction of U4, we see that she left the activity not knowing which one was the remote control for that TV.

Guideline: The artifact design should indicate the physical artifact that mediates the intended interaction.

Situation 2: Before starting Task 1, three out of ten users put their glasses on and kept them until the end of the experiment. Figure 4c shows the moment when one of these users put

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[9] In Portuguese: "Hum, e agora?".

the glasses on. In that moment the user said: "Ah, without glasses... may I put them on? [...] excuse me, otherwise I can't see a thing"[10].

Issues identified: Need of glasses in order to use the remote control.

Guideline: If there are labels – or words or acronyms – for the buttons, be them written on the button or on the structure of the physical artifacts of interaction, they should make sense and be accessible to the users, considering the language and font size.

<u>Situation 3</u>: For one of the users the time scored on Task 5 was +12.0s. This score was motivated by an unusual event that happened during the experiment with this user. After some not successful attempts trying to turn the TV off using the correct remote control, the user started to try the other remotes to accomplish the task. After 84s the facilitator decided to interfere in the experiment, since the button to access the menu was stuck "to the inside" of the remote and because of that the on/off button was not working. After watching the video we estimated the time that it took the user to hit the right button in the first trial. Figure 4b shows the exact moment that the facilitator interfered in the task. It is still worth noting that, the button was only stuck, and not broken. It happened after the user had used it in order to perform the previous task (Task 4). When leaving the room, the user said: "For God's sake, that thing wouldn't turn off"[11].

Issues identified: Buttons from the physical artifact might get stuck in the artifact.

Guideline: Whenever there are concrete buttons, they should be designed and projected in a way that minimizes the possibilities of getting stuck in the parts of the artifact.

<u>Situation 4</u>: During the experiment, one of the users stopped for a while looking at the control before starting the task, probably trying to identify which of the buttons he was supposed to press in order to access the configuration menu. This moment is registered in Figure 4a.

Issues identified: The iDTV interaction paradigm assumes a more dynamic and constant interaction with the TV system. The user that needs to look at the physical artifact of interaction in the search for some button might end up losing the focus of the task that the user is trying to perform and switch it partially to the artifact.

Guideline: If there should be buttons, they should not be numerous because the more buttons in the artifact, the more difficult it will be for the users to promptly identify its functions, which demands the use of additional symbols or texts associated with the buttons. Not only that, it is also worth considering that the arrangement of the buttons on the physical artifacts of interaction must consider its use by left and right handed people.

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[10] In Portuguese: "Ah! Eu sem óculos, posso por? [...] da licença senão eu não vou enxergar nada".
[11] In Portuguese: "Pelo amor de Deus, aquele negócio não desligava".

Situation 5: 80% of the users made use of the remote control using both hands to perform de tasks, i.e., took the remote control with one hand and then supported the remote with the other hand, either for a better support in the moment of pushing a button or to read the text written in the artifact. Only two users (U4 and U9) did not use both hands – they used the right hand – during the experiment. One factor that should be mentioned, though, is that U4 entered the room for the experiment eating something with one of her hands. She finished eating before starting the experiment, but she kept holding the napkin with one hand. U9 also used her right hand, and did not use the left hand, although she had nothing on it. U9's left hand was on her left leg during the time. It should be mentioned that U9 had some problem with one of her legs, as she is always seen using a walking cane.

Issues identified: Most of the users made use of both hands during the interaction with the remote control. Both hands were used while reading the texts or while searching for buttons or even for supporting the pushing of the button.

Guideline: Conceive ergonomic artifacts that do not depend simultaneously on the two hands.

4 Conclusion

The constitution of a culture mediated by the new media of iDTV will depend directly on the artifact for physical interaction available to the user. In the work reported here we made an *in loco* observation of barriers related to the use of remote control in the television context and identified project requirements that should be considered in the design of new physical artifacts of interaction with iDTV.

The technical report presented the experiment conducted with users with the objective of identifying problems related with remote control design. In this experiment, participants were asked to perform five basic tasks of interaction with TV using remote control. The experiment allowed us to identify important barriers and requirements for the design project of a new hardware of interaction with TV. Furthermore, this practice also permitted us to confirm the information about the barriers in the use of the remote control, as reported by these same users in interviews that they answered during the 4th Workshop of e-Cidadania Project.

Results of this experiment provided us with a better understanding about the use of remote control by users in the context of television, allowing us to identify that even to perform basic tasks of interaction with the television, this artifact still poses barriers in its use. Therefore, as a future work, we intend to implement a new physical artifact of interaction considering the problems that were identified in this work and covering the guidelines presented in the previous section. Finally, the measurements from this experiment will also serve as comparative input for a new experiment with users to evaluate a new hardware currently being proposed as artifact for physical interaction with iDTV.

Acknowledgments

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