

Prospecting a New Physical Artifact of Interaction for iDTV: Results of Participatory Practices

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Abstract. A literature review has indicated that the remote control, the main physical artifact of interaction with the television system, in its current form is not adequate to the interaction between users and applications of Interactive Digital Television (iDTV), especially in a scenario of diverse user profiles as found in Brazil. This paper describes participatory practices carried out with the intention of defining a new physical artifact of interaction for iDTV. Based on the results of these participatory practices and previous research results, we provide a definition of an artifact that can be adapted to diverse contexts of use.

Keywords: interactive digital television, interaction design, participatory design, digital artifact, gesture-based interaction, human-computer interaction.

1 Introduction

We have been investigating the design of interactions of users with Interactive Digital Television (iDTV) focusing on the physical artifacts of interaction since 2006 [13]. Starting from earlier results [10,11,12], this paper aims at presenting results of participatory practices that lead to the definition of a new digital artifact and its interaction language.

Gawlinski [5] defines interactive television as a set of technological devices that allow the establishment of a dialogue between the user or viewer with a TV channel, program or service. In its current form, the remote control, the main physical artifact of interaction with the television system, is not sufficient for a more continual and dynamic interaction of users with the iDTV, considering the problems already identified and discussed in literature by various authors, e.g. [2,3,4,8,14]. According to Rocha and Baranauskas [17], the same technology that simplifies life by aggregating a number of features into a single object, makes life more complicated by demanding efforts for learning and using technology. This is the paradox of technology and the challenge is to minimize these effects. Therefore, we emphasize the need to develop or adapt new physical artifacts of interaction for iDTV in order to take advantage of this new interactive media.

While Brazil has adopted one of the worldwide DTV Standards as a technological basis for Brazilian System of Digital Terrestrial Television (SBTVD-T), this does not mean that SBTVD-T meets all our needs in terms of how the user interacts with

television. The context of use of digital television in Brazil is different from the developed countries, because we live in a context of large socioeconomic and cultural differences, also with regard to access to technology experience and knowledge in different regions of the country. Within this scenario, we believe it is essential to analyze and propose artifacts to facilitate user interaction with iDTV, and maximize the use of such new media as an important tool for making information and knowledge available and accessible to all citizens.

This paper is organized as follows: Section 2 presents the methodology used for this work; Section 3 describes the results of participatory practices; Section 4 discusses these activities; and Section 5 presents concluding remarks and provides pointers to future work.

2 Methodology

We understand that knowing the needs of users and their context of use is very important for proposing artifacts suitable for everyone. Employing techniques of Participatory Design (PD) [18], we hence promote the active participation of representatives of the target audience during the process of defining a new interaction language for a new physical artifact of interaction with iDTV. PD was used as the methodological foundation of practices whose goal was to design and explore the interaction language for a new digital artifact for iDTV in a participatory way with end-user representatives.

This approach involves user participation in all stages of development, not just during the test phases of prototypes or evaluation. In general, this approach has three important characteristics: i) it is oriented to the context of the target audience; ii) it involves collaboration; and iii) it is iterative. Thus, this approach permits the design of solutions with users, and for users. This approach has been used successfully in several studies, including scenarios of diversity of users, e.g., in [1,16].

From the set of participatory methods and techniques, we used the technique of brainstorming, since it is a simple technique that requires few resources. The brainstorming sessions were held at different times and conducted by the first author of this paper. In this work, these activities are referenced as Participatory Brainstorming Practices (PBP). As to the dynamics of the PBPs, participants sat on chairs arranged in a semicircle in front of a whiteboard, which allowed that ideas uttered and discussed by participants were written or drawn on the whiteboard by themselves.

The participatory practices were related to the formalization of a new gesture-based interaction language for iDTV considering a new physical artifact of interaction. Our interest was to find out a language that would represent some actions to interact with iDTV, e.g., turn the TV on/off, adjust the sound volume, change channels, and activate a particular interface element. In general, the goal of the participatory practices were to share and discuss potential solutions, without restricting to only those proposals, and asking users to show possible inconsistencies of the interaction language, e.g., by means of counter-examples.

It is worth mentioning that during the participatory practices we tried not to emphasize possible limitations of the technology in order to not restrict participants'

ideas, e.g., regarding the question of how to provide enough electrical current to power a miniature radio frequency (RF) transmitter.

3 Participatory Practices

The participatory practices were conducted in Campinas (São Paulo, Brazil) in November/December 2008 and were attended by five users. We chose to initially perform these activities with a group of users with experiences in the use of digital artifacts and digital media in general, in order to subsequently present a refined proposal for discussion during participatory practices with other groups of users with greater diversity regarding skills and competencies, as well as access to technologies. This incremental approach enables the participation of different segments of the target audience during different stages of the design process, while keeping practices manageable and without needing to repeat the same practices with different participants.

During participatory practices, we explored artifacts that are not – yet – commonly used for interaction of users with digital systems in general. A point of departure for the participatory practices was prior knowledge about the artifacts identified during our analysis of interaction with iDTV presented in [11]. Consequently, during the participatory practices, mock-ups were used as a way to simulate the tasks that can be performed applying the interaction language with these artifacts. The artifacts used in the participatory practices are presented in Fig. 1.

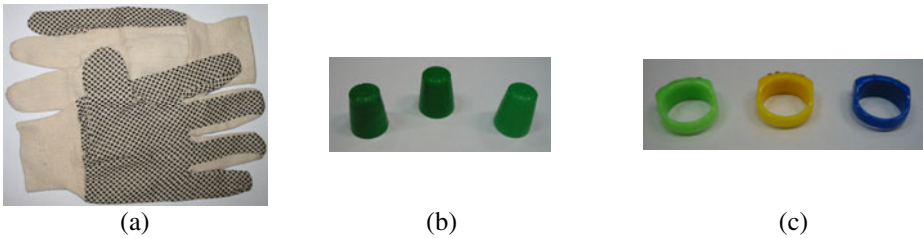


Fig. 1. Artifacts used during participatory practices (a) pair of gloves used during the first practice (b) thimbles used during the second practice (c) rings used during the third practice

3.1 The First Practice

Our initial idea for the solution involved two components: an artifact for gesture-based interaction and a capturing device for reading the movements produced during interaction. Regarding the first component, we chose as a first approach to explore, the use of gloves in order to verify if this device would fit the context of use. Fig. 1a presents the gloves used during the first practice; the gloves would later have to be electronically adapted in order to work with the capturing device.

After defining the glove as physical artifact, the next step was to define the language of gesture-based interaction enabled by this artifact. Our initial strategy was to define a set of gestures that could represent the different actions needed for interaction with iDTV.

Regarding the conduction of the actual practice, the facilitator briefly explained the research context to the participants, and subsequently presented the interaction language in order to discuss with the participants whether the language could actually be used for interacting with iDTV. The initial idea was to define the gestures of the interaction language considering up to four points of the Multi-Touch Imaginary Screen (MuTIS) Model (for further details see [10]). Considering motion in 2 axes – X and Y – and disregarding the Z-axis, each glove has mapped two points, resulting in four points for two gloves. The definition of gestures should consider relative movements of these points without considering the temporal factor, which we understood to allow the composition of a new language for interaction with the iDTV through the glove as an artifact of physical interaction.

To exemplify, Fig. 2 shows a sequence of gestures for switching on the television using the gloves. The sequence has been suggested by the users participating in the first practice. The proposal was to join the four points, two in each hand (Fig. 2a), and perform the following motion: moving the upper points upward and lower points downward while holding the respective upper and lower points together (Fig. 2b); separating the respective upper and lower points horizontally to the left and right, marking four corners of a rectangle (Fig. 2c); finally, joining the respective left and right dots (Fig. 2d). The proposal to turn off the television was the reverse sequence of movements.

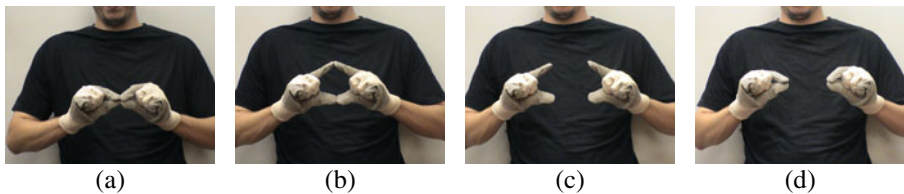


Fig. 2. Sequence of gestures for switching on the TV using the gloves

At the end of this practice we concluded that a language of interaction based on four points could be complex, since, for example, the need for four cursors on the screen to map the four points could cause difficulties in understanding and using the gloves for users with motor impairments. Hence, using counter-examples, and considering the discussion of television use by the target audience, the participants of this first practice, demonstrated the difficulty of formulating a language of interaction based on four points. Furthermore, it became clear that the solution should consider fewer points for defining the gestures of the interaction language and perhaps consider the temporal dimension besides the spatial dimension. Up to the end of the first practice, the point of departure for defining the interaction language was the simplest functions, i.e., turning the TV on or off.

After completing the first practice, we realized how complex a formalization of a gesture-based language for the desired context would be, since movements during interaction can happen unintentionally. In addition, several issues with the gloves as physical artifact were raised, e.g. questions of hygiene, which led us to the conclusion that gloves did not seem to adapt well to the use context of iDTV. For the next practice we thus defined a different proposal for the interaction language and artifact.

3.2 The Second Practice

For the second practice, we kept the same idea of the solution architecture, i.e., dividing it into two devices, one being the physical artifact enabling the interaction between the user and the television system, and the other the capturing device for reading the gestures performed by the user.

Considering the discussion about the glove during the first practice, we proposed a new physical artifact of interaction for the second practice, that we understood to be more appropriate than the glove: the thimble. Fig. 1b shows the thimbles used during the second practice.

Initially, we envisaged the use of three interactive thimbles, or an electronically adapted version of the thimbles shown in Fig. 1b, whereas only two thimbles would be mapped to the iDTV interface. We assumed that this configuration would allow flexibility of use, because the users could choose the fingers they would wear the thimbles, as well as choosing to use the thimbles on one or on both hands. The idea of maintaining the mapping of four points was discarded due to the results of the discussions during the first practice and due to potential difficulties of users with severe motor restrictions.

Although we employed gestures composed of two points during the second practice, we also took into account that the language should be usable if the two points were mapped to one hand instead of two, since within the context of television use, an interaction language that requires the use of both hands could have a low user acceptance.

Within this configuration, two of the three thimbles would be mapped as points of the MULTIS Model and used for the definition of the interaction language, which seems less complex than the four-point approach of the first practice, both in terms of use and implementation.

During the second practice, the syntax of the interaction language, that allows to represent the possible interactions with the iDTV, is composed by the relative movements of the two points and the temporal component. Taking into account a suggestion of one of the participants of the first practice, besides the spatial dimensions, i.e. rotations, approximations, this approach also considers the temporal dimension. Furthermore, at this stage of our research we also explored if real-life metaphors could inform the definition of a gesture-based interaction language.

To exemplify, Fig. 3 shows the sequence of gestures to turn on or off the TV using the thimbles, which was suggested by the users participating in the second practice. The proposal was to join two points and maintain them joined for three seconds (Fig. 3a), then to horizontally separate these points keeping them horizontally aligned for more than three seconds (Fig. 3b). After that, the two points are rejoined at the center (Fig. 3c). One problem identified in this proposal is that it would take nine seconds to turn on or off the television while when using a current conventional remote control, the response would be almost instantaneous.

At the end of the second practice, the point of departure for defining the interaction language still was exploring the simplest functions regarding interaction, i.e., turning the TV on or off. While exploring simple functions during the practices, the authors already started to explore more complex functions, such as manipulation of user

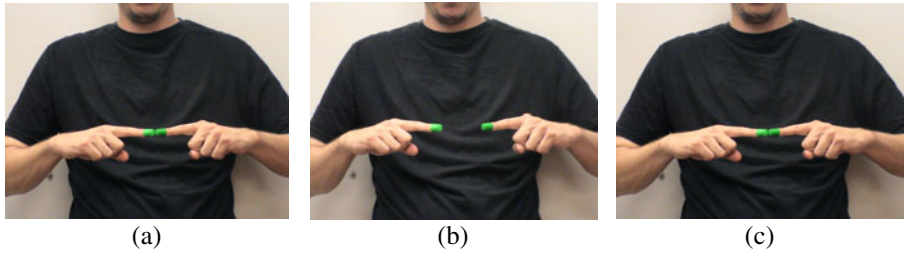


Fig. 3. Sequence of gestures for switching on/off the TV using the thimbles

interface elements. Possible gestures for those more complex functions often conflicted with simpler functions explored during the practices. Hence, at this point we realized that it was necessary to already consider those more complex functions.

As an alternate artifact, the use of band-aids was suggested during this practice. However, it was discarded for representing convalescence, which demonstrates the need for a more accurate understanding of social signifiers [15] regarding the artifacts. Nevertheless, the band-aid idea influenced the choice of the artifact to be explored in the third practice.

We observed that during this practice, issues were more related to the physical artifact of interaction and much less on the language of interaction. However, from our observations we concluded that the temporal component would bring more problems than benefits, so it should be used with caution.

3.3 The Third Practice

For the third practice we continued to use the separation between artifact of interaction and capturing device. However, as a new artifact of interaction for this practice we introduced the ring which should be adapted to electronically identify mechanical pressure, i.e. if the ring was pressed. The initial proposal did not contemplate the inclusion of any button on the device. Fig. 1c shows the rings used during the third practice.

The solution of the ring with a button, which we call interactive ring, responded to the problem we observed during the previous two practices, that the command in the MULTIS Model to activate a user interface element would be represented by the gesture of joining two points. This initial definition was unfeasible because of conflicts with other commands. Moreover, the solution of the rings also presented some advantages over the thimble, where the user's finger had to be pointed at the television screen.

One of the motivations to include a button was a comment of a participant of the second practice: "I don't see any movement that could represent the action of turning off the TV without pushing an on-screen button like in Windows and Linux". At this point, the facilitator of the participatory practices noted that creative solutions, for example the suggestion made by a user of the second practice to turn on/off the TV with a rotation of the points, show that creative ideas can indeed provide solutions to problems that seem to be hard to solve.

Aiming to design solutions for all functions of interaction with iDTV, and considering the problems identified during the two previous practices in the initial proposal of the third practice was to divide the rings into three distinct types: i) for movement; ii) for activation; and iii) for options. The three types of rings would be physically adjustable, colored, with identification in Braille¹ and a simple and easy to learn interaction language.

To exemplify, Fig. 4 shows how to turn on or off the TV using the rings, i.e. to turn on or off the television, the button of the options ring – blue – has to be pressed for at least two seconds.

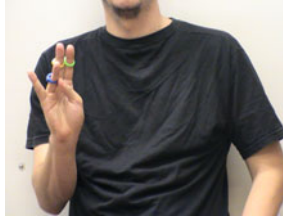


Fig. 4. Turning on/off the television using the rings

At the end of the third practice we found that an interaction language for iDTV based exclusively on gestures would be complex in order to avoid conflicts in commands. In this environment a Command Mode² would probably be necessary. However, with the advancement of the physical artifact of interaction, i.e. the introduction of a button, the proposal resulted in a simple gesture-based interaction language using rings with only one button, and without the need of a special Command Mode. During the third practice a bracelet instead of the rings was suggested too. However, during the course of the practice, we perceived that the physical location of the bracelet on the wrist would not allow as much flexibility of interaction. For example, the need of having a button on the artifact, could cause problems during interaction.

4 Discussion

After concluding the three participatory practices, it became clear that, due to numerous factors that influence the television use, it is difficult to find a new

¹ The Braille stamp was conceived as a means of facilitating the identification of the rings for visually impaired users.

² The Command Mode was defined during the second practice to minimize problems with unintentional gestures made, e.g., by users during a conversation in front of the TV. In order to be able to distinguish between intentional gestures that should trigger a command, and unintentional ones, one proposed solution was to introduce a gesture to enable or disable the so-called Command Mode. Upon activating this mode, the gestures would be mapped by the system as gestures of interaction upon disabling this mode, the system would no longer consider the gestures made by users.

interaction language for the studied context. This same consideration is valid regarding proposals for gestures as an additional mechanism for data entry in iDTV.

During the first practice, the little elaborated physical artifact of interaction did not allow the definition of an interaction language without conflicts. The complexity induced by the four-point approach of the physical artifact made it difficult to create a gesture-based language accessible to our target audience. Thus, during the second practice, we noticed that the emphasis of the work was directed almost exclusively to the formulation of gestures that could constitute the interaction language, in order to define the movements that would represent the different functions of interaction with the iDTV.

Between the first and the second practice, significant changes to the interaction language were made. However, the physical artifact of interaction did not evolve in the same order of magnitude, although different physical artifacts of interaction were proposed during each participatory practice. Upon finishing the second practice, we observed that the two aspects of this research – the physical artifacts of interaction and the gesture-based interaction language – were not explored in a balanced way. Thus, during the discussions held between the second and third practices, this new perspective was applied, which made a considerable difference in the outcomes of this work.

Table 1 presents the different artifacts explored during the participatory practices. As described in this table, each participatory practice has different settings for the artifacts, hands, and points mapped.

Table 1. Proposals for physical artifacts of interaction

PBP	Artifact	Hand	Points to be mapped
1 st	2 gloves	2 hands	4 points
1 st	2 gloves	2 hands	2 points
2 nd	4 thimbles	2 hands	4 points
2 nd	3 thimbles	2 hands	3 points
2 nd	2 thimbles	1 hand or 2 hands	2 points
2 nd	2 band-aids	1 hand or 2 hands	2 points
3 rd	3 rings	1 hand or 2 hands	1 point
3 rd	1 bracelet	1 hand	1 point

In selecting the rings as physical artifact of interaction we are not invalidating the use of other artifacts – glove, thimble, band-aid, and bracelet – as potential instruments of interaction of users with digital systems. However, considering the presentations and discussions raised during the participatory practices, these artifacts revealed not the most appropriate ones, regarding one of our research goals, namely the specification of a new physical artifact and an interaction language that can be used by all, to the greatest extent possible. The ring for example has shown to be more ergonomic in our context than the other artifacts.

Participatory practices contributed significantly to reflect on ideas and to a better understanding of the factors that influence the context of use. The practices have enabled us to better explore our proposals and to design and evaluate them together with representatives of the target audience. We also understand that the evolution of

the solution gained another momentum with the active participation of users in the initial phase of defining a new interaction language. Furthermore, this approach allowed a better understanding of the daily practices of the target audience, which facilitated the search of the artifact and the definition of the language, and enabled innovation inspired by the diversity present in the Brazilian population. Detailed results of the practices are available in [7].

5 Conclusion

Brazilian iDTV potential users are not yet familiar with the everyday use of digital interfaces. Activities carried out by our research group together with representatives of the target audience in other research contexts, demonstrated the difficulty of understanding the users of digital interfaces as well as the difficulties users have understanding digital interfaces. Paths to effective use and a more fluent dialogue with this new medium will depend directly on the physical artifact of interaction with iDTV.

This work presented participatory practices conducted with users to identify an artifact for the interaction of users with iDTV applications. Based on what was discussed during these activities, we chose to continue the work with the proposal of the ring. Thus, the goal originally proposed for this work was reached when we defined an artifact and clarified the iDTV use context with its implications on the design of future solutions.

We believe that a more direct interaction with iDTV, requires the physical artifact of interaction to be more transparent to the user. Thus, the focus of interaction must be directed to the user interface of the interactive applications and not to the interaction artifact itself. A gesture-based interaction language based on the MulTIS Model via rings provides a more natural interaction in accordance with the interaction desired by users.

As a continuation of this research are already completed the specification of the product design and the interaction language of a new digital artifact for iDTV based on the concept of a ring. We further elaborate on the formalization of the interaction language; detailed description of the physical artifact and additional resources are presented elsewhere [6,9].

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