Delegating the visual interface between a Tablet and a TV

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ABSTRACT
The introduction and wide adoption of small and powerful mobile computers, such as smart phones and tablets, has raised the opportunity of employing them into multi-device scenarios and blending the distinction between input and output devices. In particular, the partnership between a personal device and a shared one provides two possible output screens. Then, one significant research issue is to balance the visual interface between two devices with advanced output abilities. Do the devices compete or cooperate for the attention and the benefit of the user? Most notably, how multi-device interaction is appreciated in multi-user scenarios? Previous research has raised and considered the above research issues and questions for dual screen set-ups in the work environment. In our research, we are exploring multi-device user interface configurations in the context of a leisure environment and for entertainment applications. Our objective is to provide interaction possibilities that are more than the sum of the parts.

Keywords
Tablet, TV, interaction, design, evaluation

1. INTRODUCTION
The majority of contemporary user interface systems consider a clear distinction between the input and the output devices. Indeed, the user interface systems in desktop computers, TVs, telephones, have usually distinguished between the input and the output devices. Smart phones and tablets are devices that don't consider this distinction. Moreover, the plentitude of devices enable the creation of ubiquitous computing scenarios (Weiser, 1993) where the user can interact with two of more devices.

The remote control has been the most common way to interact with iTV. However, the popularity of mobile computers such as smart phones and tablets allow us to leverage the established way of interaction. A second screen could give the user more information and the possibility to interact controlling, enriching or sharing the content (Cesar et al. 2009). In this work, we examine three alternative scenarios for controlling the content in a dual screen set-up and explore the respective evaluation methods.

In the following subsections, we describe previous work that has used dual displays. While there is research that evaluates the usability or performance of the independent displays as a single continuously addressable space, there is also research that employs two synchronized screen devices. Both areas of study are of great interest and influence in our research for both the evaluation of its use and for the development of our prototypes.

2. RELATED WORK
The majority of previous research in dual-screen set-ups has been focused on the effects of increased screen real-estate, which has been considered as a quantitative parameter in performing several user tasks. Indeed, several studies have been performed in a work-setting, which lends itself to performance measurements as efficiency. On the other hand, there are few research efforts in leisure environments that have considered the qualitative effects of secondary screens. The general research area is characterized by the partnership between a personal device and shared screen one. Then, one significant research issue is to balance the visual interface system between two devices with output abilities.

2.1 Multi-device timeline
Since the advent of the PDAs there have been some studies to replace the remote control in the interaction with interactive television. One of the most influential research for this work is the Robertson one (1996), which proposes a prototype for real estate searching by a PDA bidirectionally communicated via infrared with interactive television. The author proposes a design guide remarking the importance of distributing information through appropriate devices. So the right information for display on PDA's is text and some icons, but television is suitable for displaying large images, video or audio. So the nature and quantity of information determines how to display and on which device. This research also gives priority to increase a synchronized cooperation between both devices.

In the design proposed by Sanaz (2005) is established a mobile phone as main element of interaction with the television in order to language learning. This interaction, unlike the previous one, is based on multiclient-server arquitecture: mobile phones connect through two levels of WAP and SMS to the server, which is accessed via a set top box for the iTV.

Another way to interact is proposed by Yang et al. (2009). In this case a second screen is attached to the mouse showing helpful and contextual information to interact with a PC. Although the interaction is done with a PC (different to a TV in terms of use), the paradigm is quite similar in which the main screen is extended with an Interactive Touch Display. Reducing mouse trips (in our case remote controller trips) and reducing occlusion are some of the advantages that are cited and could have application in our study.Also some released products as RedEye[1] that let the user interacts with TV through a second screen to do some basic

[1] https://thinkflood.com/products/redeye/what-is-redeye/

operations of content controlling, however, it works only like Wifi to Infrared traductor in different devices.

Previous iTV research works could be placed within taxonomy of activity that is divided into three categories: Content Control, content editing and content sharing (Cesar and Chorianopoulos 2009). Pablo Cesar et al. (2009) propose a more complex model arquitecture. Their work defines taxonomy of global actions with interactive television. This classification is divided into three levels high: content control, content enrichment and content sharing. In this paper we focus our prototypes on content control, covering among other things navigating of content, and the common video controls (Play, Pause, etc). Also we provide some prototypes for enrichment content.

2.2 Dual-screen research

In the study area of multiple-screens we should emphasize the study of Hutchings (2004) where is compared the general use of a single with multiple monitors (2 or 3). To do this, is evaluated how 31 people use different windows on Windows XP operating system. To carry out the evaluation is used a monitoring tool. As highlight features we can observe that the activation of additional screens arises as a consequence of the desire to hide information in the main screen display. Besides it is important to highlight that is not usually interact with the various windows of the same program.

Another study to really consider is from Grundin (2001). It shows that the users do not treat the second monitor as an additional space, so not establish a single window across multiple monitors. In addition users will typically set a monitor for the primary task and other tasks related to but not synchronized. Like other studies confirm the increased usability of multiple monitors in achieving greater satisfaction of users and more productivity. Besides, user satisfaction and efficiency, it is still an open research question whether coupled screens could also facilitate enjoyment. Early examples in the video-game industry have been well received (e.g., Nintendo link between GameBoy Advance and GameCube), but there are no published reports on user behavior in the context of leisure activities.

3. METHODOLOGY

In our research, we are exploring alternative multi-device visual interface configurations in the context of a leisure environment and for entertainment applications. For this purpose, we have developed a flexible experimental set-up, which we plan to employ in several user evaluations. The latter are focused on the actual user behavior in the face of important parameters, such as attention, engagement, and enjoyment.

3.1 Technological Set-up

The system architecture for the experimental set-up consists of:

- A TV connected to a set-top-box based on Linux.
- A tablet with Linux operating system installed (Figure 1)
- A local network that it is connected both devices.
- A remote controller connected to the set-top-box using Bluetooth. The design of the controller is based on a selection system based on six colors (Figure 2). These colors correspond to different options in the menu.

Figure 1 Tablet with SIeSTA system

One of the most important settings is the way in which the tablet is connected bidirectionally with the set-top-box. To connect both interfaces we could use Bluetooth, RPC or HTTP-Request. Bluetooth is already used to interact between remote control and iTV. However, it is a better option to use RPC for a complex interaction because it is more scalable and flexible. For some operations and transmission of content is used HTTP-request. So, in the end, we can define the arquitecture as a double client/server between the tablet and the set-top-box. To implement the interface has been chosen HTML5 for its opened character.

Figure 2 - Current SIeSTA remote controller

3.2 User Evaluation

Dual-screen interaction might not be suitable for every type of Television content. Actually, it might be rather suitable for some types of content, but completely irrelevant for other types of content. Although researchers have highlighted some of the benefits (e.g., personalized view of related content), they have not yet coupled them to the respective types of content. Instead, previous efforts have only regarded the technological facts, such as the segmentation of long videos, in shorter clips and providing links to related information. As a matter of fact, obvious choices of dual-screen compatible content include sports, news, documentaries, series, and movies.

This work is focused on the evaluation of a secondary-screen as a control device for TV content. Previous research has regarded the secondary-screen as an editing and a sharing interface, but has neglected the control aspect. Moreover, previous research has only concerned user attitude, but has neglected to employ a methodology that explains actual user behavior. Indeed, Cesar et al. (2008) have focused on the utility and the general acceptance of a dual-screen system, but have not employed any user behavior measurements. In particular, we are seeking to understand the balance between the shared and the personal screen during alternative TV-control scenarios that regard the secondary-screen as a: 1) simple remote control, 2) related information display, 3) mirror of the same TV content.

The main objective in the evaluation of a dual-screen TV set-up is the measurement of actual user behavior rather than just user attitude. For this purpose, we are measuring user attention and engagement with TV content. In contrast to measurements of efficient and effective task completion, which are common in work settings, we are focusing on measurements of user involvement with the TV content, which are common in a leisure setting. Moreover, we are working on measurements that consider the main of benefit of TV, which can be summarized as "a significant shared experience" within smaller or larger social circles, and regardless of the actual or perceived quality of the content.

In particular, we have developed a flexible experimental set-up for testing several hypotheses, such as those developed in previous related research:

- Cesar et al. (2009) 'argue that secondary screens provide a less obtrusive mechanism for affecting television content than traditional solutions in the form of television overlays.'
- 'A number of participants did not want to browse while something was already showing' (Cesar et al. 2008).

3.3 Outline of ongoing research

For our research we consider the following situation: Peter is watching a cooking program on TV on demand and he wants to control the video content (play/pause/stop) and do some interactive actions like: see more information about the video, mark as favorite, share comments and watch related videos. It is worth highlighting that the proposed functionality is a subset of that provided by the API of YouTube, which is a rather diverse and growing pool of video content.

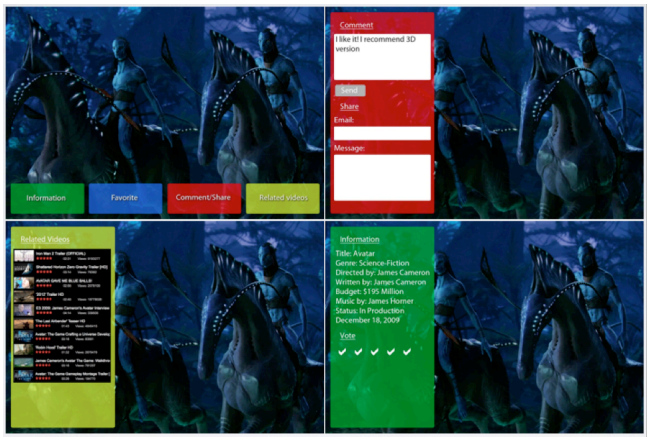

Figure 3 - Scenarios 1 and 3

So far we have developed three scenarios of tablet-TV interaction:

1. To Interact with iTV using a remote control (Figure 3): In this case user interacts with iTV using remote controller (Figure 2). To control the content there is a button in the remote controller to play or pause the video. To use interactive actions: Information, Favorite, Content/Share and Related Videos, the user press the color buttons to access every one. When the user presses one-color button a bigger rectangle is opened. Now the remote controller is used to move (up or down) the focus into the content. When the user wants to select an option he would press the central button. To introduce text it is necessary an extra keyboard. On the top-left of figure 3 we can see the possible actions: Information, Favorite, Comment and share and Related Videos with different colors to be associated with remote control. On the top-right we can see de dialogue shown when we want to comment or share the video. On the bottom-left is shown a list of related videos and, on the bottom-right, information about the content, ratings and comments.
2. To interact with iTV using a tablet as remote controller (Figure 4): In this case, all the overlay information shown in the first scenario is displayed in the tablet cleaning the first screen of interactive information so it wouldn't disturb other users. On the top-left we can see the main functionality, although the same options are shown, more functionality could be added and access to it with one click or tap on the screen. Basically the figure 4 shows the functionality cited before although now the Play/Pause controls are in the tablet. Now to introduce text is shown a virtual keyboard in the tablet screen. (Figure 5)

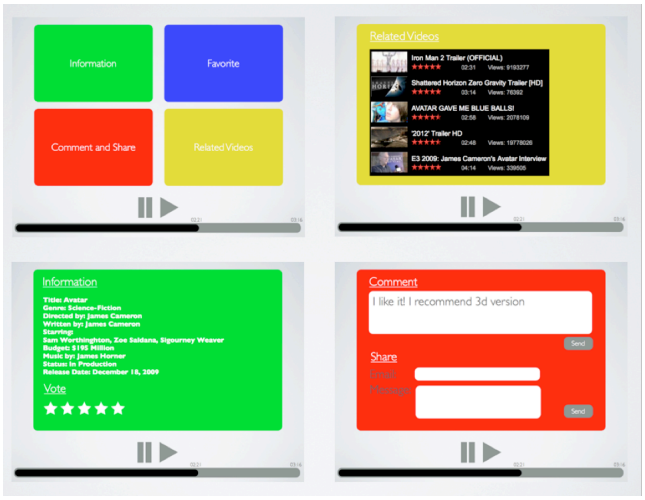

Figure 4 - Scenario 2

3. iTV inside the tablet (Figure 3): This scenario suppose that the user is watching the iTV in the tablet so the prototypes is very similar to the Figure 3 but, in this case, it would be the tablet screen. In this prototype would be necessary to introduce a video control bar similar to the scenario two. (Figure 4).

Although in scenarios 2 and 3 is not necessary, in all prototypes the buttons are differenced by colors to provide consistency between them.

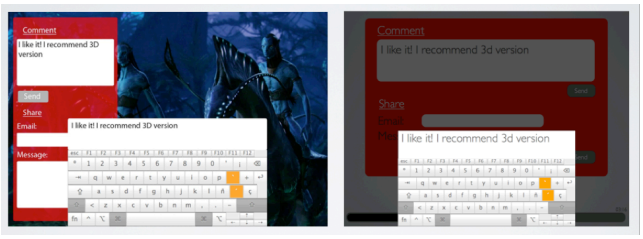

Figure 5 - Virtual keyboards in scenarios 1 and 3 (left) and in scenario 2

4. EXPECTED OUTCOMES

As it has been shown three scenarios include the same options and functionalities. It is important to remark because the more complex are these functionalities the more appropriate it will be the tablet to do that. But when we do common actions that we usually do when we watch videos on Internet is when the advanced visual interfaces in a second screen can affect the user attention in a negative way.

In summary, we are motivated by the introduction and wide adoption of small and powerful mobile computers, such as smart phones and tablets. The latter has raised the opportunity of employing them into multi-device scenarios and blending the distinction between input and output. In particular, we are addressing the following research questions:

- Do the advanced visual interfaces compete or cooperate for the attention and the benefit of the user? We have seen in related work (Hutchings, 2004)(Grundin, 2001)(Yang et al., 2009) how the productivity increases and how the content distortion decreases when we use multiple displays, so the expected results could be a better user experience in scenario 2 for content controlling. It is relevant to indicate, "for content controlling" because the user evaluation in other more complex actions the scenario 3 a better option.
- How coupled-display visual interfaces are appreciated in multi-user scenarios? Scenario 2 let's separate all the overlay information in the second screen so the rest of user don't be disturbed. But sometimes it is possible that the users want or need particular information in the main screen so in these cases would be better a new scenario configuration. This scenario would be based on scenario 3, but the tablet user would have the possibility of showing the information that he wants (video, comments, ratings, etc.) in the main screen acting as extended screen and transforming the scenario 3 in scenario 2. For this comment, a hypothetical better user experience could be obtained in a mix between scenario 2 and 3.

Anyway, it is expected that the case study of TV users and TV content could provide complementary evidence for the design of coupled display interfaces in general.

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