

First, there are issues of the UI in relation to a variety of display types. The iTV UI can have various types of screen display since it allows users to manage information while watching TV (Table 1). The “OSD UI type” utilizes a full screen mode thereby interrupting TV viewing due to the overlaid information. On the other hand, the VIP type may diminish the viewing pleasure by resizing its screen. The UI is working on a trade-off in terms of resolution between the TV viewing and “information” display.

The second issue is on multi-tasking. The iTV is a medium that allows multi-tasking of TV viewing and “information navigation.” Just like the recent full-browsing mobile service that allows the use of web services on cell phones, the availability of the full browsing service on TV helped increase multi-tasking services that involve a simultaneous use of the Internet and TV viewing. According to a previous study, the increased working space on multiple monitors provides more opportunities for users to multi-task [1]. Research has suggested that those who used the multi-monitor display were more inclined to multitask and scored higher on performance measures than those using the single monitor [2]. Therefore, this paper proposes the need to consider the increase in display as a way of providing diverse multi-tasking services.

Finally, the third issue is about the characteristics of TV viewing. TV viewers are used to a traditional way of TV viewing. The iTV entails an unprecedented viewing pattern due to its encouragement of active interaction with diverse information. However, the current display types cannot sufficiently deal with overflowing information and its management and thus result in interrupting the two tasks of “TV viewing” and “information navigation” thereby undermining both functions.

As discussed above, I argue that the current TV display creates many problems in regards to the iTV UI and therefore I intend to explore how to apply this to multiple monitors. Specifically, this paper examines what elements of the UI should be applied in the study of the iTV UI with respect to its multi-display and what should be considered in order to develop this.

Display Type (Video Size)	UI Type
Full Screen	OSD (On Screen Display)
Scaled Video	VIP (Video in Picture)
Thumbnail	Mosaic
No-Video	-

Table 1. The iTV UI in terms of Display Types

2. Research Direction

There are a variety of applications in the multi-display including the separation of the actual physical device and the types of devices and display. This paper focuses on the display in a dual-type physical device rather than a single device as well as on TV as the device type (Figure 1). The study on the surroundings such as “home” or its context go beyond the scope of this study since this paper concentrates on the interface that distributes iTV and information in each display type of multiple monitors.

The standards for the study of the iTV UI in multi-display consist of (1) “multi-tasking” (2) “interface design” and (3) “interactions” and the contents of each section are as follows.

The first section on “multi-tasking” analyzes tasks for users that take place in iTV and categorizes them as main tasks and sub-tasks. The second section on “interface design” explores the interface that applies to the above categories of tasks. Finally, the section on “interaction” examines what kind of interaction should be taken into

consideration, added, and/or excluded in multi-display in terms of the interaction between a remote controller and iTV.

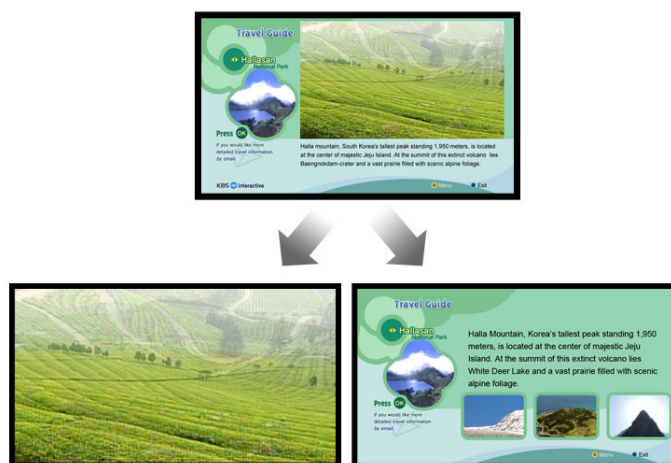


Figure 1. iTV in Multi-display

3. Interactive TV UI

3.1. Multi-tasking

The iTV has the characteristic of multi-tasking given its simultaneous function of TV viewing and information managing. In fact, a lot of iTV services involve multi-tasking such as a TV-Shopping or browsing function and TV-Communication services like texting or chatting. While multi-tasking provides users with diverse patterns of activities, the incidents with interruption between various functions result in reducing their task performance abilities [3]. Moreover, according to a study on the modality in multi-tasking, it is suggested that visual information, particularly text-based information, has little influence on multi-tasking performances but in the case with conflicting visual and aural modalities the level of comprehension and satisfaction of multi-tasking performances decreases. For instance, such visual and aural modality as “TV viewing” is influenced by multi-tasking performances like “information navigation” when simultaneously watching “TV broadcasting” and doing “information navigation” like using a “messenger” or “texting” function [4].

For this reason, a device for effective multi-tasking performances is needed for such cases like iTV where “interruption” takes place including a “pop-up” or “menu selection” during the process of traditional TV viewing, or “information navigation” in the middle of TV viewing with its visual and aural modality.

Previous research analyzes that the motives for multi-tasking in using IPTV include (1) simultaneously watching TV and using the Internet, (2) conveniently purchasing products while watching a TV program, and (3) obtaining additional information while watching a TV program [5]. In other words, “TV viewing” is a more important task than other tasks of navigating and utilizing information and remains as a task that still relies on traditional TV viewing practices. Therefore, this paper categorizes “TV viewing” as a main task and “information navigation” as a sub-task in iTV’s multi-tasking, which also serves for the categorization of display forms.

Unlike traditional TV viewing practices, however, iTV utilizes a variety of “broadcasting” modes that include a “repeated viewing on demand” such as VOD and contents-based broadcasting such as “UCC.” Technically, these modes of broadcasting are different forms but due to the common idea of “TV=VIDEO” viewers may consider them “watching TV.” Seen in this view, iTV necessitates new additional tasks like “video controls” and

“channel-related menu selections” in comparison with the “traditional TV viewing,” which only required simple tasks like changing channels and volume (Table 2).

Display	Multitasking		Task
Main Display	Main Task : TV View	Traditional TV	On/off
			Channel up & down
			Volume up & down
			Ch. numbers select
		Interactive TV	mute
			DCA(Direct Cannel Access)
Sub Display	Sub Task : Information-Navigation Information		Video Controls
			Select Home menu(Go to Home)
			Select menu
			OK
			Number Input
			Text input
Stepback / cancel / exit			
			Direct Service Select

Table 2. The Classification of iTV’s Multi-tasking in Multi-display

3.2. Interface

The UI in iTV is an important factor in terms of usability. Particularly in the case of synchronized data broadcasting where TV programs and relevant information are provided at the same time, there has been constant usability issues on both domains that rise from layered presentation among TV content, image and text data. For instance, OSD (On Screen Display) inevitably hinders content experience because it overlaps on the content regardless of its position. VIP (Video in Picture), another way to present content and information, still degrades viewing experience because the content area shrinks down to make space for information which will surround the content and it breaks down user's immersiveness into the content. Multi-view display in a form of EPG (Electronic Program Guide) does provide some benefit of overview on multiple channels but with a trade-off of having more or less information-clutter on the screen. In summary, there has been constant issue of compromise on screen-territory between content and information due to the limitation of a screen resolution. Considering such issues, this paper separates the task of “TV viewing” from the task of “information navigation” in the multi-display format and applies this division to the categorization of display forms as well. As discussed above, the display forms categorized in terms of multi-tasking types maintain the experience of traditional TV viewing as follows:

1. Users can continue to experience the joy of freely zapping actual channels and viewing in full-screen resolution. They are not interrupted by popup windows or “additional information” that overlay the screen and they are not forced to interact while watching TV.
2. Users are free of frustration resulting from a chronic problem of the slow loading speed in iTV’s usability.
3. Users can secure the resolution of the increased space in the information managing display. They are relatively free from limitations of working space in terms of menu positioning and information quantity.

1) The Interface in the “TV Viewing” Display Domain

In traditional TV viewing, there is no display of UI in the midst of TV viewing. The Video Only mode is common and there is no visible interface on the screen except a volume bar when controlling the volume. Yet, there exists a variety of interface in iTV ’s TV viewing compared to “traditional TV viewing.” As previously

categorized in multi-tasking, iTV enables “reviewing TV,” “viewing it later : Start over” and the UI takes place to allow to go directly to a favorite channel, my channel, mini-EPG, and DCA. However, such cases of UI are closely related to actual “video” and thus requires visible feedback on the TV screen, which makes them belong to the “TV viewing” display. That is, the characteristic of “information management” in these types of UI is close to “TV: Channel” controls rather than “Content controls.”

Figure 2 illustrates that these kinds of UI would show up in a small size and position that do not hide much of its “TV viewing” screen in order to provide a feedback function, and then disappear a few seconds later when no additional interaction takes place.

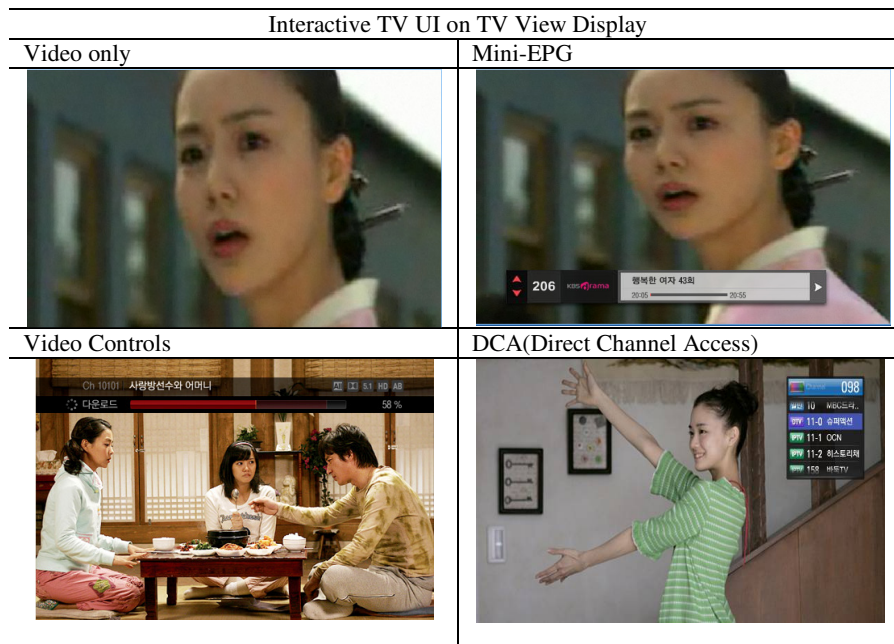


Figure.2 Still images from CJ HelloD 2008 / myLGTV 2008 / KT MegaTV 2009

2) The Interface in the “Information Management” Display Domain

The TV viewing takes place in the “main display” domain while “information navigation” shows up in the “sub-display.” The UI shown in the information navigation display is either the one interlocking with “TV : Video” or independent information (contents). The information management interface presents the free interface by providing increased resolution for hidden contents, which have been displayed as the “OSD UI” in the single display format being pushed by “TV” or have disappeared through “exit.” It is also freed from the limits of being displayed in “semitransparent color” in order not to block the TV screen or being positioned at the edge of the screen. Liberated from the issue of the VIP (Video in Picture) UI that reduces the screen to a Scaled Video in single display, which in turn reduces “TV viewing” pleasures, it can focus on the contents navigation while providing the UI environment that fosters the workings of the two-way contents like “games” and “messaging.” Even the UI with high usage frequency and priority in the iTV service such as a “home portal” or “EPG” in Figure 3 is displayed as Default thereby provides a new “TV viewing” experience for the traditional TV viewers who have disregarded the UI that blocks the TV screen or for the users who haven’t paid much attention to the UI while focusing only on their “TV viewing.”

Interactive TV UI on Information-Navigation	
Menu select	Service Home Portal



Figure. 3 Still images from Xbox360 IPTV 2008 / SkyTouch iTV Portal 2007 / KT MegaTV2009 / iDIGITAL TV 2008

3) Changing the Multi-display Mode

The multi-display enables a variety of display modes due to the increased span of separated devices. The multi-display modes that PCs generally provide comprise the “Clone, Span, and Expand” modes. However, in the case where the iTV services are applied to the multi-display, users should be able to change the display modes depending on the features and types of particular services [6]. For instance, it is efficient to apply the “Expand mode” to such services as “2play game service” and “map service.” Therefore, this paper utilizes three categories of multi-display modes according to the iTV characteristics (Table 3).

- TV mode: TV is shown in two screens. In the iTV display information disappears and instead a preset display mode (Clone or Span) appears.
- iTV mode: It is exclusively used for iTV. One screen displays TV while the other displays “iTV contents.”
- Expand mode: The contents can be expanded to the TV screen by changing the iTV-only mode to the Dual Mode based on the service.

mode	Display View	UI
TV mode		TV mode – Viewers can turn off the iTV contents and just watch TV whenever they want. When turning it off, the TV screen will be shown in either Clone or Span mode.
iTV mode		iTV mode – The display mode exclusive for iTV shows “TV” on one screen and “information” on the other.

Expand mode

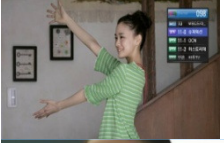



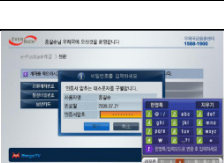


Expand mode – As a display mode expanded from the iTV mode, it can also be seen as the display exclusive for iTV. In the case of a map service, both the span mode and expand mode are possible while in a multi-play game each player can play in each display.

Table 3. The iTV's Display Mode in Multi-display

3.3. Interaction

The tasks and interface categorized by previously discussed display types create interaction by using a remote controller. The following table4 matches particular interaction with the remote controller's keys in terms of their tasks.

Display	Multitasking	Task	UI	RC Key	
Main Display	Main Task : TV View	Traditional TV	On/off		Power
		Channel up & down		Channel up & down	
		Volume up & down		Volume up & down	
		Ch. numbers select		Number Key	
		mute		mute	
	Interactive TV	DCA (Direct Cannel Access)		Channel Hot key (favorite Ch./ Popular Ch. / My Ch). Arrow Key	
		Video Controls		Arrow Key Control Key (Play / stop / forward / reward / speed / record / caption. etc.) Color Key	
Sub Display	Sub Task : Information-Navigation	Select Home menu (Go to Home)		Menu(Home) Key	
		Select menu		Arrow Key Color Key	
		OK		OK	
		Number Input		Number Key	

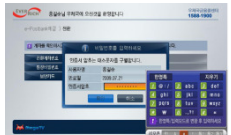

	Text input		Arrow Key Number Key
	Stepback / cancel / exit		Stepback / Cancel / Exit
	Direct Service Select		Service Hot Key (EPG / Search / SMS / Widget / Etc.)

Table 4. iTV’s Interaction & RC Key in Multi-display

Table 4 demonstrates that users can apply Hot Keys to the remote in “TV viewing” for “direct channel changing” to the “favorite channel,” “popular channel,” and “my channel” and for video controls using “Color Key,” “Video Control Key,” and “4 Arrow Keys.” The information navigation task shares these “four arrow keys” and “number keys.”

The “Menu Key” used most frequently to view iTV in single display is still used frequently as the Default UI in “TV viewing,” but in multi-display the display selection of the “iTV mode” can provide similar functions to the “menu” selection interaction since it displays as the Default UI like “iTV Portal” in the separate “information navigation” display domain.

It is necessary to consider the “Hot Key” on the remote when it comes to operate interaction in changing “display modes” given the importance of operating in time when returning to a particular task while multi-tasking [7].

The following shows matters to consider in the remote control interaction in multi-display:

1. We need to make sure that there is no confusion between interaction by distinguishing the RCU(Remote Controll Unit) in relation to the keys to use for “TV viewing” and to the keys for “information navigation.”
2. We need to consider the definition of interaction in relation to the Hot Key in changing the various display modes (TV-only mode, iTV mode, Expand mode) and to the “menu” Key.
3. We need to consider controlling the areas and directions of sensors within the display’s visible field since the two physically-separated display formats provide unclear standards for direction controls.

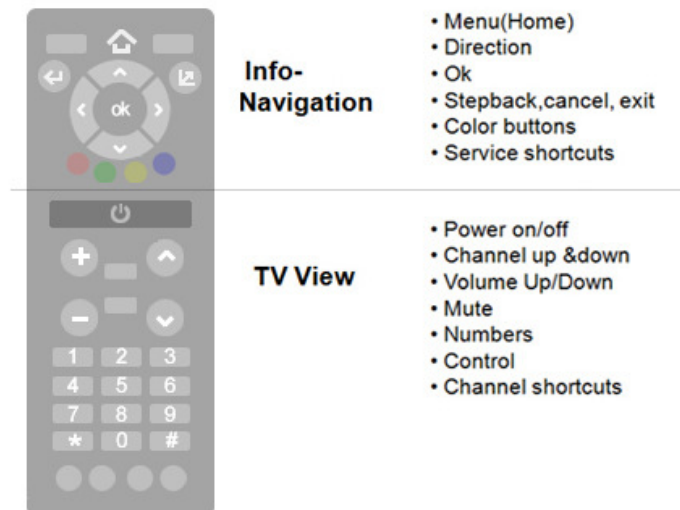


Figure. 4. Prototype of Remote controller

4. Conclusion

This paper has looked at the iTV UI in a multi-display environment focusing on three aspects of “multi-tasking,” “interface,” and “interaction.” The following summary of guidelines can be suggested from each section of this study.

First, the multi-display format can be divided into two categories, “TV viewing” and “information navigation,” according to their multi-tasking types. The UI shown in the “main display” is similar to the one in “traditional TV viewing.” However, the UI, which has both elements of “TV viewing” and “information navigation” such iTV devices as “Video Controls” and “DCA,” belongs to the display of “TV viewing.”

Second, various display modes with more iTV features are needed, which are different from the usual “dual display mode” provided by setting a PC monitor as a dual monitor in multi-display. This paper distinguishes the “TV mode/iTV mode/Expand mode” so that users can freely change their display modes while watching TV in terms of the services’ characteristics and types.

Third, the key arrangement on the remote should be carefully considered in order to not confuse two different tasks since the multi-tasking of “TV viewing” and “Information navigation” is displayed in separate monitors in multi-display. Issues of interaction should also be considered in order to quickly perform such tasks as “mode changes” and “device controls” that reflect “dual display” features.

5. Discussion

In recent years we witnessed the coming of mobile TVs like “DMB” with the influence of digital technology, but “home” is still the main place where TV viewing takes place. In the case with a TV set situated at the center of our living room, it is unrealistic to accommodate a dual TV environment by simply purchasing another “monitor.”



Figure 5. Image of a Multi-display Concept (google image)

Yet, the “information navigation”-related contents as much as TV viewing will continue to enter the TV display domain as IPTVs become available, which allow the use of the Internet and provide “Google search” and “Yahoo portal” services via a TV monitor. Therefore, the traditional TV viewing practices will eventually

decrease as iTV services increase and there will constantly be issues of the UI that aim to satisfy iTV's "two-way services" and provide "information" more effectively.

Currently TV viewers are used to and loyal to the traditional way of TV viewing, but the contents' high quality and diverse services will promote the needs and desires to collect information provided by iTV. As iTV provides more contents of good quality that appeal to the viewers, "information navigation"-related tasks will increase as well. The multi-display enables both "TV viewing" and "information navigation" and therefore is expected to become a new platform for domestic TV viewing in the future.

The intention of this paper was to envision ever-changing digital television environment and to reflect speculated issues when applying multi-display UI to interactive TV with an expectation to make contribution to not only academic community but also to industries of digital television looking for better solution. Further study will focus on creating a prototype using multi-display solution proposed in this paper and conducting in-depth user study.

6. References and Citations

[1] Grudin, J. (2001). Partitioning Digital Worlds : Focal and Peripheral Awareness in Multiple Monitor Use. *CHI 2001*. vol.3. Issue no.1, pp.458-465.

[2] Truemper Jacob M., Sheng Hong, Hilgers Michael G., Hall Richard H., Kalliny Morris and Tandon Basanta, (2008) Usability in multiple monitor displays. *SIGMIS Database*, vol. 39, pp. 74-89.

[3] Neerincx, M. A., van Doorne, H. and Ruijsendaal, M. (2000) Attuning computersupported work to human knowledge and processing capacities in ship control centers, *Proceedings of the Cognitive Task Analysis*, pp.341-361.

[4] Ki-Ho Lee , Seung-Ki Jung , Hye-Jin Kim , Inseong-Lee , Jinwoo-Kim (2007) Interruption in Digital Convergence : Focused on Multi-Modality and Multi-Tasking Interruption in Digital Convergence : Focused on Multi-Modality and Multi-Tasking . *Journal of the Ergonomics Society of Korea*. Vol. 26, No. 3, pp. 67-80.

[5] Jae-Won Kang, Sang-Woo Lee (2006) A Convergence-Adoption Model for IPTV Use : Functional Similarity & Media Substitution. *KSJCS*, vol. 50-2, pp. 5- 32.

[6] Altmann, E.M. and Gray, W.D. (2000). An integrated model of set shifting and maintenance. In *Proceedings of the Third International Conference on Cognitive Modeling*. The Netherlands, Universal Press, 17-24.

[7] Gopher, D. and Donchin, E. (1986). Workload: An Examination of the Concept. In Boff, K.R., Kaufman, L. and Thomas, J.P. (eds.), *Handbook of Perception and Human Performance, Vol II: Cognitive Processes and Performance*, New York, Wiley, 270-319.