Design Proposal for Smart TV Interface and Remote Controller

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Abstract

This study was conducted with the aim of redesigning the interface for smart TV. TV has been a monopolist for a long time as a video distribution platform. However, the content market is rapidly changing due to the development of digital technology and the emergence of personalized smart media. As a result, people are starting to use various platforms to watch videos, and TV is also trying to create a new paradigm of smart TV by applying various digital technologies. Especially, it is necessary to develop an interface to make TVs with a wide user base easy and comfortable to use. For this purpose, we conducted a theoretical study on TV and examined the changes of contents market and TV in chronological order, and we defined the concept of smart TV. After analyzing the content structure and interface characteristics of 15 cases introduced to the domestic and overseas markets. At this time, the study on the remote controller is also carried out to consider the operation. In addition, through analyzing the papers related to the user segment, we extracted the five factors influencing the segmentation of the TV user and derived six segments based on the extracted factors. We analyzed the needs of actual TV users by observing them, analyzing tasks, and interviewing them. Based on the results of the analysis, we derived a new type of interface mapped to the 4-way button and created a prototype for to test how it works. Even though there is a regret that it was carried out for domestic users, but it is meaningful that the user-centered interface design has been derived.

Keywords: Smart TV, User Interface, Remote controller

1. Introduction

The global success of smartphones has been the beginning of the digitalization of electronic devices. TV is changing to a new concept of 'smart TV' in response to the market change, which was the media to convey the fun and information to people over a long time. TV was only one hardware dependent display for a long time and has been regarded as a symbol of old media that delivered video contents in one direction. However, the development of technology has enabled interactive communication, which has been known as a symbolic feature of new media. As viewers consuming video contents can use TV more actively, the concept of TV is changing.

In particular, 'Smart TV' is a term has emerged to conceptually redefine TV. It can be seen as a concept that adds the features of smart media to the hardware characteristics of existing TVs. Since Smart TV has a display and is connected to the network, it has been evaluated as a media likely to evolve into smart media. Each manufacturer has launched various types of smart TVs to lead the market paradigm shift.

But the market of TV is not simple. The main purpose of the traditional TV was to watch video contents.

Unlike in the past, where expensive equipment and systems were required to produce video contents, now everyone can shoot and edit video, and the amount of contents has increased sharply. Furthermore, it is possible to enjoy not only the video but also the contents of the application such as the game and the SNS on the TV. In order to watch the video contents transmitted in real time, both of the conditions, which is the time for transmitting the video and the space for the TV, had to be satisfied. Now, the distribution of VOD is generalized so that anyone can enjoy the contents at the desired time, and the appearance of personal media has freed viewers from spatial constraints. TV, which was on a monopolistic position as a platform for watching video content, is no longer a monopoly. The development of networks has opened up a ubiquitous era in which content can be enjoyed without a physical network. Users who use TV now are rarely used as a single device. People watch thousands of channels through set-top boxes, connect with personal media to enjoy content, and create content consuming experiences on the internet that are different from the past. TV was the only media for video content, but it is now used only as a display for connected devices.

Lee Jae-hyun (2014) claimed that the media consisted of five layers. It is seen that each layer influences each other organically, with unit contents, media packaging, media platform, physical network, and media device. Today's TV has come to a situation where all the above five layer elements are changing. It is clear that the paradigm shift is necessary. Many manufacturers have also introduced new TVs to meet these needs. However, these new strategies are still experimental. It can be the reason that each manufacturer produces TVs with different interfaces each year. Therefore, this study aims to propose a new kind of interface for Smart TV based on this market change. In order to develop the interface, conceptual study of TV, case study of TV market, and user survey were conducted, and a prototype of smart TV interface is proposed by combining these findings.

2. Background research

2.1. Development of video technology and change of TV role

The first appearance of the TV media was in the early 20th century, when it first began broadcasting in England in 1929. Since then, color television was invented and household income level was raised, and the era of TV popularization began.

Especially in Korea, broadcasting started for the first time in 1956, In the early days of broadcasting, there were only imported TVs, which were expensive, so it took 20 years to get popularized. In low-income regions, it was common to gather together in a neighborhood for watching TV. However, as the TV became popular, most of home environment was reorganized around TV. As the medium of TV came into people's daily life, the broadcasting time influenced the life pattern. (Scannel, 1996; Lim, 2006) As a result, the influence of TV media on viewers' lives continues until now.

The development of video technology centered on TV has changed people's way of life. The development of technology can be broadly divided into the development of technology for producing content and the development of technology for transmitting it. Especially, the development of transmission technology is closely related to the way of people's media consumption. In this study we saw classified into five steps, which it can be defined as follows.



Figure 1. Generation of TV and contents

The first generation can be defined as the period when terrestrial broadcasting enjoys monopolistic status. Early TVs were able to play only content transmitted over terrestrial channels. In order to produce and transmit broadcast contents, an infrastructure that requires a large-scale budget is essential. Thus, several nationally approved broadcasters were able to enjoy a monopoly position. As a result, the amount of video content also had to be limited. Therefore, the media platform was operated in closed form, and the content creator and the platform owner were the same. TV is the only tool that can receive and play video contents. It can be said that the concept of contents and TV is the same.

Since cable broadcasting had become common, channels had started to increase. Various contents providers had begun to emerge, and the set-top boxes receiving the contents became a common media. For the first generation of TV, the channel was also limited because of the limited frequency band. On the other hand, wired set-top boxes had larger bandwidths so that can operate more channels. The quantitative growth of content producers had led to a quantitative increase in the content itself, and the monopolistic position of broadcasters was gradually broken down. Which means it can be seen that the roles of production and transmission of contents started to be separated. People could now enjoy a wider choice of channels and content that had grown explosively than before. As the set-top box replaced the function of receiving the contents, the role of the receiver of the TV began to be reduced. So TVs' function was limited to the display only for the set-top box.

The third generation can be defined as the IPTV era that has emerged with the development of Internet transmission technology. TV was a symbolic device of mass media and functioned as a one-way communication platform. However, the ability to connect the Internet to TVs or set-top boxes had enabled two-way communication, which is one of the most important feature of new media. Compared with the previous era, the oligopolistic nature of content producers and CPs didn' t changed much, but viewers had a different watching experience apparently. Personalized style television consumption became possible. (Park hyunju, 2008; Lim jongsu, 2005) In addition, as the computer technology developed, nonlinear editing technology, which allowed the general people to easily create video contents, this was the basis for explosively increasing the amount of video contents. This trend of change has continued to the present. TV is completely separate from content, the function only as a display for content playing tends to be strong. In particular, all actions such as channel manipulation are performed in the set-top box. Particularly, as VOD (Video on Demand) service became generalized, the degree of influence of broadcasting organization on people's life was expected to start to weaken gradually. In other words, 'distributed television (Marshall, 2009)' is now available.

The fourth period may be named (Over the top) OTT generation. Computers and wireless internet technologies have been developed, and contents providers are no longer restricted to the network. In particular, OTT services can be categorized into two categories: Apple-based devices such as Apple TV, and software-based services such as Netflix and Amazon TV. Unlike the previous era, people are able to watch the video contents in front of the computer, not only TV. Now everyone can easily create video contents, and owns channels for broadcasting them. So there will be a quantitative increase in content as well as a qualitative development. As the channel grows, the subject and format of the content begin to diversify. As the boundaries between content producers and viewers become blurred, the dependency between content and platform disappears. This change is expected to accelerate, especially with the advent of the digital native generation. The control ability of viewers' video contents has been expanded so that it is difficult to compare with previous ones. (Lee donghu, 2012)

Finally, it can be defined as the Cross Platform era. As seen before, TV is no longer the only terminal to view video content. People have gained access to more channels through set-top boxes, and as they watch video over the Internet, they are beginning to escape the influence of TV. The content production and distribution paradigm begins to overthrow. This is a significant threat to TV manufacturers, and each TV manufacturer has begun to take various countermeasures to raise their self-sufficiency. In addition to ensuring connectivity with various devices, it also provides a content server or a builtin hardware and software to provide OTT services in order to provide VOD service by itself. Now the TV is off the terminal that sends only the video contents. It has become a crossplatform form that allows users to directly access the Internet and enjoy various forms of content. Jenkins defines this feature as the ability to trans media, which means to interact with various media platforms and formats. (Jenkins, 2006) As a result, the TV experience itself has begun to be redefined.

2.2. Charateristics of Smart TV

The changes mentioned above are gradually accelerating. The transition from first generation to second generation took about 30 years, on the other hand the transition from third to fourth generation took only five years. Now all these changes are mixed. Manufacturers are working to respond to these changes by launching Smart TVs. The terms smart TV and connected TV, both are used now, in this study, smart TV is used as a main term. Smart TVs include different concepts depending on the subject they define, commonly, the device is defined as a device that uses various contents simultaneously by combining Internet function with existing TV function.

Table 1. Definition of Smart TV

	Reference			
	Definition			
1	'Report on Smart TV', KCC, 2010.8			
	 Digital TV with OS and Internet access Real-time Broadcasting, VOD / Game / Search TV available in a convenient user environment 			
2	'Smart TV development strategy', MKE, 2010.9			
	 Providing unique function of watching live broadcasting PC function via Internet connection Future smart home service enabled TV 			
3	'Report on Smart TV', Samsung Electronics, 2010.8			

		 Easy and convenient content available always TV that can recommend and provide content to customers want 			
	4	'Smart TV Developer Conference', Google, 2010.5			
 Integrating Internet functions into existing TV Concurrent use of internet web browsing with consuch as cable / satellite broadcasting / pubroadcasting / mobile app 					

The development aspect of smart TV can be divided into hardware side and software side. Looking at the change of the display, the conventional TV which is remembered as a cathode ray tube had a very large volume with a small screen. However, with the development of LCD and LED technology, the TV display gradually became thinner and bigger. The size of the TV display is a feature that differentiates the TV from other media. At the same time, the resolution is improved, and it is possible to watch clear images. This is a change that occurs with the format change of the video content. In the early 2000s, the video format was NTSC(720 x 480px) type, but UHD (3840 x 2160px) format as well as Full HD (1920px x 1080px) are common now. This improvement in resolution makes it possible to utilize an Internet browser as well as watching video on a large screen. Unlike general video, Internet browsing has a lot of small text, so it is difficult to use it smoothly if resolution is low. Now, based on high resolution, various contents can be used Internetbased video content such as Youtube and Vimeo, as well as textbased web services also.

In addition, physical connectivity is also expanding. Previous TVs received terrestrial broadcasts via antennas, and received video and sound through cables such as RCA or S-video. However, only by this cable and it is difficult to receive a highdefinition image. Therefore, a cable with a high data transmission rate such as HDMI appears. This makes it possible to connect the TV directly to the computer. Furthermore, through wireless communication technologies such as Wi-fi, DLNA, Miracast, NFC, TV can be connected with other devices. By connecting with various home appliances efficiently, TV can serve as a platform to share and control the information generated by these devices. Lee Jae-hyun and Lee So-eun (2017) argued that TV is expanding the screen through networking with peripheral devices. It is expected that synergies will be achieved with the development of digital network technologies such as home network and IoT.

On the other hand, the video content transmitted from TV is expanding quantitatively and qualitatively. As nonlinear editing technology based on digital technology became popular, people can create their own content. Also, it is easy to observe that the contents that depend on different media cross each platform. For example, visual contents such as movies and games have become contents that can be viewed on TV, and various applications are being developed in a form can be used on TV. This diversification of content can be interpreted as a positive change that gives viewers more choice at first sight, the diversity of genres also causes viewers to be confused about content selection and operation.

As a result, TV manufacturers have developed a separate OS to enable TV to function as a main platform for video contents. In particular, efforts have been made to create a TV-oriented content ecosystem by building an open platform using Android, Taizen, and HTML5. However, competition with other media is fierce, so it is still in a state of standstill because of it cannot offer TV's own benefits.

To solve these problems, the need for a more systematic user interface has increased. Previously, the function of the TV was focused on changing channels. However, the diversification of contents has caused the need for information system beyond the content channels. As complexity of information is increased, clear interface is needed more than before. Therefore, many manufacturers have begun to develop and mount various types of interfaces. But sudden change only makes viewers confused to manipulate the TV. Therefore, this study suggests that it is necessary to develop an interface suitable for a TV that has begun to evolve into a platform for various contents.

One of the biggest features that distinguishes TV from other media is Lean-Back media, which means viewers watch TV at a distance. Therefore, it is indispensable to have a remote controller that can control the TV from a long distance. A viewer with a remote control has full rights to control over the TV. Mainly used media is determined depending on what kind of remote controller is mainly used. Although the previous remote control was mainly composed of a hardware button for adjusting the channel and the volume, the present remote controller is developed in various ways that use a gyro sensor as well as a QWERTY keyboard, a touch pad, a ball mouse and so on. In particular, the development of such a remote control is accompanied by the development of the software embedded in the TV. To develop the interface for TV, research on remote controller should be done together.

2.3. Users of TV

Many previous studies have demonstrated that television affects people's time and space. People reorganize their lives according to the schedule of TV contents. But the development of technology has expanded the freedom of viewers. Unlike traditional TV viewers, where channel zipping was the only control measure, today's viewers can watch VOD, play games, or use OTT services. With the diversification and personalization of media that can access video content, people can enjoy content anytime and anywhere. It is easy to see multitasking using personal media while watching TV. As a result, previous 'viewers' were redefined as 'consumers' or 'users'.

TV users are composed of people of all ages. When considering that the TV is began to popularize in the mid 20th century, it is enjoyed by a wide variety of people, from elderly people up to 80 years old to infants and toddlers. For interface development, users should be considered as very important factors. The younger generations, who can be called digital natives, are very natural to get information through the Internet or learn new functions. However, older people, who have been exposed to digital technology at the point of time when their learning ability has deteriorated, feel difficult to use smart devices. There is a huge difference in digital literacy among generations. The interface of the TV should be developed in such a way that it encompasses people at various levels.

3. Market research

3.1. Case study for Smart TV

Unlike the smartphone market, the smart TV market does not yet have a unified platform. Therefore, each manufacturer tries hard to lead the market to launch new Smart TV with different functions and interfaces every year. The analysis was conducted to derive insights on the development direction of smart TV.

There are 15 cases, divided into display-integrated type, dongle type, and set-top box type. The most recent model among the products was selected. In the traditional view, TV means only a device with a display. It is needed to study the interfaces of settop boxes and dongle-type devices, because there is a common characteristic that the user can view video contents. We analyzed the features of each product, the structure of the interface, the features of the platform, and analyzed the functions of the first screen that is first seen when watching TV. This is because each manufacturer provides the most important function on the first screen.

Most of the cases have open platform for the various content circulation. Especially, it is common to use general language such as Android and HTML5. Some of them have found that developing and deploying the SDK encourages participation by third party vendors as well as manufacturers. However, in the case of App Market, it is difficult to find the activated case, which is quite different from the smartphone market. This suggests that despite the efforts of the manufacturer, there is no killer content to transfer the role of TV to the area of transmitting video content. On the contrary, among the existing smartphone applications, the transformation of application related to the video content is mainly found, so that the main functions of the smart TV still remain in the video viewing.

DLNA, Miracast, and NFC technologies are being developed in various ways to expand connectivity with other devices. In many cases, the user can use the TV as a computer by incorporating its own data storage device, cloud server system was found to be limited due to copyright problems in video contents. However, when the future of home IoT environment is established, this feature can be expected to be a base for TV to function at the center of home networking.

One of the most important features of content consumption now is the ability to personalize. Although TV is still a family-based media in the center of the home, it has begun to incorporate features that reflect personal preferences in response to these changes. It has also been found that the present invention

Туре	Manufacturer	Features	UI	Image		
Dianlari	Someung	Platform	Main Menu	9 6 6 8		
type	Electronics	- Open platform construction	- Tile-type			
cype		- Providing contents DB	- Panel			
		- App Store : O	- On TV			
		- Open API : O	- Movies/TV shows			
			- Photo, Video, Music	STATE STORE STATE STATE STORE		
			- Apps	방송 안내 시간대별 추천 프로그램 녹화된 TV		
			- Game	And her You walk		
	LG	- Web OS application	- Dock type			
	Electronics	- Make all content APP	- List-type			
		- App Store : O	- App store			
		- Open ATT: O	- On TV	Adual agos. 6 content may any to region		
			- Internet			
				→ + (b)		
	Panasonic	- Cloud server-based services	- Tile-type	Ufettyle Screen		
		- Face recognition function	- Panel			
		- Personalize your content		Aune/AUN 11		
		- Personalized content				
		(notes, events, etc.)				
		- App Store : O	- On TV	WEETA Concer WEETA CONCER WE		
		- Open API : O	- Customized content			
	Sony	- Curation service of contents	- List-type	ອງອີນແຫຍ່ 12 ໂດຍແລະ (2) ໂດຍ. 2) ໂດຍ. 2) ໂດຍ. 2) ໂດຍ. TV Collections.		
		- Emphasize social TV features	- Tile-type			
			- Drop-down menu			
		- App Store : X	- Featured Apps			
		- Open API : O	- History			
			- Settings	ef Connectar of Balance Balance Balance		
			Settings			
	Sharp	- Highlight the APP	- List-type	** SmartCentral*		
		- Netflix service emphasis	- Tile-type			
		- Ann Store · X	- Video	Nettrine Constantiane Valor Marcha		
		- Open APL : O	- Social apps	Fair Factor Four reads Four reads		
			- Internet, Search	Parme Barc		
			- Support			
			- Settings			
	Philips	- OTT app	- Tile-type			
		- Cloud Services				
		- Highlight Connectivity	0.771			
		- App Store : X	- On TV			
		- Open API : O	- Recommended Apps			
			- chho	Toole Ready Barly Park Ready Ready Ready		
	Toshiba	- Cloud Service	- Tile-type			
		- Watching pattern recognition				
		- Enhanced recording				

Table 2. Features of Smart TV

		- App Store : X - Open API : O	- Apps - Games - My Page - Search - Media Guide - Settings	<page-header></page-header>
Dongle Type	Google	 Expansion of smartphone experience Chrome-based personalization Chromecast function App Store : O Open API : O 	 List-type Dock-type Widget Notification Apps On TV Internet Google play 	
	Apple	 Expansion of smartphone experience iTunes based personalization Contents DB Mirroring function App Store : O Open API : X 	 List-type Tile-type Movies TV shows Music iTunes Radio Mirroring 	Image: state stat
	Roku TV	 Application-based Enlarge search function App Store : O Open API : O 	 List-type Tile-type My Channels Channel Store Search Settings 	Rocal Canada Can
Set-top box Type	Xbox	 Voice / Face Recognition Multitasking Game-specific devices App Store : O Open API : O 	 Tile-type Notification Pins Home panel (Friends, Snap, Games, Internet, TV) Store 	Image: state in the state
	Fan TV	 SNS linked, recommended content Unique menu structure Quit service on 2017 App Store : X Open API : X 	 List-type Tile-type On TV Movies Shows Search 	Nume Strends Image: My Modes
	SKT-B box	 Widget structure Home monitoring function Build your own platform 	- List-type - Tile-type - Widget	

	- App Store : O - Open API : O	- On TV - Internet - Apps - Family board - Monitoring/ VOD	Image: State Stat
 KT-Olleh	- Biggest content DB(in Korea)	- List-type - Tile-type - Panel	이입는 ft v skylife 표준 전 2 11 입 수 2 11 입 h 2 11 (h 2 11 h 2 11 h 2 11 h 2 11 h 2 11 (h 2 11 h
	- App Store : O - Open API : O	 Recommended Channel TV VOD Movies 	
		 Children/Education Music/Life Apps/Shopping 	
LG U+	 Built-in Google TV Applying NFC technology 	- List-type - Tile-type - Widget - Panel	
	- App Store : O - Open API : O	 Time table VOD Movies/Animation Kids/Education Documentary/Life 	0841*** 100 988 100000 0841*** 100 100 100 100 100 100 100 100 100

provides a function of allowing the user to log in directly, identifying users through facial / speech recognition, so the TV suggests curated contents reflecting users' preference and habits.

In order for content selection and consumption activities to be enjoyable, a proper system to make users access easily is needed. In addition, it is necessary to differentiate from other media devices. Now, however, manufacturers may be tempted to try different things in order to find a special benefit.

3.2. Interface of Smart TV

As we have seen, the complexity of the features and content embedded in the TV has increased the importance of the interface. Due to the genre diversification of contents, the



Figure 2. Smart TV interface

information structure of TV became much more complicated than before. In terms of content, content on various levels such as music, games, Internet, shopping mall, Social Network Service, and App Store, as well as video contents such as movies and TV shows, can be enjoyed on TV. The reason why the main screen of each device is different also comes from the characteristics of contents complexity. Because the main screen is the first thing that viewers see when they turn on the power, they are the most exposed part of the manufacturer's strategy. Their types and methods of the contents are different from each other. The figure below shows that the main screen of each device is simplified according to the nature of the contents, and each manufacturer constructs menus in different forms.

The most commonly found method is a tile-like structure that exposes thumbnails of video content. This is especially suitable for video contents, and the user can obtain more information about the content through the thumbnail. In addition, the specialized functions emphasized by each maker are arranged together. In this case, different kinds of contents, that is, image contents and application contents, are mixed together to form a complex structure. Furthermore, in the case of a product emphasizing the customization function, information other than contents is also exposed, and a tile structure and a list structure are mixed up together. If the tile structure is a method of horizontally arranging contents, the list structure can be regarded as a vertical arrangement method. On the other hand, Google TV and LG Smart TV suggest application based menu in the form of docks, which is based on users' smartphone

experience. The disadvantage of dock structure was that the amount of menu exposed was small.

This mixed interface ultimately results in confusing users. As a result, smart TV is perceived to be difficult and causes it to stay in the old viewing behavior rather than learning new functions. TV is a medium with almost similar forms of watching habit over the past 70 years. Therefore, considerable effort is needed to change the strong mental model. This is the reason that easy interface is needed. In the case of FanTV in US, it was interested in presenting a new UI, but withdrew from the current market due to radical change of interface and a lack of contents.

A special case to look at is LG Electronics' smart TV with WebOS, which was acquired by LG, a mobile operating system based on Linux, developed by Palm. It differs from the conventional TV UI in that the main menus appear in the form of docks from the bottom of the TV screen. The dock form itself has been tried by other makers so it is not special, but the detailed functions composing the menu are different from the previous ones. It has been placed on the front to allow access to OTT, content store, and the Internet, including applications such as Youtube and Netflix, including Live TV, and a menu for selecting external input is placed in the same level with the content. This can be seen as a way of presenting a new paradigm of information architecture in a way that horizontally constructs information elements of different levels such as content area and physical area. In addition, the users can customize the menu so to improve usability of the TV.



Figure 3. Features of Remote controllers

Users operate the interface of the TV indirectly through the remote control. So, regarding on the interface, analyzing remote controllers was conducted. Conventional remote controllers are generally designed to be specialized for channel control and volume control. However, recently released remote controllers are designed suitable for the structure of the changing interface. As the convenience of content searching has an important

influence on determining TV usability, various methods for searching have been introduced. Some of cases use a QWERTY keyboard to input characters directly or to attach a touch pad, which allows the user to write letters or move the cursor. Furthermore, it was easy to find cases where voice recognition function was installed. In the case of a remote control equipped with a gyro sensor, the user's motion is recognized, so they can use it like a air mouse. These direct search methods are useful when the users know what they want to use. Otherwise, the function to help users navigate recommended channels or content quickly is also noticeable such as wheel button and touch pad, with that users can move up and down, right and left. Also, there are remote control apps for smartphone to control the Smart TV.

However, for the majority of users who are still used to moving channels for browsing content, some manufacturers also offer two remote controllers at the same time. For users who want to maintain their existing viewing style and for those who have a high psychological burden on digital technology, it is possible to maintain the existing habits by providing a conventional button-type remote controller. As with the interface examples, it is possible to guess that manufacturers are seeking the solution for the remote controllers between the past learned experience and the new technologies.

Every manufacturer has the same opinion that connected smart TVs are developing in various directions. It is clear that the TV contents are expanding both qualitatively and quantitatively. As it can be inferred from the development roadmap of smartphones, it is time for the TV to be positioned as a platform that not only functions as a content terminal, but also as a platform to cover various contents. However, complex information structures and the ununified interfaces can be a major obstacle to create satisfying experiences.

4. User research

TV has a wider user base than other media, because TV is still in the center of the home, unlike the expectation that TV will develop into personalized media. This seems to be due to the fact that personal media such as smartphones and computers have begun to replace the role of TV. Therefore, in order to make the TV convenient, it is necessary to design an universal interface that can satisfy the users of various levels. For this purpose, TV users were classified into 6 groups and the observations, in-depth interviews and usability tests were conducted.

4.1. Defining user segment

In order to define user segments, we analyzed market trend related research articles published in Korea since 2012. Five variables affecting the TV watching behavior of the users were extracted. We set detailed conditions for each variable by Smart Device Adaptation, Functionality, TV Using Time, Content Consumption, Communication and Communication. Each detail was combined to yield a meaningful segment. It could be defined as six senses: Seonsorial early adopters, Bright nowherians, digital natives, Sociable neighbors, stepwise learners, and Passive seniors. Based on the results of previous case studies, we define a persona that includes scenarios that reflect the functions of the TVs and their expected role for future TV.

After that, a total of 15 users who belong to each segment were recruited and the in-depth investigation was conducted. Users have been configured to range of age from 10 to 60. For the first survey, we visited each user's home and observed TV watching behavior for 2 hours, focus on the functions and

Factors	Classification		User Segment	Description
Smart Device Adaptation Are they good at using smart devices including TVs?	Hardcore Pioneer Digital Native Stepwise Learner		Sensorial Early-adopter	"They love to use brand new technology, and are enthusiastic about various contents.
	Passive Attitude	•	Bright Nowherians	"They have their own concept of world,
TV Functionality Why do they use the TV?	Enjoying Media Informative Media Display Screen		Digital Native	"They are new type of people with digital revolution,
TV Using time How long do they	for Short time for Long time		Digital Halivo	and use high-end technology like their mother tongue.
watch the TV?			Sociable Neighbour	"They are family and society centered, and are seeking for the minfulness and ethical value.
Content consumption How much do they buy contents?	More Buying Reasonable Less Buying		Stepwise Learner	"They try to adapt to digital paradigm, and learn technology step by step.
Communication Are they social?	Social Mutual Individual		Passive Senior	"They have weak economic power, and use TVs only for seeing video contents

Figure 4. User segmentation

contents mainly used for watching TV, multitasking behavior and how to use remote control. After that, 5 tasks related to the functions of smart TV were selected, and the users were asked to perform the tasks. By varying the degree of difficulty of the task, we tried to determine the degree of utilization and technical acceptance level of the users for TV contents.

It was to determine the degree of utilization and technical acceptance level of the user for TV content. Each task consisted of 'Searching for a specific program', 'Getting information about other channels', 'Booking for programs', 'Searching for keywords using search function', and 'Installing app from app store'. Finally, in-depth interviews were conducted to hear the user's overall opinions on smart TV.

4.2. User research result

All of the users who participated in this survey were watching TV contents through set-top boxes, and activities other than watching video contents were barely found. Regardless of age and segment, users were using VOD services, which are provided by set-top boxes. But the smart TV' s own function was rarely used. In particular, except for Sensitive Early Adapters and Digital Native Segments, most were observed to have no experience with smart TV specific features at all. The main function used was content search through channel zipping across all segments. While watching TV, the users' behaviors are very habitual. Therefore, we can guess that experience and learning for smart TV functions are needed. we need experience and learning about new functions of smart TV. However, users of Digital native segments used Youtube app on TV, this seems to be due to the differences in accessibility of digital technologies among generations. Furthermore, this tendency can be expected to continue in the future.

In addition, most users mainly were observed multitasking activities, such as using smart phones together or doing housework when watching TV. Some users watched contents with a high level of immersion, but they also showed different behaviors according to the genre of contents. Most of them tend to habitually watch TV while doing routine tasks that are repeated. Furthermore, they enjoyed the contents only with listening to the sound. Particularly, in the case of non-immersive watching, users who continuously changed TV channels were also observed. Unlike the expectation that TV will be personalized, there are many people who are still watching with family members, like the former study by Lee dinghy (2012). The user replies that they use a laptop or smartphone if they need a personalized screen. Therefore, it can be predicted that this tendency will continue for a while.

Users often seemed to be confused when performing tasks related to smart TV functions. At this time, users of segments that are not familiar to digital technology often seem to be afraid of searching for new functions. When entering the wrong menu, some reset the TV by turning off, rather than looking for a solution. At this time, observers used to orally explained the solution, but in many cases, it was difficult to understand the term related to smart TV itself. This can be seen as evidence that the mental model of the menu structure of smart TV is not formed yet.

Despite the familiarity with installing and using apps on smartphones, it was found to be very difficult to enter the App Store and install on the TV. Users can interpret Smart TV and Smart Phone as completely different media areas. As a result, it is clear that it is difficult to apply the experience of smartphone to TV as it is.



Figure 5. User observation

The fact that users are highly dependent on content provided via set-top boxes can be observed that they used set-top box remote

controllers for watching contents. The most commonly used buttons are the channel button, the volume button, the 4-way button and the OK button. Existing watching habits have been continuing not only in the consumption of contents but also in the area of manipulation. In the interviews, many users responded that the remote controllers with the new technology was not comfortable.

Given a task that using the new features, the first thing the user did was find the name of the function on the remote controller. The interface of the TV is still bond to the remote controller strongly. It is clear that the new technology and fancy design alone cannot satisfy users, and that the remote controller also requires a learning process.

5. Strategies for Smart TV UI

5.1. Horizontal Menu structure

There are two main types of information provided on TV. The first one is information about the physical characteristics of the TV, which can adjust various setting values, and includes information such as external input. The second is information about the content, which can be viewed and used on the TV, includes information such as live TV, VOD, and various apps. Due to their different characteristics, the structure of the menu becomes complicated. In order to solve this complexity, all information elements need to be structured horizontally. By packaging each information in the same way, the uniformity of information recognition can be improved. But when contents with different purposes and themes are listed without rules, the accessibility of the desired information may deteriorate. In the case of smartphones, the users can customize the application by adjusting the position directly. However, in the case of a smart TV that requires indirect manipulation through a remote controller, the process of customizing may be difficult.

To overcome these limitations, 4 categories have been set up. The category was centered on the content aspect of the functions that users expect from TV, which added video, game, life, and external input. The classification criteria are for the purpose of each content, which are Video, Game, Life and Link. The Video category includes OTT apps that can watch video content such as Terrestrial broadcasters, Pooq, Tving, Netflix, and Youtube and so on. As the name implies, the game category includes game-related applications. Because of the nature of the game, game is dependent on display. It is also an area where it is possible to develop contents specialized for TV in the future. This is the reason that manufacturer are focusing on game genre. The third category, Life, includes apps not included in Game and Video, especially SNS, music-related applications, and health-



Figure 6. Main menu for Video category

related applications. In addition, the name of the category was set considering that smart TV will become the center of smart home system in the future. Lastly, Link means external input like set-top boxes connected via HDMI, OTT devices, and smart devices connected via DLNA. This connection is not simply a physical connection, but rather an approach to consume connected content. So they are set up in the same way as other contents.

User observation shows that most users tend to consume TV habitually. In other words, the difference in information preference between frequently used functions and non-frequently used functions is clearly distinguished. Therefore, the service entry route is divided into two ways. Users can approach to the frequently used apps via short cuts, or they can unfold all of apps for each category.

5.2. 4-way menu structure

As we have seen, smart TV users now have a high psychological resistance to rapidly changing interfaces. This resistance was particularly large in segments with low understanding of digital technology. An easy interface is an indispensable factor to lower their resistance. Therefore, it is necessary to present an easy-to-understand interface at first sight.

Generally, people perceive the two-dimensional space as fourway directions of north, south, east and west. This is a conventional characteristic that has been derived from the past, which are evident when viewing maps or explaining directions. Therefore, in the process of exploring the two - dimensional information world of screen, it was thought that the information structure can be easily recognized and manipulated by reflecting this recognition structure. This is why we set four categories for the menu. By mapping four directions and four menu categories defined above, users can easily recognize the structure of menu and learn it.



Figure 7. 4-way menu structure

5.3. Unified structure of visual and tactile

Most of the users tend to prefer the traditional type of remote controllers even though they have new ones. It is observed that 4-way buttons are mostly used except for channel button and volume button. When they tried to use other function on the remote controllers, they read the name of the button. But in case of 4-say buttons, they were convenient to operate with only the tactile sense, and the result of the operation was clear.

In this study, it was suggested that using these 4-way buttons

would be positive for user's menu recognition and learning. Because visual experience and tactile experience are the same, information structure recognition and manipulation can be unified. Therefore, the interface is defined by assigning each category menu to each 4 direction key.



Figure 8. Mapping of menu and remote controller

Next to the 4-way buttons, the Back button and the Option button are placed. The Back button provides the easiest way to navigate users' action. If the user performs wrong action, the user can immediately cancel the operation, thereby alleviating the fear of the OS operation itself. In particular, support for returning to the previous stage can be found in the app experience on the smartphone. For Android, there is a touch button on the bottom of the device, so user can go back to the previous step regardless of the type of app. Apple's iOS has no basic rules for this, but most apps place a back button at the top left corner. So it can be helpful to be familiar for manipulating TVs.

The Option button is defined as a function that can call detailed menu to control each app. It is a support strategy for third party companies developing smart TV apps. Once the API for the Option button is released, content developers can place the necessary menus for each app using the Option button. Considering the changes in the digital market, smart TV app market will be activated soon. In other words, it can be expected that it will function as a platform for various contents, so the market will be led by contents providers and users not by manufacturers. So it enables users to continue the same interface experience while installing and using various apps.



Figure 9. Option button on Remote controller

5.4. Development of Remote controller

The major disadvantage of the four - way menu structure presented in this study is that the amount of menu displayed at a time is small. If the amount of content increases, it is not easy for the user to access the desired content. Also, in order to reach the menu far from the currently selected menu by using the 4way button, users have to go through all the menus. As the amount of content increases, such disadvantages may become more prominent. In order to support convenient contents search and to cope with the change of smart TV, we propose a mixing method that incorporates a gyro sensor in the form of a conventional remote controller.

The remote controller with the gyro sensor normally does not see the pointer but when the user shakes it, the pointer appears on the screen. At this time, when the main menu is called, the menu is opened at the position of the pointer. Thus, the user can minimize the distance to move the pointer to enter the desired menu. In addition, it is possible to mix and use four directional keys. It is thought that users can learn and be familiar slowly.

	4-way button	Pointer with Gyro sensor
Pros	- Absolute coordinates	- Fast movement
	- Consistent operation	- Visual pleasure
	- Stable usability	- Future Response
Cons	- Small the amount of	- Relative coordinate
	information	- Affected by user's
	- Low adaptability to	posture.
	feature expansion	- Delicate manipulation

Table 3. Pros and Cons of RC tech

5.5. Customization of Menu

The menu structure proposed is based on the theme each content. However, depending on the characteristics of the users, the formal classification may be considered more comfortable. Therefore, the users can select a menu structure suitable for their taste. As the smart TV market and user's ability to use digital contents change, the manufacturer can suggest a suitable menu structure at that time. Users can change the menu like Android's launcher. However, users have to operate it at a distance so it is designed that customization is limited.



Figure 10. Customization of Menu size

In addition, the user can adjust the size of the menu displayed on the screen. Due to the decrease in production cost for display panel and technological development, the physical size of TV has been continuously expanding recently. However, the size of the screen is not proportional to the distance from the user. On the other hand, a smaller screen size does not mean that users are getting closer to the TV. Therefore, it is defined that the users can adjust the size of the content icon that is exposed according to their taste. This feature can be expected to be effective in that the resolution is increased to UHD level and the users have different physical conditions.

5.6. Enhancing approach to the contents



Figure 11. Notification panel

Finally, the feature of the proposed interface is to create a 'notification panel'. Smart TV will be used as a content platform for a variety of applications including OTT, SNS, Home networking, and Health. Quick accessibility is a prerequisite for the continued use of these content. In this case, user can use the notification panel.

In the notification panel, users can see the information about updated apps or new events occurred in apps. So, without turning on the apps, users can get new information, at the same time they get a short cut that allows them to enter the apps. As a result, it can be expected that users will experience various functions of smart TV, and it will be helpful to create a new habit to use apps. Therefore, the prototype of the remote controller has a exclusive 'Notify' button so that it can easily be called and accessed at any time.

6. Result

The market change around smart TV is expected to become more dynamic in the future. Xbox, the industry leader in console game device market, launched set-top boxes and Google and Apple, both starting with smartphones, also entered the TV market. OTT services such as Netflix are increasing their market share by targeting the worldwide VOD market. Digital native generations get information from video channels like Youtube rather than text-based search engines. People watch movies and listen to news through personalized smart media. People are filming and sharing personal hobbies such as games and cooking, there are tens and millions of followers in content created by semi-experts. TV, which enjoys the absolute status of video content distribution, needs to find a new position in line with changes in the content market. Manufacturers are also sensing this need and continuing to try new ones. However, there are still various attempts and the market-leading interface is not seen yet. Looking at the changes in the smartphone market, the smart TV interface may also be integrated into a specific interface design after a certain period of time. Therefore, it is a suitable time for smart TV interface design research.

technical research were conducted. On the other hand, almost all manufacturers producing TVs are marketing to the domestic market as well as the international market. This means that the wall of the inter-state market has become thinner. Therefore, we analyzed not only domestic devices but also devices from US and Japan. We defined user segments and analyzed users at various levels through observation, task analysis, and interviews. As a result, research was conducted to create user-centered interfaces rather than technology-based interfaces. The meaning of this study can be found here. However, the fact that the study was conducted only for domestic users is a part to be complemented by the follow-up study.

The results of this study were produced as prototypes demonstrable in the Chrome browser. The interface built on HTML5 can be manipulated by using the keyboard. In addition, a remote controller mock-up that can be used for usability testing was also produced. It has been developed to enable menu operation by mounting a PCB board inside. However, changing the actual channel was difficult to implement, so we could use sample images and test them with experts. As a result, most of them were satisfied with new interface design. Based on these results, it has been applied for a patent. In the future, it will be more effective if usability evaluation is conducted for general users at home and abroad by using prototype.

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