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Design of functions in Smart TV

A survey study of user acceptance on Smart TV functions

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Abstract

This paper is defined as a qualitative study and mainly uses a survey, interview and previous reports and papers as methodology. We research which functions in the Smart TV that are widely used and what functions of the Smart TV do people need, and if people accept the design of the functions in the Smart TV. We compare some particular function out of Human-Computer Interaction (HCI) perspective. We present if the design of this studied function correspond to all the criteria that we have stated. Through the investigation we got three conclusions: firstly, we have discovered the top four popular functions of Smart TV based on the questionnaire, secondly, the precautions the developers should pay attention to when they design the product, lastly we have said that people do not accept these intelligent functions in the Smart TV, and after the study we give the future direction and suggestion for how to make well designed functions for the Smart TV.

Keywords: Smart TV, HCI, Functions, Design

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1 Introduction

In recent years, people spend almost half of their waking hours consuming media, as computers and the Internet have become ever more embedded in our life. With the innovation and development of smart technology, the smart TV has become another important part, and useful functions are the major factors in their growth. Smart TV is the most advanced television, which can connect to the Internet [1]. A smart TV provides more advanced computing ability, powerful software and high performance hardware resources [2], than a regular TV. The Smart TV can connect to the Internet and allow the user to run more advanced applications that has User-generated content (UGC) technologies, such as Facebook, Instagram etc. And the Human-Computer Interaction (HCI) is to make software easier to use and to make human and computer interact in harmony, such as wireless transmission screen, motion control, voice control and face recognition.

The main purpose of this paper is to study the users opinions about what the widely used functions in the smart TV are and we describe some technologies that are used to design the smart TV. And if the design of this studied functions correspond to all the criteria from HCI.

1.1 Research questions

People are increasingly aware of the smart TV, and the functionality is also increasing. In this paper, the following research questions will be answered:

- What are the widely used functions for the smart TV?
- What functions of the smart TV do people need?
- Do people accept these intelligent functions in the smart TV?

2 Background

Here are introduction to the smart TVs by the definitions and the development of smart TV techniques and benefits and drawbacks of Smart TVs, thus the reader could get background information of the Smart TV.

2.1 Definitions of Smart TV

The smart TV is a medium that is expected to combine TV and Internet, and provide more applications, contents, and intelligent services of a computer as well as operating platform on the set-top box [3]. This technique will be equipped with a graphical user interface, and access contents of the program from the network, Audio Visual equipment, PC and other virtual channels, the contents that people want to watch can easily be viewed on the big screen by easy operations.

The smart TV has various functionalities, such as the possibility to watch HD Movie- and TV shows, Web browser, Face recognition, Motion control, Voice control, Online games, Built-in Camera and to use a Wireless transmission screen. It also supports user downloaded content and applications.

2.2 The development of Smart TV functions

In the very early days of television the image was only black and white and without sound. As new technology arrived, TV has gradually got more advanced, with for example color TV, the bright images, surround sound, and recently high definition [4] Going from there, Internet TV services have become more available. The current trend of the TV's is that it should be more intelligent. This is accomplished by making the TV's more "Smart" with many functions. The smart TV's allows users to quickly and easily download a variety of content personalized applications for example entertainment, games, lifestyle, education, news and information [5]. And "some devices function additional interactive natural user interface technologies for navigation controls, such as second screen companion devices and speech recognition." [6]

2.3 Design of certain functions in the Smart TVs

As the development of computer science and technology goes on, the research field of user interface is being paid more attention. With the technology of open platform software, smart TV has emerged as a new media service [7]. The hardware technology has upgraded, and the high-performance chips can run various software programs smoothly [6].

2.3.1 Human-Computer Interaction

Human-Computer Interaction (HCI) studies humans and machines in communication, it draws from supporting knowledge on both the machine and the human side [8]. The main goal of Human-Computer Interaction (HCI) is to make software easier to use and to make human and computer interact in harmony.

There are several HCI technologies used in the Smart TV, for example:

- **Face recognition**

The Smart TV proposes a design and implementation of an embedded system of human face recognition. It includes the hardware, its driver and application. The face recognition system consists of face detection, feature point location, image pre-processing, and feature extraction.

Generally speaking, illumination-robust face segmentation is used to detect the faces [9]. During side face image detection, the user's face area is located by use of integration projection in the pre-disposed binary image, in order to enhance the classification information of an image, it uses band pass filter to preprocess face image, improve the sorting performance of singular value(SV) feature [10].

There are some algorithms for face recognition. The simplest method is based on geometrical characteristics, identification is based on the shape of the facial features and the relationship between them. This algorithm is designed for simplicity, but recognition rate is low. Principal Component Analysis (PCA) was one of the popular approaches for face recognition. This algorithm, regarding the class scatter matrix as generating matrix, extracts the algebraic features of face images through Karhunen-Loeve transform (KLT).

Face recognition applications can use Visual C++ as a development tool, MFC uses object-oriented approach, using C++ programming language.

- **Motion control**

Motion control is a convenient and natural way for people to achieve anthropomorphic interaction between television and controller through their own hands and some special

gestures. For systems where the act of acquiring a physical controller could waste too much time it can be used as an alternative control mechanism that could do the direct operation without delay. [11] Through the use of gesture recognition the user can with the wave of a hand control the Smart TV in some ways, for example, change the sound volume, change the channel etc. The hand gesture system is implemented with a message passing multi-thread program. It has two parts, which are RTU (Recognition To UI) and IUI (Interactive User Interface). [12]

The motion control system needs to consider the direction of the gestures, the optical flow, the skin color and many other influence factors. All these try to reduce the interference factors of the environment and analyze the right area of the gesture and then execute the gesture command.

2.3.2 User-generated content technology

UGC is an abbreviation for User Generated Content, sometimes it is also known as UCC (User Created Content). With the emergence of Web 2.0 applications, user generated content originated in the field of the Internet. It is a modern communication technologies which often produced through open collaboration: it makes each user available to be a generally active contributors or non-contributors through the Internet platform [13].

2.3.3 Software Application (Apps) technology

An application is a program, which is designed for the user to perform an activity, and the application software can be divided into two general classes: systems software and software applications [14]. There are several applications based on UGC technology used in the smart TV, for example:

- **Social networking and Internet forums**

These are mainly applications used in the form of UGC, for example Facebook, Twitter, Blogger and WordPress, where users could write messages and diary, post or share photos, videos and links. Meanwhile, it solves the problem of real-time updates of information. The popularity of mobile phones and other smart devices make each user likely to become the first publisher.

- **Video and Photo sharing**

Such sites like YouTube, Flickr, and Picasa, are mainly for uploading and sharing videos or photos. These websites also connects friends in real life like the above does, but it focuses more on your personal preference depending on what kind of genre you like.

2.4 Benefits and drawbacks of functional design on Smart TVs

As being the most new technology, there are some advantages and disadvantages of the smart TVs.

2.4.1 Benefits

- **Rich functionality**

The smart TVs is not only for selecting a channel and sitting down to watch, with the Internet component that the generation of TVs is designed for it provides an interactive experience which includes being able to access online videos, games, and music [15].

- **Convenience**

The user of the smart TVs can easily connect to all their online activities from one spot, and also enjoy the convenience of the TV's suggestions based on social behaviour rather than the old way to swap channels to find something to watch [15].

2.4.2 Drawbacks

- **Security and Privacy**

There are some features of Smart TV related to security and privacy problem. Malicious Software and hackers obtain information from cameras and invade the privacy of many unsuspecting users of such services, according to Pandula S. [16].

- **Limitations of the applications**

Smart TV provides a wealth of application software, allowing users to create their own free download personalized TV. However, the selectable range of applications is limited in scope [16].

- **Complex operations**

Since the interaction between TV and users are through the remote control, the Smart TV has a complex operation of its remote control. If the user never used any other intelligent system before, it will be hard to them for control the Smart TV [17].

2.5 The acceptance of Smart TVs on users' lives

In this study we investigate user percentage of usage of total population. People have started to accept and use smart products. By acceptance meaning that the ways of using a device has changed, and that the new way is acknowledged by the user as more convenient or "the way it was meant to be used". Accepting the new way means the old way is obsolete and inferior. However, predicting technology acceptance toward the smart TV function is always challenging for designers, and the users' preference and needs change rapidly.

3 Method

As this paper is used to get people's options about the design of Smart TV's functions, the information were collected from other previous researchers and the answers of questionnaire. We studied 12 scientific papers and 8 online articles to complete the thesis. They were relevant to our topic and provided valuable information of Smart TV and its functions. In addition, this thesis mainly involved a survey, comprised of a set of questionnaire. Moreover, in order to examine more deeply the user acceptance of the smart TV functions, interviews were conducted with salespersons and customers as well. We also studied the functions from a Human Computer Interaction (HCI) perspective.

3.1 Data collection and framework

3.1.1 Design criteria for evaluating HCI

To evaluate the design of a function, and especially to compare the criteria of a design, usability researchers must establish comparison criteria. The interface is important for most users. However well or poorly designed, it stands as the representation of the system by reflection. A well-designed interface improves the fit among the user. Below are four criteria that we use to study the design of some functions.

- **Consistency and standards**

The user should not have to be concerned about which system he is using, or which company developed the function, the same command should be able to work regardless. Consistency should make it easier for the user to learn how to use the system.

- **Matching friendly**

The system should speak the language that the user understands, with words, phrases and concepts familiar to the user, instead of system-oriented terms. The user interface should make information appear in a natural and logical order.

- **Minimalist user action**

Dialog is the communication between the computer and a person. Dialogues should not contain information that is irrelevant or rarely needed. Well-designed dialog makes it easier for people to use a computer. [18]

- **Feedback for users**

Users should know if the input is being accepted and if requests can be processed. During the process of interaction, the user operation can get the feedback in time on the screen, and to improve user efficiency. [18]

3.1.2 Interview

For the qualitative interviewing, we visited two appliance stores, one is in Sweden and another is in China. We interviewed some of the salespersons and the users in both stores. We asked about the acceptance of the smart TV and the frequency of using the smart TV's functions. All the interviews gave us valuable information.

Through this investigation, we determined the direction of the thesis and adjusted the content of the questionnaire to make it better. And then, we put questionnaire on a website and shared it in order to get more random samples and participants. Meanwhile, we sent the link of questionnaire to Blackboard (the learning management system which can send email and assignment between students and teachers) at the University of Gävle. As we needed accurate statistics during the thesis, this online questionnaire was closed on May 1st, 2014. Some of questionnaires were sent out by hand in Gävle City center, in order to collect all the statistics in one place we filled out those answers on the website by ourselves given the answers from the hand-outs.

The information we collected from interviewing and questionnaire was put into different forms in the software Excel, and then generated histograms and other figure automatically to make the result results more clarity.

3.2 Questions in the survey

Since we were research the user opinions for the design of Smart TV's functions it is necessary to know whether the respondents would like to have a smart TV and why they use the smart TV. Through interviewing the salespersons and customers on the stores, we learned some reasons why the customers would like to have a smart TV and sorted the reasons to the questionnaire. Therefore questions about whether the people have a smart TV and why they have it are placed in the questionnaire.

Afterward, we listed most of the smart TV's functions in the questionnaire in order to know which function was used often or which was not. We also want to know why people do not often use theses functions. Therefore, the questionnaire contains these requirements.

We prepared 3 open ended questions in the end of questionnaire that inquired the respondents about what they like and dislike about the smart TV and what more they want to tell us about the smart TV.

4 Result

4.1 Interview

The mainly research approach we used for fulfilling the objectives is through interviewing both managers and customers from different nations and in different group of age. A specifically, we have made interviews in two stores which are located in Sweden and China, for the reason of the manager don't want their brand showed in our study, so we don't mention the name of the two companies in our work. We interviewed ten people in China and the same number of people in Sweden, the difference is there are including two shop assistants in China but there are three in Sweden. We have put up with several questions in the interview generally cover the aspects of satisfaction from users' feedbacks, the frequency of using Smart TV's function. And the result of the interview indicates that the smart TV is more popular with young people, most of the people showed up in the smart TV shops concentrate on teenager group, they are more interested in the product and willing to have it. One of the teenager said: "The Smart TV is so cool. I have always heard good things about it and I am curious and want to try it now." In addition, medium-aged people are the main purchasing group, according to their economic ability. Therefore, it will be easier for them to accept the expensive cost of the product. In fact, there is a customer has ordered a smart TV during our interview in the Chinese store, he is a 38 years old man, and he told us: "This TV's functions is very attractive, and I'm glad to have it to back home." All the results above are similar to the result of questionnaire. The interview also presents that there is a big difference between Sweden and China. In China, there is more variety of the brand of the smart TV, and most people prefer to have a smart TV rather than a regular one. Actually it is difficult to find a regular TV in the store, unless it is a very big size or has a high definition of the screen, most of the sales have intelligent and interesting functions. But in Sweden, we can't find many people searching for the smart TV, meanwhile, we got the information from shop assistants in Sweden's store that there are not many people have the awareness of this kind of product. They have to give extra information to the customers about the smart TV.

4.2 Questionnaire

In our questionnaire, we made 12 questions. These questions mainly focused on the satisfaction of respondents for the smart TV's function to indicate which functions was practical and which was not. For more details about the questionnaire, please see the Appendix.

A total of 188 respondents participated in the questionnaire. 140 of them are under the age of 25 years. Meanwhile, there are 38 respondents between 25 and 40 years old and 10 respondents are above 40 years old. In these 188 respondents, 82 are male and others are female. The following sections covers the first two questions of what age and which sex the respondents have.

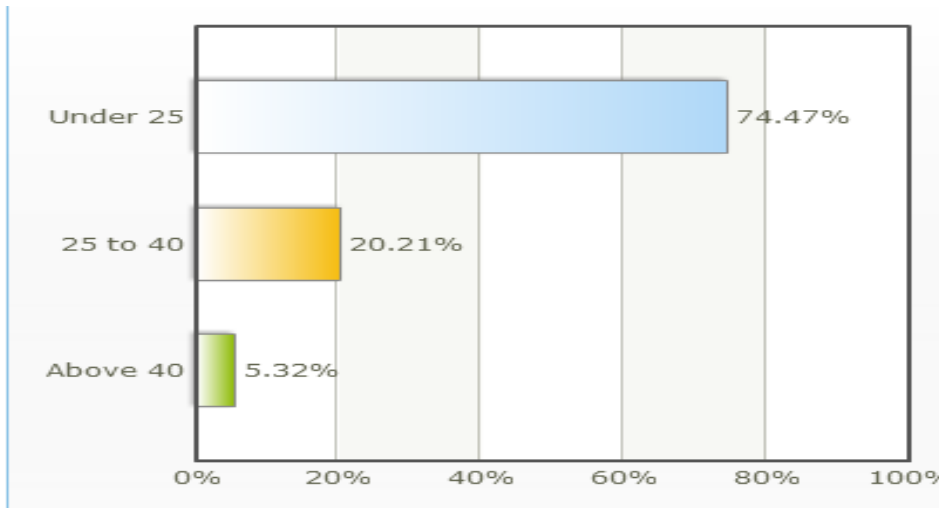


Figure 1.

The age of respondents.

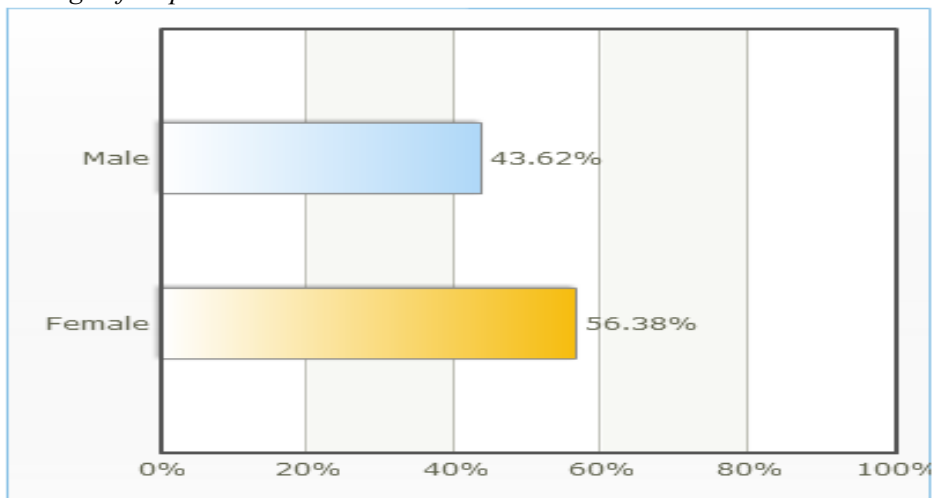


Figure 2. The sex of respondents.

The third question is the nationality, half of the respondents (93 respondents) are from China, but from different provinces, and 74 respondents come from Sweden, the rest of the 21 are from other countries such as Spain, Germany, Canada and etc.

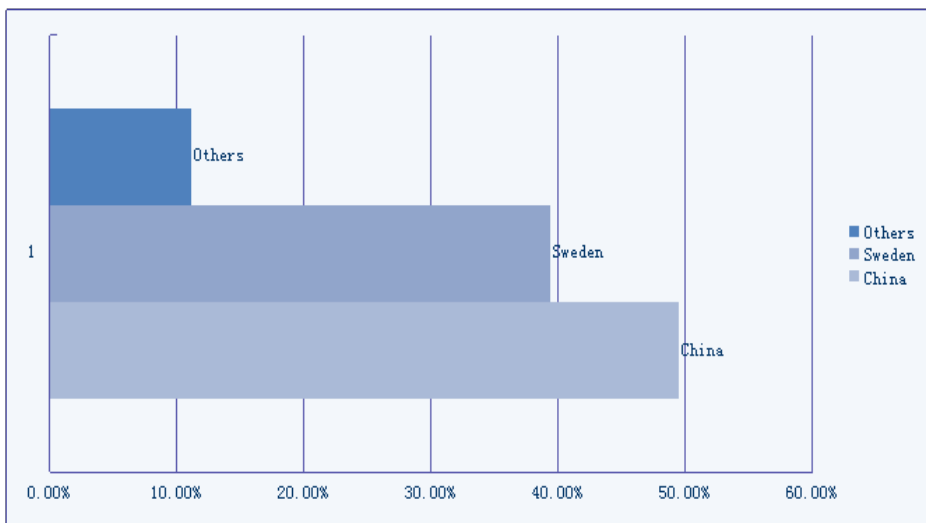


Figure 3. The nationality of respondents

According to the results, most of respondents do not have a smart TV at home, only 82 respondents selected yes when we asked if you have a smart TV or not.

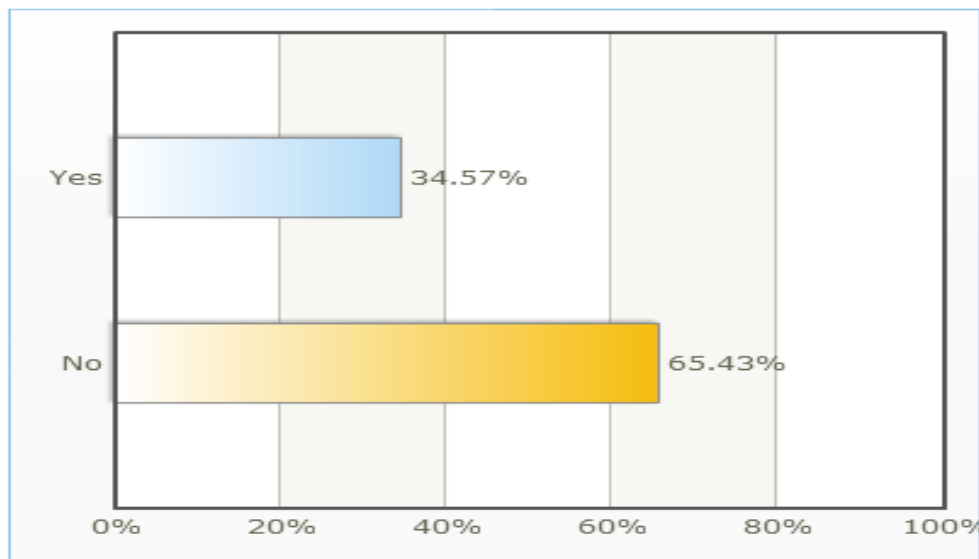


Figure 4. Answer for “Do you have a Smart TV?”

As we can see below, an interesting thing is that the older the participants become, the fewer of them owns a smart TV.

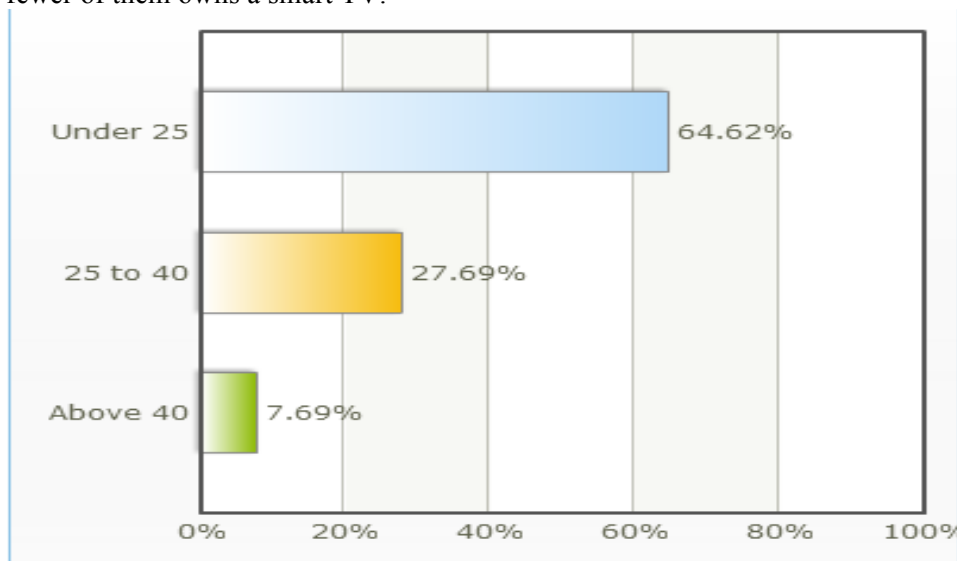


Figure 5. The percentage of age of who have a Smart TV.

Question 5 and 6 are talking about why the respondents have or why they do not have a smart TV. Most of the owners have a smart TV because of the interesting functions. While those who do not have a smart TV, about 60 percent of the respondents, think the smart TV is too expensive to buy, they would prefer to have a regular TV. Meanwhile, some of respondents do not have any interest in the smart TV. In the “other” option, there are many different answers for why they do not want to get a smart TV. Some of them wrote “the normal TV still can be used”, “it does not have a mature technology” and “lack of international brands and don’t know which is better” etc.

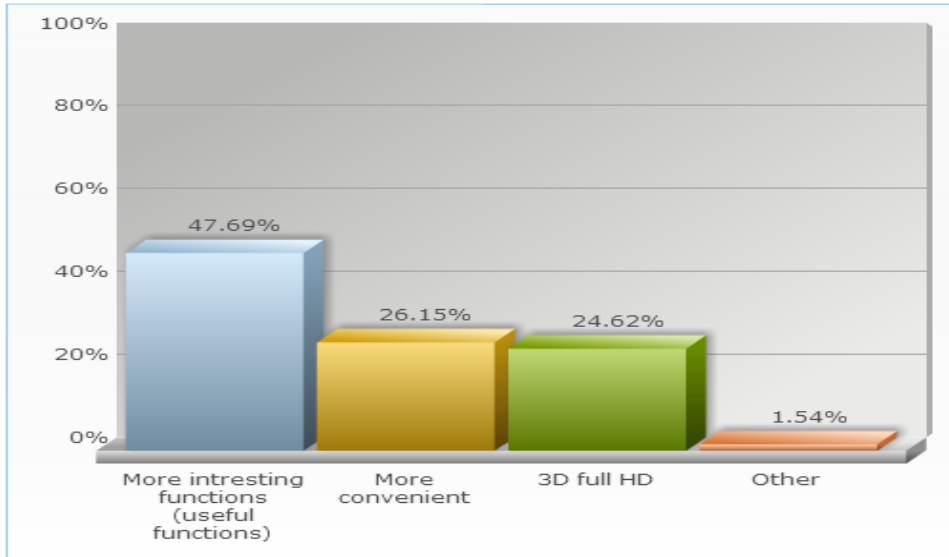


Figure 6. "Why do you have a Smart TV?"

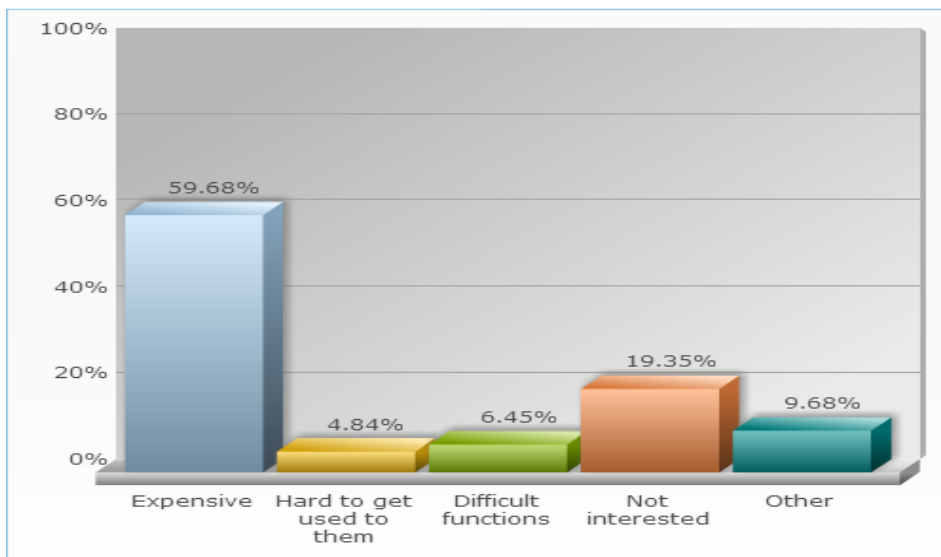


Figure 7. "Why do you not have a Smart TV?"

To see if different age groups answered different on why not having a smart TV, we divided these into 3 categories. The result figures out that the main reason for respondents under 25 do not have the product is the high cost and therefore they could not afford it, and it is the same reason for the age between 25 to 40. Meanwhile, the respondents who are between 25 to 40 lack the interest of the product because of another reason. But for respondents above 40, they give the answer that the smart TV has complex functions and it is difficult to operate for them. More detailed information is displayed in the figure below.

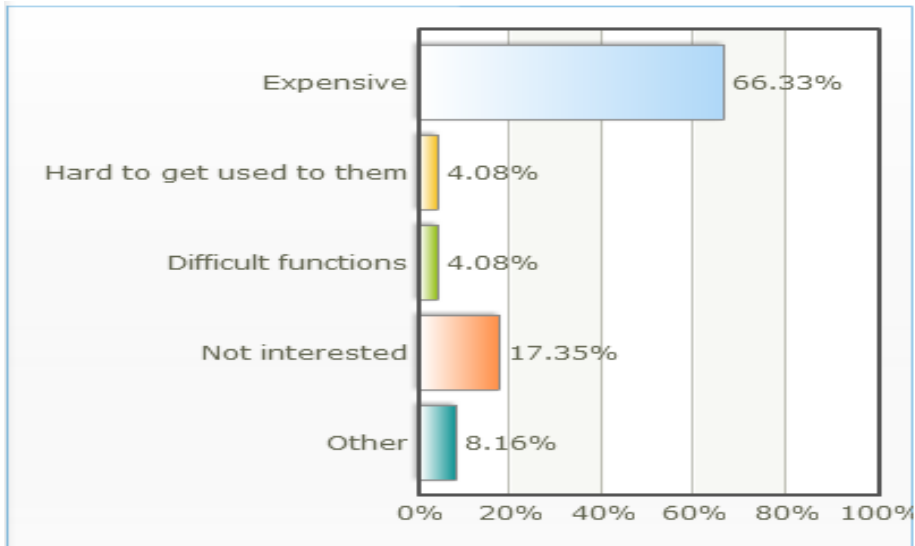


Figure 8. The percentage of reason why not having Smart TV (Age: under 25 years)

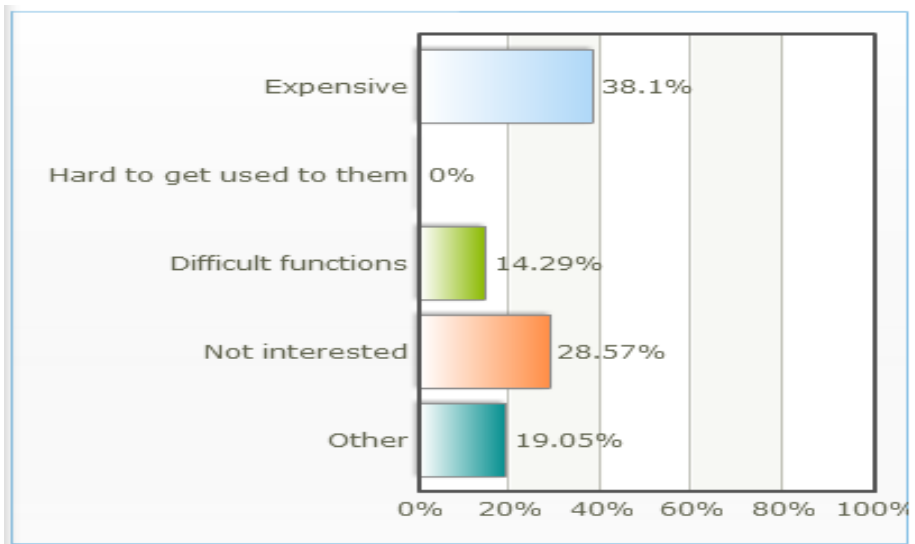


Figure 9. The percentage of reason why not having Smart TV (Age: between 25 to 40 years)

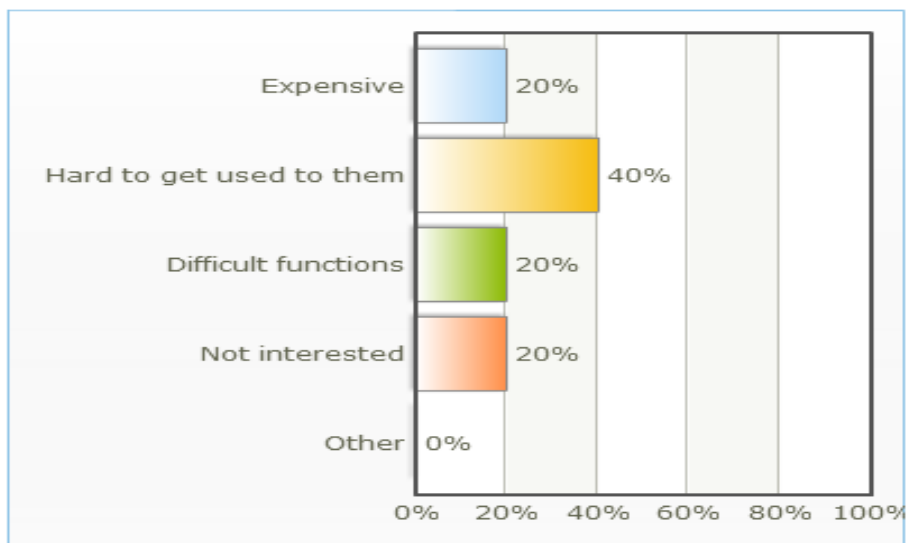


Figure 10. The percentage of reason why not having Smart TV (Age: above 40 years)

According to question 7 and 8, the top 4 of the most used functions of the smart TV are “Movies and TV shows”, “Photos, video and music”, “Apps” and “Web browser”. In particular, “Apps” and “Web browser” have the same number of votes between respondents. However, for “Which functions in the smart TV do you not use”, more than half of the respondents chooses “Face recognition”. Others common choices are “Voice control” and “Social network”. On question 9, respondents tell us that why they are not using these functions. Most of them think there is no need to use these functions on a Smart TV, and some of them think the function has complicated control and are not interested in these extra features. The figures below shows the percentages for these two questions.

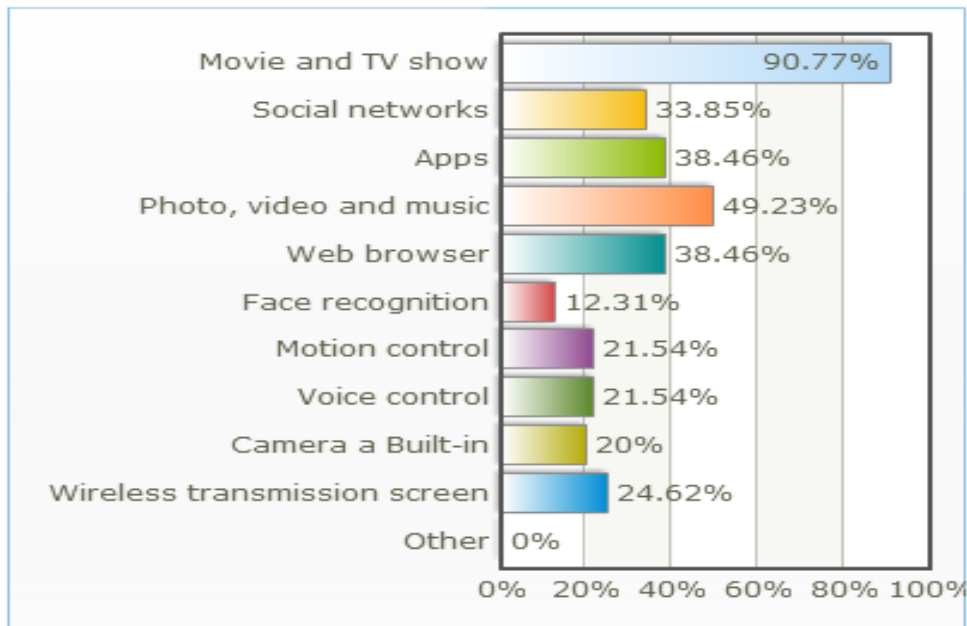


Figure 11. “Which functions in the smart TV do you use often?”

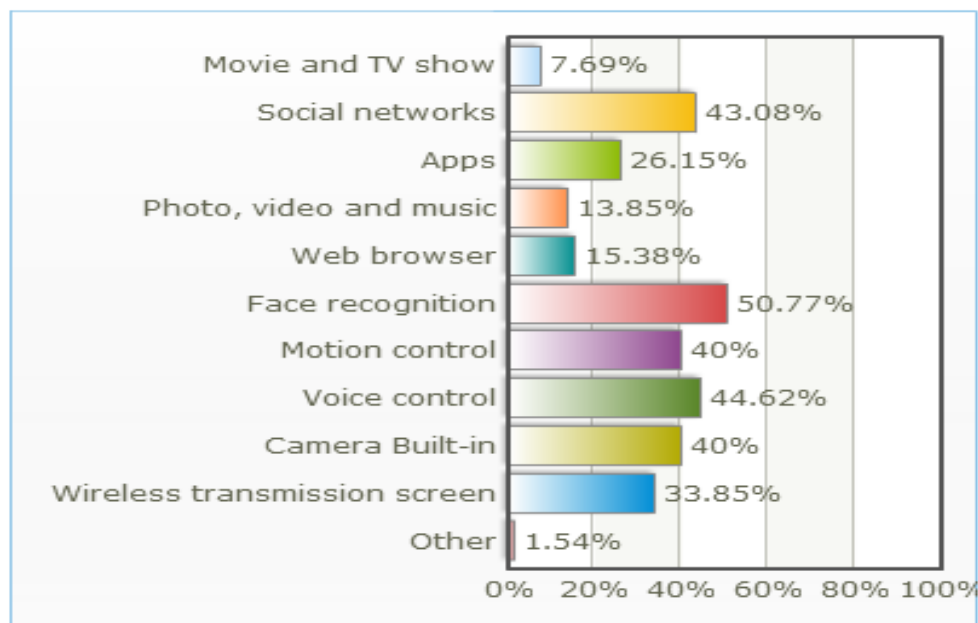


Figure 12. “Which functions in the smart TV do you not use?”

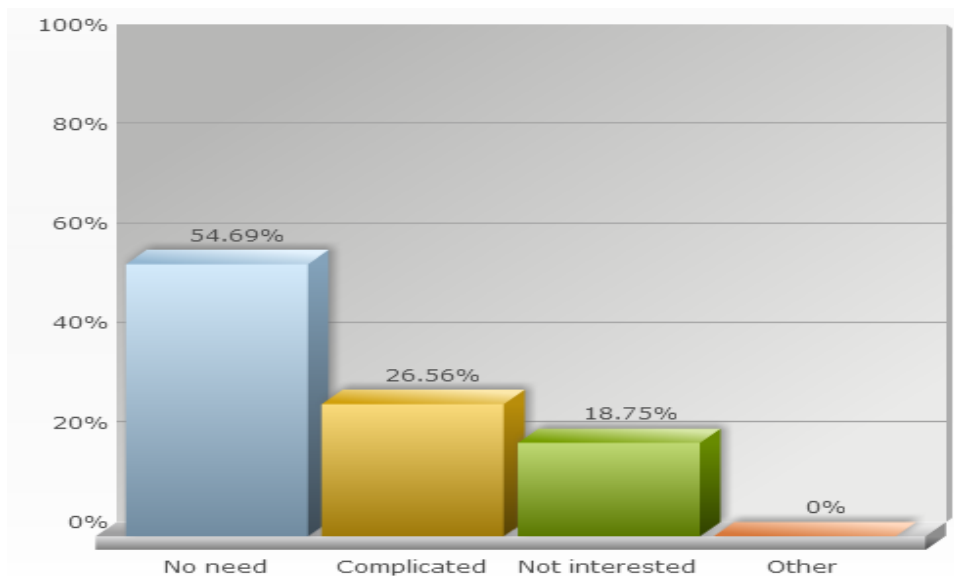


Figure 13. “Why do you not use these functions?”

In the essays questions (Question 10 to 12), we talk about what do respondents like or dislike about their Smart TV and do the following summary. Most of the respondents approve of the big screen of the Smart TV. They think that the Smart TV can be used to watch online videos through a bigger and higher definition screen than a computer and regular TV's. And it can be convenient for them to contact with social network. In summary, respondents like the flexible functions and high definition screen of a smart TV that is also the main reason of consumers to buy a smart TV. Moreover, for another question respondents think that the smart TV is too expensive and is complex in its navigation to control. There are more than 80 percent respondents referring to “expensive” here, it is true that the regular TV is cheaper than the smart TV so that customer are willing to keep the regular TV.

4.3 Summary of the criteria for HCI design

From the research results and the questionnaires, most respondents reflected ‘face recognition’ is the lowest usage function among the HCI. The respondents think it is meaningless function in smart TV. What’s more, over half of the respondents said they have never used face recognition function. According to the result, the face recognition function does not apply the criteria of HCI, which means most people do not use this function.

Both motion control and voice control functions are rarely be used by users. The users clarified the reason is that these two functions are hard to operate in a correct way. The design violates consistency standards and matching friendly principles of Human Computer Interaction (HCI). The majority of people does not accept or use these functions, which means the design of these functions not correspond to the criteria from HCI perspective.

Most respondents showed their willingness and happiness when answered questions about wireless transmission screen function. They described this function as the most useful one as well as the most convincing function. The users can easily connect the smart TV by Bluetooth or local area network to control the smart TV. As a result, the design of this function corresponds to the criteria of matching friendly from HCI perspective.

5 Discussion

According to the survey 82 people in our material had a Smart TV. The results showed that the only suitable functions of Smart TV are being able to Watch TV shows and Movies. The least useful functions are Face recognition, Voice control and Motion control.

Due to the big screen characteristics of the Smart TV, many users preferred a Smart Phone, Tablets and other devices to connect Smart TV, enhancing the user experience by the big screen and sound effect of Smart TV [19]. But, these relative popular functions, which are real-time TV, shows, online music, and USB play video, does not require a Smart TV at all, other devices can also do that.

In this case, the Smart TV has been rendered obsolete. Then why do the user most prefer to 'Watch' TV rather than to 'Play' TV, i.e. use its interactive functions? So far the smart TV's applications have been very rich, but most of them are overlapping with Smart phone and tablets functions, and it is more convenient to 'Play' on the smart phone and tablets because of the easier way to interact with the devices.

Many functions are seldom used, simply because they are not needed, such as face recognition. It may be as simple as the TV manufacturers didn't find a good use of this function yet, but decided to implement it anyway for future use. People may question that if there are a camera and a microphone in the living room, will it make people a little nervous or will they be hacked [20]? This is an unavoidable problem of "Privacy". Imagine, if your photo is shown on a website someday. However, the least useful functions according to the results of the questionnaire are maybe not the least useful functions in reality. It may just be that the idea is poorly designed and executed by the production companies.

From a HCI perspective, poorly designed functions have been proved to be bad. They have not figured out how the Smart TV should be operating. For instance, using your finger on a touchpad provides high precision control, while the motion control requires a large motion to be captured and often introduce delay and arm strain. People don't use motion control, because from HCI perspective they don't follow the same standard from different TV's. Voice control would provide speech to text but words can misinterpret if spoken with a dialect or accent. It is not user friendly enough to be used. In addition, motion/voice controls are easy to arouse resentment of users, because in others' eyes waving hands and other excessive movements may look strange. That might be the reason people do not use these functions.

Feedback of some applications might also not correspond to the criteria of HCI design, no one would like a smart TV where you could not get it to feedback your error message immediately. It is frustrating when nothing appears to be happening, while in reality the smart TV simply didn't understand what the user wanted to do.

In the questionnaire, we can find that people of older age does not prefer to use Smart TV's. As the main user of the smart TV, the acceptance or adaptability and the requirements of Internet of the older age people is not that high. Obviously, Smart TV is not the best choice for them.

In all, The Smart TV technology and its functions still have plenty of room to grow.

6 Conclusion

6.1 What are the widely used functions for the Smart TV?

The most used functions according to our questionnaire are:

- Movies and TV shows
- Photos, video and music
- Apps
- Web browser

We can see here that the user is drawn towards the simpler of the functions in the Smart TV. These are functions that users know from previous experience with other devices, such as a smart phone or a computer. The other unfamiliar functions are left out and not as widely used. This means that research need to focus on simplification the functions, thus providing a better user experience and fulfilling the requirement of the user. In the future when the Smart TV have more useful functions and applications that can give full play to its big screen advantages, then the users can really use their Smart TV's to its full potential.

6.2 What functions of the Smart TV do people need?

The most crucial part of using the smart TV is being able to control its functions. Without a proper and convenient way to do this all other functions will fail to provide their usefulness. What developers of smart TV's need focus on is the motion capture, as it was the second to last useful feature according to the questionnaire. Being able to control your TV without a remote or the use of another device would provide the most convenient usage of the TV, thus improving all other applications usefulness. The smart TV needs to reduce the cost by removing the unwanted functions and keep improving the basic functions to get the people's approval.

6.3 Do people accept these intelligent functions in the smart TV?

Our research indicates that functions such as the face recognition, voice and motion control and social network are somewhat popular. Therefore we can say that people do accept some functions in the smart TV to some extent, whilst others, like the face recognition, is not accepted by many.

In the future, designing the useful functions is more important, instead of creating new functions that people avoid because of the lack of practicality and efficiency. What developers of smart TV's should focus on is the motion capture, and get full understanding of HCI, in order to make well-designed functions. That way people will accept the smart TV as a replacement of the regular TV, and the manufacturers would sell more units.

7 Acknowledgment

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Appendix 1:

Questionnaire of what are the widely used functions for Smart TV?

1. How old are you?
 - A. Under 25
 - B. Between 25 to 40
 - C. Above 40

2. Your sex?
 - A. Male
 - B. Female

3. Nationality _____

4. Do you have a Smart TV?
 - A. Yes (jump to 5)
 - B. No (jump to 6)

5. Why do you have a Smart TV?
 - A. More interesting functions (useful functions)
 - B. More convenient
 - C. Three- Dimensional full HD
 - D. Other _____

6. Why you do not have a Smart TV?
 - A. Expensive
 - B. Hard to get used to them
 - C. Difficult functions
 - D. Not interested
 - E. Other _____

7. Which functions in the Smart TV do you use often? (Multiple)
 - A. Movie and TV show
 - B. Social networks
 - C. Apps
 - D. Photo, video and music
 - E. Web browser
 - F. Face recognition
 - G. Motion control
 - H. Voice control
 - I. Camera a Built-in
 - J. Wireless transmission screen
 - K. Other _____

8. Which functions in the Smart TV do you not use? (Multiple)

- A. Movie and TV show
- B. Social networks
- C. Apps
- D. Photo, video and music
- E. Web browser
- F. Face recognition
- G. Motion control
- H. Voice control
- I. Camera Built-in
- J. Wireless transmission screen
- K. Other _____

9. Why you do not use these functions?

- A. No need
- B. Complicated
- C. Not interested
- D. Other _____

10. What do you like with your Smart TV?

11. What do you dislike with your Smart TV?

12. What else do you use with your Smart TV?