Evaluating the Usability for Interactive Digital Television Applications

First Author[1][0000-1111-2222-3333] and Second Author[2][1111-2222-3333-4444]

[1] Princeton University, Princeton NJ 08544, USA
[2] Springer Heidelberg, Tiergartenstr. 17, 69121 Heidelberg, Germany
lncs@springer.com

Abstract. Applications for Interactive Digital TeleVision (IDTV) are becoming increasingly popular. Users no longer interact only with software applications on computers or smartphones, but also through a television set. Therefore, it is necessary to ensure the satisfaction, efficiency and effectiveness that users may have when interacting with those applications. This paper presents an Application Usability Model for DTV based on two approaches: the quality of the product and the quality in use of the software product. The model is based mainly on the ISO / IEC 25010 standard in which a set of usability characteristics are defined. These characteristics have been divided into sub-characteristics, attributes and metrics of the IDTV in order to quantify each attribute and identify the usability problems that might be present. In addition, to have a better idea of how the evaluation should be performed, an example of using the usability model for a weather application designed for IDTV is presented.

Keywords: Evaluation, Usability, Interactive Digital Television, Feature, Metric

1 Introduction

Digital television (DTV) is a concept that is taking more prominence nowadays in different countries. The DTV is not only governed by the transmission of daily television signals, those that transmit audio and video for the user to view, but also software applications similar to those that a user is accustomed to use on a computer or on a smartphone and which can be displayed and presented on a television screen. In addition, some standards for DTV, such as the ISDB-T, recommend the use of a set-top-box of digital signals. These decoders have their own structure of hardware and software where it is even possible to install applications, which can be later executed and presented on the TV screen [1]. All of these allows the concept of Applications for digital television to emerge.

The concept of interactivity, in the context of DTV, can be understood as the active participation of the user with the content broadcast. Thus, being able to determine the direction of the flow of the content, allowing viewers to participate and interact with

the deployed applications [2]. In this way, the concept of Applications for IDTV emerges.

An application for IDTV can provide three types of services [3]: information services that are not related to the broadcast program, services related to transmitted programming and transactional services that enable the sending and receiving of information. Particularly, in the last type of service, the user is able to interact with the application using a remote control or any other device that serves as a second screen.

At this point, the following question arises: How is it guaranteed that users of IDTV applications actually obtain the best satisfaction, efficiency and effectiveness when interacting with said applications? To answer this, it is necessary to evaluate the usability considering characteristics, sub-characteristics, attributes and metrics that help to generate measurable values to have a clear perspective of the quality, always in terms of usability, of the different applications.

To evaluate the usability of applications for IDTV, a usability model based on the ISO / IEC 25010 standard is proposed [4]. The model is important because it considers a set of characteristics of the IDTV applications, which have attributes that can be measured through the definition of metrics. Considering this type of attributes makes it possible to evaluate each of the parts of an application since they are capable of directly affect the quality of it.

The method considers two approaches: the model of product quality and the model of quality in use of the product. Regarding the first approach, ISO / IEC 9126 refers to the usability of the product as the "ability of a software to be understood, learned, used and attractive to the user, under specific conditions of use" [5]. While on, ISO / IEC 9241 refers to the quality in use as the "effectiveness, efficiency and satisfaction with which a product allows specific objectives to be reached by specific users in a context of specific use" [6]. Some aspects are considered here, such as the means available to the viewer to interact with the applications: remote control, second screen devices, etc.

This article has the following structure: Section 2 presents works related to usability evaluation methods for IDTV applications. In section 3, the proposed usability model is presented. Section 4 contains an application example of the usability evaluation model. Finally, section 5 presents the conclusions and future work

2 Related Word

The usability evaluation proposed in [7] is based on a proposal made of others usability evaluation methods (UEM) that integrate collaborative processes, which according to the authors, allow to obtain results richer in content than traditional UEMs. They propose three different paths, which depend on two factors: the objectives of the evaluation and the desired results. The paths are explained below:

- Global evaluation: analyzes an IDTV application in a complete way using heuristic evaluations, constructive interactions and interrogation methods.
- Specific evaluation: analyzes specific functionalities of the IDTV application through heuristic evaluations, formal experiments and interrogation methods.

- Complete evaluation: deeper analysis than the previous ones, making use of each of their techniques.

The previous proposal is different from the one presented in this article because it is based on the active collaboration of the user making use of experiments and methods of interrogation. The proposal of this article considers a set of characteristics of the IDTV applications represented in a quality model formed by sub-characteristics, attributes and a set of metrics that provide a clear picture about what will be evaluated. The evaluation will help to determine if an application is usable or not; also, both, the developers and the users themselves, can perform the evaluation.

3   Usability Model for DTV Applications

In this section, the Application Usability Model for IDTV is presented along with a brief description of the sub-characteristics, attributes and metrics. For reasons of space, only the most relevant attributes of each sub-characteristic will be presented. The complete model can be found at the following URL: goo.gl/Nawpsh.

Regarding to the usability of the product, each of the sub-characteristics come from five of the six recommended features for usability in the ISO / IEC 25010 standard [4]: **Intelligibility**, learning, operability, protection against user errors, aesthetic. The feature not considered is accessibility because it focuses on the "ability of the product to be used by users with certain characteristics and disabilities" [4], however, the proposed method focuses on the common user.

Table 1 shows the sub-characteristics and attributes related to the Intelligibility. This characteristic refers to the ability of the application to be comprehended or understood.

Table 1. Sub-characteristics of Intelligibility.

Sub-characteristics	Attribute	Meaning
1.1 Textual semantics	1.1.1 Understanding textual information	Is the textual information presented in a coherent manner and is it easy to find in the message that is desired to transmit?
1.2 Audivite understanding	1.2.2 Sound and images synchronization	Are the audio and video image synchronized (no lag)?
1.3 Familiarity	1.3.2 Internationalization	Are the available actions to navigate the application similar to the ones commonly used?
	1.3.3 Component Popularity	Are the components presented easily recognized because they have been accepted and commonly used?

1.4 Visual readability	1.4.6 Density of the information presented	Is the amount of information presented on the screen adequate?
	1.4.7 Layout of components on the screen	Are the components easy to find and recognize?
	1.4.8 Size of the components	Is the size of the components suitable for viewing?

The *Layout of components* on the screen attribute refers to the strategic location of the components in the application interface, so that they can be easily found and recognized. The associated metric consists in the division of the number of visible components among the total number of components. If the result is 0, there would be a greater usability problem, if it is 1, then there is no usability problem.

The attribute *Size of the components* refers to the fact that the objects shown do not cause an overloaded presentation of objects that hinder visual understanding. The associated metric refers to the ratio of the number of components with appropriate size among the total number of components. A result of 0 reflects a greater usability problem, while a result of 1 reflects the opposite.

Table 2 shows the sub-characteristics and attributes related to **Learning**. This feature refers to the capacity of the product that allows the user to learn from its correct use and application.

Table 2. Sub-characteristics of Learning

Sub-characteristics	Attribute	Meaning
2.1 Help to user	2.1.1 Help on buttons use	Is there information provided to the users about the actions to be executed when using a button? (Red, yellow, green button, etc)
	2.1.2 Information on activities to be performed	Is there information provided about the activities necessary to perform a task?
2.2 Predictability	2.2.1 Expressiveness of the labels associated with the media	Is it easy to foresee that a concept is associated with a label of an element of the interface?
	2.2.2 Predictability of component actions	Is it easy to predict the action a component performs?
	2.2.3 Determination of possible permitted actions	Is it easy determining the actions allowed by the application?

The *Help on buttons use* attribute refers to the information of the functionalities associated with each button so that the user always has in mind what is allowed to do. The

associated metric corresponds to the ratio of the number of buttons that have a description of the activities they perform among the total number of buttons available in the application. A response of 0 represents a greater usability problem, a response of 1 indicates there is no problem.

The attribute *Expressiveness of labels associated with the media* refers to a label that defines the functionality of the associated medium to allow consistent navigation and rapid learning by the user [8]. The associated metric consists on the relationship between the number of expressive labels associated with the media and the total number of labels associated with the media. A response of 0 represents a greater usability problem, and a result of 1 indicates there is no problem.

The attribute *Predictability of component actions* refers to the ease of determining what action will be executed if a component shown on the TV screen is used. Its metric is associated to the relationship between the number of components with foreseeable actions and the total number of components. A response of 0 represents a greater usability problem, while 1 indicates there is no problem.

Table 3 presents the sub-characteristics and attributes related to **Operability**. This feature refers to the capacity of the product that allows the user to operate and control it easily.

Table 3. Sub-characteristics of Operability

Sub-characteristics	Attribute	Meaning
3.1 Graphic interface adjustment	3.1.1 Auto-adjustment of the interface to various screens	Can the graphic interface be auto-adjusted to screens of different sizes without damaging the visualization of its components?
3.2 Effort reduction	3.2.1 Minimum actions	Are there mechanisms that allow carrying out a task where the user performs few actions?

The attribute *Minimum actions* refers to everything that facilitates the application, allowing to a quickly execution of certain actions, for example, the use of shortcuts that favor users to be able to operate the application quickly and easily [8]. The associated metric refers to the relationship between the number of actions required to complete a task using shortcuts with the number of actions without shortcuts. A result of 0 has a minor usability problem, 1 the opposite.

Table 4 shows sub-characteristics and attributes related to **Protection against user errors**. The characteristic refers to the ability of the product to protect users from making mistakes.

Table 4. Sub-characteristics of Protection Against User Errors

Sub-characteristics	Attribute	Meaning
4.1 Prevention of mistakes	4.1.1 Validation of data entry	How much data entered into the application has any mistakes?
	4.1.2 Restriction of non-necessary functions of the remote control	Is there a small and limited number of functionalities available to interact with the application?

In the *Restriction of non-necessary functions of the remote control* it is necessary to consider that having a short and limited number of functionalities available to interact with the application improves usability because the user does not have to remember the operation of each button of the remote control.

Table 5 presents the sub-characteristics and attributes related to the **Aesthetics**. This feature refers to the ability of the user interface to please and satisfy the viewer.

Table 5. Sub-characteristics of Aesthetics

Sub-characteristics	Attribute	Meaning
5.1 Proportionality	5.1.1 Ratio of size between elements and screen size	Is the area occupied by a component on the screen correctly related to the total area of the application on the screen?
5.2 Visual consistency	5.2.1 Coherence in the grouping of components	Are the components grouped according to the purpose they must fulfill?
	5.2.2 Uniformity of colors	Are the background colors used consistent in all sections of the application?
	5.2.3 Contrast colors	Is the level of brightness and colors of the components adequate?

The attribute *Coherence in the grouping of components* refers to the fact that the components must be grouped in contiguous zones of the screen according to the actions they execute. For example, those components with similar actions or those whose execution precedes the execution of another component. The associated metric corresponds to the relationship between the number of coherently grouped components and the total number of components. If the result is 0, there is a greater usability problem, if it is 1, there is no problem.

It is also necessary to establish a quality model to evaluate the quality in use of the applications for IDTV considering the devices through which the user can interact with

said applications. It was considered to evaluate the quality in use in terms of the satisfaction achieved by the viewer.

Table VI presents sub-characteristics and attributes of **Satisfaction**. This characteristic refers to the degree to which users feel satisfied with the experience of using a product in a context of specific use [9].

Table 6. Sub-characteristics of Satisfaction

Sub-characteristics	Attribute	Meaning
6.1 Simpathy	6.1.2 Compliance on the behavior of the application	Does the user feel comfortable with the tasks that are allowed to perform in the IDTV application?
6.2 Comfort	6.2.1 Navigability between available functions	What is the level of compliance achieved when using the available navigation method to move from one functionality to another?
	6.2.2 Text input modes	How much time does it take for a user to enter text into the application?
6.3 Trust	6.3.1 Consistency of the result	Are the results presented adequate?
	6.3.2 Results waiting time	How long must a user wait for the results to be presented after having executed an action?

The *Results Waiting Time* attribute refers to the waiting time between the execution of an action and the presentation of results. The associated metric states that it will have a value of 0 if the response time is greater than or equal to 10 seconds, it is 0.2 if the response time is between 5 and 10 seconds, 0.4 if it is between 2 and 5, it will be 0.8 if the response time is between 0 and 1, and lastly, it will be 1 if it is less than or equal to 0. It is considered a metric of 0 as a major usability problem and 1 as the best result.

4 Application of the Usability Model for IDTV Applications

In this section the usability evaluation of an application for IDTV is presented to illustrate the use of the Application Usability Model for IDTV. The application offers the service of visualization of the weather of a city, which has been selected by the user, along to the weather of places near that city. Fig. 1. shows the user interface of the application.

Fig. 1. Weather display application for IDTV

In order to develop the evaluation, in the first instance, a set of sub-characteristics and attributes of the Usability Model for IDTV should be selected. Then, using the metrics of each attribute's sub-characteristic the application is evaluated. This step is performed to obtain measurable values of usability to gather information and then generate a usability report. Said report will have the usability problems detected and will also provide suggestions to solve them.

Next, the usability evaluation of the application for weather visualization is presented, using four attributes with their respective metrics, the objective is to generate a brief usability report. The used attributes are: Size of the components (1.4.8), Help on buttons' use (2.1.1), Navigability between available functions (6.3.1) and Results waiting time (6.3.2).

To apply the metric associated with the Size of the components (1.4.8), it is necessary to know the number of components, or elements in the interface, with an appropriate size and the total number of components in general. There are 10 components with an appropriate size and 20 components in total. When calculating the metric obtained is of 0.5

Regarding the Help on buttons' use (2.1.1), there is a total of 2 buttons that are associated with a description of the actions performed and 8 buttons available in the application. When calculating the metric, a value of 0.25 is obtained.

Also, when using the Navigability between available functions (6.3.1) attribute, the metric is calculated by using a Likert scale with a range of 0 to 1 to indicate the level of conformity in the available navigation method. Here, 0 is the lowest level and 1 the highest to indicate the level of compliance in the available navigation method. The value obtained is 0.8.

For the Results waiting time (6.3.2), it is perceived that when applying for the weather of a city, the application takes 3 seconds to display the result, for which a value of 0.4 is assigned.

With the results obtained, a usability report can be prepared. Table 7 shows a summary of the before mentioned report together with the attributes, results and degree of the usability issue.

Table 7. Summary of Usability Report

Attribute	Metric Value	Usability Issue
1.4.8 Size of the components	0.5	Medium
2.1.1 Help on buttons' use	0.25	Major
6.2.1 Navigability between available functions	0.8	Minor
6.3.2 Results waiting time	0.4	Medium

As seen in the results report, attribute 6.3.1 has a minor usability problem because it has an adequate inter-function navigability. Attributes 1.4.8 and 6.3.2 present a medium usability problem because, in the first instance, there are large components that occupy an area too large of the screen and, second, the response time is relatively slow. The biggest usability problem is presented by attribute 2.1.1 because there are few buttons with information about their actions compared to the number of buttons that are used in the application, which can cause the user's lack of knowledge about what should and can be done.

5 Conclusions and Future Work

This paper has presented an Application Usability Model for IDTV, which can be used to evaluate the usability of the applications that are deployed on TV. The model in question breaks down the usability characteristics proposed in the ISO / IEC 25010 standard into sub-characteristics and, at the same time, said sub-characteristics into attributes. It has also been defined a set of metrics associated with each attribute in order to quantify them and therefore be able to identify usability problems, whether these are major, medium, minor or none. The model is complemented with the satisfaction characteristic present in the quality of use of the product, which also considers the means of interaction with the application.

All the characteristics, sub-characteristics, attributes and metrics suggested in the Application Usability Model for IDTV refer to important elements that must be considered in applications of this field to achieve both an adequate product usability and a good quality in use.

As future work, it has been considered the design and develop of a method of evaluation of usability of applications for IDTV in which the process necessary to carry out

this evolution is detailed and, at the same time, give guidelines of how the evaluators should apply the Application Usability Model for IDTV, both from the perspective of the developer or of the buyer.

6. References

[1] L. Loyola Arroyo, «Tecnologías de transmisión y recepción,» de *Televisión digital al alcance de todos*, España, Bubok Publishing, 2011, pp. 39-64.

[2] F. Fernández y S. Goldenberg, *Aplicaciones interactivas para la televisión digital en Chile,* 2008, p. 12.

[3] M. F. Miranda, S. I. Casas y C. A. Marcos, *Línea de Producto de Software para aplicaciones de TVDi basado en patrones de diseño,* Río Gallegos, 2015.

[4] ISO25000, «ISO/IEC 25010,» 2017. [En línea]. Available: http://iso25000.com/index.php/normas-iso-25000/iso-25010. [Último acceso: 2 Julio 2017].

[5] «The ISO 9126 Standard,» Issco, [En línea]. Available: http://www.issco.unige.ch/en/research/projects/ewg96/node13.html. [Último acceso: 4 Julio 2017].

[6] ISO, «International Standard ISO/IEC 9241,» de *International Organization for Standardization, Ergonomic requirements for office work with visual display terminals*, 2012.

[7] A. Solano, C. Collazos y J. Arciniegas, «Evaluando la Usabilidad de Aplicaciones de Televisión Digital Interactiva desde una Perspectiva Colaborativa,» 2012.

[8] A. Solano, G. Chanchí, C. Collazos, J. Arciniegas y C. Rusu, Directrices para el diseño de aplicaciones, Bogotá, 2014.

[9] M. Azuma, ISO/IEC FCD 25010: Systems and software engineering – Software product Quality Requirements and Evaluation (SQuaRE) – Quality models for software product quality and system quality in use., Tokyo, 2009.