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Research Paper

Usability testing on game interface design using video-based behavior analysis

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Abstract

The objective of this study is to quantitatively incorporate user observation into usability evaluation of game interface design. In this study, an experiment was conducted to monitor and record users' behavior using built in video-cam. The experiment was done after the user play "A Garuda" game. All the character movement controlled by user were captured and recorded for comparative analysis. There were about 20 people involved as a subject for this experiment. The data from video recordings were coded with Noldus Observer XT in order to find usage patterns and thus to gather quantitative data for analyzing the GUI effectiveness, efficiency and satisfaction. The result of user's interaction towards the design of game's GUI able to give additional information for the game designer to develop a better responsive game toward its usability. The effect of user's control and emotion that can be seen from user's face will give the information needed to be considered in game development. Previous studies mostly focusing on evaluating the usability with performance measures by only looking at task results. Thus, at the end of this study, a method is proposed by incorporating user observation into usability evaluation of game design interfaces.

Keywords: *Game design; Usability; User-observation.*

1. Introduction

Usability is usually understood as a tool for examining User Interface from various perspectives. The usability has been widely used in various level of understanding. One of it is to associate the usability with it efficiency and its effectiveness to the interface. This view was accepted as a theoretical basis for the field of human-computer interaction.

Many studies on the usability focusing on interface design [1]. The study by [2] for example states that "the difference between the effectiveness of interface and usability is not clear."

Usability has some attributes of its own. The ISO [3] defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." While in [4] shows that usability has five attributes: learnability, efficiency, memorability, error rates are low or easy error recovery and satisfaction. In [5] share the same perspective where usability is correct in terms of functionality, efficient to use, easy to learn and remember, error tolerance and subjective matter is made. In addition, in [6] underlines that usability has four factors: usefulness, effectiveness (ease of use), learnability and likeability attitude. This contrasts with [7] which classifies usability into early performance, long-term performance, learnability, retainability, the use of advanced features, the first impression and long-term user satisfaction. Moreover, researchers referred to as a guide in this study is [8]. He underline three criteria; effectiveness, efficiency and satisfaction with the interface application in research.

However, in [9] said that usability is the "extent to which users can successfully learn and use the product to achieve 'a reference to researchers in their research focus in this area".

Usability study conducted may have an impact on research. This is supported by Jeng1who has studied the relationship of interface design with its product acceptance. He himself had stated that the impact of the interface usability study toward the related industry is very large. This is due to the fact that consumer acceptance of a product depends on the usability of the product itself. Based on these facts, this study is based on three construct of the usability aspects. The constructs are based on effectiveness, efficiency and user satisfaction towards the interface design of the computer game produced.

Similar approach also been taken by some of these researcher which are [10-11]. Thus, the basis of this study has taken into account usability aspects as part of the method of determining the suitability of the design characteristics of the game's interface has been selected.

2. User observation tools

There are a variety of techniques for usability evaluation including in-depth interviews, think-aloud protocols, scenario building, cognitive walkthrough, heuristic evaluation and surveys [11-12]. However, in conventional methods such as usability testing and surveys, users often do not speak well or express fully. Thus, user observation is necessary for eliciting the detailed information needed.

Referring to the experience of the players during interacting with the game, in [13] uses streaming video to get data for the effectiveness and application efficiency domain tested.

In [14] categorized user observation techniques into 2 types: first-person and third-person observations. Behavior is self-recorded in first-person observation, while it is recorded from an outside posi-

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tion in third-person observation. Since first-person observation gives understanding in a user's point of view while third-person observation shows related environmental factors, both views need to be considered.
In our experiments, Noldus Observer XT, a video coding software was used to process the video recordings and to gather quantitative data.

3. Development metrics

Attributes and factors of usability have been defined in various ways by existing standards and models. Most of them include common attributes for defining usability: effectiveness, efficiency and satisfaction. Definitions for the three factors are described in Table 1.
Studies have focused on developing methodologies and measurements for evaluating usability in terms of effectiveness, efficiency and satisfaction. Quantitative metrics are necessary in order to analyse data more objectively. This study developed metrics for each factor, while also adopting relevant measures. The metrics for effectiveness and efficiency as shown in Table 2 and 3 respectively were developed to produce results based on data from monitoring finger and eye movements. For satisfaction, relevant subjective criteria were organized for questionnaire as shown in Table 4.

Table 1: Factors of usability (ISO 9241-11, 1998)

Factor	Definition
Effectiveness	The accuracy and completeness with which users achieve goals
Efficiency	The resources expended in relation to the accuracy and completeness with which users achieve goals
Satisfaction	The freedom from discomfort and positive attitudes towards the user of the system

Table 2: Metrics for evaluation of effectiveness

Metric	Description
Task completion rate	Ratio of tasks correctly completed in the allotted time
Error frequency	Total number or errors made in task completion
Spatial accuracy	Ratio of correct, on-target fixations to total

Table 3: Metrics for evaluation of efficiency

Metric	Description
Task completion time	Total time to task completion
Deviation from optimal	Number of extra actions taken
Number of fixations	Total number of fixations
Scanpath length	Total length of scanpath

Table 4: Metrics for evaluation of satisfaction

Metric	Description
Task completion time	Total time to task completion
Deviation from optimal	Number of extra actions taken
Number of fixations	Total number of fixations
Scanpath length	Total length of scanpath

4. Experimental design

An experiment was conducted for usability evaluation of game design based on user observation. Twenty people (8 males and 12 females) participated by playing the given game. While the subjects playing the games, the video recorder will record their faces along with the game interface they are playing without them being aware. Whether they lose or win in the game, the recording will be taken into account from the game until the game ends.

According to [15], the use of video recording automatically by the computer has indirectly been able to record every game interface design space played by the user in real time without disturbing their focus while playing the game.
This video recording technique was used by some researchers such as [16-18], while the use of screen footage is intended to see the exploration or exploration activities of users used by researchers such as [19-20].

4.1. Device and tools

There are three basic things were used in this study; 1) laptop / PC equipped with camera, 2) "A Garuda" game and also 3) screen recorder software. The camera used will be connected directly to the screen recorder software to record the player's face and also record the game interface screen. Screen recorder software used in this study is Lotus Screen Cam 8.
The features available in Lotus Screen Cam 8 software enable computer screen recording and video recording simultaneously. This recording will be stored in a video file containing both the recording. While using this computer game interface design, the video recording display will be minimized so that the recording of the video will not be seen on the screen.
Video recording and game interface screenshots are shown in Figure 1. The game's interlayer screen recording will see the movement of game characters controlled by the subject. Each movement and character activity will be reflected on the video recording.



Fig. 1: Example of an image with acceptable resolution

In this study, all the subjects will be given a prototype of the game that has been developed specifically for this purpose. As users interact with the games, video recording and screen recording software are pre-installed before the user starts the game. This is due to the overall recording required to facilitate the process of analysing user activity. The use of Lotus Screen Cam 8 software that can record both types of recording makes it easy to make the recording.
After the recording process is done, the process of analyzing the data will be executed. The process of analyzing this is done using The Observer XT version 9.0 software where the recording will be played back from the beginning of the recording until the user finishes their game. From this moment, face-to-face user interface will be researched and matched with facial express database introduced by [21]. Every emotional impression that can be detected from facial expressions will be highlighted in the software according to the category of emotional effects. The same process will be performed on every video recording that has been recorded on another user.
After all the video recordings were analysed, the determination of the mean value and standard deviation is used to determine the emotional impact with the results of the user interaction interface design used in the game.

4.2. Gathering data

Video recordings were coded into quantitative data using Noldus Observer XT, a software for accurate analysis of observational data. Each subject-controlled character controlled activity will be marked in the Observer software through the recorded video, which will then be analyzed. The recording is a manifestation recorded along with a corresponding time dimension and description on behavioral characteristics.

5. Results and discussion

5.1. Description of game character control and user facial expression

Based on Figure 1 shown, shows how both footage is screen recording and user face recording is obtained in one video view for analysis purposes using The Observer. Each character movement will be marked to see how often users control game activity based on the checklist that has been set up

5.2. Result

Data regarding the usability evaluation of the game interface design is obtained through a video file containing screen recording and recording of the user's face expression during play. In addition, the data log file of every user recorded by the computer using The Observer XT software is also used to support the findings obtained through screen recording and video recording of user face-to-face analysis. To get relevant usability assessments, all users involved in this study analyzed the data. Based on that data source, the usability rating used by the user when using the game interface design is based on the following three factors:

i. Effectiveness factor
ii. Efficiency factor
iii. Satisfaction factor

Table 5: The frequency distribution of activity for the evaluation of effectiveness

Metrics	%	
	Male	Female
Task completion rates	65.39	67.56
Provision area	71.06	79.89

Table 6: The frequency distribution of activity for the evaluation of effectiveness

Metrics	%	
	Male	Female
Task completion (number of successful)	4	3
Deviation from optimal		
a. Press button"RUN"	4	30
b. Meet a enemies	86	60
Scanpath length (average)	15:32:40	18:02:34

Table 7: The frequency distribution of activity for the evaluation of efficiency

Metrics	%	
	Male	Female
Error frequency		
a. Press a choice button	28.94	20.11
b. Follow a wrong path	34.61	32.44

Table 8: The frequency distribution of activity for the evaluation of satisfaction

Metrics	%	
	Male	Female
Sense of control	102	54
Perception of interaction	154	83
Physical Discomfort	182	73
Enjoyableness	156	69

Table 9: The frequency distribution of activity for the evaluation of satisfaction

Metrics	%	
	Male	Female
Total	88	93

Based on Table 5, it is found that the rate of job settlement rate for female users is slightly higher than that of male users. In terms of space accuracy metrics - female users also show a slightly higher percentage of frequency than male users. Whereas in terms of metrics of frequent mistakes made by users, male users often do two things that often include pressing the selected option while fighting and following the wrong path during exploration.

From the analysis of data made in Table 6 and 7, it can be concluded that most of users, especially female consumers, prefer to press the "RUN" button which means to avoid risking losing the game while fighting against the enemy. The frequency of pushing this button is done thus forming a pattern where female users will try to play in a safe state without risking it. This is in contrast to male players, though on average they can spend the game successfully within a short period of time, but the frequency of escaping from taking the risk of losing is very little. In terms of task completion metrics that have successfully completed the game by achieving the goal, the number of successful male users is more than female users.

The analysis results from Table 8 and 9, can be summarized that more male users show satisfaction elements in terms of usability, interaction perceptions and excitement. Even from the physical discomfort criteria, male users also show the frequency of play compared to female users.

6. Conclusion

In the experiment, user behavior was closely monitored by recording user interaction with the generated game interface. By coding the video data, quantitative analysis was conducted to evaluate usability with metrics developed.

A comparative evaluation showed that the resulting game interface design can be seen from the effective, efficient and satisfactory angle of user interacting with it. With that a game designer can take this initiative to understand the needs of target users in designing their game interface later.

This study proposed a method for incorporating user observation into usability evaluation of game design interfaces. It can be expected that the method of quantitative analysis based on user observation can contribute by suggesting a way for comprehensive evaluation of usability.

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