

Usability Analysis in Gesture Operation of Interactive E-Books on Mobile Devices

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Abstract. This paper analyses usability of interface including gesture operation and interaction in HCI (human-computer interaction). We explore the common gestures which are used to read e-books, and summarize the mode of operation of these gestures. This analysis bases on the five indicators that are proposed by Nielsen in 1993 to assess user interface of the interaction e-book. It discusses the interface of e-books that experts read and places emphasis on key points for visibility, button design and operation mode of multimedia button. Heuristic evaluation was adopted to study the gestures operation in reading e-book modes based on mobile devices. The study concludes that operation mode, perception & feedback design, and user's behavior are important interactions mode for interface design on mobile devices. The paper offers interaction design principles for development and improvement of the interactive e-book.

Keywords: Interactive e-Book, Gesture Operation, Usability Analysis, Mobile Device.

1 Introduction

The advance in electronic technology leads the trend and the mode of digital learning. Due to the development of internet the publishing industry experiences the power of digital knowledge transmitted over the network. They saw the limitations of traditional publishing, and realized e-book as the trend of modern learning. Approximately 5.9 million U.S. adults own an eReader according to the latest data from GfK MRI--up from 2.1 million owners in the March-October period of 2009 when GfK MRI first began asking consumers about their usage of devices like the Amazon Kindle and SONY Reader. In the period of survey of March-October 2010, 49% of eReader owners were male and 51% were women. According to the survey, currently 55% of eReader owners have annual household incomes in excess of USD\$100,000[1].

Since mobile devices of which production owes to new media and new technology are endowed with the advantage of flexibility, and since user behavior has changed, touch screen is widely used on mobile devices, such as iPhone, iPad and HTC. These mobile devices use multi-touch control methods for intuitive operations, such as drag and zoom, which promote the trend of e-books, and built-in auto-rotation, intelligent sensing and other new technologies.

This study discussed the mode of gesture operation used to read e-books on mobile devices, sorted out the gestures common operations on the touch screen to read e-books by the literature, analyzed the relation between the user's perception and touch screen user interface design to find out the relationship between efficiency and error rate.

The purposes of this study are as follows:

1. To explore the common gesture which has been used to read e-books, and to summarize the mode of operation commonly used gestures.
2. To analyzed the relationship between sensors on mobile devices and interactive books.
3. To summarize the principles of interactive design interaction for the e-books on mobile devices.
4. To assess the interaction e-book user interface according to five indicators, proposed by Nielsen in 1993[2].
5. To propose features and differentiate services that the e-books on mobile devices may have.

2 Literature Review

2.1 A Study of Present E-Book

The e-book is a new information technology product that facilitates reading and acquisition of information. It is a written work readable on the screen of a PC, a PDA (personal digital assistant), or a reader specifically designed for the purpose. It provides the same meaning as a conventional paper book (C-book) which can stores and communicate knowledge through reading. On the positive aspect, an E-book is superior to a C-book from diverse perspectives such as storage, transfer, delivery, and accessibility[3]. Recently, many types of e-book readers (see Table.1) have been developed for iPad device as (Fig.1):



Fig. 1. Types of e-books

iBooks. The iBooks app is free download form app store. Readers can select and download the e-book to their libraries, or import PDF files to the iBooks. Readers can use gesture operation to move from page to page on the e-book. Additionally, readers can also select and include interactive page ctrl option, which let readers drag a page corner to turn the page[4].

WIRED. WIRED has approved the app as an interactive digital edition of the magazine. The WIRED app is available from the iPad app store. Every page in the issue is individually designed for optimal viewing on the iPad screen in both portrait or landscape orientation. It is an electronic document that supports a variety of interactive function on the touch screen. Readers can open a new page or change dynamic mode by selecting a button on the e-book. Readers can also use the action buttons to get multimedia content[5].

Atomic Antelope. Alice for the iPad by Atomic Antelope is an interesting book which includes game, sensor, illustration and story book. By providing some of breathtaking animated scenes, it revolutionizes the Lewis Carroll classic. Pictures that move and animate as you tilt the device. The interactive e-books were entertaining kids on car journey[6].

Table 1. Elements of visual analysis on e-books

Sample	Description	Element
iBooks	The iBooks content which is the most important thing is word and the second one is picture. The iBooks App provides basic function (e.g., scale, label...) to read.	Word/ Picture
WIRED	The WIRED magazine combined with a variety of multimedia elements (e.g., video, audio, VR).	Word/ Picture Video/Audio 360° VR Button
Atomic Antelope	The Alice for the iPad which was sensor and multi-touch features to create interesting interactive situation.	Word /Picture illustration animation

2.2 Interaction Mode Gesture Operation on Mobile Devices

A sensor is typically an electrical or electronic component whose job is to detect changes in the environment. These changes can be any number of things, depending on the type of sensor. The most common types currently used for interactive gestures include pressure, light, proximity, acoustic, tilt, motion and orientation [7].

Currently, most gestural interfaces can be categorized as either touchscreen or free-form. Touchscreen gestural interfaces—or, as some call them, touch user interfaces (TUIs)—require the user to be touching the device directly. For example, these would typically include(Fig.2)[8]:

- 1. Tap: Briefly touch surface with fingertip
- 2. Double tap: Rapidly touch surface twice with fingertip
- 3. Flick: Quickly brush surface with fingertip
- 4. Drag: Move fingertip over surface without losing contact
- 5. Pinch: Touch surface with two fingers and bring them closer together
- 6. Spread: Touch surface with two fingers and move them apart

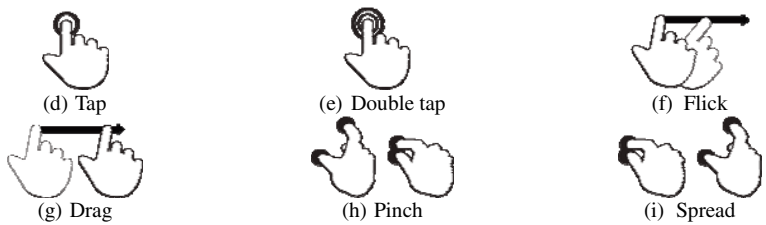


Fig. 2. Gesture operation on touch screen

2.3 Usability Evaluation for Mobile Devices

Nielsen indicates that a variety of methods e.g., Heuristic evaluation, Performance measures, Thinking aloud, Observation, Questionnaires, Interviews, Focus groups, Logging actual use, and User feedback, can be applied for usability evaluation. For the reason of space, it is necessarily simplified, but it still provides a good, quick overview of these methods. It is obvious that these methods are intended to supplement with each other, since they address different parts of the usability engineering lifecycle, and since their advantages and disadvantages can partly make up for each other. It is therefore highly recommended not to rely on a single usability method to the excluding others[2]. Also, Nielsen indicates that the choice of method may be partly dependent on the number of users that are available for usability activities. If very few users are available, emphasis should be placed on heuristic evaluation, thinking aloud, and observation.

There are many possible ways to combine various usability methods; each new project may need a slightly different combination; it depends on its exact characteristics. A combination that is often useful is that of heuristic evaluation and thinking aloud or other forms of user testing. Typically, one would first perform a heuristic evaluation to clean up the interface and remove as many "obvious" usability problems as possible. After a redesign of the interface, it would be subjected to user testing both to check the outcome of the iterative design step and to find remaining usability problems that were not picked up by the heuristic evaluation.

This study analyzes the current situation according to the above e-book, and summarizes the characteristics of interface design should have in Table 2.

Table 2. The characteristics of interface design

Items	Functions	Characteristics
Multimedia buttons	Video control	Striking tool prompt
	Audio control	Intuitive button design
	Pinch and zoom	
	Scroll	
Navigation mode	Story view	Quick page switching mode
	Page switch	Clear navigation map
Content menu	Slide show	Suitable menu prompt
		Appropriate guidance reading

3 Methods

Heuristic evaluation is a discount usability engineering method for quick, cheap, and easy evaluation of a user interface design. Heuristic evaluation is the most popular method of usability inspection. Heuristic evaluation is done as a systematic inspection of a user interface design for usability. The goal of heuristic evaluation is to find the usability problems in the design so that they can be attended to as part of an iterative design process. Heuristic evaluation involves a small set of evaluators that examine the interface and judge its compliance with recognized usability principles (the "heuristics") [9]. Therefore, this study is intended to search the interface usability experts, which have conducted the heuristic evaluation.

3.1 Participants and Tools

Single evaluators found only 35% of the usability problems in the interfaces. However, since different evaluators tend to find different problems, it is possible to achieve substantially better performance by aggregating the evaluations from several evaluators. There is a nice payoff from using more than one evaluator, and it would seem reasonable to recommend the use of about five evaluators, and certainly at least three [2]. Therefore, this study has selected five interface usability experts, such as interface usability, interface design and programming to evaluate interactive interface design for WIRED magazine on the iPad. Finally, researcher was summarized reader gesture in interactive e-book of interface usability principles on mobile devices.

3.2 Procedure

The researchers conclude based on the literature of interactive e-books should have the interface design features: multimedia buttons, navigation mode, content menu. First, listed the main page of interactive design on WIRED magazine, and then according to Nielsen in 1993 proposed the principle of the five criteria (learnability, efficiency, memorability, errors, satisfaction), the last question of usability. The steps were stated as follows:

1. Inviting five experts evaluation of WIRED Magazine.
2. Explaining the process of heuristic evaluation.
3. Sending to the expert evaluation questions of WIRED Magazine.
4. Conducting for each expert evaluation of 1-2 hours.
5. Communicating comments with each other, and concluding them in the discovery of interface usability.
6. Integrating evaluation results and recommendations.

3.3 Usability Evaluation

Fig.3 shows the common page when user read the WIRED magazine on the iPad. Expert evaluation might take about 1-2 hours. The researcher completely recorded the operating gestures and error rate of interface usability problems in the interactive e-book. Finally, we arranged the production features for the e-books on the iPad.

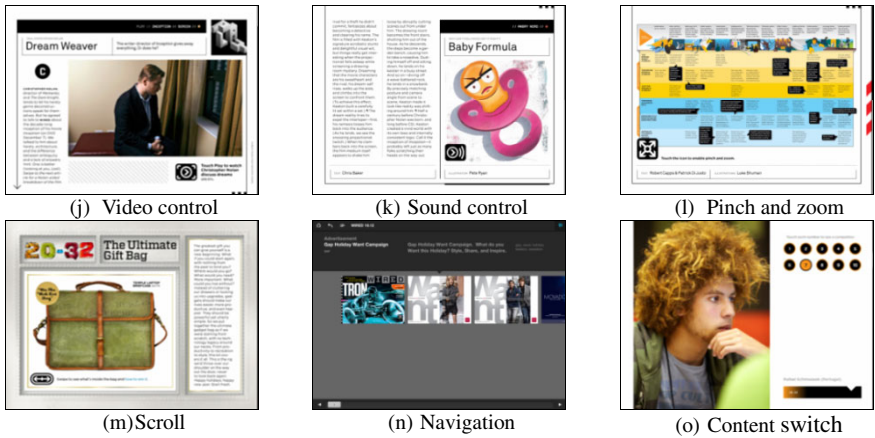


Fig. 3. Features of WIRED magazine's interface design

Focus on recording and analysis:

1. Analyzing the advantages and disadvantages of WIRED magazine interface?
2. Collecting common gesture used to read e-books, in addition to the above mentioned documents outside of basic gestures, what?
3. Using five criteria which were proposed by Nielsen in 1993 as an index to evaluate WIRED magazine's user interface.
4. Analyzing the relevance between sensors of existing mobile devices, and interaction e-books.
5. Archiving interactive design principles of interactive e-books of mobile device.

4 Research Results and Discussion

4.1 Results of Heuristic Evaluation

We organized practical user evaluations within the setup of a heuristic evaluation by experts. Five experts (four males and one female) were invited. All of these experts have experience in multi-touch panel and three of them are regular users of iPad. This study investigates the background of these experts (Table 3) and usability of interface design and operation mode on WIRED magazine.

Table 3. Background information of the subjects

participant number	1	2	3	4	5	Average
Sex	M	M	F	M	M	4M, 1F
Age	32	27	30	33	32	30.8
Years of work experience	2	1	4	7	5	3.8
Experience with e-books	Y	Y	Y	Y	Y	5Y
Experience with multi-touch panel	Y	Y	Y	Y	Y	5Y
Experience with iPad	Y	Y	Y	N	N	3Y, 2N

These heuristics were given to five experts to evaluate WIRED magazine on iPad independently. The researchers recorded all the operating gestures and problems of interface usability that came forth in the evaluation.

Table 4 shows the evaluation results of expert reading e-books on three aspects: key points for visibility, button design and operation mode of multimedia button.

Table 4. Key points of heuristic evaluation results

Function	Icon	Gesture	Visibility	Button design	Operation mode
Video control		Tab	Passably visible, but easily be taken as background	Simple. recommended to animate button	Easy to operate
Audio control		Tab	Easily overlooked	Easy to be confused with the video control	Simple operation. Advisable to show time line.
Pinch and zoom		Tab, Pinch, Spread	Prompt was not clear	Image design disagreed with the user cognitive	Zoom could not be as free as photo operation
Scroll		Flick, Drag	Easily overlooked	Image design easy to cause misunderstanding	Simple operation, but prompt was not clear

Summaries of the key aspects of each evaluation paradigm for the following issues:

1. Multimedia buttons: WIRED magazine contained a lot of multimedia elements. User could start button when he wanted to read more contents. Multimedia buttons were easy and quick operation, the most common gestures were tap and double tap.
 - Visibility: Content of the WIRED magazine's video could passably be identified, but some of the control buttons are not obvious.
 - Button design: Video control button is easy to be confused with the audio control buttons, pinch and zoom button disagreed with the user's cognitive. Button design recommends animated buttons in order to attract user's attention.
 - Operation mode: It takes time for beginner to become familiar with the touch screen. It is propose to show time line and provide functionality for adjusting volume while sound is played. Using pinch & spread could scale image, but not as free as in and out photos zoom. Images drag button could not express operation mode clearly, it is proposed to use tap and prompt with the direction of arrow.
2. Navigation mode: Navigation interface of WIRED magazine could be quickly and easily used. But for beginner it needed time to find the navigation, and the icon design was not easy to understand. The navigation scroll underneath the screen facilitated quick access to the designated page, but there was the problem of turning too many pages. The commonest gesture for turning pages was flick.
3. Content menu: The function was simple and easy to operate, the common gesture for switching content was tap, but the color on the design of the menu was inconsistent, because some were number buttons, and others were image buttons, so it requires care to look out for. In addition, users jumped easily to other pages by touching out of mistake, and found it difficult to recover.

Some of the features that could be improved include: learnability, efficiency, memorability, errors, satisfaction. It should be taken note that issues were ranked in ascending priority: low, medium, and high. Table 5 shows improvements and recommendation suggested by experts.

Table 5. Recommended improvement of the result of heuristic evaluation

NO	Issue Priority	Issue	Recommendation
1	Medium	For the first time young men could quickly get started, but older men without the guidance found it difficult.	Advisable to add help pages or guidelines that enable users a quick start.
2	High	The image button was easy to be confused with the content, and difficult to be identified.	Provide unified image button and create animate button for highlighting.
3	Medium	Magazine with thematic modes, among which some flipped left or right and the other flipped up or down. This causes confusion.	Provide choice by addition of two-page mode.
4	Low	Contents could be adjusted vertically or horizontally to read with sensor, but some media would not display in certain type.	Several tests are needed to confirm that the e-book can play and read in both vertical and horizontal type.
5	High	Attention is not easily drawn to navigation buttons.	Navigation buttons should be made more prominent.
6	High	If user had never used it, he did not know how to use the image zoom	Addition of help pages to guide the user for a quick start.
7	Low	It was difficult to restore images when they had been enlarged and causing the turn page unsmooth.	Addition of undo key for quick undo.
8	Medium	Not all images and content could use the zoom function.	All images should contain as much as possible the facility of zoom function.
9	High	Articles with different lengths and mixed with ads are not provided with clear prompt in reading. It is easy to make mistake for searching reading page.	Ads and article should be clearly marked so that user could make choices.
10	Medium	It is easy to lose the position while browsing content.	Addition of chapters page.
11	Low	Fonts too small, not easily readable for everyone.	Provide possibility of changing fonts. Font colors should be made distinct from the background color.

4.2 Satisfaction Survey Results

This study investigated the expert's usability of interface design and operation mode on WIRED magazine. Table 6 show results of usability satisfaction.

Table 6. Results of usability satisfaction

Question	Very unsatisfied	Unsatisfied	Neutral	Satisfied	Very Satisfied
Learnability			1	4	
Efficiency		1		4	
Memorability		1		2	2
Errors		2	3		
Satisfaction		1		4	

The results showed that experts felt satisfied with the learnability, efficiency, memorability, errors and satisfaction of the using of WIRED magazine. WIRED magazine classified content and advertising separately, but the classification was not clear leading difficulty in reading and in the usage of interface. Therefore, e-book should contain clear illustrations to guide readers. It should provide some interactive information to give readers a sense of participation and rich content for reading. The study concludes interaction design principle of interactive e-books for mobile devices as follows:

1. Easy usage
2. Guided reading
3. Clear illustrations
4. Interactive mode
5. Sense of participation

5 Conclusion

This study provides usability of reading e-books for mobile devices. These heuristics were given to five experts who have evaluated WIRED magazine on iPad independently. We compiled their comments and discussed with them about their findings in a meeting and obtained suggestions from them on strategies for addressing problems. The following are some important points of their findings:

1. Learnability: Help pages or clear guidelines should be added for a quick start for beginner.
2. Efficiency: Navigation buttons should be made more prominent for easy usage and more satisfaction of user.
3. Memorability: Gestures commonly used for the touch-screen should be found out for simple usage to read e-book for WIRED magazine.
4. Errors: More tests are needed to confirm readability in vertical and horizontal type.
5. Satisfaction: Ads and article should be marked clearly for easy choices of user.

The study concludes that operation mode, perception & feedback design, and user's behavior are important interaction mode for interface design on mobile devices. This study has shown the interaction design principles (easy usage, guided reading, clear illustrations, interactive mode and sense of participation) for development and improvement of the interactive e-book.

1. Operation mode: Addition of multi-function sensors (e.g., pressure, light, proximity, acoustic, tilt, motion, orientation) in order to design the service interface
2. Perception & feedback design: High visibility of button to guide user, and give real time feedback to enable usability satisfaction.
3. User's behavior: Tap, double tap, flick, and drag were common gesture for reading e-books, and intuitive gestures could improve user satisfaction. Pinch and spread gestures should be added to complete instructions so that users could quickly get started.

This heuristic evaluation which involves a small set of evaluators to examine the interface is in accord with Nielsen's suggestion. We have to acknowledge the limitations with a sample size of five in this study. In order to achieve a higher validity we hope to have a larger survey sample for the future research.

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