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Using Zooming Applications for Mobile Devices

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1. Introduction

Although mobile devices, cellular phones, Personal Digital Assistants (PDAs) and other handheld devices have hardware constraints such as small screen, small storage, low CPU speed, and low resolution, their popularity has been enormously increasing. This is enhancing the opportunities for researchers to overcome those open problems caused of small size hardware constraints. However, still the biggest difficulty is that these devices are too difficult to load today's visual information because most current information is based on a large visual documentation. How do we present information effectively on mobile devices? This is a main challenge for mobile interface developers since viewing is becoming more and more crucial point in our daily lives.

One of the methods is to build a Zoomable User Interfaces (ZUIs) by using several zooming tools so that the amount of information, which needs to be handled by users, can be shown on a small screen unlimitedly. Smooth zooming technology helps users to interact with their sense of the focus-and-context by shifting the cognitive load to the human visual system, and it can provide a possible solution that satisfies the above demands by means of increasing the effectiveness for using the small screen. Thus supporting zooming tools on mobile devices is a necessary item with enabling users to effectively control the zooming methods.

The goal of this paper is to increase the performance of user interfaces by developing zooming tools on mobile devices. Three zooming approaches will be introduced in this paper. First, focus zooming tools, which consists of the magnifying glass that was introduced from a "Bifocal Display" (Apperley, Tzavaras, and Spence, 1982), the gray scaling and blurring lens that was introduced from a "Focus+Context Visualization" (Giller, Tscheligim, Schrammel, Fröhlich, and Rabl, 2001), will be proposed. Second, file zooming tools including zoom-in and zoom-out functions to enlarge or reduce data and images based on the geometric zooming technology will be proposed. Finally, search zooming tools, which have two functions support a popup zooming and a shadow zooming functions to assist user easy to control for seeing many files on the device, will be introduced. Furthermore, the paper addresses a new usability testing method which combines heuristic, scenarios, and questionnaire approaches in order to effectively take experimental results from users. Its testing methods and procedures will be introduced by conducting usability test with user.

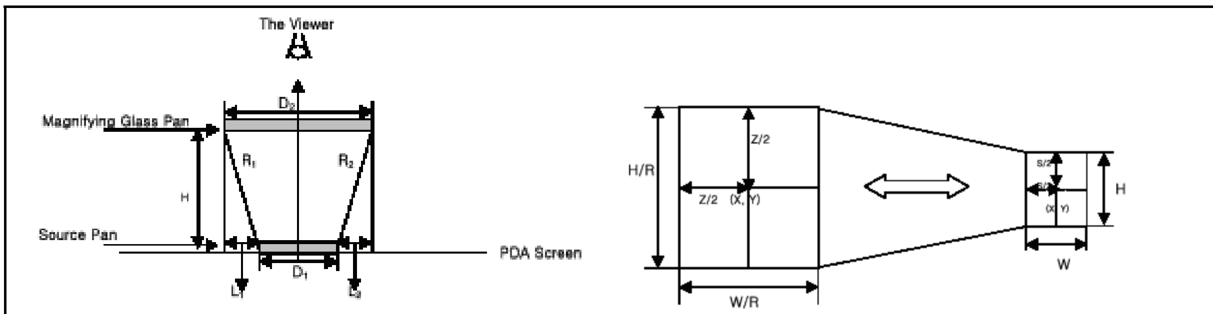
In this paper, we first describe the basic zooming technique and prototype on a PDA in section 2. In section 3, we introduce a new mobile usability testing method, and conduct usability testing and show the results in section 4. Finally, we conclude by describing some of our experiences in building the system and outlining future work.

2. Basic Zooming Structure

In this section, we discuss the theoretical background for basic zooming techniques on mobile devices, and mention the necessary concept needed to support our approaches.

2.1 Magnifying Process

The magnifying processes transfer pixels from a specified source pan to a specified destination pan, which is the magnifying glass, altering the pixels according to the selected raster operation code. To magnify data, a source pan containing source data on the original screen is smaller than the magnifying glass pan, as seen in Figure 1 (a). Thus, the ratio to magnify data will be decided by comparing the size of two pans, a source pan and a magnifying glass pan.



D_1: The size of source pan, $(x_1 \times y_1)$
D_2: The size of the magnifying glass pan, $(x_2 \times y_2)$
R_1, R_2: Magnifying ratio
L_1, L_2: Data loss area
H: Height

(a) Magnifying process (b) Zoom-in and zoom-out process

Fig. 1. Zooming process on a PDA screen

A degree of interest (DOI) function map which was introduced by Furnas (Furnas, 1986) indicates the level of interest in the item and it can be used to control how available space is allocated amongst items. The DOI concept has been changed over time according to the change of user interaction such as searching process and the moving focus. So, instead of using DOI, we suggest another approach to calculate how much data is magnified and how much data is lost.

In the magnifying glass, the technique allows user to determine the glass size and magnifying ratio based on the varying interest levels of parts. To calculate the magnifying ratio, we can use three factors: the source pan *(D_1)* that is based on the original source data; the data loss *(L_1+L_2)* that is an obscured region due to the big magnifying glass; and finally, the destination pan *(D_2)* that is the target window for copied the source data. Thus, the magnifying ratio depends on the size of each pan and data loss

2.2 Zooming Process

Zooming processes are copying bitmaps from the source rectangle and transferring them into a destination rectangle by stretching or compressing the size of bitmaps to fit the dimensions of the destination rectangle, if necessary. By the zooming size, *S*, and the zooming ratio, $R=\{0<\ldots\leq 1\}$, defined by the user, we are able to reduce the size by transforming a bitmap image into the zooming size. The PDA screen address, $P=(X, Y, Z)$, has both a location and a scale defined by the rectangle size, $Z=(S/R)$, is defined by the linear transformation, T_p: $(X-(Z/2), Y-(Z/2)) \leftrightarrow (X-(S/2), Y-(S/2))$. A zooming region, $A=[P, W, H]$, is a rectangle defined by an address together with a pixel width and height *(W, H)*, as seen in Figure 1 (b).

The other level of zooming applications is to visibly display windows to the users as a popup or shadow zooming style. Every display window in the popup or shadow zooming applications has a region, $[P_i, W_i, H_i]$ where *i* is window number, which is the portion of the PDA screen, and these windows are located behind the original window by the fingernail-viewing file or the icon-viewing file. In particular, the shadow zooming has another window area, $[P_{i+1}, W_{i+1}, H_{i+1}]$, which is the small magnifying glass to magnify the hidden data instead of showing all data. Here we summarize the properties of zooming methods as follows:

- Visibility window: The visibility range of objects for user.
- Background window: The range of popup or shadow viewing objects which include the source image copied.
- Magnifying window: The glass to magnify data should have a certain range of magnification that allows users to see a small part in which they are interested.

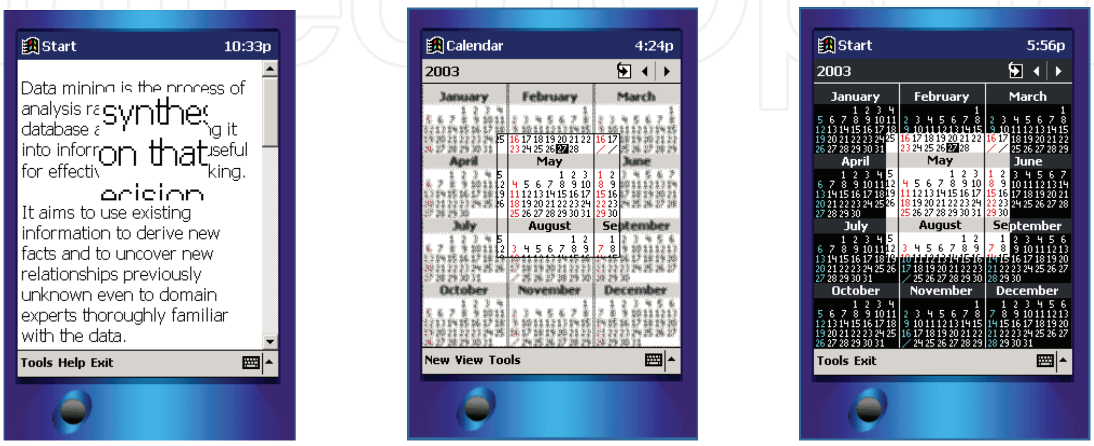
2.3 Basic Structures and Prototypes of Zooming Tools

In this part, we design and implement various zooming tools we mentioned with focusing on their usefulness and extensionality on a PDA, as seen Figures 2 - 5. Those tools were written in embedded Visual C++ supported by Microsoft® and developed on common Pocket PC.

2.3.1 Focus Zooming Tools

We introduce the focus zoom mechanism for increasing users' focusing ability in term of two facts. One is that the human transition is based on focusing on a magnified moving object according to the human perceptual system. The other is that the human eye is used to ignoring blurred objects because the eye also has a limited depth of filed by blurring currently irrelevant objects (Giller, Tscheligim, Schrammel, Fröhlich, and Rabl, 2001). When these tools are moving on the screen, their movements are represented with interactive magnification or the amount of blur, so that the user easily focuses on what is being displayed. These focus zooming tools give users more detail of certain parts of the screen, which is particularly helpful when lots of data is showing on the device.

As seen Figure 2, the focusing glass, (x_n, y_n) rectangle, shows a detailed view as a 2D form, and the other regions remain de-magnified or blurring areas according to the physical position. Cutting, pasting, and blurring various sections of bitmaps in real time will generate this focusing area. Even though the focusing glass does not provide good spatial continuity between regions, it is relatively simple in terms of using and implementation, and also it does not need much of the computational power of system memory. Therefore, focus zooming tools will be a good viewing technique for relatively low memory and mobile devices.



(a) Magnifying glass (b) Blurring lens (c) Gray scaling lens

Fig. 2. Focus zooming tool processes on a PDA

2.3.2 File Zooming Tools

Zooming methods can be categorized by the following presentation techniques: distorted and non-distorted zooming, geometric zooming, and semantic zooming methods (Furnas & Bederson, 1995), (Leung & Apperley, 1999). While the semantic zooming changes the shape or context in which the information is being presented, the geometric zooming has a scale operator to perform a geometric transformation, which can be used to shrink or magnify the size of an image. Each method will be adapted for making an efficient view for a user by considering the characteristics of hardware, software, and necessary environment.

In Figure 3, the file zoom has zoom-in and zoom-out methods in mobile devices based on this geometric method, which allows the user to specify the scale of magnification to increase or decrease the image or display screen. This shrunken file can be saved on the mobile device without changing the original content of the file. To expand its contents, the user touches the icon or the small image. These two viewing methods represent how to save files into a database, and also efficiently retrieve files from the database in mobile devices.

The first method is to save a file as a fingernail view by using a geometric zooming method. The second method, an icon view, uses the semantic method, so a certain icon can cover the small zoom-out file. Both are useful ideas for making user interaction with a database on the mobile device easier by saving screen space, and also providing visual abstractions to the user for what kinds of files are saved on the database. Moreover, the method should be used for memory buttons that are needed in graphic interaction in the small screen interface where the current file and its status can be saved as a small image or an iconic representation (Gheel & Anderson, 1999). Thus, if users desire to access the previous file state or browser, just handling the graphical memory button will bring up the previous file or browser status

(a) Zoom-out process (b) Fingernail viewing files (c) Icon viewing files

Fig. 3. File zooming tool processes on a PDA

2.3.3 Search Zooming Tools

This section introduces the search zoom implementation using a popup and a shadow zooming methods to make another viewing tool of the above zoom-out files. These two viewing tools will be used for searching and retrieving files in a database of mobile devices according to users' preferences.

(a) Popup viewing (b) Shadow viewing (c) Shadow viewing on icons

Fig. 4. Search zooming tool processes on a PDA

As seen in Figure 4 (a), the first method is a popup viewing tool which allows for the touching of the area of the original zoom-out files, and then a bigger zooming window is shown as a popup style. The popup zooming window promptly fades away when the user's attraction is moved to another place. So, the user easily knows what file or data included in the zoom-out file. In Figure 4 (b) and (c), the other method is a shadow viewing tool. When a user has located the point of interest with a small magnifying glass, which is embedded, the magnifying glass reveals the content of the file as a background, like a shadow. If the user touches the area of the file with the magnifying glass, then the embedded background of the

zoom-out file will be shown. The more the magnifying glass moves on the area, the more background image appears. When the user's attention moves to another place, then the zooming promptly fades away.
In this way, the user easily knows what files or data are saved in the original file. Here, we summarized two types of methods as follows:

- Popup Style: This shows the overview file information as a thumbnail image size like a popup menu when a user points to the file location.
- Shadow Style: This shows the overview file information with the magnifying glass, where the magnifying caption views the content of a file.

Both techniques will be potentially powerful tools by saving the searching time to see a full text or image in the mobile device database. We expect that great research efforts should be focused on exploring the application for searching methods and building databases with these applications on mobile devices

3. Key Components for Usability Test on Mobile Devices

In this section, we discuss a usability testing method we designed, and discuss how to build the testing plan for mobile devices.

1. Preparing Guidelines: In doing mobile application evaluation, well-defined guidelines enable the developers to easily assist participants for operating tools when they have problems caused by unstable prototypes and limited domain expertise.

Function Level	Given Tasks
Focus Zoom	• Task 1 – Use magnifying lens to see the interesting content of a file • Task 2 – Use blurring lens to see the interesting content of a file
File Zoom	• Task 3 – Use zooming operation on a file • Task 4 – Save a file as Fingernail view by zooming out function • Task 5 – Save a file as Icon view by zooming out function
Search Zoom	• Task 7 – Search a file by using popup viewing on Icon based PDA database • Task 6 – Search a file by using popup viewing on Fingernail based PDA database • Task 8 – Search a file by using shadow viewing on Fingernail based PDA database • Task 9 – Search a file by using shadow viewing on Icon based on PDA database

Table 1. Given tasks to participants for usability test

2. Developing Prototype: To build final tools much faster and much more cheaply in mobile devices, we use a prototype on a PDA. In many cases, using the prototype reduces the likelihood that people have erroneous communications about the product, and increases better understanding of the user interface designed.

3. Making Scenario-Based Tasks: Scenarios describe tasks in a way that takes some of the artificially out of the test such as explaining situations and environments, and also they can have an encapsulated description of an individual user or group using a specific set of computer facilities to achieve a specific outcome under specified circumstances over a certain time interval. Thus, the scenario-based task is a necessary approach for building mobility tasks to simulate certain mobile environments
4. Preparing Presentation: We prepare enough presentation time for introducing each developing function or interface which includes a step-by-step description of how to manipulate functions and complete given tasks. By using a checklist, we prepare detailed examples and steps for inexperienced participants.
5. Conducting Test: In conducting the testing itself on mobile devices, we have a time to interact with the participants without expressing any personal opinions or indicating whether the user is doing well or poorly. Users are interacting physically and emotionally with the prototype.
6. Debriefing Session and Post Testing: After all evaluations have been completed, we should prepare a meeting in which all participants come together to discuss their impressions from the test. This session is conducted primarily in a brainstorming mode and focused on discussions of the major usability problems and general problematic aspects of the design on mobile devices.

4. Experimental Results

4.1 Conduct Usability Test

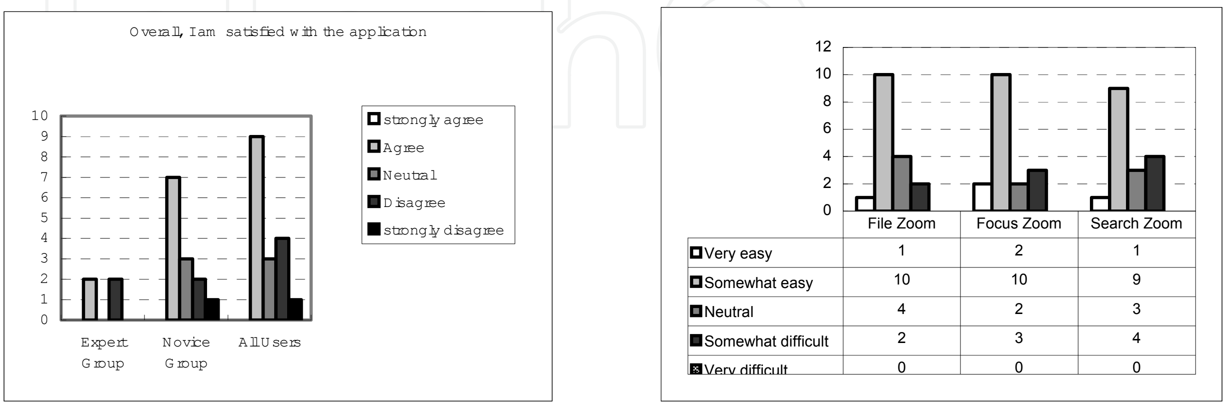
To achieve usability test under mobile environments, we design a combination method prescribed in the previous section, and then conduct usability test for zooming tools using this method (Lee & Grice, 2004), (Johnson, 1998), (Lindroth & Nilsson, 2001). This combined testing method include heuristic evaluation, questionnaires and scenario-based tasks, and it consists of six attributes such as overall impression, success and timing, satisfaction and preferences, feature use and understanding, compatibility and interoperability and functionality.

To conduct the test, we recruited 17 students who were students, and then classified them into two groups based on pre-screening testing results:

- Expert Group: The group members have substantive knowledge regarding mobile devices, and they are familiar with both HCI and usability. Also, they have fundamental knowledge of mobile devices and personal computers. We choose four students from all participants who have a history of operating mobile devices.
- Novice Group: The group members lack substantive knowledge regarding mobile devices, but they are reasonably familiar with HCI and usability. We recruited 13 students who do not have any experience with mobile devices; however they can manipulate personal computers

All testing was conducted in the class lab, and individual users were asked to inspect the prototype alone. After each user tested the prototype and completed given tasks at least two times, the user started to answer questions, which were based on dialogue elements based on heuristic categories. There were nine tasks that included a proper scenario to help users to evaluate the prototype well, as seen Table 1.

We evaluated the users' satisfaction and preference for how the prototype solves physical limitations, provides an easy way to use zooming tools, and supports feedback for increasing users' interaction. Usually we focus on job completion time: rapid, accurate and completeness of task processing for each main task because it is important that the application is working rapidly and accurately as the user request. Generally, all users agree that the application allows for rapid, accurate and complete task processing.



(a) Overall satisfaction (b) Post-test evaluation

Fig. 5. Usability testing result

As seen Figure 5 (a), in testing users' overall satisfaction with the zooming tools, we find that the expert group has split opinions, both agreeing and disagreeing. One reason is based on the expert group's experience, because they may have expected a desktop quality application on a mobile device. However, the actual zooming functions on mobile devices are of much lower quality. A second reason is the choice of sample files, graphics and figures in the test may have highlighted the low quality more than the text files, so we chose non-suitable files for the test. The novice group however is satisfied with this application.

In Figure 5 (b), even though some users disagree with each approach, typically more than 65% of the users are satisfied with each function, the focus zoom, the file zoom, and the search zoom. The preference rates of the focus zoom and the file zoom is bigger than the search zoom method. However, many users answered "neutral" and "somewhat difficult" because of unclear terminology and non-suitable tasks. Therefore, to increase usability, we have to find proper terminology and modify the application according to the results when we redesign the product.

4.2 References and Recommendations

In order to ameliorate the most pressing usability problems with the zooming tool by considering the global problems, we describes each group's preference and recommend future changes for developers as follows:

- Expert User Preferences: Usually, expert users want fast and accurate functions to complete tasks, and they need good feedback from the tool. Also, they want to modify the tools to be more compatible with other tools, and feel the difficulty of handling several functions. Finally, expert users need clearly defined instruction to properly use them.

- Novice User Preferences: Many novice users are satisfied with the tool more than expert users. They think this approach is a very useful tool for solving small devices' problems, however they have great difficulty with the tools' feedback, and they want to easily access and exit each function. They think the tool needs more compatibility working with other programs and exchanging information

Here, we summarize user recommendations for redesigning the product.

1. Reducing many clicking steps: The tools ask users to click the pen several times to operate the menu. This procedure might be awkward for users.
2. Making well-organized menu interfaces and more functions: Preparing useful functions and constructing well-organized menus are critical points to increase usability.
3. Trying to develop other uses of the zooming function: Developers should try to develop other uses of the zooming function and to find kinds of tasks/areas to which it would be useful.
4. Drawing borderline when zooming functions are working on the screen: All zooming windows should have a borderline because users cannot easily recognize which parts are zoomed.

5. Conclusion

This paper has described specialized zooming tools on mobile devices with designing and developing basic geometric and semantic zooming methods in order to increase the usability of the device. Based on three zooming methods, we created new zooming tools for the device by describing the detail prototype and implementation of these applications were introduced in this paper.

However, we have problems because the tools were designed for the PDA simulation program in a desktop computer. So, we do not know how many different results exist between the application program and the real physical device. Especially, in terms of hardware, the current PDA does not have enough pixels, so users could potentially encounter broken characters when the magnifying glass is used.

Although these zooming tools are not substantially implemented in commercial PDAs, it will be used for new interfaces in mobile devices by supporting various zooming functions. We look forward to continuing the research and development of this tool according to the future development of the PDA's hardware performance and elements. Therefore, the biggest contribution of this paper is the creation of zooming tools on PDAs by encouraging the development of practical zooming methods over theoretical methods.

6. References

Apperley, M. D., Tzavaras, I. and Spence, R. (1982). A Bifocal Display Technique for Data Presentation. *In Proceedings of Eurographics '82*, pp. 27-43

Bartram, L., Ho, A., Dill, J. and Henigman, F. (1995). The Continuous Zoom: A Constrained Fisheye Technique for Viewing and Navigating Large Information Spaces. *Proceedings of the 8th annual ACM symposium on User Interface and Software Technology*, pp. 207-215, Pittsburgh PA

Furnas, G. W. (1986). Generalized Fisheye Views. *In Proceedings of ACM SIGCHI '86*, pp. 12-16, ACM Press

Furnas, G. W. and Bederson, B. B. (1995). Space-Scale Diagrams: Understanding Multiscale Interfaces. *In Proceedings of the SIGCHI conference on Human Factors in Computing Systems CHI '95*, pp. 231-241, ACM Press

Gheel, J. and Anderson, T. (1999). Data and Metadata for Finding and Reminding. Proceeding of the 1999 *International Conference on Information Visualization 4th*, pp. 446-451, Washington DC

Giller, V., Tscheligim, M., Schrammel, J., Fröhlich, P. and Rabl, B. (2001). *Experimental Evaluation of Semantic Depth of Field, a Preattentive Method for Focus+Context Visualization.* Technical Paper TR-2001-3, Vienna University of Technology

Johnson, P. (1998). Usability and Mobility; Interactions on the move. *In Proceedings of the First Workshop on Human Computer Interaction with Mobile Devices*

Khella. A. and Bederson, B.B. (2004). *Pocket PhotoMesa: A Zoomable Image Browser for PDAs.* MUM 2004, pp. 19-24, College Park MD

Lee, K. B. and Grice, R. (2004). Developing a New Usability Testing Method for Mobile Devices. IPCC 2004, *IEEE Professional Communication Society*, pp. 115~ 127, Minneapolis MN

Lee, K. B. and Grice, R. (2003). The Embedded Zooming Application for Personal Digital Assistant. IPCC 2003, *IEEE Professional Communication Society*, pp 109-116, Orland FL

Leung, Y. K. and Apperley, M. D. (1999). Readings in Information Visualization Using Vision to Think. *A Review and Taxonomy of Distortion-Oriented Presentation Techniques,* pp. 350-367, Morgan Kaufman Publishers, Inc

Lindroth, T. and Nilsson, S. (2001). Context Usability, *Rigour meets relevance when usability goes mobile*, pp. 24-26, ECIS Doctoral Consortium

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