XEBPER: an E-book using Java 3D API

Hameed, N, Cheah, Yu-N, and Rafie, M.
School of Computer Sciences
Universiti Sains Malaysia
11800 USM Penang, Penang, Malaysia
E-mail: noorul.cod04@yahoo.com

ABSTRACT

E-book visualization is being shown by interpreting book metaphors on computer display devices. It can be expressed with advanced features such as hyper-linking, note-taking, highlights, bookmarks, etc. However, it does not contain enough elements for representation and layout procedures, especially advanced techniques for rendering methods. This paper presents a visual layout using 2D/3D perspectives for e-book personalization and building. Here, our e-book includes personalization structures with 3D modeling using the Java 3D API. This model consists of four main components: structural, processing, layout and stimulus functions. A survey and experimental analysis was carried out to evaluate the e-book personalization feature. It was concluded that XEBPER is more suitable for personalizing and browsing e-book contents.

Keywords: *e-**book, multimedia, interactive 3D graphics modeling, human-computer interface design***

1.0 INTRODUCTION

An e-book represents a printed book in electronic form. While current e-book capitalizes on various multimedia technologies, it does not commonly contain structures or components for developing graphical or visualization elements. Additionally, e-book building is still considered complicated. Generally, an e-book system allows the browsing/rendering of contents according to the document's internal structure, e.g. as in Portable Document Format (PDF), which is internally encoded for structuring the author's contents. Thus, an e-book is commonly browsed page-by-page.

To address these issues, we propose the printed book metaphor-oriented representation structure for designing layout, building the e-book and visualizing the e-book elements. This representation structure is designed as a generic framework called extensible e-book personalization (XEBPER), which is an e-book builder structure [1]. XEBPER consists of seven object layers: package, visual, metaphor, media, content control, device control, and book update objects. With the problems and issues in mind, XEBPER aims to fulfill two main objectives.

1. To represent 3D graphic visualization elements for e-book that is extensible and personalizable.
2. To render and animate e-book with functionalities that allows advanced e-reading.

The paper is organized as follows: Section 2 describes related work on e-book functionalities and features, as well as on e-book modeling, design and rendering for more advanced layout in academic publications. Section 3 describes the builder structure, graphic visualization, and guidelines for the e-book graphic visualization. In Section 4, we propose an e-book model with three perspectives: (1) as internal orientation with XEBPER structure, (2) layout, and (3)

functionalities and features, while Section 5 provides details of our experiments and evaluation of the resulting outputs.

2.0 RELATED WORK

Many graphic-oriented e-book applications such as Adobe Acrobat eBook Reader, Microsoft Reader, and FlipViewer systems were introduced with features to simulate the logical and physical aspects of the original printed book. Logical aspects include the identification of a book hierarchy or abridged material such as chapters, outline, summary and notes. Physical aspects included the physical components of the printed book such as metaphor, portability, and graphic design enhancements.

The design of display technology is a major concern for e-book and/or e-book devices. The page layout on the e-book display corresponds to that of the printed book. A study also suggested that dimensions and weight of recent readers should be the same as the paperback [2]. Many researchers also applied the e-books and technological support for student learning resources such as e-textbook or e-publications in universities [3]. E-books are implemented with powerful media contents such as video, analysis tools, algorithms and simulation experiments [4]. The types of the e-reading devices range from dedicated readers to hybrid computers/readers to smartphones.

In another study [5], many researchers developed guidelines for e-book human-computer interaction such as the following.

1. Human interaction (physical level): The utilization of e-book functions and interactions are described with elements such as customization, visibility and accessibility, readability of screen, accessibility by the disabled, good ergonomics, ability to jump to a specific page, pagination functionalities, and durability.
2. The ability to read and understand the text: The reader (i.e. the human person) obtains the knowledge through e-book functionalities such as inter-textual search-ability, intra-textual browse-ability, ease of navigation and sense of places, header, similarity of print and electronic versions, and inclusion of reference models.
3. The efficiency of e-text: E-book communication is more efficient as it has richer learning objects such as the inclusion of multimedia, support for text-to-speech, links to research data and findings, personalization, inclusion of forms, and connection with bulletin board and chat rooms.
4. Text placements with one or more contexts: Contextual information can be placed on e-books in one or more locations to provide contextual information, and to link to other e-books and e-contents. The information can also be placed on e-bookshelves.
5. The ability to modify and expand the e-text: Readers can update the e-book reading material through annotation and bookmark, printing, cut, copy and paste, and e-updates.
6. Library functions: E-book library features resulted in the increase of readership. This provides the ability to loan, circulate, locate, and delete the e-book, preserve confidentiality of readers, provide a variety of aggregation on usage statistics, and download to software and hardware devices.
7. Legal and contractual functionality: The copyrighted material follows general rules as in printed books. These include the ability to provide fair use of the e-text, and ability to maintain the right of first sale related to the e-text.

Some advanced features are proposed for e-book design such as functionality or usability, as well as on e-book standards and formats, e.g. PDF, HTML or other user-friendly formats [6]. Improvements to e-book design principles such as footnote, modification of contents, replication of e-book, and bibliography that is linked with other documents were also suggested [5]. E-book design issues such as the quality of e-book images with deskew, color correction (white-balancing), cropping, enhancements on color-contrast and text-sharpening, compound document image-compression, search of content with TOC and bookmarks [7] were also highlighted.

In the area for formatting, important issues include those regarding font, color, e-text format, as well as open e-book for multipurpose and library catalogue functions [8]. These relate to e-book standards that should be defined, as well as the need for suitable user-friendly reading software, links between e-book contents, and the need for network access [9]. Another key issue involves e-book interface factors in view that the e-content is rendered by software on desktop PCs, laptops, or PDAs. In the interface, it was noted that features such as bookmarks, progress bar, and use of button controls for turning pages should also be present. Functions and static features of printed-book such as pagination and typographical elements [10] should be maintained as well.

In addition, the use of book metaphor in the e-book features was deemed important [11]. So are virtual reality features and those that enhance readability, interactivity, and scalability. Digital libraries could also be implemented with 3D graphic visualization [12]. As a matter of fact, many 3D e-books are already considered as good as the print book [13, 14, 15] in view of the realistic environment that is provided, i.e. with table of contents, search, e-book metadata/identifier, e-book reader program, front cover, title page, the abridged material and indexes.

3.0 RESEARCH METHOD

The research method involves three steps: (1) XEBPER builder structure and markups, (2) graphic visualization methods (2D/3D modeling), and (3) tool for e-book education. Each step produces an output. Figure 1 presents an overview of the research methodology.

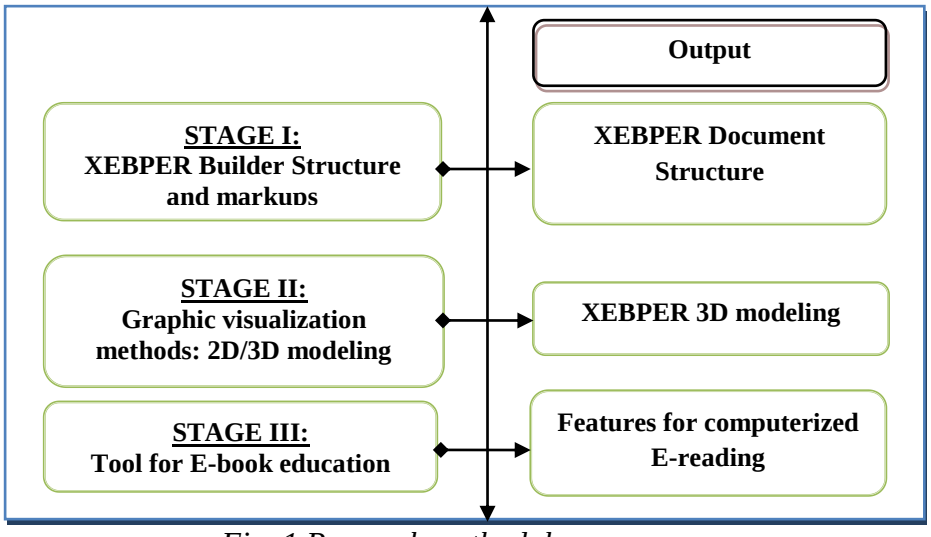

Fig. 1 Research methodology

In the first stage, the XEBPER builder structure is the primary input. It consists of various markups and is the basis for e-book representation. Through using the XEBPER builder structure, XEBPER document structures that are extensible and personalizable are produced.

In the second stage, graphic visualization methods are employed to produce a XEBPER 3D model of the e-book. This adds the visualization components for developing the e-book system with functionalities for layout, page turning and interfaces.

Finally, an e-book system or tool is developed by applying 3D graphics that would facilitate the rendering of the existing e-book with advanced layout features, i.e. with dynamic capabilities for all features.

4.0 E-BOOK

The XEBPER structure from the first stage formalizes the e-book conceptualization using XML-like internal representation. In this section, we highlight efforts in the second stage. The XEBPER modeling consists of four main components: *the orientation with XEBPER structure*, *processing*, *layout* and *stimulus functions* (this will be elaborated in Section 4.4). These modules are combined for efficient output rendering based on 3D-graphic and visualization methods. Hence, these components are collectively called *XEBPER 3D modeling components*. Figure 2 shows that the XEBPER structure is enhanced with the visualization components for XEBPER 3D modeling.

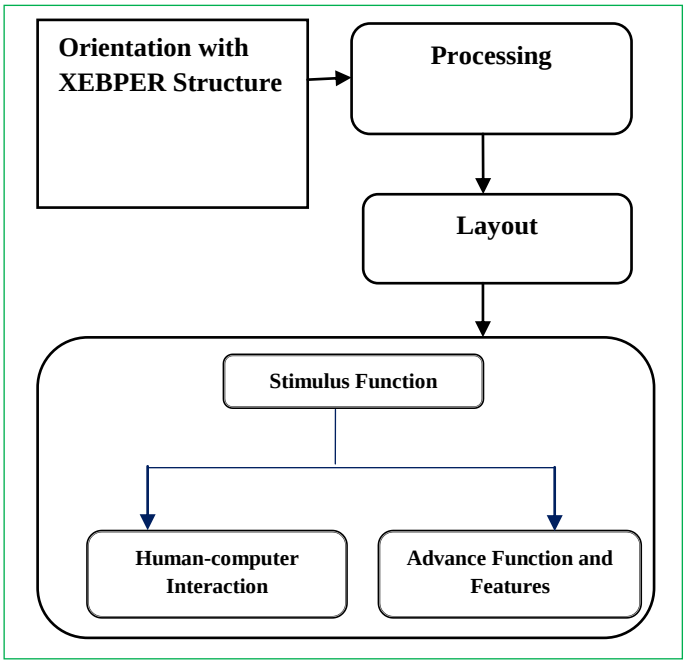

Fig. 2 E-book visualization modeling using XEBPER structure

4.1 Orientation with XEBER Structure

This component provides the core interface features, i.e. XEBPER Builder components and its markups. As mentioned earlier, XEBER contains seven object layers, and these are divided into structural and functional objects.

The structural objects are:

- Package object: describes e-book packaging representation with metadata, numbering and Digital Rights Management (DRM) perspectives.
- Visual object: enhances the representational information with layout, font, design and positioning features.
- Metaphor object: expresses e-book material as parts, chapters, pages, etc.

Functional objects are:

- Media object: describes multimedia characteristics and taxonomy.
- Content control object: describes control over the content, multimedia element synchronization, etc.
- Device control object: this is wide in range and involves functions such as highlights, bookmarks, messages, etc.
- Book update object: describes real-time connection for e-book content, allowing e-book users to search and update the content.

The XEBPER structure is specified within a builder framework which consists of the XEBPER format, XEBPER library, taxonomy, personalization, metaphor, viewer, parser, and operation. All these are unified in the form of the XEBPER builder specification resulting in a standardized proprietary format. The XEBPER structure can be represented using Extended Backus-Naur Form (EBNF) notations. For example:
xebper → *(package) (visual) (metaphor)*
metaphor → *(media)** | *(content control)** | *(device control)**| *(book update)**

A XEBPER program or source in XML contains some header information at the beginning and is followed by the structural objects – package, visual and metaphor. The metaphor object is further extended with the functional objects – media, content control, device control, and book update objects.

4.2 Processing

The XEBPER structure is processed with a XEBPER builder application that is written in Java. The builder stores, parses and renders either HTML-based outputs or other 3D visualization methods. Initially, Java Abstract Windowing Toolkit (AWT) is employed, but this has shortcomings for advanced users as it only features simple fonts and shapes in solid colors. These shortcomings can be addressed with Java 2D graphics through its improved support for colors, patterns, transparent drawings, and local fonts. However, 2D is not suitable for drawing virtual reality objects for engineering purposes. In order to do so, Java 3D API is an ideal solution as it utilizes a tree-like structure for the client-side that allows users to add or remove certain nodes at run-time [17]. This model could also facilitate Graphical User Interface (GUI) application. Our 3D solution, called XEBPER 3D, provides 3D graphics and visual representation components for e-book layout. It uses Java 3D scene-graph for dynamic modeling (shape, sound, lighting, location, orientation and appearance of visual/audio objects) and viewing of the contents. In this modeling, Java 3D API supports high-level, object-oriented, and graphic design features for developing e-book system.

4.3 Layout

Layout is the visual representation that focuses on the skeleton structure of e-book contents. More importantly, it allows the design of page flipping and other visual elements of e-book. These parameters can be further extended with structure-related e-book components.

In XEBPER 3D modeling, the settings for page layout come under visual objects. Consider the following example in Extended Backus Norm-Form (EBNF):
Visual → *(paper type), (margin left), (margin top), (margin right), (margin bottom), (paper thickness), (gutter size) (gutter color), (gutter position), (belly band), (transform), (scale), (rotate), (flip state), (flip second) (spine color)*

The parameter *paper type* specifies standard paper sizes and types of paper. The *margin* parameters present margin sizes at the top, left, right, and bottom. For the *paper thickness* parameter, the appropriate simulated thickness can be seen visually on screen The *gutter* parameter describes how two pages are joined together in terms of size, color of surface, and position (top or left). The *belly band* parameter is sometimes used to "wrap around" the book for esthetic purposes.

The *transform* parameter is used to specify basic transformations, which contains default positions in 3D-coordinate (0.0f, 0.0f, 0.0f) which in turn, describes *x*, *y*, and *z* positions. The *scale* parameter is used to enlarge or reduce the size of the entire e-book material by using a fixed scale factor specified between the values 0.0 and 1.0. The *rotate* parameter is used to turn the e-book sideways. It is centered along the *x*, *y*, or *z* axes (default is the *y*-axis, i.e. 0.0, 1.0, 0.0) and is specified in rotational angle (in degrees). No rotation is specified by default. The *flip state* specifies the waiting time between page-flips. It is either automatic or manual (set to 0 second). *Flip seconds* indicates the waiting time between page-flips. Finally, *spine* describes the physical book spine, e.g. color.

All these will be visualized in XEBPER 3D modeling, which explores the *x*, *y*, and *z* axes for rendering objects as shown in Figure 3.

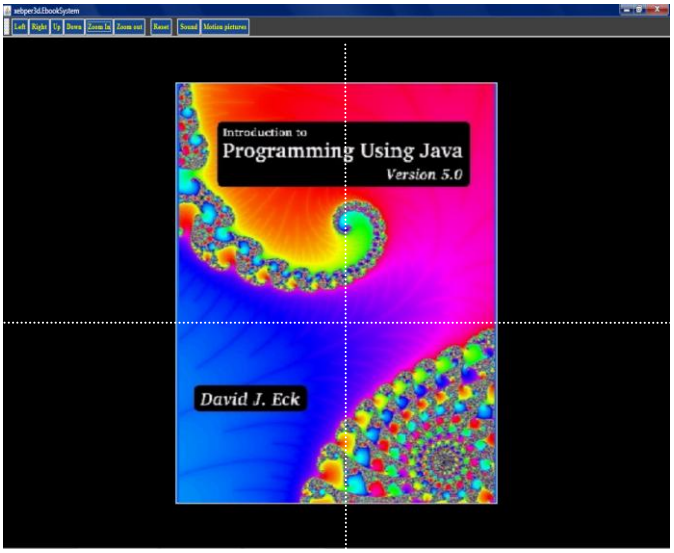

Fig. 3 Visual metaphor (for reading)

The e-book can be opened, and pages can be flipped by clicking on e-book surface. Figure 4 shows the typical form of rendering with two pages on screen.

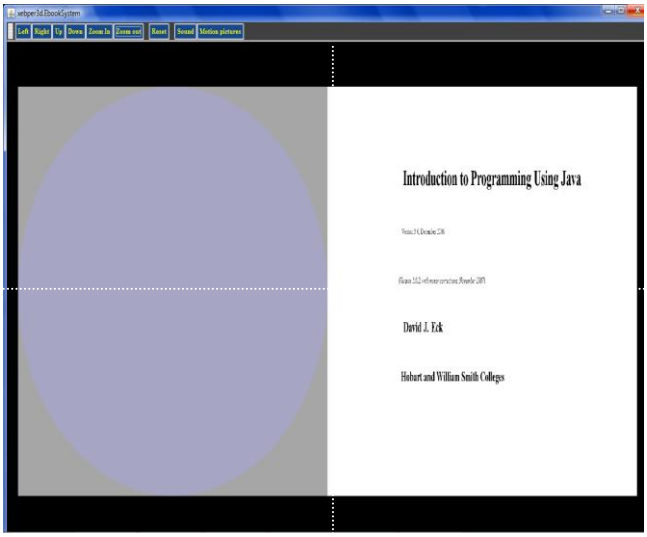

Fig. 4 A typical opened e-book

4.4 Stimulus Functions

The stimulus functions represent the e-book's functionalities at run-time. With these functions, e-book users can enjoy realistic 3D experiences. The parameters are described as follows:

E-book functionality = {selection of e-book, browsing, visualizing, flipping state}

The *selection of e-book* is a method for acquiring an e-book from the e-library or e-bookshelves through the use of icons or figures, i.e. opening a document with the extension .xebp. *Browsing* is a function to access the content by interaction components such as visual metaphor for e-book, page flipping, and other interface design, while *visualizing* refers to the presentation of content in a virtual environment in 3D-space. The *flipping state* describes page-flipping options.

5.0 USER EVALUATION STUDY

The survey was conducted to evaluate and compare the representation structure, personalization features, and usability of the XEBPER and PDF formats in an academic setting. A questionnaire was utilized as the instrument for data collection. It focused on evaluating the following features: package metadata, e-book interoperability, library catalogue, security, visualization, taxonomy of multimedia content, hypertext, bookmark capability, progress of reading, file attachment and web search. The study was conducted with fifty students (respondents). The students were randomly selected from undergraduates and graduate students at the School of Computer Sciences from Universiti Sains Malaysia (USM). For content, the first and second chapters from the e-book entitled "Introduction to Programming Using Java" [18] were rendered using XEBPER 3D as shown in Figure 4.

For the research hypothesis, we hypothesize that that an e-book structure that employs personalization mechanisms results in better browsing experiences. The Spearman-rank correlation was -0.70. The analysis is shown in Table 1.

Table 1 Analysis of XEBPER and PDF using Spearman-Rank

			XEBPER	PDF
Spearman's rho	XEBPER	Correlation Coefficient	1.000	-.700(*)
		Significance (2-tailed)	.	.016
		N	11	11
	PDF	Correlation Coefficient	-.700(*)	1.000
		Significance (2-tailed)	.016	.
		N	11	11
* Correlation is significant at the 0.05 level (2-tailed).				

Hence, two-tailed value is less than the 5% level, i.e. 0.016, and we reject the null hypothesis, i.e. there are no differences. We accepted the alternative hypothesis that there are differences between the XEBPER and Adobe PDF structures in terms of browsing experiences. Hence, our results and findings show that the XEBPER structure is preferred over the Adobe PDF structure.

CONCLUSION

In this paper, a 3D e-book is being explored with enhancements in structure and specification. This model facilitates the design of e-book in a virtual reality environment. This is possible through the use of Java 3D API that was used in the XEBPER 3D modeling. As future work, the strategies for designing academic publications and the refinement of the e-library/e-bookshelf will be further explored. We anticipate that 3D e-books will have much to offer due to the increasing popularity of portable devices such as tablet computers.

REFERENCES

[1] N. Hameed, Y.-N. Cheah, and M.R. Mohd. Arshad, "A Representation Structure for the Personalization of Extensible Electronic Book". Computer Science and Mathematics Symposium (CSMS 2006), Kuala Terengganu, Malaysia, 2006.

[2] Z. Scheidlinger, "The E-book vs. the ordinary book", Educational Technology & Society, Vol. 7, No. 1, 2004, pp. 1-5.

[3] H.P. Schoch, H.Y., Teoh, and M., Kropman, "Adopting an electronic text book for a postgraduate accounting course: An experimental study", Australian Journal of Educational Technology, Vol. 22, No. 2, 2006, pp. 166-188.

[4] S. Paxhia, and B. Trippe, "Digital Platforms and Technologies for Publishers: Implementations beyond eBook", The Gilbane Group.

[5] S. Gibbons, T.A. Peters, and R. Bryan, "E-Book Functionality: What Libraries and Their Patrons Want and Expect from Electronic Books", Chicago and Landon: LITA-ALA.

[6] P. Cesarini, "EBooks: A Battle for Standards", The Writing Instructor, 2002.

[7] A.A. Terry, "Electronic ink technologies: showing the way to a brighter future", Library Hi Tech., Vol. 19, No. 4, 2001, pp. 376-389.

[8] S.E. Randolph, "Are e-books in Your Future?", Information Outlook, Vol. 5, No. 2, 2001.
[9] D. Dillon, "E-books: the University of Texas experience part 2", Library Hi Tech., Vol. 19, No. 4, 2001, pp. 350-36.
[10] R. Wilson, "The Look and Feel of an Ebook: Considerations in Interface Design", In Proceedings of the 17th ACM Symposium on Applied Computing, Madrid, Spain, 2002.
[11] K. Coyle, "Stakeholders and standards in the e-book ecology: or, it's the economics, stupid!", Library Hi Tech., Vol. 19, No. 4, 2001, pp. 314-324.
[12] J. Fan, L. Xiaofan, and S. Simske, "A Comprehensive Image Processing Suit for Book Re-mastering", In Proceedings of the 2005 Eight International Conference on Document Analysis and Recognition (ICDAT'05), Seoul, Korea, 2005, pp. 447-451.
[13] L. Hong, S., Card, and J. Chen, "Turning Pages of 3D Electronic Books", In Proceeding of IEEE Symposium on 3D User Interfaces, 2006, pp. 159-165.
[14] Y. Chun, I.W. Witten, R. Lobb, and D. Bainbridge, "How to turn the Page", Joint Conference on Digital Libraries, 2003, p. 186.
[15] A. Hornung, E. Dekkers, L. Kobbelt, "Character animation from 2D pictures and 3D motion data", ACM Transaction on Graphics, Vol. 26, No. 1, 2007.
[16] N. Wacholder, L. Lu, & Y.-H Liu, "User behavior during the book selection process", In Proceedings of the Annual Meeting of the American Society for Information Science & Technology, Austin, TX: American Society for Information Science and Technology, 2006.
[17] Sun Microsystems Inc., Java 3D Application Programming Interface (API), http://java.sun.com/javase/ technologies/desktop/java3d/.
[18] D. Eck, Introduction to Programming Using Java. Geneva, NY: David Eck (Creative Commons Attribution-ShareAlike 2.0), 2006.

BIOGRAPHY

Noorul Hameed Mohamed Meerasa completed his Ph.D. from Universiti Sains Malaysia in 2010 in the area of e-books.

Yu-N Cheah received his B.Comp.Sc. (Hons) degree from Universiti Sains Malaysia in 1998, and his Ph.D. from the same university in 2002. His research interests include knowledge management, intelligent systems, and health informatics.

Muhammad Rafie Mohd. Arshad received his B.A. degree from Macalaster College, Minnesota, U.S.A, and his MBA-MIS from the University of Dallas, Texas, U.S.A. His research interests include multimedia systems, computer-aided instruction, computer games, and virtual reality.