An HTML5-based Interactive E-book Reader

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Abstract

In this paper, we introduce an HTML5-based interactive and integrated e-book reader system, which supports hyperlink, user interaction, audio and video, animation, and 3D model view. The reader has been implemented as a hybrid application – web and wrapping Android application. For the web, we utilized HTML5 and CSS3 for page layout, JavaScript and jQuery for scripting and user interaction, and WebGL/Three.js libraries for 3D model view. Our work shows that the possibility of e-book viewer with rich interaction and rich multimedia features utilizing pure Web technologies, and some reasonable merits of this approach. HTML-5 based technologies have reasonable merits for e-book: ease of implementation, rich built-in features for multimedia and user interaction, a lot of existing libraries and tools, and many developers who are familiar to these technologies.

Keywords: E-book reader, HTML5, Interactive, Integrated, 3D View

1. Introduction

With the spread of smart devices, e-book content [1] has been very common, and its sales surpassed the traditional paper book sales at Amazon in 2010 already [2]. However, most of the current e-book viewers support text only, and some advanced readers such as Apple’s iBook support multimedia and user interaction [3] or augmented reality [4]. As smart devices are getting popular, the advanced e-books that support rich media and interaction will be widely used [3]. In order to meet those requirements, ePUB3 [5] standard format has been published, but we still do not have many fully featured e-book readers for ePUB3. According to Michael Kozlowski’s article [6], the Marketing and Communications Manager of W3C, emphasized the importance of user interaction and multimedia in e-book, and the web technology could be a solution for the requirements:

Digital publishing already is web-based. If you think about today’s ebooks, they’re really ‘frozen’ web sites packaged in a container. Readers today, however, are demanding more flexibility in how they access and use content. They want rich media and the ability to interact with more and different kinds of content. They want to choose how, when, and where to access stories or information. And they want to use media to engage others much like they share physical books with others to expand a conversation.

In order to meet the requirements of multimedia and rich user interaction in e-book, we decided to adopt web technology, especially HTML5 because the web component already has supported rich features for those requirements. Therefore, in this paper, we introduce an HTML5 based e-book reader, which supports hyper-link, multimedia, user interaction, sensor activated actions, animation, and other interesting features such as 3D rendering. The reader
is an extended version of our previous works [7-9]. The e-book reader has been implemented as a hybrid app which has web component and Android native application. The native code wrapped the web component, which reads and renders HTML/CSS codes, executes JavaScript codes, and plays multimedia data. In order to test and evaluate the e-book reader, we also developed an e-book content. The e-book content is written in HTML5 format with JavaScript and CSS. It includes pictures, audio and video data, and object data for 3D model. Our e-book reader is an integrated reader, because it renders text, multimedia, and 3D model within one viewer, which is the distinguished change from our previous works. In our previous works, we adopted three different viewers for the different media types, but in this work we integrate two views (web view and 3D model view) into one view.

Our work has two contributions to e-book technologies. First, we introduce an integrated reader that supports user interaction, multimedia, and 3D model view. It will encourage software developers to create new e-book viewers with new features. It will also encourage e-book authors to create and design their e-book to adopt those features. Second, we introduce an HTML5 based e-book reader. HTML is rather well known to end users, and this will allow end users to create their own e-books.

This paper consists of four sections. In Section 2, we will summarize the related works and compare them to our work. After then, we describe the requirements and design issues for the e-book system in Section 3. And we also introduce our interactive e-book reader implemented utilizing HTML5 features in Section 4. In Section 5, we evaluate our work and describe some limits of our work and our future plan. Finally, we will reveal our conclusions in Section 6.

2. Related Work

The existing research on e-book can be classified into two groups: new technologies for e-book system, and psychological or educational evaluation of e-books. The main research topics of the second group are about the possibility of replacement of the paper book, usability of e-book, e-book’s effectiveness in education, and social engagement of e-books. However, the main research topics in the first group are about technical issues in e-book reader implementation, and new e-book readers.

Our work is related to first group of research. Therefore, we survey the existing research in the first group in this section. The first group research can be classified into two groups again: e-book readers for specific target users [10, 11], and general e-book technology [12, 13].

There have been researches on e-book reader systems for specific target users. Gaurang Kanvinde [10] introduced an Android platform e-book reader for dyslexics, and it helps the readers by providing text-to-speech and adaptive text layout. Velazquez R. [11] also proposed an e-book system which helped the blind by translating text into Braille. Those researches are very meaningful because they allowed people with disability to read e-books.


Some Apps, called "AppBook", are dedicated smart device applications to e-book content, and they have interesting merits including multimedia, animation, and rich user interaction. However, AppBooks are hard to develop because they are created as applications. Some frameworks [14] support converting e-book in HTML5 into AppBook, and those tools reduce efforts and time to write e-books, but those do not support user interaction.
Compared to the existing works, our e-book reader has some commons and some uniqueness. Our reader is a general purpose reader, and supports text, multimedia, user interaction, scripting, and 3D model.

3. E-book Reader Design

In this section, we introduce some requirements that we faced during the system development, and some design issues to meet the requirements.

3.1. System Requirements

The spectrum of e-book software users is very wide because it is for reading books. However we note children under 12, because they require rich multimedia, user interaction, and other interesting features to get interests in reading. After targeting those users, we drew requirements for the e-book reader. And it has functional requirements as shown in Figure 1. The requirements are little bit different from our previous work [7], because this is a new version of e-book. And in this work we focus on utilizing web technology as much as possible.

Figure 1. Use Case Diagram and Functional Requirements for the e-book Reader

Users should be able to read text, and play video and audio in the e-book as depicted UC1, UC2, and UC3. Video and audio will help users to understand e-book content. Furthermore, users should be able to interact with embedded objects such as images, links, and buttons by touching, dragging, or clicking the objects (UC4, UC5, and UC7). They can also interact with the devices by changing orientation, shaking it, or other manipulation (UC8). Users should be able to see object in detail, so they want to see objects in three dimension and manipulate (rotate them, flip over them, or magnify them) the objects (UC6).

3.2. System Design

From the requirements, we decide to adopt MVC architecture for the e-book reader. We adopt MVC architecture because we have one e-book content, but we may have multiple viewers according to media or devices. People can read books, watch video clips, and
manipulate 3D models. Figure 2 shows our MVC architecture for e-book reader. In the figure, Javascript Framework is the core part in the Controller. It interacts with users, and handles user's events and other interesting functions for users. Its main roles include event handling and animation.

![MVC Architecture for the e-book Reader](image)

Figure 2. MVC Architecture for the e-book Reader

The e-book reader is a hybrid Android App with WebKit component and it allows HTML and JavaScript to work in the viewer. However, some features such as using sensors and controlling back light brightness are not possible to be accessed from HTML and JavaScript. Therefore, we divide the features into two groups: features accessed by JavaScript and the others. Figure 3 shows the separation of HTML Layer and Native App Layer.

The HTML Layer does the web related tasks: HTML parsing and rendering, application of CSS, processing user events (click, touch, drag, ..), and 3D model rendering. Furthermore, there are JavaScript function libraries to access Android Native code, so that e-book writers can access sensor values and control devices by calling JavaScript functions.

The Native App Layer does device related tasks: accessing sensors, manipulating back light brightness, local data processing, execution of external processes, and others. It has functions to access sensors and devices and allows the JavaScript layer to invoke the functions.

![Separation of HTML Layer and Native App Layer](image)

Figure 3. Separation of HTML Layer and Native App Layer

4. Basic Viewer Implementation

In this section, we specify development environment and e-book reader implementation.
4.1. E-book Reader Development and Testing Environment

We separated development environment and test environment. For development, we used a win64 desktop computer with Chrome web browser, jQuery libraries [15], and Android SDK [16]. For 3D model viewer, we used WebGL [17] and Three.js [18] libraries. We also developed Javascript Framework, which allows e-book page flipping, animation, and user interaction. We wrapped WebKit component with Android native App. For test environment, we used Samsung Gallaxy Note 10.1 with Android 4.1 platform.

4.2. E-book Reader Implementation and Testing

In order to test our e-book, we wrote a fairy tale e-book which describes about seashore mud flat, because it is described in elementary school textbooks for its ecological importance. The e-book includes text, pictures, video clips, audio clips, and 3D models. It also supports animation, and user interaction.

The e-book content consists of HTML and each page is distinguished by <DIV> tag structures. Therefore it supports only fixed page flow. It allows user interaction and animation using JavaScript libraries. Table 1 shows a sample code of e-book for user interaction and animation. The “draggable” class means that users can drag the object. And the JavaScript function “hmove()” will move objects toward horizontal orientation. It allows object animation.

<table>
<thead>
<tr>
<th>Table 1. Example Code for User Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>
| <div>
|  
| <img id='p2_lana' class='draggable' style="display:block; position:absolute; left:450px; top: 200px; " src='t/p2-lana.png'>
|  </div>
|  
| <div>
|  
| <a href='javascript:hmove("#shell-2")'><img id='shell-2' ... src='t/p3-shell-2.png'>
|  </div>
|  

Figure 4 shows a page in the book, which support text and image animation. The text shows up with animation, and users can drag birds, and touch shells to play music.

![Figure 4. Interactive e-book Page](image-url)
The e-book includes education materials such as picture gallery, and video clips. Figure 5 shows educational pages on “Fishing and seashore mud flat”. The left page explains “Fishing on Seashore Mud”, and the right page shows multiple pictures which support the explanation on the left page.

![Figure 5. Educational Pages on Mud](image)

5. Evaluation and Future Work

Our HTML5 based e-book reader provides basic features for interactive and multimedia e-book content. It provides features: page flip, hyperlink, video and audio, animation, Javascript, user interaction, sensor based interaction, and 3D model view. Therefore it can be used as a new e-book reader for e-book content written in HTML.
The e-book reader has some issues to be solved. First, the WebGL features are not fully supported in the mobile devices, so that 3D model viewer is not fully supported. However, in the near future, WebGL will be fully supported in the mobile devices. Second, Augmented Reality has interesting features for e-book, but the current e-book does not support it. However, Chrome browser supports camera control in the web, Augmented Reality will be supported in the HTML5 based e-book reader soon. Third, the current e-book uses fixed page layout, which means that each page is determined and fixed when writing e-book. However, ePub2 and ePub3 allow automatic reflow according to device size and font size. Therefore HTML5 based e-book reader should support automatic reflow according to device size and font size. Fourth, our e-book reader does not support content protection mechanism such as watermark or encryption. For commercial usage, those content protection mechanisms are a very important issue.

The HTML5 based e-book reader has issues to be solved as described above, but it supports rich media and rich user interaction features. Furthermore, because the web technology advances fast, HTML5 based e-book reader can utilize those new features easily with less efforts.

6. Conclusions

The e-book market has already surpassed the traditional paper book market, and the needs for rich media and user interaction in e-book also has increased. The current e-book readers do not fully support multimedia, user interaction, and 3D models.

In this paper, we introduced an HTML5 based e-book reader, which supports text, images, hyperlink, video, audio, animation, user interaction, sensor interaction, and 3D model view. We specified system requirements, system architecture, some design issues, and implementation. Compared to other technologies, HTML5-based e-book reader was easy to implement. Furthermore, e-book written in HTML is easy to write and modify its content. There are some issues to be solved such as reflow and content protection mechanism, and we also work on those issues to solve.

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