

Smart Books – Adding context-awareness and interaction to electronic books

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ABSTRACT

The availability of e-Inc reading devices, such as Amazon's Kindle, and tablets like the Apple's iPad dramatically pushed the market for electronic books and magazines. The well known advantages of electronic content compared to printed media are instant delivery, multimedia capability, less weight and additional media related services, such as dictionaries and language translation. Beside these known advantages, mobile electronic devices further offer a broad spectrum of sensors and input/output capabilities to further enrich the presentation of modern electronic media. Within this work we propose a system architecture and a mobile reader software for further enhance the capabilities of ebooks and magazines. The proposed enhancement enables ebooks to react context- and situation-aware onto the readers demands in various application domains. By adding active elements, such as rules and conditional events to electronic media, we enable smart behaviour of electronic content. Furthermore it enables the reader complex interactions with an ebook, which goes further than just page flipping and chapter selection. A case study presents a personalized travel guide which reacts context-sensitive according to the user's actual situation.

Categories and Subject Descriptors

H.5 [Information Interfaces and Presentation]: Multimedia Information Systems — *Artificial, augmented, and virtual realities*; H.5.2 [User Interfaces]: Input devices and strategies

Keywords

pervasive computing, ubiquitous computing, context-awareness, ebooks

1. INTRODUCTION

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Since Amazon introduced in 2007 with Kindle one of the most popular e-Inc reading devices it seems clear that electronic books (ebook) and magazines change the way we are consuming media. Kindle was one of the first reading devices which was able to display ebooks, which are given in a multitude of different formats, on a high contrast and passive energy consuming e-Inc display. An ongoing discussion followed which focused on the issue to find a common ebook format and to find a general definition of the term ebook. A good definition of the term ebook is given by Zivcovic [9]: "An electronic book consists of one or more files of monographic character available to the public online or in physical form (on CD-ROM, diskette and the like physical carriers)" Today most ebook readers are able to interpret traditional input formats, such as Plaintext (.txt), Adobe Portable Document Format (.pdf) and even HTML (.html). Beside these formats specific formats for ebooks were published since 2007, which are Kindle (.azw), Mobipocket (.mobi), (.lit) and (.epub). All these specific ebook formats try to further increase the main advantages of ebooks compared to printed books, which there are:

- Less weight: Compared to a traditional printed book an ebook reader is able to contain a library of ebooks without increasing the weight of the device.
- Instant delivery: Compared to a traditional book or newspaper ebooks can be delivered worldwide without any delay or printing overhead. According to this fact, the publishers will have to discuss the traditional daily or weekly publishing cycles.
- Navigation: An ebook offers quick navigation between chapters or bookmarks.
- Bookmarks: An ebook reader can offer bookmarks and highlighting to mark important parts of the content by a reader. This features are quite an important advantage for professional users.
- Translation: An ebook reader can offer additional services, such as the quick language translation of parts of the text or to query a topic within an encyclopedia.
- Digital Rights Management: ebook formats can include mechanisms for Digital Rights Management (DRM), which control the access a reader has to a certain media item.

Compared to the existing presentation of digital content on HTML based Web-sites, ebooks combine the advantages of traditional books with the flexible and dynamic presentation of HTML based content. By downloading an ebook the user receives an editorial package which can be used as offline content as well as online with offering additional information and services. By using ebooks the user also has the advantage of not losing the flexibility of navigation between the different sections and bookmarks of an ebook, as it is offered by HTML presentations. By combining the advantages of these two approaches ebooks have a good chance to replace printed books in various application domains (e.g. user manuals, travel guides, school books, technical tutorials and scripts). Within the last 20 years the ebook market significantly grew, see Just 2007 [5]. Just states that the amount of ebooks increased by an average of 20 percent per year over the last 20 years. Compared to printed books the share of the ebook market was up to 11 percent. These numbers of course do not reflect the increase of ebooks offered online through direct publishing. According to these numbers it can be stated that the delivery of electronic media through ebooks and magazines will continue to increase within the next years. ebooks will appear within new application areas such as travel guides, restaurant guides, school books and so on. These new application areas will greatly benefit from the advantages of ebooks, which were mentioned above, and will add new features to ebooks. Within this work we will focus on such new additions to ebooks which there are the use of context-awareness and the use of interactivity between the book and a reader in order to enrich the reading experience.

2. RELATED WORK

Context-sensitive applications have quite a long tradition, since Mark Weiser stated 1991 in his article 'The computer for the 21st century' [8] that the modern computing devices will be enhanced with context-information and can support users in their identified situation. The idea of context-sensitive books and magazines is not new as Weiser's statement from 1991 shows: 'My colleagues and I have built what we call tabs, pads and boards: inch-scale machines that approximate active Post-it notes, foot-scale ones that behave something like a sheet of paper (or a book or a magazine)...'. Over the last decade a multitude of different context-sensitive applications were successfully published. Bates et al. for example describe a context-sensitive and interactive museum guide [3]. This wireless mi-guide reacts on the user's actual location and delivers accurate and personalized information about exhibition objects onto the user's handheld device. Modern users are getting more and more technologically aware and expect that the digital systems they wear and which are embedded into the environment, react context-sensitive and context-aware on their actual needs. Other prominent examples for context-sensitive applications are community platforms such as foursquare where a user can check-in, by use of a GPS enabled smartphone, to venues and collaborate with the actual environment. According to a steady increase of user numbers, such platforms show that the users are interested in their actual environment and to the digital information that is bound to the physical location.

Another interesting work by Battle and Bernius [4] describes collaborative editing and publishing of digital content to ebooks which are connected to their origin, in or-

der to follow updates. This transquotation in ebooks represents another interesting advantage compared to traditionally published digital content or books. The publishing market has to face major changes within the next years compared to the traditional form of publishing and reading of text based content. Kratky highlights within his work 'Re-thinking reading in the context of a new wave of electronic reading devices' [6] these major changes within the next decade of reading various content. One of these major changes will be the enhancement of traditional ebook media with interaction and context-awareness. Schoning et al. describe in their work a GPS enabled ebook reader which enables the users to create location bound stories [7]. These iBookmark stories change according to the actual location of a reader, in order to enhance the expressiveness of story telling. An example shows a story which reacts on the readers actual location and displays augmented elements into the story. So if the reader is standing in front of a building the story is able to project fictional elements into the story and onto an image of that building. The work by Schoning et al. follows the same concept as we discuss within this work except the fact that within our work the focus lies on the use of a general model for context information within ebook formats, which is not restricted to location information.

3. APPROACH

Before discussing the general approach of building a context-aware ebook reading system, we have to focus on the different requirements for such a system. The different requirements lead to a very specific system architecture which provides several advantages compared to the alternative systems above. The main requirements for our system are listed here:

- **Multimedia content:** The system has to offer the possibility to use multimedia content. In order to offer a modern system for reading content, we have to enable the use of formatted and hyperlinked text as well as images, video and sounds.
- **Device independent representation:** The system should target all kinds of reading hardware, ranging from simple eInc ebook readers (e.g. Amazon Kindle, Sony PRS) without sensoric input, to actual smartphones or tablet PCs. Our context-aware ebooks should at least be readable on the different hardware, even if the hardware does not offer any sensoric input. The markup format should also be able to present the content on different display resolutions.
- **Simple and standard delivery:** In order to target a global audience, it is necessary to use already established protocols for online and offline delivery.
- **Context-awareness:** The reader software should be able to interpret incoming sensoric input, ranging from absolute GPS position to acceleration information. It should be possible to highlight or refer to specific content that is evaluated as relevant according to the context interpretation.
- **Offline mode:** The content should be available through an offline mode, in order to consume the content even when no network is present.

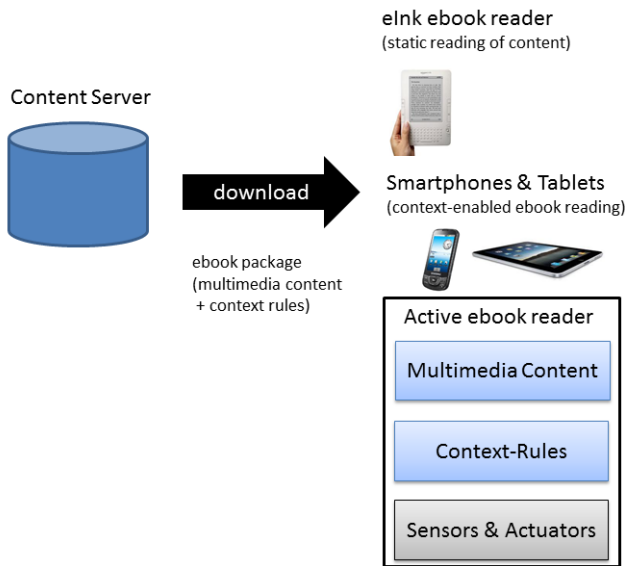


Figure 1: Architecture of an interactive ebook reading system.

- Open format: The content should be packed into an open ebook format, which most of the actual readers are able to interpret.

Figure 1 shows the general system architecture of the interactive ebook reading system. The system architecture, as it is shown, consists of a central content server which enables the user to select single pieces of information (chapters), which are packed into an ebook package. The ebook package also contains context-rules which control the intended behaviour on specific situations. So the entire ebook package contains the multimedia content along with all necessary context-rules. The context-rules react on specific sensoric input and decide how to present the multimedia content to the reader. In combination with an interpreting reader software this enhanced ebook package results in a context-aware and interactive ebook. It is also possible to specify rules that react on specific user input, in order to take the users decisions and answers into account. On the client side we distinguish between static eInk clients and smart clients. Static eInk clients, such as Amazon’s Kindle or the Sony PRS series, are able to download the ebook package and present it as static text and images. Such static clients ignore the context-rules as well as multimedia content such as videos. On the other side, smart clients such as Android-based smartphones, Apple iPad or iPhones are able to use a specific interpreting ebook reader software. The ebook reader software is able to present the content as well as it is able to use their sensoric input to trigger the context-rules. A smart client is able to use its sensoric input to fill the working memory of a rule engine within the reader software in order to decide how to present the static content to a reader. Modern smartphones offer a broad spectrum of different sensors which we can use to interpret a specific situation. Some examples for sensoric input are:

- Absolute location: By using the GPS sensor it is pos-

sible to measure the absolute position, as well as the traveling speed of a reader.

- Relative location: An acceleration sensor and a digital compass module measures the direction and the relative movement of a reader. This can be used to track the line of sight and to perform gesture recognition.
- Sound: The microphone can record the surrounding noise level or perform simple speech recognition.
- Camera: The camera can perform image and object recognition.
- Light: A light sensor measures the level of lightning.
- Time: The internal clock and calendar delivers timing and date information.
- Network: By using a network access the reader can request specific information about the actual situation of the surrounding environment, such as the actual weather situation, traffic, local events and many more.

Examples how to use these sensoric information, in order to adapt the presentation of the static multimedia content, could be to present location and weather dependent tourist information or to sort local events according to the actual date and time. There are unlimited possibilities to use context-information to change the presentation of an ebook’s static multimedia content bound to the reader’s actual situation.

4. IMPLEMENTATION

The implementation of the system requirements above was focused on the two different parts, namely the content server and the mobile reader software, of the system architecture in Figure 1. The content server was implemented as a PHP-based server which packs and delivers an ebook package out of a database over a Web-portal. This Web-portal also offers additional configuration and personalization possibilities for a reader, before an ebook is packed and downloaded to a specific reading device.

The implementation of the ebook package is based on the open standard EPUB, which was introduced by the International Digital Publishing Forum in 2007 after some previous standardization efforts [2]. According to the standard the EPUB format consists of a zipped package of XHTML hypertext chapters combined with a set of XML files which contain additional information. An EPUB package contains an uncompressed mimetype file, a container.xml file which defines the publication’s root entry point, an .opf file to specify all single media files and types and a .ncx file (Figure 3) to define the navigation between the different chapters. Within our implementation we added meta-information about the single chapters into the .ncx file, e.g. the location where a chapter is relevant and what kind of information the chapter contains. The context-aware ebook reader takes a single navigational point (navPoint) as the smallest and atomic piece of content it can present to a reader. Figure 3 shows an example for a valid EPUB ncx navigation file which contains one atomic piece of content. To enable the use of context-information, which is specifically bound to the type of content that is packed into an ebook, an additional context-rules file has to be added into the ebook package.

```

<?xml version="1.0" encoding="UTF-8" ?>
<!DOCTYPE ncx (View Source for full doctype...)>
- <ncx xmlns="http://www.daisy.org/z3986/2005/ncx/"
- <head>
  <meta name="dc:Title" content="Hello World" />
  <meta name="dtb:uid" content="id_Hello_World" />
</head>
- <docTitle>
  <text>Hello World</text>
</docTitle>
- <navMap>
  - <navPoint playOrder="1" id="id_Hello_World_01">
    - <navLabel>
      <text>Hello World</text>
    </navLabel>
    <content src="atomic_content_part.xhtml" />
  </navPoint>
</navMap>
</ncx>

```

Figure 2: Example for a valid EPUB ncx navigation file.

```

<?xml version="1.0" encoding="UTF-8"?>
<rule-execution-set>
  <name>ZainooRelevanceSet</name>
  <description>Site Relevance Context Model</description>
  <synonymn class="com.zainoo.site" name="site"/>
  <synonymn class="com.zainoo.Location" name="location"/>
  <synonymn class="com.zainoo.Time" name="time"/>
  <!-- relevance linear proportional with distance to the actual location.-->
  - <rule name="DistanceRule" description="calc distance relevance factor">
    <if rightTerm="true" op="=" leftTerm="context.useDistance"/>
    <then arg2="linear" arg1="location" method="site.addFactor"/>
  </rule>
  <!-- if site is a restaurant and daytime is between 7 and 11 (breakfast time).-->
  - <rule name="BreakfastTimeRule" description="daytime relevance factor">
    <if rightTerm="Restaurant" op="=" leftTerm="site.getType"/>
    <if rightTerm="7" op=">" leftTerm="time.getHour"/>
    <if rightTerm="11" op="<=" leftTerm="time.getHour"/>
    <then arg2="1" arg1="time" method="site.addFactor"/>
  </rule>
  <!-- if site is a restaurant and daytime is between 13 and 15 (lunch time).-->
  - <rule name="LunchTimeRule" description="daytime relevance factor">
    <if rightTerm="Restaurant" op="=" leftTerm="site.getType"/>
    <if rightTerm="13" op=">" leftTerm="time.getHour"/>
    <if rightTerm="15" op="<=" leftTerm="time.getHour"/>
    <then arg2="1" arg1="time" method="site.addFactor"/>
  </rule>
  <!-- and so on ... -->
</rule-execution-set>

```

Figure 3: Example for context rules defining the relevance of a place of interest.

The context-rules file contains a set of rules that define how the reader software should interpret the incoming sensor information. The presentation of the ebook content depends on the ebook readers context-rules interpretation. So the author of a context-sensitive ebook is not only responsible for providing the multimedia content in form of XHTML pages, he also has to attach rules that handle the presentation of the content. The author therefore defines the relevance of a piece of content to a given situation, e.g. a location, by the set of context-rules that are attached to an ebook package.

The second component of our system architecture is given by the context-sensitive ebook reader. The reader software was implemented on top of the Android mobile platform. It uses an existing rule engine implementation (JRuleEngine [1]) for interpreting the context-ruleset that comes with an ebook package. The mobile reader application presents a list of visible atomic content pages, sorted according to the relevance to the actual context. The sorting order is given

	Porta Borsari <i>Die Porta Borsari stammt aus dem 1. Jahrhundert vor Christus und markierte den ...</i>	0.0 km
	Via Mazzini <i>Die Via Mazzini stellt die direkte Verbindung zwischen der Piazza Brà und der Piazza ...</i>	0.2 km
	Arena di Verona <i>Nach dem Kolosseum in Rom und dem Amphitheater in Capua ist die Arena das ...</i>	0.3 km
	Piazza delle Erbe <i>Die Piazza delle Erbe ist bis heute das lebendige Herz Veronas. Zahlreiche Restaurants haben ...</i>	0.3 km
	Torre dei Lamberti <i>Besonderer Anziehungspunkt in Verona ist neben der römischen Arena der Palazzo del Comune ...</i>	0.4 km
	Piazza Brà <i>Hauptplatz Veronas und zugleich einer der größten Plätze Europas ist die Piazza ...</i>	0.4 km
	Haus der Julia <i>Das Haus Julia (Casa di Giulietta), eine der Hauptattraktionen Veronas mit dem wohl ...</i>	0.4 km
	Piazza dei Signori <i>Die Piazza dei Signori war das frühere</i>	0.4 km

Figure 4: Context-aware recommendation of sight-seeing locations.

by the set of rules that are defined for the specific ebook. Content pages that are not relevant at all in a certain context are not visible within this list.

5. USE-CASE: TRAVEL GUIDE

The following use-case was selected out of a running project in cooperation with ZAINOO, which is a platform operator for personalized travel guides. The philosophy of ZAINOO is to enable a traveler to personalize a travel guide according to specific regions, cities and landmarks. The ZAINOO travel guide should replace the traditional printed travel guides where it is not possible to combine more than one region or city on a fine grain level of single landmarks within one guide. The ZAINOO Web-portal offers travelers to personalize a travel guide out of a collection of editorial multimedia descriptions for single landmarks. The result of the personalization process is a collection of landmark descriptions which can be packed and downloaded as an ebook, as it was already mentioned in section 4. As ZAINOO replaces the printed version of travel guides the possibility of offline reading is a quite important requirement. The downloaded personalized ZAINOO travel guide also contains the context-rules, which are then interpreted by the ZAINOO context-aware ebook reader.

Each of the atomic multimedia landmark descriptions contains some meta-information about the location and a classification of the landmark, such as e.g. place, church, tower or arena. The context-rules of the ZAINOO ebook reader is responsible for deciding the relevance of the available landmarks to the actual situation. In this example the relevance is defined as a combination of personal preferences, the distance to the actual location of the reader and the actual time. The result is represented as a list which is sorted according to this relevance, as it is shown in Figure 4.

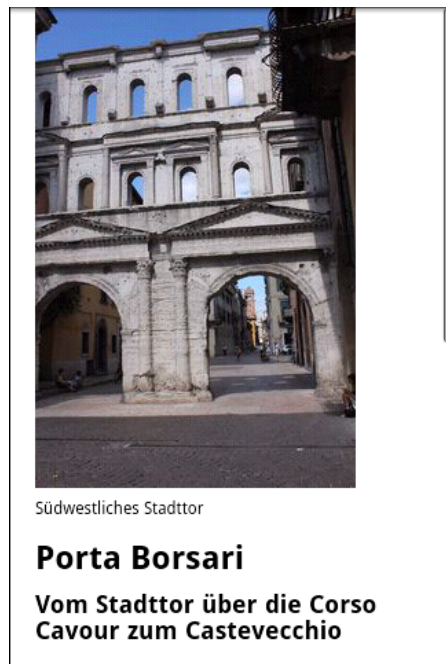


Figure 5: Description of a selected sightseeing location in epub format.

The reader can refer to each of the multimedia landmark descriptions by simply clicking on the sorted list of landmarks. The descriptions are atomic chapters which can be dynamically combined to any reading order the user demands. Figure 5 shows a single description of a landmark within the ZAINOO travel guide reader.

Additionally the reader can view his actual location on a map, which also shows the collection of landmarks that are available within a downloaded guide. The reader is able to automatically zoom to a selected landmark description from the sorted list view. The actual location on the map, as well as the available landmark collection is shown in Figure 6.

6. CONCLUSION AND OUTLOOK

Within this work we discussed the possibility of adding context-sensitivity as well as interaction to ebooks. A prototypical implementation of the proposed system architecture lead us to interesting application areas where these smart ebooks can provide great advantages. A case study of an interactive and context-sensitive travel guide shows how flexible such smart ebooks can support a reader by his daily tasks. At the actual state of implementation the context-model as well as the proposed context-rules are quite simple. Within an ongoing work we try to enhance the possibility of this context-rules to identify more complex situations and to evaluate different application scenarios. Furthermore we plan to roll out the prototypical context-aware reader software to a public marketplace in order to get a broader spectrum of user feedback.

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Figure 6: Overview map of selected sightseeing locations.

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