Abstract

The background of this article is formed by work on IMAGEN, a toolset for the creation of Web portals that aim at providing their users with personalized content packages. After an overview of the system, we focus on the resolution of layout problems imposed by the content packaging approach. The core of the presented component for layout management applies constraint techniques for integrating layout preferences of authors, portal providers, and end users who receive the compiled content packages. Since IMAGEN aims at cross-platform delivery, we continue the discussion of our component with the question of how IMAGEN can be extended so that mobile access to personalized content packages becomes possible. Our discussion includes a description of experimental work conducted within the IMAGEN project. The focus of this work is on the customization of graphical representations for display on mobile devices with tiny screens. We have developed a module that uses techniques from the area of machine learning to chose from a set of available image transformations a transformation which most likely produces a reasonable result for a yet unseen image.

Keywords

Web Publishing Tools, Applications Software for Content Providers, Publishing on Mobile Devices

1 Introduction

A key factor for the success of online portals is the presentation of the provided content. Ideally the presentation reflects the portal user’s information needs and interests as well as the capabilities of the user’s display device. Hence the operators of online portals demand for tools that facilitate setting up such personalized information services. Key requirements to such tools include the capability of using content that is already available, and the application of existing standards. Thus rather than generating presentations from a rich semantic representation of domain knowledge (e.g., [MW98], [RFW97]), selection, packaging, and reformatting of existing media assets for the purpose of reuse are becoming dominant tasks.

Within the EU funded project IMAGEN (Intelligent Multimedia Application Generator) we develop a platform for the set-up and operation of portal services that aim at customized publication and distribution of multimedia content. A first pilot application of IMAGEN is the MyArt application. MyArt will be a free entertainment/promotional application. A major business objective of MyArt is to establish a communication channel between a large Italian publisher in the art domain and the community of English speaking Internet Users interested in Renaissance arts.

2 IMAGEN Platform and Workflow

IMAGEN can be conceived as a mediator between content authors (1st-level users) on the one hand, and content customers (3rd-level users) on the other hand. In between we have to consider a further user group, which are usually publishers, content syndicators/owners and administrators of Web portals. Such 2nd-level users may purchase media assets from a number of different 1st-level users and compile new multimedia products for their 3rd-level users.
The platform and its core components are roughly sketched in Figure 1. The process of delivering content from the content provider to the content user is divided into three major steps: Content Management, Layout Management, and Transaction Management—which are implemented by separated components. All components interface with a number of possibly distributed content repositories that store so-called content units. A content unit is an XML file and consists of a small composition of multimedia assets, such as texts, graphics, images, sound and video clips, and programmed interactive units, e.g., Java applets or Flash animations. A graphical editor, such as the eXact Packager¹ may be used for the creation of content units.

In response to 3rd-level user requests, the IMAGEN tools create and deliver so-called content packages. Originating from the area of computer learning, this approach describes a method for representing learning courses as content packages, which consist of a set of interrelated resources. The IMS consortium has developed XML-based standards (see http://www.imsproject.org/) for representing content packages; these standards are supported by a broad range of tools from the consortium members as well as the learning community. In IMAGEN the idea is to provide 3rd-level users with a content packages, which are created on the fly based on content that is of interest for them. In the sequel we describe how the resulting tasks are handled by the IMAGEN components.

2.1 Content Management

In response to a 3rd-level user’s request the content management component selects content units from one or more repositories and organizes the retrieved units in a package. To obtain a selection of content units of interest for the given 3rd-level user, document profiles are matched against a user profile. Here document profiles are created offline using a classification engine. For creating user profiles, two different methods are provided.

Implicit profiling creates interest profiles of the 3rd-level user by observing his browsing behavior. This feature relies on a module that runs on the 3rd-level user’s platform, and that creates automatically a profile based on the documents the user is reading. The approach is described in [CK02]; how it can be combined with an engine for automated layout is elaborated in [KKT02].

In contrast, explicit profiling requires that the 3rd-level user states his interests explicitly. Here not only the user profile is applied for the content selection. In addition, collaborative filtering is applied too. That is, the content selections presented to other users with similar profiles and their feedback about the quality of these selections is also taken into account.

The content selection produced by the content management is a collection of pointers to content units from the repositories, and to Web pages taken from all over the Internet. All retrieved pointers are stored and organized in a content package. In IMAGEN this process, called content packaging, relies on a template-based approach. That is, different user queries are associated with different types of package structures.

¹ The eXact Packager® produces assessments (IMS QTI), multi-device style sheets and is interoperable with any 3rd party Learning Management System (LMS) or Information Systems (HR, KMS, ERP, Legacy ...) conforming to international standards. See http://www.learnexact.com/.
2.2 Layout Management

After content management a content package is available, which could be delivered to the 3rd-level user. However the included content units have in generally different authors with varying ideas of a “good” layout, which may result in a quite heterogeneous appearance of the whole package. Furthermore, at this point constraints imposed by the 3rd-level user’s platform have not been taken into consideration for layout.

Thus the package layout is revised according to a set of layout requirements specified by the different user groups. This task is performed by the IMAGEN Layout Manager, basically a set of components, whose core module is the so-called Style Assistant. It applies a finite domain constraint solver for constraining attribute values of an XML document’s nodes. In MyArt, it unifies style attributes of the content units included in a package. The style attributes are initialized with the values suggested by the 1st-level user, and the applied constraints are specified by the 2nd-level user. In addition, a set of values and constraints describing the 3rd-level user’s platform may be included, so that the final layout may reflect the preferences of all user groups.

This process is illustrated in Figure 2, where the impact of the different user groups’ layout preferences on the colors, font sizes and alignment of three content units is shown. Their styles are originally defined by 1st-level users, and are then constrained by 2nd-level user preferences during packaging. Finally, before delivery, colors defined by the 3rd-level user override partially the result.

The constraint satisfaction problems handled by the Style Assistant are specified using an XML binding explicitly developed for IMAGEN. This binding enables the specification of variable domains, and of different classes of constraints. Required Constraints express layout preferences, which cannot be relaxed. In contrast, Rating Constraints aim at optimizing the result, but may be relaxed in order to find solutions at all. This class of constraints is used to determine the “best” solution out of a set of eligible solutions, i.e., layout attributes that satisfy the required constraints. Since the set of eligible solutions is often huge and since rating constraints often compete among each others, the definition of rating constraints is a difficult task on its own. To facilitate the definition of rating constraints we have developed an interactive visual solution-space explorer, for a detailed description of this component we refer to [KBR02].
2.3 Transaction Management

For any kind of business applications it is important to keep track of the performed transaction. In an environment where content from potentially different content owners is delivered, a transaction record is also required in order to allow for the allocation of income from cleared transactions back to the rights owners of the media assets. In addition, applications as MyArt require mechanisms that help enforcing the rights of content owners. For instance, all images included in IMAGEN content packages obtain an electronic watermark so that it can be traced-back in which package the image was delivered to who.

Hence in IMAGEN a Transaction Manager keeps track of the content units that got compiled into packages, and of the 3rd-level users, who eventually received the packages. As additional feature, this component enables watermarking of images delivered with a package [BKZ98]. Such watermarking may be applied statically to encode information such as the ownership, or dynamically to save information about the transaction itself.

3 Mobile Access to IMAGEN

MyArt aims at a Web portal primarily designed for access by regular desktop PCs. However, mobile devices with Internet access become more and more popular, and thus we anticipate that some of the potential 2nd-level IMAGEN users might seek the capability to deliver content to mobile devices. Compared to the “PC world”, however, the spectrum of mobile devices is much more diverse in terms of hardware and software capabilities. As to hardware, differences are due to broadly varying display capabilities given by different screen sizes, resolution, and available colours if colour display is supported at all. As to software, one has to consider that mobile editions of browser and display programs are usually less powerful than their counterparts running on a PC. In the sequel, we discuss two extremely different classes of mobile devices which might be used to access the IMAGEN platform.

3.1 Pocket PC’s and Palm Computers with Medium-size Screens

For mobile devices that feature medium-size screens and are able to run mobile editions of ordinary Web browsers, the current IMAGEN toolbox provides already a set of quite flexible components, which have of course to be set up for a mobile scenario. For instance, content management may be asked to select fewer content units, or only such units, which are appropriate for display on a mobile device. The device's layout requirements can partially be expressed as finite domain constraints, so that the Style Assistant may perform an optimization of layout according to the device. The outcome can even be further improved by XSLT transformations applied during the regular post processing of the layout management, a technique that is already applied in MyArt for converting the Style Assistant's results to Cascading Style Sheets (CSS).

In our current experiments we use a variety of different mobile devices, among others a Nokia 9110 Communicator with a small-size color display and a built-in web browser that supports basic HTML.
features. In deed, our test cases confirm that suitable presentations can be produced with the IMAGEN tools. A showcase of accessing MyArt with the Nokia Communicator is shown in Figure 3. To account for the small screen of this device, package layout has been adapted in several ways. For instance, the Style Assistant has been set up so that larger fonts are preferred,\(^2\) and a page-breaking component distributes the delivered content units over several pages, so that less scrolling is required. Finally, XSLT is applied to refine the page layout and to connect these pages with a navigation bar that appears in the upper left corner of a page.

3.2 Devices with Tiny Screens

While the IMAGEN approach can be used to serve users of mobile devices with a medium-size screen, the approach is only of limited use if devices with strong resource limitations are used. Today, the delivery of content to small mobile devices, such as contemporary cell phones, remains constrained in terms of bandwidth, memory, and processing power. In the near future, however, rapidly improving hardware and infrastructure will make these limitations disappear. However, one problem will not be solved this way – a great deal of mobile devices will come with tiny displays, which impose strong constraints on the way how content is presented and accessed.

3.2.1 Transcoding Content

The MyArt application of IMAGEN relies on regular Web pages. A frequent approach to delivering such content to mobile devices with tiny displays is transcoding \([BCC+01][GST+02]\). This technology aims at adapting content according to constraints and preferences associated with specific environments. Here a number of approaches exist to transform text represented in an XML format into so-called stacks of WML (Wireless Markup Language) pages.\(^3\) However, up to now, these approaches provide little support for the automated transformation of visual content (images, graphics).

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\(^2\) Note that on the 9100 Communicator a font appears smaller than on a regular screen.

\(^3\) A prominent product is for example IBM’s WebSphere™, or the product xCA.suite by xCA.com.
Furthermore, preliminary tests conducted at DFKI with MyArt content units showed that a mere syntactical transcoding resulted in huge stacks of WML pages. Such stacks are cumbersome to handle with a tiny display and weak navigation facilities, and thus hardly meet the idea of providing 3rd-level users with an easy to use content access.

Hence sophisticated transcoding mechanisms are required. For instance, a sophisticated “mobile” IMAGEN would not only have to provide smart techniques for summarizing text assets, but also robust mechanisms of reducing visual media, including graphics, animation and video. However, for some of these media types a reduction is still beyond of the current state of the art, and even the transformation of static graphics yet remains a challenge. Neglecting graphical representations completely may be acceptable if these representations serve as decorations only. Unfortunately, however, there are many examples of services which can hardly do without using graphical representations to encode information. In the sequel, we present some ideas based on our previous work in the area [RBH+00][RB01] to extend the IMAGEN platform in a way so that it can be accessed by mobile devices with tiny screens, too.

3.2.2 Mobile Access to Graphical Information

To increase the benefit of services provided to mobile users, it is important to explore the actual information needs of this user group. For instance, consider a mobile user visiting Florence. This user might be interested in accessing Giunti’s content about the Uffizi art museum in order to decide whether to visit the museum or not. In that case it would be a good idea to compile a package consisting of a few selected artworks and to present this to the user in the form of a virtual walk through the museum. It is not only the amount of information delivered but also the form (e.g., an exploratory walk-through) that may attract a mobile user to access the presentation.

Figure 4 shows such an application. As input serves a floor plan of the exhibition, and a set of content units, which correspond to the exposed artworks. The user may browse through the exhibition by following a predefined path. Waypoints of this path are presented as small 3D graphics representing rooms and floors of the exhibition building (see the sequentially aligned screens in Figure 4). Some of the graphics include icons which indicate points of interest, e.g., artworks exposed at this location. By selecting the icon, the exposed content units can be accessed (see the 4th waypoint). Using IMAGEN terminology, a 2nd-level user would be able to compile such a presentation by using special strategies for content selection, content organisation, and layout management.

A central aspect of many mobile scenarios is the ability to deliver visual content to mobile devices. Their small or tiny displays are usually little suited for displaying large-scale images. In the case of the MyArt application it is of little use to deliver the same images to 3rd-level users that access the portal with small mobile devices. Thus images should be transformed according to constraints imposed by the output device. To address this problem, the IMAGEN Layout Manager includes the so-called Image-transformation Assistant. Originally, it was designed as a helper component in the case that an image needs to be adapted to some page dimensions. This task is realized straightforward by scaling the images. For mobile devices an extension of this component is required. Therefore we started tackling the problem of how to transform images so that they can be displayed on very small displays, such as a 90x60 pixel display of a mobile phone.

Unfortunately, it is very difficult to find a general-purpose transformation that reliably produces suitable results for the large variety of graphics found on the web. A more promising approach starts with an analysis of the source graphics in order to inform the selection and adjustment of transformation parameters. Basically the analysis phase performs a classification of the image source amongst syntactic or even semantic features. For instance, in our current work, the set of implemented semantic classifiers comprises classifiers that distinguish between portrait and non-portrait images, outdoor versus indoor images, outdoor images that show a scene with blue sky, clouds, sunset, water, forest or meadows, and snow-covered landscapes. In the ideal case, each image class can be associated with a certain transformation that produces acceptable results for the vast majority of instances of that class.
While image classifiers provide a basis for selecting among different available transformations, it is still difficult to make an assignment between recognized features of an image on the one hand, and available transformations and their parameter adjustments on the other hand. We are currently investigating in how far this problem can be solved by deploying machine learning techniques. That is, in a training phase, a graphics design expert manually assigns transformations to source images and thereby allows the system to recognize and generalize correspondences between image features and transformation parameters. A screenshot of our trainable image transformation system is shown in Figure 5. When loading a source image into the system, the image gets displayed in the left part of the frame and an analysis is carried out to construct a feature vector that can be used to classify images. In our current test setting we use 430 features that result from regional color distributions of an image. In contrast, our repertoire of transformations comprises eight different transformations and is yet quite small. The result of applying each of the eight available transformations to a source image is displayed on the right-hand side of the screenshot.

By means of a software package for machine learning [WF00] we trained the system with a set of 130 images including portraits of persons, images of landscapes, in- and outdoor images of buildings, images of everyday objects and photographs of artworks. In the learning or training phase, a graphics design expert tells the system which of the eight transformations yields the best result for a given source image. While we have experimented with several different learning methods, a standard C4.5 decision tree algorithm has proven useful for this task. In the test phase, the system is asked to recommend one of the eight transformations on its own for a yet unseen image. For the source image shown in Figure 5, the system recommends T1 for transforming it to an image that can be displayed on a mobile WAP phone. In cases where the system remains undecided, which of the eight transformations to recommend, it may not recommend any of them but pick the nil option T9.

4 Summary

The IMAGEN platform aims at enabling personalized content packaging for web portals. Its architecture includes tools for content management, layout management, and transaction management. This contribution has focused on the layout management, which enables the integration of layout preferences of content authors, content providers, and content customers into content packages that are eventually delivered to the customers. To be able to account for the different layout preferences of the three different user types we proposed a constraint-based approach. In particular, we express layout preferences as constraints over attributes of nodes in XML documents. The second part of the paper was devoted to a discussion of how this approach can be extended to support mobile user who want to access content packages via small portable devices. We distinguished between devices with medium screen sizes, and such devices that have tiny screens only. For devices with small screens we presented a showcase to demonstrate how the IMAGEN tools can be configured to adapt packages for
this device class. However, such an adaptation will not be sufficient for devices with tiny screens. For this device class we presented a method for the transformation of images based on a machine-learning approach. However, we conclude with the observation that much work remains to be done in the area of media transcoding and media transformation to adapt information presentations for devices with limited output capabilities, such as tiny displays.

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References


