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ADAPTING THE INTERACTIVE MULTIMEDIA PUBLICATION CONTENT TO MOBILE DEVICES

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The method for content adaptation of the interactive multimedia publications to various mobile devices is proposed. A comprehensive set of utilities is built for generation of the optimized output view in any of the broadly used forms, including HTML, Flash, etc. The implementation of the method is performed in a way, which allows an easy adoption of the new source applications and/or output views.

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1. Introduction. Until recent years, the printed publications were widely viewed as the most user-friendly medium ever created for reading. Advances in technology allowed taking these publications to the displays and solved the problem of fast and effective distribution. Adobe PDF [1] was one of the first formats adopted for representing documents in a manner independent of the application software, hardware and operating systems.

Nowadays, the digital publications are not simply digital replicas of the printed publications. They include rich media and are designed for easy interaction between readers and the publication, not just for one-way content delivery.

These publications also encourage readers to interact for access to additional content. In the further text we will refer to a representative of this kind of publications as to an Interactive Multimedia Publication (IMP).

Due to the rapid development in the digital media consumption applications, mobile devices and operating systems, the IMPs became even more popular, especially in the educational sector. However, diversification of the client devices made it difficult to build a single static IMP content well suited all types of client devices. In this paper we propose an effective method for adapting the IMP content to modern and, especially, mobile devices taking into account the device specifics and user profile. The existing adaptation methods are targeted mainly to web content [2] and make emphasis on mobile devices of the old type with significantly restricted capabilities (see [3, 4]).

The method we propose covers the last generation mobile devices (smartphones and tablets) used for IMP visualization and interaction with it. The method comprises of two

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phases: conversion and transformation. The conversion phase brings a variety of source content formats, coming from different applications, to a special unified interactive representation.

The transformation phase optimizes the obtained representation taking into account the platform and profile peculiarities of a given user/user group. A comprehensive set of utilities is built for generation of the optimized output view in any of the broadly used forms, including HTML, Flash, etc. Proposed method has been implemented in the adaptation module of Interactive Multimedia Publication System (IMPS) [5] the backend engine of the Joomag web services for creating and distributing the IMPs [6] and is broadly exploited by the users of Joomag.

2. IMP Model. While many multimedia publication content models are proposed, none of them suits well to IMP formatted as a paged digital book or magazine with embedded rich media and reader interaction tools. For example, the model presented in [7] is destined for particular class of publications, where semantics significantly influence the structure and imagery of the final product. The Semantic Adaptation Framework proposed in [8] provides tools for building the semantic metadata needed for the conceptual adaptation of the multimedia content and is focused on providing an integration of MPEG-7 semantics description tools [7] into the MPEG-21 Multimedia Framework [9]. The framework for interactive multimedia documents proposed in [10] is targeted mainly to application designers and hardly can be used for authoring the page structured interactive multimedia publications, because does not have the corresponding support.

The proposed IMP model is designed specifically for page structured Interactive Multimedia Publications. It considers IMP as consisting of the *Page* and *Spot* objects. *Spot* is a logical section of the page with content in it. It may include the actual content elements like static texts, shapes (line, oval, rectangle, etc.), images, video, audio, animations and/or the other *Spot* objects. More than one version of the *Spot* object can be created for the same content on the server, depending on the publication type, the client devices in use and the audience it is intended for. The *Page* object corresponds to the page of publication. It contains information about the *Spots*, which are used on that page, along with the page metadata. An IMP *Page* is actually a hierarchy of nested *Spots*.

At the time of a *Spot* creation, a number of properties is being assinged to the *Spot* by the author. The set of all possible properties is predefined in the system, but may vary depending on the publication type. There are two groups of properties:

a) properties related to hardware characteristics of the client device used with IMP;

b) properties related to the end user profile.

We will define the set of all possible device properties accepted by the system as D and the set of all possible user properties as U. Each property in D and U is bound with a set of values that can be assigned to the property. The set of the device properties $\overline{D}_i$ assigned to spot S_i is a subset of D, where each element of $\overline{D}_i$ can be, in its turn, a subset of the corresponding element in D. Similarly, the set of the user properties assigned to S_i is a subset of U, and each element of $\overline{U}_i$ can be a subset of the corresponding element in U.

When an IPM client running on user device (be it a desktop PC or a mobile device) establishes connection with IMP server, it sends the device and user profiles to the server. The concept of these profiles is close to properties used on the server side. The device profile $\overline{\overline{D}}$ of the client defines the subset of properties from D with the values supported by the device. Similarly, the user profile $\overline{\overline{U}}$ defines the subset of properties from U with those values of the properties that are applicable to the user.

3. Adaptation Process. In IMPS, before sending an IMP page to the client device, the server adapts the page making decision on what *Spots* and what *Spot* versions (if there is more than one version of the same *Spot*) should be sent to the client device for opening on the screen. In a simple scenario, when there is only one version of each *Spot*, the decision is made according to the following procedure.

Step 1. For each *Spot* S_i on the page the server determines the intersections of the non-empty value sets of each property in $\overline{D}_i$ with the corresponding value sets in device profile $\overline{\overline{D}}$ of the client. If the result of intersection for any property in $\overline{D}_i$ is an empty set, then the S*pot* is not chosen for sening to the client device. Otherwise, the *Spot* is being chosen as a candidate for sending to the client device and rendering there.

Step 2. If the *Spot* S_i has been chosen on the Step 1 then the server determines the intersections of non-empty value sets of each property in $\overline{U}_i$ with the corresponding value sets in the user profile $\overline{\overline{U}}$ of the client. If the result of intersection for any non-empty value set in $\overline{U}_i$ is an empty set, then the *Spot* is not being sent to the client device. Otherwise, the *Spot* is being sent to the client device.

In case, if there are many versions of the same spot in the page structure, the above described method is enhanced in a way that the resulting page structure would include only one version of each *Spot* to be sent from the server to the client device. For that purpose the device and user properties are extended by the "weight" parameter: any device property $d \in \overline{D}_i \subseteq D$ or user property $u \in \overline{U}_i \subseteq U$ will be described as a 2-tuple: *(v,w)*, where v is the value of the property and w is the weight corresponding to that value. The weights indicate the importance of the property values for the subjective and objective quality assessment of the spots on the client device and used as follows. The weights corresponding to property values included in the intersection for each *Spot* version are being summed up, and the S*pot* version having the highest total weight is being chosen for sending to the client device.

The adaptation process described above results in most of the cases in quality degradation of the final publication opened on the client device, compared to the "ideal case" quality, where the client device supports the "best values" of all device and user properties. Therefore, it is important to have a quantitative method for accessing the quality of the IMP adaptation. Criterion for assessing the relative IMP adaptation quality for specific session is calculated as $Q_r = Q_A/Q_I$, where Q_A is the actual quality, calculated as the weights' sum of all property values of the *Spot* versions chosen for sending to client device; Q_I is the "ideal case" quality, calculated as the sum of all "best value" weights.

Relative IMP adaptation quality Q_r is being calculated automatically by IMPS every time, when user closes the session after viewing and interacting with IMP. That information is being stored in the system's database along with the device and user profiles having relation to that session. The analytics module of IMPS processes this data and generates reports indicating the average quality rating of the publication for various types of client devices and profiles. The module also generates recommendations to publication authors and the administrator of the web service built on IMPS regarding making changes in the set of the *Spot* versions for improving the relative quality of publication. For example, if some of the video *Spots* of publication does not have version with resolution matching well with the resolution of some broadly used mobile device, the module will recommend to add such a version to the *Spot*. The statistical data collected on Joomag web service using IMPS indicate significant improvement of the relative publication qualities after a few steps of revising the *Spot* versions sets based on IMPS recommendations.

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