Multimedia Analysis and Composition Cloud Service

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multimedia, digital photography, image analysis, image composition, automatic layout, photobook.

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ABSTRACT

Multimedia computation such as analysis and composition is increasingly moving from desktop to cloud. This trend is enabling multimedia cloud services that can be accessed through a browser, as well as mobile applications and social network applications. In this paper, we discuss the architecture of a multimedia analysis and composition cloud service. We show examples of using this architecture to provide browser-based multimedia applications, mobile applications, and social network applications, while comparing the advantages of each access method.

Categories and Subject Descriptors

J.7. **[Computer Application]** Computers in Other Systems - Publishing

General Terms

Management, Design, Experimentation.

Keywords

multimedia, digital photography, image analysis, image composition, automatic layout, photobook.

1. Introduction

Multimedia information such as photos and videos are increasingly viewed and shared through social networking sites such as YouTube and Facebook. Although online sharing makes the content easier to access, users continue to face many challenges in dealing with multimedia. People snap large numbers of photos to capture events in their lives, but only a very small fraction are tagged. Most people don't have time to organize their photos and videos. Yet, they desire simple ways to tell their stories using their photo and video collections. Multimedia analysis and composition technologies are keys to meeting these needs without requiring large upfront investment from the user.

As photobooks are becoming a popular way to share stories and preserve memories, major advances have been made in the industry over the past few years to reduce the amount of effort required to author a photobook. One of the key capabilities is to build a photobook from a photo collection automatically. This process consists of automatically selecting the best photos for inclusion in the book, and automatically composing the pages. For example, an automatic photobook generation system was developed in [1] using content-based and context-based image analysis. New generative image composition technologies such as Block Recursive Image Composition [2] make it possible to create flexible image layouts with good aesthetics in real time. Coupled with new user interaction models such as Mixed Initiative Collage Authoring [3], it becomes relatively easy for ordinary people without special graphical design skills to tell customized stories from their photo collections. In addition, web content can be added to make the story-telling more compelling [4]. Finally, the experience of preserving and sharing memories on paper can be enhanced by linking with digital content [5].

We propose to offer a rich photobook authoring experience with core technology components delivered via multimedia cloud services. We will use these services to build multimedia web services, mobile applications, and social network applications. Although our multimedia cloud services infrastructure can be used to deliver a wide variety of multimedia processing capabilities, we will focus on photobook creation, using advanced techniques in image processing to move digital story-telling to the next level.

2. Autophotobook Workflow

Photobook creation is one of the most technically challenging workflows for photo product solution and service providers. The workflow from photo collection to final photobook tends to be fragmented and time-consuming. These problems are only magnified when the authoring platform is expanded beyond PCs to mobile and social platforms. Our AutoPhotobook system [8] uses core imaging algorithms to streamline the workflow and automate many of the more cumbersome steps, which both simplifies the creation process on PCs and makes it more amenable to authoring applications on mobile devices and social networks.

The AutoPhotobook system uses a series of image analysis and composition algorithms. At a high level, we use ImageRank, Pagination, Mixed Content Block Recursive Image Composition (McBRIC), Structured Transformable Artwork (StArt), and Auto Crop algorithms in the photobook authoring system [6]. Each algorithm, in turn, may contain additional component algorithms. For example, the ImageRank algorithm uses both Quality Assessment and Near Duplicate Detection algorithms to select representative photos. Pagination algorithm uses Cover Page Selection algorithm as well as a Theme Clustering algorithm to decide which photos will be allocated to each page.

The workflow of a photobook creation process is as follows. ImageRank and Pagination are first used to select and group

photos to produce a structured representation that helps to tell the story behind the photos. The Structured Transformable Artwork technology is then used to select and adapt designed backgrounds to the pages of the book, adapting to the size and shape of the book while creating style-consistent page spreads. Finally, the McBRIC layout engine is used to dynamically create custom layout templates for each page that accommodate the book size and the number and shapes of photos assigned to that page.

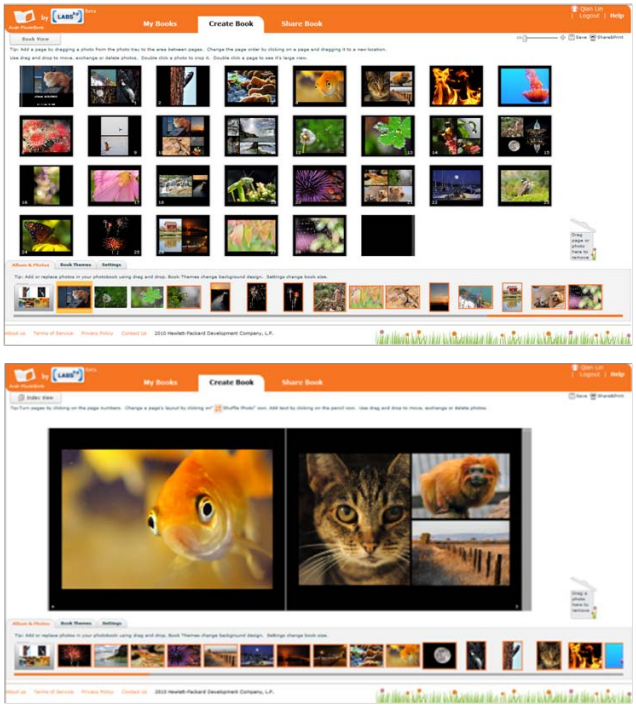

Figure 1. AutoPhotobook Creation service: index view (top) and book view (bottom)

The user is then presented with a finished book for editing and fine-tuning. Photo selection, page assignments, and layouts can all be adjusted with simple drag and drop functionality, which can be supported on a variety of devices. Users can crop individual photos in a window where default crop is displayed using an auto-crop algorithm**[7]**. The user interface and interaction mechanisms are designed to allow users to quickly explore photobook variants and converge to a desired customized version. The final result is a photobook creation system that adapts automatically and intelligently to user photos and editing actions.

3. Powering Mobile and Social Network Applications with AutoPhotobook Cloud Service

AutoPhotobook.com is a full-function web destination that is accessed using a standard web browser. We can increase its effectiveness and reach by incorporating AutoPhotobook services within a larger ecosystem that makes use of functionalities from other sources, as well providing photobook creation services to other clients. This integration allows users to build solutions where the AutoPhotobook capability is one component among many others within a software stack. For instance, we may create photobooks using photos stored on Flickr, a popular photo storage web site. We may also provide users with creation applications on mobile devices and social networks. In this section, we describe how this integration is done and show how the AutoPhotobook features are delivered to devices as part of a broader customer solution.

AutoPhotobook web services can consume services and import content from other web sites. It also allows clients to control various steps in the AutoPhotobook creation process and export final photobooks to other destinations programmatically, without the use of a human-driven interactive interface. The most popular style of web services communication is REST (Representational State Transfer), a simple architectural pattern commonly implemented on the ubiquitous HTTP protocol. Many Web 2.0 sites, such as Flickr or Facebook, provide a REST API to allow clients access to the stored content. AutoPhotobook is equipped with a number of REST client modules to access the services from these sites.

There are two primary categories of services that AutoPhotobook integrates with: Web 2.0 social community services with large amounts of media content, and print fulfillment services. Social community sites, including Flickr, Snapfish, and Facebook, are popular content sharing sites capable of archiving large amounts of data. As AutoPhotobook is primarily focused on photobook creation, rather than replicating functionality found in existing services, we simply reuse their functionalities. Thus, it is possible for an AutoPhotobook user to import her photo collections from one of these popular photo sharing sites into AutoPhotobook and create a photobook from these pictures.

Another class of web services used by AutoPhotobook is related to print fulfillment. After creating a photobook online, users often want a physical copy of the book as a keepsake. Although AutoPhotobook provides a PDF file for users to share and print at home, print fulfillment providers can produce photobooks on higher quality material and binding which may be more suitable for a keepsake book. Currently, AutoPhotobook can submit photobooks to HP's MagCloud print-on-demand service [9], although this capability can be extended easily to any site that provides a REST interface for clients.

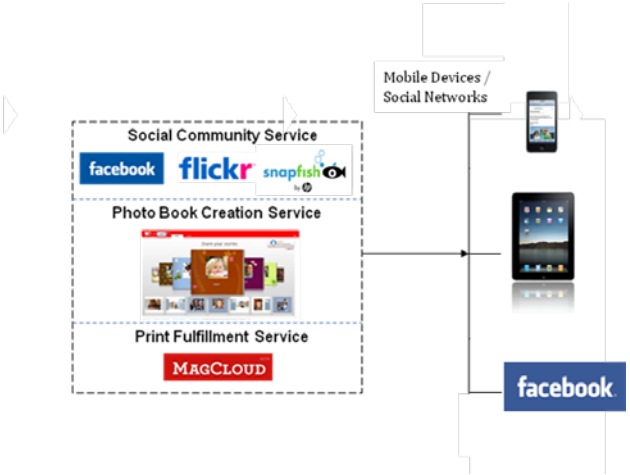

Figure 2. The extended AutoPhotobook ecosystem.

In addition to using web services provided by the media sharing and print fulfillment sites, the AutoPhotobook system also provides a photobook creation cloud service to other clients. Although the most visible part of the AutoPhotobook.com application is the standard web page interface for web browsers, the services and content from AutoPhotobook are also available via web services using a REST programming interface. A number of the algorithms that operate on a single photo or photo

collections, such as auto-crop or ImageRank, are structured as web services. Many of the operations which map to user actions, such as uploading photos, shuffling photos within a page, or moving a photo from one page to another, are also exposed as web services. In fact, the standard user interface in AutoPhotobook.com, which is implemented with Adobe Flex, is simply a client that knows how to invoke the AutoPhotobook REST interfaces. The server itself does not know, nor care about, the origin of the client requests. Thus, it is possible to develop multiple client front-ends for AutoPhotobook. Figure 3 shows how the components come together to form a photobook creation solution.

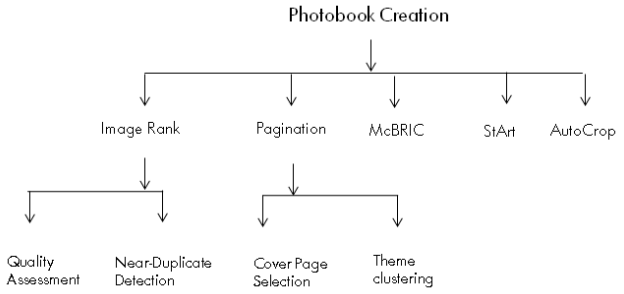

Figure 3: Algorithm components in autophotobook system.

It is the exposure of the AutoPhotobook functionalities as programmatically invokable web services which makes it possible to use these same services to augment the functionalities found in mobile devices. From the point of view of the AutoPhotobook REST server, the mobile device is a client no different than the standard Flash client on the AutoPhotobook web site. One obvious mobile platform for integration is the tablet, which can host the photobook application for digital story-telling, with the end product potentially a physical photobook as well.

In designing the mobile photobook creation application, we partitioned multimedia computation between cloud-based processing and client-based processing. The ImageRank and Pagination algorithms are only run at the automatic book creation stage, and are thus deployed on the cloud. The McBRIC layout algorithm supports interactive editing, and is implemented on the client side for faster user interactions. Figure 4 shows the partition of the components for mobile implementation.

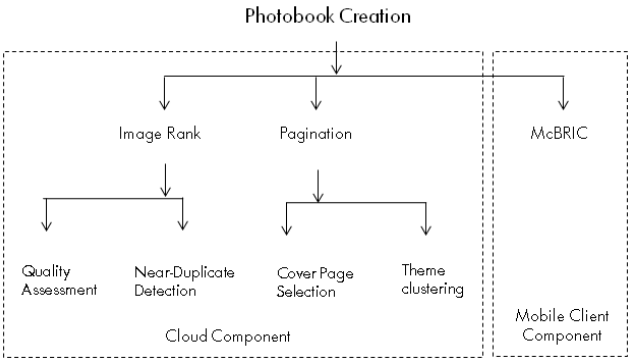

Figure 4: Partition of analysis and composition algorithms for mobile implementation.

Figure 5 shows an example of a photobook application running on an iPad. Note that in this case, the user interface on the tablet looks nothing like the actual web site but has been designed and customized for the mobile device. When a mobile device is enhanced with web services, the additional service functionality is integrated into the device, but user interfaces are typically custom created to best leverage the specific capabilities and characteristics of the device.

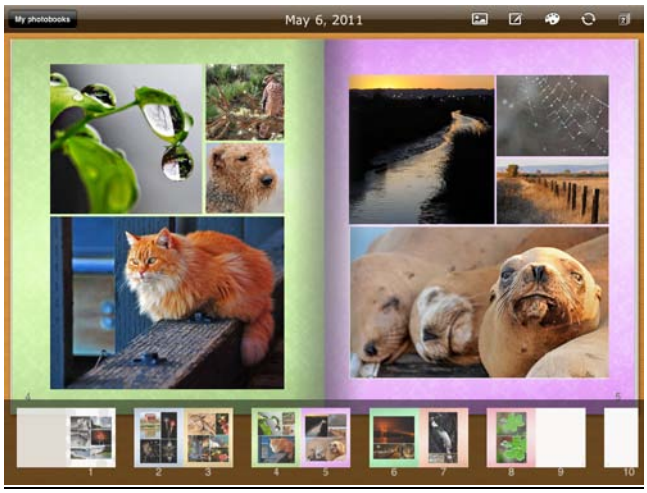

Figure 5. iPad app connected to the AutoPhotobook creation service.

This pattern of augmenting devices with web services can be extended to social network sites such as Facebook. By developing a photobook creation application inside Facebook, a user can author a photobook using Facebook photo albums and share it with other Facebook users, all without leaving the site. The AutoPhotobook cloud service retrieves photos from the Facebook albums and auto-creates the photobook, which is then displayed as an iframe in the Facebook application. Figure 6 shows processing workflow.

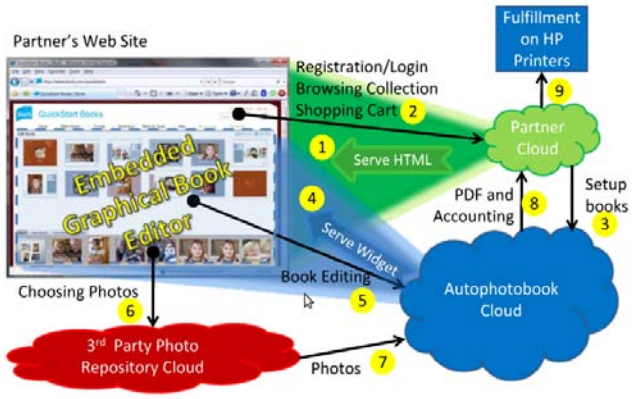

Figure 6. AutoPhotobook cloud service for social network websites.

Figure 7 shows an example of a photobook created with the autophotobook application on Facebook. The benefit of using the Facebook platform is that the photobooks created can immediately be shared with friends. In addition, you can view the photobooks that your friends created in the application area.

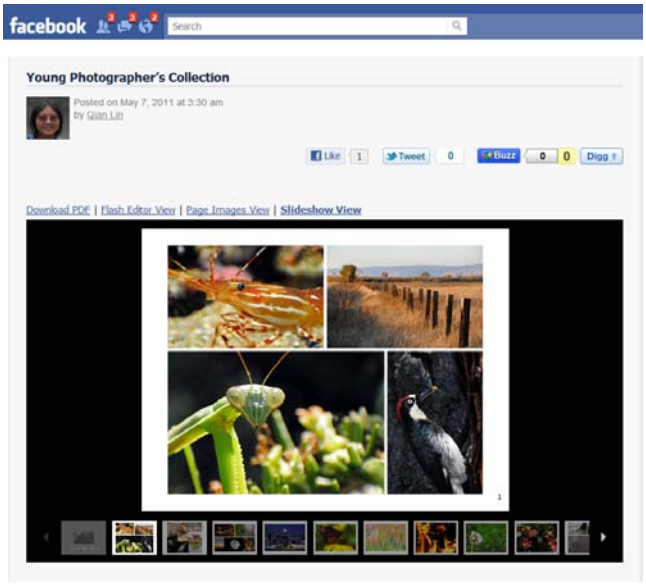

Figure 7. Autophotobook Facebook Application.

4. Results

All three of the Autophotobook applications (web-based Autophotobook.com, iPad HP Photobook application, and Facebook Autophotobook) have been built and deployed, and all of them are currently available for beta use by the public. As of May 2011, 517 users had tried out our Autophotobook.com web application, and 133 had tried our Facebook Autophotobook application. The iPad HP Photobook application is more heavily used, having been downloaded over 5200 times.

The average photobook created on AutoPhotobook.com contains about 28 photos, although the average uploaded album has over 34 photos. This indicates that users often do not want their photobook to include all photos in a collection but on average kept over 80% of their photos in the book.

The Facebook Autophotobook application had fewer photos per photobook, but users created more photobooks on average. The average photobook contains about 19 photos, and the average user generated about 2.5 photobooks (the average was less than 1 photobook per user for the web application). We surmise that the Facebook application makes it easier to create and share photobooks, since the photos are already on Facebook and the books can be automatically shared. This makes Facebook users more likely to complete their photobooks than website users.

The iPad HP Photobook application averaged 24 photos per photobook, which is between the results for the other two versions. Over 5200 photobooks have been created using the iPad application, more than the other two applications combined. We believe this is due to several factors. First, users can easily discover applications in the app store. This is not true for web solutions. Also, we believe the tablet offers a compelling interface for both creating and viewing photobooks. Of the photobooks created on the iPad, nearly 900 (about 17%) were uploaded to HP's MagCloud site for sharing and printing. This indicates a significant demand for cloud-based sharing of photobooks from a mobile device. The ratings and comments on the application are generally positive, showing that many users find the application fun and useful, and that sharing and viewing on the device is a popular feature.

Overall, our results indicate that the different applications are used in slightly different ways, with dominant use cases customized to the client. This allows us to target different use cases with the same technologies by simply creating new clients that call the same web services.

5. Conclusion

Multimedia analysis and composition cloud services enable rich, powerful multimedia applications on the web, in mobile applications and in social network applications. In the AutoPhotobook system example, intelligent image analysis and composition are core technologies used in multiple implementation paradigms targeted at creating a portable multimedia experience. This shared backend also allows the possibility of sharing authored content across the various clients, thus creating a truly seamless user experience.

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