Using MILOS to build an on-line photo album: the PhotoBook ⋆

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(Extended abstract)

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Abstract. Building new digital library applications requires a developement platform that offers standard and powerful building blocks to support application developers. In this paper we discuss our experience of using MILOS, a multimedia content management system oriented to the construction of digital libraries, to build a demanding application dedicated to non-professional users. Specifically, we discuss the design and implementation of an on-line photo album (PhotoBook), which is a digital library application that allows people to manage their own photos, to share them with friends, and to make them publicly available and searchable.

1 Introduction

The aim of this work is to illustrate the use of MILOS [2], a Multimedia Content Management System (MCMS) for digital libraries, to develop a demanding application: the PhotoBook Digital Library (http://milos.isti.cnr.it).

The advent of digital photography, combined to the wide access to internet resources, has made popular the creation of personal and publicly accessible distributed photo archives. Typical examples are the *Flickr* service (www.flickr.com), the *snapfish* service offered by HP (www.snapfish.com), and *Picasa* (picasa.google.com). Users of these archives may create and manage their own photo albums, decide who and how can access their photos, provide a description of the photos to simplify their access. This simple yet powerful application, poses several complex requirements to the MCMS component, which must support: (i) the distributed storage and classification of photos, (ii) the description of photo content through an appropriate metadata model, (iii) the search based on photo description and photo content, (iv) the management of personal folders (photo albums), (v) the controlled access management. Some of the mentioned functionality, do require the development of an appropriate Web-based user interface. A final, but significant requirement is that the development of the application must be simple and fast. The tools previously mentioned (flickr, snapfish, and Picasa)

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offer most of these functionality but with search capabilities limited to manually associated metadata tags. However, everybody knows how little textual comments users are willing to manually associate to their pictures. Furthermore, as mentioned at the beginning of this paper, they are ad-hoc applications, whose development required significant investments and whose extensions would also require considerable efforts. Our aim is to show how, by using the general purpose MCMS system MILOS, is possible to build an application with similar functionality – and even with more powerful search capabilities – with a limited effort.

The development of the PhotoBook application has a twofold purpose: i) testing how the most recent digital library technology is able to deal with these new emerging trends, and ii) to verify if the MILOS multimedia content management system is capable of providing effective tools to rapidly develop a multimedia digital library application with demanding requirements.

2 The PhotoBook digital library application

On-line photo albums are mainly addressed to non-professional users. However, they can be reasonably considered as digital library applications. In fact, such systems typically offer important functionality also offered by professional digital library systems. As an example, on-line photo albums offer storage and preservation services, privacy and rights management, personalization, metadata editing and annotation functionality, advanced search functionality.

Two distinct types of users can be broadly identified for such systems. Users can act as *publishers* when they publish, annotate, classify, and manage digital photos. Users can act as *searchers* when they search for published digital material. Both publishers, and searchers are non-professional users of these on-line services. The two roles sometime can be merged. Many people are in fact at the same time publishers and searchers.

On-line photo albums nowadays represent an emergent phenomenon of the internet society. Several stand-alone on-line photo album services are in fact available on the internet. In addition, almost all internet providers, portals, search engines, photo camera producer, and photo printing services have added an on-line photo albums to the services that they already provide.

In the following we discuss the requirements of the PhotoBook (http://milos.isti.cnr.it/) application, its architecture and the various components.

2.1 PhotoBook Application Functionality

The PhotoBook application is intended to be accessible on-line by everybody. It offers services to two categories of users: *non-registered users* and *registered users*.

Non-registered users can use the PhotoBook application to search for and access photos that were uploaded in the system and made publicly available.

Registered users in addition to the capabilities of the non-registered users can also

1. upload photos in the system
2. manage their own photos

3. share their photos with friends
4. make their photo publicly available

Each photo managed by the PhotoBook has one single owner, which is the user that uploaded it (we suppose that a person that uploads a picture owns it or he/she has the right to do it). The owner can set a photo to be *private* or *public*.

All users (registered and non-registered) should be allowed to search and access digital pictures that were uploaded in the system and that were marked by the owner as public.

Registered users can organize their own photos in *albums*. An album is basically a *collection* of photos. For instance, a user can decide to create an album containing the photos that he/she took during last summer. A photo may belong to several albums at the same time. Users can share an album (containing both private and public photos) with friends. A private photo can be accessed just by the owner of the photo and by his friends, when they are given an handler to an album that contains it. A user's friend does not need to be registered in the system. Access to an album is obtained by using a system-generated URL containing the handler to the album. Every non-registered user can access an album using the album handler.

The owner of an album can remove an album at any time. An album deletion does not delete the photos that it contains, which must be explicitly removed from the system if needed.

When a registered user uploads a new photo, he/she can associate it with some descriptions related to the picture's content. Descriptions can be changed and refined afterward. A bulk upload functionality is also supported to easily insert photos having common descriptions. For instance, a user can insert, with a single action, all photos taken during last weekend in the mountains. In this case, all inserted photos are associated with the same common description.

In addition to descriptions created by the users, the system automatically analyzes photos to extract additional metadata. Specifically, feature descriptors that enable similarity search are automatically extracted. Similarity search [8] allows users to search for pictures similar to pictures chosen as queries. This possibility can be particularly useful to retrieve poorly described pictures. Consider that, as previously stated, the PhotoBook application is addressed to a non professional target. Therefore, imprecise, erroneous, incomplete, or completely missing descriptions may frequently occur. Similarity search is an option for searching for photos of interest, which is really useful especially in this non-professional context. With similarity search, a user can be able to retrieve, for instance, pictures of the tour Eiffel by using another picture of the tour Eiffel as a query, even if the retrieved pictures were not correctly annotated by their owner.

Metadata manually and automatically generated are represented by using standard metadata schema. Specifically we have used MPEG-7 [5] metadata schema, given that it is able to represent both low level feature descriptors, for similarity search, and more conceptual descriptions. However, given that the PhotoBook application is intended to be used by non professional users, the metadata complexity is hidden to them. This implies that information is presented to the user in a natural and intuitive way and that users are asked to insert a minimal amount of descriptions when uploading photos. A relevant part of information is obtained automatically, and the system is able to satisfy

most of the user requirements even with incomplete, erroneous, or partial information. For instance, in addition to image analysis to support similarity search, a lot of more conceptual information can be obtained exploiting file names and folders names.

During photo management and photo searching activities, users see on the screen the photo thumbnails. However, a user can download full size pictures, if needed.

2.2 PhotoBook Architecture

The architecture of the PhotoBook application is sketched in Figure 1. It is a classical n-tier application, where the data layer, the application layer, the presentation layer, and the client layer are responsible of different classes of activity of the application.

At the data layer we have MILOS, which is responsible for the management, access, and retrieval, of all types of data of the application. Data managed by MILOS include pictures uploaded by users, metadata, and user data.

At the application layer we have a set of components responsible of mediating the interaction of the modules that implement the web user interface with MILOS. These components actually implement the application's logic, separately and independently from the user interface logic and the data management logic. These components are responsible of checking the credentials of users, organizing retrieved result on behalf of the application logic, translating the user queries into correct queries to MILOS, building valid metadata on the basis of the user input, implementing storage strategies for the uploaded material (relying on the MILOS features), and generating additional metadata by analyzing uploaded data. Interaction with MILOS is obtained using the SOAP protocol, being MILOS a Web service. These components are also implemented as Web services.

The presentation layer contains the software modules in charge of drawing the user interface for the client layer. PhotoBook is a web application: accordingly, the interface layer is composed of Java Server Page (JSP) modules which dynamically generate the web user interface. These modules interact with the application layer by using SOAP.

Clients access PhotoBook by using a normal web browser. In addition at the client side, users may optionally use a Java bulk-load component that allows them to upload several pictures in the system, and to locally analyze them to automatically generate additional metadata. The use of the bulk-load tool, moves part of the logic for metadata generation to the client side, distributing the burden of image analysis among several clients and improving upload performance of the system.

2.3 The PhotoBook user interface

A sketch of the main web interfaces is shown in Figure 2. The home page of the PhotoBook application is shown in Figure 2a. From the home page, every user (registered and non-registered) can search for public material on the system, login for managing the owned material, registering into the system. From the home page users can search for pictures by using a fielded search or similarity search. In case of fielded search users can search for pictures by expressing restrictions on the owner of the pictures, the location where they were taken, their title, and on the textual description of the pictures. In case

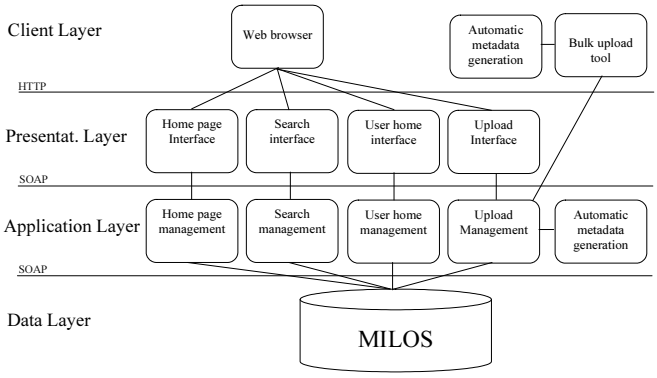

Fig. 1. Architecture of the PhotoBook Application

of similarity search, the user can search by choosing a picture among those randomly proposed by the system. Random pictures can be renewed on demand by the user.

Results are shown in the search page (Figure 2b). From there, users can refine their queries by choosing a picture in the result to submit a new similarity search or to submit a complex search query, which combines similarity and fielded search. For instance, a user can search for images similar to the chosen one, whose location is Pisa.

Registered users that enter the system (Figure 2c), can also manage their own collection of pictures. Registered users can update metadata associated with pictures, organize pictures in thematic albums, share albums with friends, and upload new pictures.

There are two options for uploading new pictures. Registered users can use the web interface (Figure 2d) or a bulk-load tool running on their computers. By using the web interface users can upload up to two pictures at a time, by specifying common descriptions for both. In this case, automatic metadata extraction for similarity search is executed on the PhotoBook server. By using the bulk-load tool, users can submit an arbitrary amount of pictures from their hard disk. In this case, users can assign common descriptions to the uploaded pictures. In addition the bulk-load tool can refine these descriptions by using information extracted from the folder and file names. Image analysis for similarity search is also performed on the user computer. By using the upload tool, the PhotoBook server has just to register the insertions, store the pictures, and update the internal indexes.

3 Metadata Management

We decided to use MPEG-7 metadata [5] for the image description. MPEG-7, in fact, is the standard for multimedia content description. Figure 3a gives an example of the MPEG-7 description of a picture. An MPEG-7 description contains low level features to be used for similarity search, conceptual content descriptions, usage rights, creation time information, etc. Specifically, the `<VisualDescriptor>` tags, in the figure, contain scalable color, color layout, color structure, edge histogram, homogeneous texture information to be used for image similarity search. MILOS indexes this tag with a

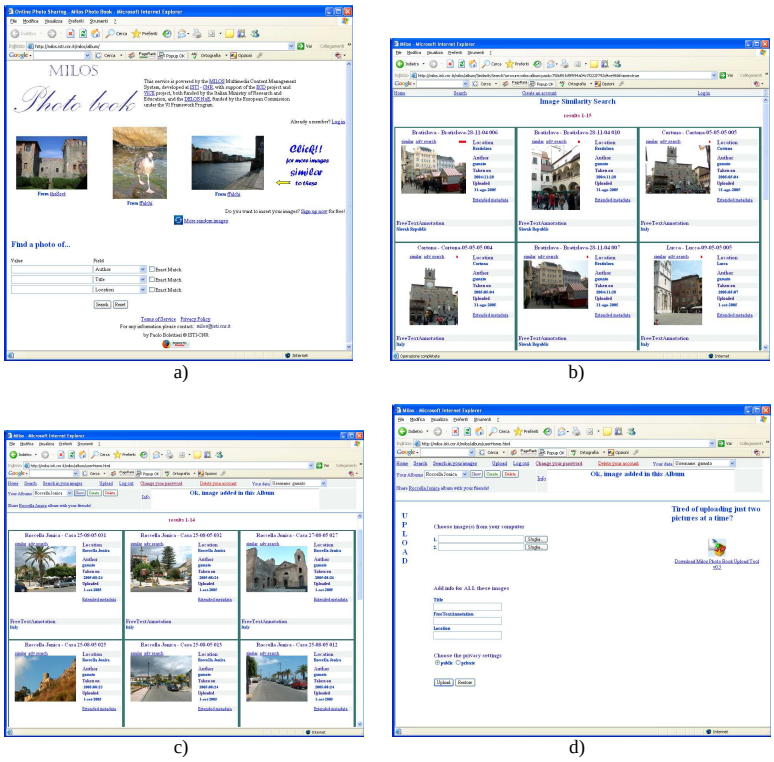

Fig. 2. The PhotoBook interface (http://milos.isti.cnr.it). a) The home page of the PhotoBook application, b) The search interface of the PhotoBook application, c) The registered user page of the PhotoBook application, d) The upload page of the PhotoBook application

special index to offer efficient similarity search. Conceptual information is contained in the `<Title>`, `<Abstract>`, and `<Location>` tags. Right management information is contained in tags `<UsageInformation>`. Creation time information is maintained in `<CreationTool>` tag. Specifically, eXtended Image File Format (XIFF) information is automatically extracted from pictures. This information includes parameters set in the camera when the photo was taken, the type of camera, etc.

Users can create thematic albums containing pictures related to an event. As shown in Figure 3b, albums are also encoded in XML and contain basically a name, an owner, and a set of pictures included in the album.

User data are also very simple, as shown in Figure 3c. A user has a username, a password, and an email address.

3.1 Automatic image processing

Feature extraction was performed employing an application we built upon the MPEG-7 experimentation model (XM) of MPEG-7 Part 6: Reference Software. For the PhotoBook we extract 5 MPEG-7 descriptors: ScalableColor (a color Histogram in the

```
<Mpeg7 schemaLocation="urn:mpeg:mpeg7:schema:2001 Mpeg7-2001.xsd" >
  <Description type="ContentEntityType" >
    <MultimediaContent type="ImageType" >
      <Image>
        <MediaLocator>
          <MediaUri>
urn:milos:album:paolo:image_jpeg:7897056ecc55cd6f7cffa78413e4e2ac
          </MediaUri>
        </MediaLocator>
        <VisualDescriptor type="...." .... >....</VisualDescriptor>
        <UsageInformation>
              <Rights> <RightsID>paolo:public</RightsID> </Rights>
        </UsageInformation>
        <CreationInformation>
          <Creation>
            <Title>Tour in Umbria</Title>
            <Abstract><FreeTextAnnotation>...</FreeTextAnnotation></Abstract>
            <Creator><Role href="creatorCS" ><Name>creator</Name></Role>
              <Agent type="PersonType" >
                <Name><GivenName>paolo</GivenName></Name>
              </Agent>
            </Creator>
            <CreationCoordinates>
              <Location><Name>Perugia</Name><Region></Region></Location>
            </CreationCoordinates>
            <CreationTool>
                        ....eXtended Image File Format (Xiff) data....
              <Tool><Name>Canon Canon PowerShot A85</Name></Tool>
            </CreationTool>
          </Creation>
        </CreationInformation>
      </Image>
    </MultimediaContent>
    <DescriptionMetadata>
      <CreationTime>Aug 5, 2005</CreationTime>
    </DescriptionMetadata>
  </Description>
</Mpeg7>
```

a)

```
<album>
  <owner>gamato</owner>
  <name>Roccella Jonica</name>
  <id>fead7ff5333fa069401abe8bf2521d3d</id>
  <urn>.....</urn>
  <urn>.....</urn>
  .....
</album>
```

b)

```
<login>
   <username>gamato</username>
   <password>sjadfe</password>
   <email>gamato@interfree.it</email>
...
</login>
```

c)

Fig. 3. Metadata used in the PhotoBook application: a) Mpeg7 metadata to describe the pictures, b) representation of albums (thematic collection pictures), c) user data

HSV Color Space), ColorStructure (captures both color content and information about the spatial arrangement of the colors), ColorLayout (represents the spatial layout of color images), EdgeHistogram (spatial distribution of five types of edges), and HomogeneousTexture (characterizes the properties of texture in an image). For all these descriptors the suggested distance functions are metric. The result of the extraction process is an XML document like the one in Figure 3 without usage and creation information. The values inside the `<VisualDescriptor>` tags are integer vectors (ScalableColor, ColorStructure and EdgeHistogram) or more complicated XML subtrees with integers as values (ColorLayout and HomogeneousTexture).

4 Search capabilities

The MILOS native XML database/repository supports high performance search and retrieval on heavily structured XML documents, relying on specific index structures [1, 7], as well as full text search [6], automatic classification [4], and feature similarity search [3]. This is compatible with current trends of the new generation of XML encoded metadata standards, such as MPEG-7, which include in their description also features automatically extracted from visual documents, such as color histograms, textures, shapes, etc. Specifically, the MILOS XML database allows the system administrator to associate specific XML element names with special indexes. For instance, the tag name `<abstract>` can be associated with a full text index. On the other hand, the MPEG-7 `<VisualDescriptor>` tag can be associated with a similarity search index.

The PhotoBook application allows users to use similarity search, by exploiting the `<VisualDescriptor>` tags included in the MPEG-7 metadata. Users can also sub-

mit full-text queries, by using the full-text descriptions included in the `<abstract>` tags. In addition, users can perform a search by expressing queries that use any tag content of the MPEG-7 metadata. Most important, users can also express complex queries, where full-text, fielded, and similarity search is conveniently combined.

5 Conclusions

This paper illustrates the main characteristics, architecture and design choices adopted in the PhotoBook Digital Library application, which supports archiving, indexing, sharing and content-based search of photos. PhotoBook was built by using a general purpose Multimedia Content Management System, MILOS, which is specifically designed to create high performance Digital Library applications. By using MILOS we had several advantages: (a) the development of the entire application was realized with a limited effort – approximately one month of work of an experienced programmer, that developed the user interface of the application, (b) powerful and efficient content-based search capabilities have been included, (c) flexible storage management is possible – for example, if the size of the archive will increase in the future, the storage strategies can change without any modification to the application and transparently for end-users, (d) integration with other similar archives, based on different metadata formats, or archiving of photos represented in metadata formats different from that used in PhotoBook, can be easily obtained.

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