OVERVIEW OF JPSEARCH: A STANDARD FOR IMAGE SEARCH AND RETRIEVAL

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ABSTRACT

In this paper, we review the on-going JPSearch standardization activity. Its goal is to provide a standard for interoperability for image search and retrieval systems. More specifically, JPSearch aims at defining the interfaces and protocols for data exchange between devices and systems.

1. INTRODUCTION

Powerful image compression and coding standards, along with rapid evolution in computer technologies, image sensors, storage devices and networking, have made digital imaging a tremendous success with consumers and businesses. As a result, a phenomenal growth in personal, professional and shared digital image collections has been observed in recent years. However, searching and managing these large distributed collections represents a considerable challenge.

With the evolution from film to digital camera, it has become easy, fast and free to take lots of photographs. Yet, to organize the resulting digital photo shoebox, a modern variation of the traditional photo shoebox, remains cumbersome. Photo organizer applications allow for a simple classification of images to generate albums or slideshows, but often require manually annotating the whole collection, a very tedious and time-consuming process. Furthermore, because the portability of data and metadata is not guaranteed, the consumer is de facto locked into one system.

Stock photography companies, such as Getty Images [1] or Corbis [2], boast tens of millions of digital photographs. These photographs are labeled and organized based on professionally developed taxonomies. The tremendous cost of generating the annotation is justified and recouped by the high commercial value of the content.

More recently, photo sharing websites, such as Flickr [3], have gained in popularity, fueled by innovative online community tools that allow users to categorize images by use of tags, in order to allow searchers to easily find images concerning a certain topic. The resulting folksonomy [4] consists of collaboratively generated, open-ended labels authored by the users, and sometimes submitters, of the content. However, again these systems are closed and lock up the user.

The JPEG committee, formally known as ISO/IEC JTC1 SC29 WG 1, has throughout the years developed and brought to market successful standards for data representation such as JPEG [5] and JPEG 2000 [6].

Recognizing the need of a standard for interoperability for image search and retrieval systems, JPEG has recently launched a new activity, JPSearch [7][8], also known more formally as ISO/IEC 24800. The aim of this standard is to allow different image management systems to inter-operate. It is foreseen that JPSearch will enable more complete solutions and give consumers and businesses confidence in the longevity of their annotations and collection maintenance effort.

In this paper, we review the on-going JPSearch standardization activity. As of the time of this writing, JPSearch is still at an early stage. Per consequent, the description below is still subject to possibly significant changes.

This paper is structured as follow. We discuss the main features of JPSearch in Sec. 2. We then introduce the JPSearch framework and system architecture in Sec. 3. The structure of the JPSearch specification is outlined in Sec. 4, where the scope of each part is detailed. In Sec. 5, we present a number of relevant use cases. Finally, a summary is given in Sec. 6.

2. JPSEARCH OVERVIEW

JPSearch aims at inter-operability between devices and systems by defining the interfaces and protocols for data

exchange between them, while restricting as little as possible how those devices, systems or components perform their task. Existing search systems are implemented in a way that tightly couples many elements of the search process. JPSearch provides an abstract framework as well as a modular and flexible search architecture that allows an alignment of system design to a standard framework. In this framework, inter-operability can be defined in many ways, for example between self-contained vertical image search systems that interact to provide federated search, between the different layers of image search so that these components could be supplied by different best-of-breed vendors, or at the metadata level such that different systems may add, update or query metadata for images and image collections.

In particular, JPSearch facilitates the use and reuse of metadata. A user makes a heavy investment when annotating a collection of images. With JPSearch, the portability of the metadata is guaranteed, hence allowing a user to subsequently migrate to applications or systems which best suit his needs. In community based image sharing systems, this portability enables the owner of an image collection to merge community metadata back into his own management system, hence helping to overcome the manual annotation bottleneck.

Similarly, JPSearch makes possible the use and reuse of ontologies to provide a common language for contexts. Indeed, searching for images always takes place in a context, either implicit or explicit. A common format for handling context allows a user to carry his context with him to different search engines. It also allows the context to be owned by the user and not by the system, hence protecting the user's privacy.

JPSearch also provides a common query language, giving search providers a reference standard to remove ambiguity in the formulation of a query, and to make searching over shared repositories consistent. The common query language also defines query management process such as relevance feedback.

Finally, by providing a solution for the carriage of image collections and associated metadata between compliant devices and systems, JPSearch enables image search and retrieval functionality across multiple repositories. Therefore, it allows leveraging the generally high cost of creating metadata.

3. JPSEARCH FRAMEWORK AND SYSTEM ARCHITECTURE

A JPSearch architecture has been defined, as illustrated in Figure 1. This architecture is generic in the sense that most existing image search systems can be straightforwardly mapped to it.

The architecture is divided into four layers, namely:

- **User layer:** The user layer aims at the personalization of the search service.
- **Query layer:** The query layer is dealing with the formulation of the query and presentation of the results.
- **Management layer:** The management layer is handling the distribution of a search task over multiple image repositories.
- **Content layer:** The content layer includes the image repositories and the associated metadata, as well as the corresponding schema and ontology.

Note that while the query, management and content layers are in the scope of JPSearch, the user layer is outside of the scope.

In turn, four independent functional modules are involved in the architecture, as detailed below:

- **Query process:** The query process is part of the query layer. It aims at the efficient execution of search tasks. More specifically, it forms a machine understandable query from the user's search task which is then conveyed to the subsequent management and content layers. Conversely, it validates the search results and ranks them according to the user's criteria. Finally, the query process may also generate a new query based on relevance feedback mechanisms.
- **Repository management process:** The repository management process belongs to the management layer. Its purpose is to allow users to simultaneously search multiple distributed image repositories with the same query. Another purpose is to comprehensively aggregate the results returned from the image repositories.
- **Image repository process:** The image repository process is located in the content layer and supplies basic search functionalities. More specifically, this includes receiving a set of queries, executing the matching of these queries with the stored metadata, and forming a result.
- **Metadata creation and update process:** The metadata creation and update process is also part of the content layer. On the one hand, this process enables to build metadata using a proper schema and ontology definition. On the other hand, this process also provides with the functionality to update the metadata, e.g. by adding, replacing, removing all or part of the metadata. In particular, whenever the image content is modified, it verifies that the metadata is suitably brought up to date.

4. JPSEARCH SPECIFICATION AND SCOPE

JPSearch is a multi-part specification. Five parts are currently envisioned, as detailed hereafter:

- **Part-1: Framework and system components:** This part is a type-3 technical report which provides a global view of JPSearch [8]. In particular, the technical report reviews the traditional approaches to image search and motivates the importance of the user in the search process. It describes a number of use cases in order to identify user needs and requirements. It then explains the overall search and management process. This leads to the introduction of a JPSearch architecture composed of 4 layers: user layer, query layer, management layer and content layer. Finally, the technical report outlines the organization of the JPSearch specification.
- **Part-2: Schema and ontology registration and identification:** This part standardizes a platform-independent format for the import, export and exchange of ontologies. It also defines a registry of ontologies which can be imported into a JPSearch compliant system. Finally, it standardizes basic functions to query and manipulate one or more ontologies in a repository.
- **Part-3: JPSearch query format:** This part provides three standardized functionalities between users and image repositories. Firstly, it allows users to express their search criteria. Secondly, it allows users to describe the aggregated return result sets for user presentation or machine consumption. Thirdly, it defines query management processes such as relevance feedback.
- **Part-4: Metadata embedded in image data (JPEG-1 and JPEG-2000) file format:** This part specifies image data exchange format with associated metadata to accelerate the re-use of metadata. It supports two functionalities, namely the mobility of metadata and the persistent association of metadata with image.
- **Part-5: Data interchange format between image repositories:** This part standardizes a format for the exchange of image collections and respective metadata between JPSearch compliant repositories. The data interchange format enables the synchronization of repositories in order to facilitate simple and fully interoperable exchange across different devices and platforms.

The overall structure of the JPSearch standard is illustrated in Figure 2, where the role of each part of the specification is shown in the previously defined JPSearch architecture.

5. USE CASES

To define the scope of JPSearch, use cases illustrating the current problems with image search and management have been identified. An extended and detailed list of these use cases can be found in [8], while some of them are mentioned hereafter:

- **Searching images in stock photo collections for usage in magazines:** The user wishes to buy a selection of images in order to illustrate a publication to be sold to consumers.
- **Mobile tourist information:** A tourist is in an unfamiliar place, sees an interesting landmark and wants to know what it is. He takes a picture of the landmark on his mobile phone and sends it to a tourist information server which calls him back and gives him the information.
- **Surveillance search from desktop to mobile device with alerts:** The user sets up a visual surveillance query on a desktop computer, saves the query for real-time monitoring with results saved periodically for retrieval from a mobile device.
- **Finding illegal or unauthorized use of images:** The user holds his original content. He wants to find unauthorized variations of his original content using search engines.
- **Matching images between collections for synchronization:** The user ends up with a large collection of images stored on multiple computers, laptops, external drives, portable USB key drives, portable photo players, photo sharing websites, photo printing websites, and mobile phones. He needs his collection to be synchronized across all platforms.
- **Image search in the medical domain:** Many pathologies have visual symptoms which are essential for doctors doing diagnosis. There are cases where the visual symptoms are not familiar and the doctor would like to consult a visual reference material (an atlas, or previously diagnosed reference cases). The user (a doctor in a hospital clinic) searches then for the best matches to the symptoms and retrieves case histories (including other images, metadata, text, etc.) to aid his/her diagnosis.
- **Servants image searchers:** The user accesses content by means of a standard web browser. The web site forwards the user's requests to the application using a standard communication protocol. For each provided query, the application creates a personalized intelligent search agent that will effectively take care of the search on behalf of the user.

- **Open federated repositories:** Digital archives set up access to part of their databases for being consulted from cultural and institutional search interfaces. The data provider manages the database and provides a standardized protocol to consult the data. The service provider manages in turn the added value services (search and retrieval and presentation), harvests the collection and provides the user interface.

6. SUMMARY

In this paper, we have reviewed the on-going JPSearch standardization activity. JPSearch aims at a standard for interoperability for image search and retrieval systems. We have first discussed the limitations of current systems and motivations for JPSearch. We have then introduced the JPSearch framework and system architecture. Next, we have discussed the scope of each part of the JPSearch specification. Finally, we have presented a number of relevant use cases.

7. ACKNOWLEDGEMENT

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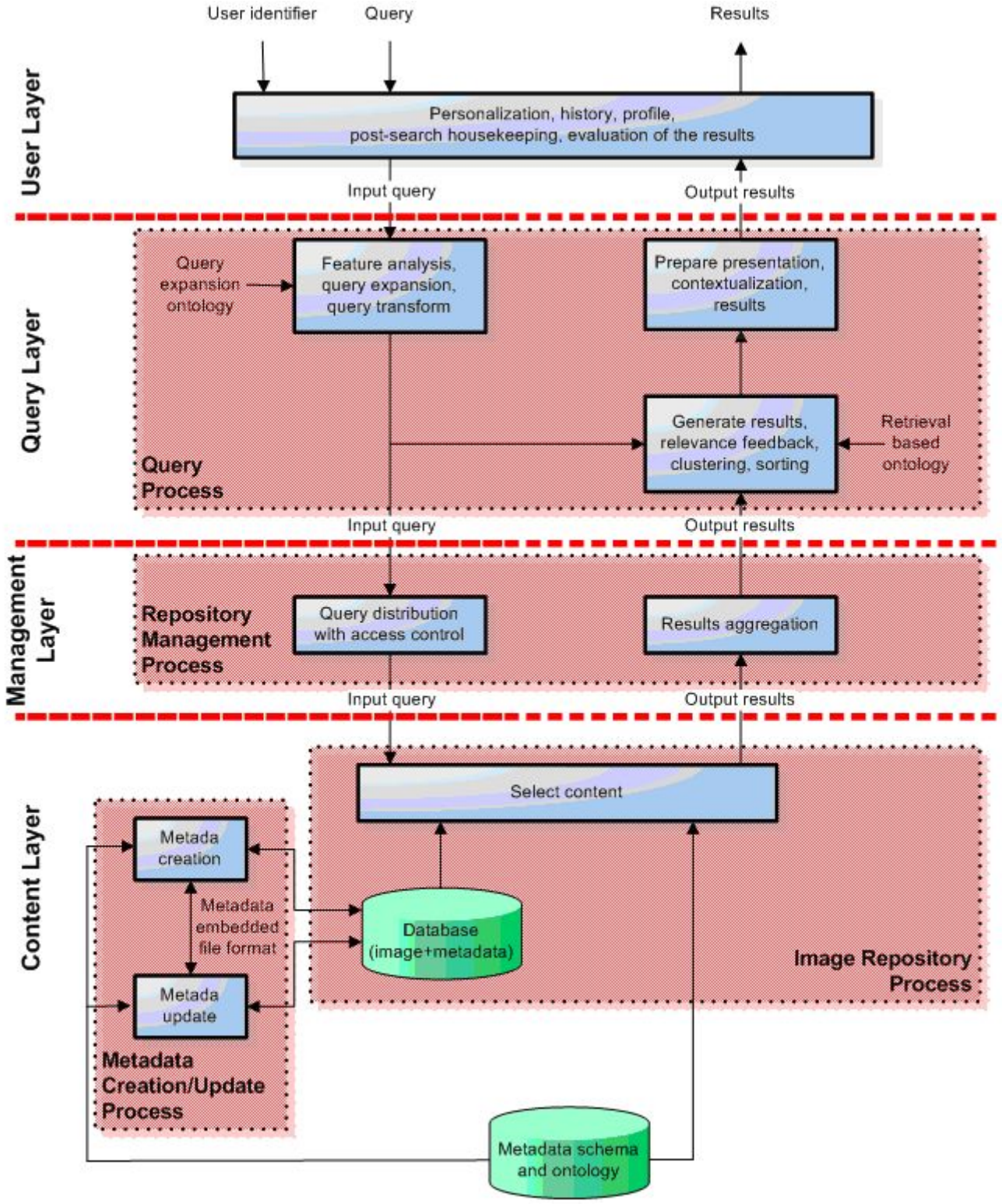

Figure 1: JPSearch architecture (adapted from [8]).

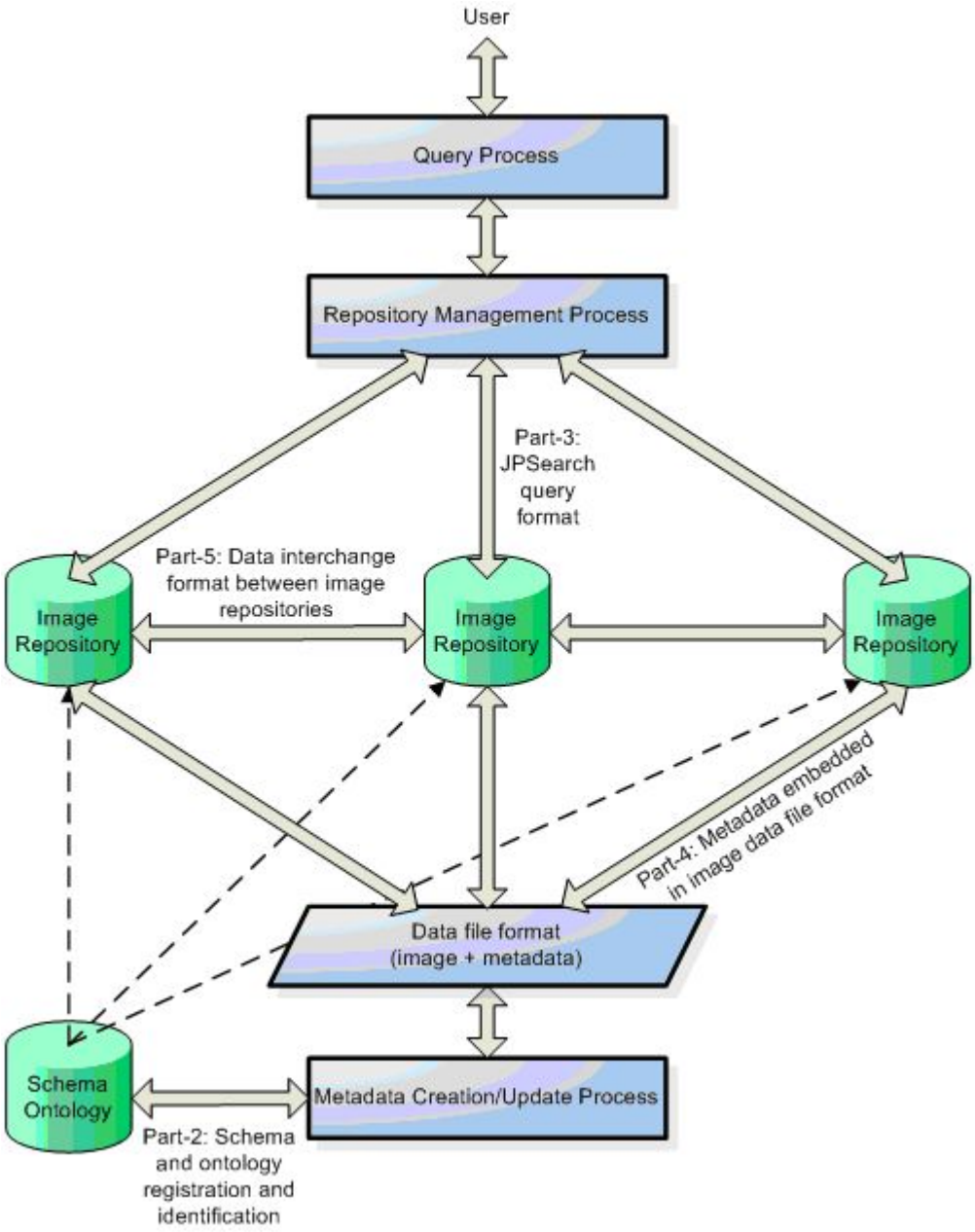

Figure 2: Overall structure of JPSearch (adapted from [8]).