JPSearch: New international standard providing interoperable framework for image search and sharing

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A R T I C L E   I N F O

A B S T R A C T

For the last 15 years, there have been various research and great advances in the field of content-based search and retrieval of images. In this paper, we present an overview of the JPSearch Standard, which is a recently published set of international standards providing interoperable framework for image search and sharing. The JPSearch standard is composed of six parts, which are Part 1: System framework and components, Part 2: Registration, identification and management of schema and ontology, Part 3: Query format, Part 4: File format for metadata embedded in image data (JPEG and JPEG 2000), Part 5: Data interchange format between image repositories, Part 6: Reference software. The Part 1 provides motivation and overview of the JPSearch framework. The Part 2 supports interoperability among various metadata specifications and social tagging using the specification of core metadata and translation rule description language. The Part 3 provides powerful image query language for interoperability among multiple image databases. The Part 4 specifies a file format based on JPEG and JPEG 2000 file format in which arbitrary number of metadata description of a image can be embedded. The Part 5 supports interoperability in interchanging images with metadata between image repositories. Finally, the Part 6 provides reference and utility softwares based on which the JPSearch compliant systems can be easily developed. In this paper, summaries and usage examples for each part of the JPSearch standard are presented.

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1. Introduction

Since the introduction of Query-by-Image-Content [1], there have been various research and great advances in the field of content-based search and retrieval of images [2]. The effort of research on image search and retrieval was greatly increased with the popularity of digital cameras and phone cameras. Some efforts, which may not cover the complete scope of JPSearch Framework, related to parts of JPSearch standard can be found in [3–8].

In 2003, 50 million units of digital cameras were sold worldwide according to Photo Marketing Association (PMA) (www.pmai.org) marketing research, and the digital camera market was growing rapidly. Stimulated by the explosion of digital camera market and JPEG images, JPEG working group of ISO/IEC started to explore the JPSearch

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project with the objective of specifying metadata format and related functionalities to support flexible and efficient still image search, in April 2004.

The idea of developing standard for image search and retrieval became concretely structured over time. Providing an abstract framework of search architecture that decouples the components of image search and a standard interface between these components became the objectives of the JPSearch standard. The idea of searching images using metadata and developing related functionalities had been exchanged with MPEG working group. It evolved over time resulting in the idea of producing one technical report, four parts of technical specifications and finally a reference software from 2007 to 2011.

The development of the JPSearch standard aimed at solving three main problems as the following:

- Lack of the ability to reuse metadata
  When a user annotates a collection of images using one system, it is almost impossible to adopt second type of annotation system with additional functionality without redoing the annotation. Also, when a community of users are annotating a single shared image, which we call a social tagging, it is very hard to merge all the annotations into a single unified metadata.
- Lack of a common query format and search semantics
  Search is an essential functionality of large image repositories. However, the various systems providing image search functionality do not provide a common way of specifying a search. Therefore, a query given by a user may be interpreted in different ways. To provide homogeneous interface for the users and make searching over various image repositories consistent, a common query format and search semantics should be defined.
- Lack of a common format for handling context in searching
  The terms that people use for query may have different meaning from user to user and from case to case. The specific meaning of a term used may depend on the context of use. For the system to understand the context of a specific user there should be a common format of specifying the context of a certain term being used in the query.

About 4 years have been spent to provide a concrete specification of standard framework for image search systems. As a result, one technical report of JPSearch Part 1 and technical specifications of five parts are either published or on their way to publication as international standards, which are JPSearch Part 2: Registration, identification and management of schema and ontology [9], JPSearch Part 3: Query format [10], JPSearch Part 4: File format for metadata embedded in image data (JPEG and JPEG 2000) [11], JPSearch Part 5: Data interchange format between image repositories [12] and JPSearch Part 6: Reference software and conformance [13].

Part 1 is the technical report providing an overview of the JPSearch standard with some usage scenarios.

Part 2 specifies three main tools to support interoperability between image descriptions based on different metadata schemas. The core metadata serves two purposes. One is to provide definitions of essential metadata describing images. The other is to provide a reference in describing third party metadata with help of translation rules. The JPSearch Translation Rules Declaration Language (JPTRDL) is defined to enable specifying guidelines for translating third party defined metadata schema to core metadata. In addition, management tools are defined to register, update and retrieve third party metadata with translation rule to the JPSearch metadata authority, so that users can understand metadata instances which are not defined using JPSearch Core Metadata.

Part 3 specifies message format in XML schema to be sent and received between information requestors (clients) and information providers (database servers). These messages are divided into three types of input query, query output, and query management tools. Input query specifies the syntax and semantics for composition of queries by specifying complex combinations of query conditions, such as boolean combinations of various query conditions, mix of query conditions of various media types as well as relevance feedback. Query output specifies the expected message format and information to be included in the returned data from the responder. Query management tools help users or applications to select the service by defining message formats describing service capabilities of individual service provider.

Part 4 specifies file formats based on JPEG file format and JPEG 2000 file format to carry metadata with the images. These file formats allow multiple metadata to be embedded inside the JPEG file or JPEG 2000 file. Social tagging is supported by enabling multiple occurrences of metadata inside an image file.

Part 5 specifies a data interchange format for the exchange of image collections with metadata which can be provided at the individual image level as well as the collection level. By defining the interchange format, JPSearch allows synchronization between image repositories, independent of platform or device types.

Part 6 provides reference and utility software to show normative use of the JPSearch tools and various use cases.

Fig. 1 shows the architecture of JPSearch Framework. When a query is composed, it can be represented by the Input Query of JPSearch Query Format defined in Part 3, and is marked as (1) in the figure. The query can be based on the metadata or an image implementing query-by-example. When an example image is given as a query, either a feature extracted from the image or a metadata can be given as the query condition. If the metadata given in the query is defined by a metadata schema other than the JPSearch Core metadata, it can be translated into an instance of the JPSearch core metadata, shown in (8), by following the interpretation of the translation rules defined in Part 2 and represented by (2). The query can be sent directly or after going through the query preprocessor to the database. The database can be a collection of images and metadata as shown in (5) or a collection of images in which metadata is embedded using the file format defined in Part 4 as shown in (4). The database or the collection of images with metadata can be exchanged using the interchange format defined in Part 5 as shown in (3). The image file format defined in