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About Relationship between Metadata and Content of Digital Photo Images

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Abstract. Working with files, containing raster graphical information, analyzing the content is a difficult task. Even something elementary for human eye recognition, can appear unachievable for program recognition. That is why, the metadata of the digital photo images are from particular importance, because they can give some information about the content of the image. For example, a number of technical characteristics (as picture taking conditions), saved as metadata, bring information about the content and the context of the photo image. The paper discusses the main metadata standards of files containing digital photo images. Software system realizing extraction of metadata in EXIF, IPTC and XMP standards with the aim of finding information about image content and context is presented. The system saves extracted metadata in database and gives the opportunity for searching photo images with different criteria.

Keywords: Photo Metadata Standards, Metadata Extraction, Metadata.

1 Introduction

Digital images besides visual information, visible for everyone, bring many hidden data describing the image, named *metadata*. A number of *standards for* such *metadata* exist – IPTC IIM, IPTC Core, IPTC Extension [3], TIFF, Dublin Core [2], Exif [6], XMP [1], ICC, etc. There is no unified standard for description of images established yet, which brings problems with metadata compatibility. The digital images are described through different standard and even more often through some of them. It resulted in duplication of metadata information and sometimes in difference of the data in the same field of the different standards. Another big problem is that many companies do not disseminate free their standards, mostly with commercial purpose. Their metadata can be read only with software, given from producer, which rarely is platform independent.

The present work presents a *software system for extraction of metadata*, containing in every digital photo image (in different standards) with the purpose of content searching. The extracted metadata are saved in database (DB), which gives the opportunity for organizing the search in different criteria.

2 File Formats for Digital Images

The contemporary file formats for raster images are containers for different type of data. The most widespread such file format is JPEG.

JPEG file [4] is composed of start marker, different number of metadata fields, after the last field graphical data is located and end marker. Each metadata field is consisting of marker, showing what kind of information there is in the field, following by field size in bytes and at the end the information itself. In this way the field, that can not be read (for example metadata, saved in an unknown format), could be skipped without any reflection to the reading of the visual information. Like that maximum readability (compatibility) of files from large number of applications and metadata interoperability between different operating systems and software is provided.

The structure of *TIFF* file format [7] is also similar container, beginning with header, followed by the so called Image File Directories (IFD), consisting of number of fields, content of fields and pointer to the next directory. The fields are containing markers for kind and type of information, size of information and pointer to information itself.

On the base of TIFF a large part of file formats used from digital cameras are developed. The details about the structure of file formats are hidden, because usually it is a firm secret of the producer, but the basic structure is kept, which allows a large number of different file formats to be treated in one unified way.

3 Metadata Standards for Digital Images

The most popular metadata standard *EXIF* (Exchangeable Image File Format) [6] is developed in 2000 by commercial organization Japan Electronics and Information Technology Industries Association (JEITA). EXIF is used by raster graphical files, as the most often the standard is met in JPEG files, but also can be discovered in TIFF, PNG, MIFF, HDP, TIFF based RAW images, and even in AVI and MOV video files. Almost all digital cameras use EXIF format.

The structure of EXIF for saving metadata is based on the structure of TIFF format. The aim of the standard is mechanism for saving data to compressed and uncompressed image to be the same. In files with uncompressed graphical information (TIFF), EXIF metadata are inserted as additional IFD directory. In files with compressed graphical information (JPEG), EXIF metadata are saved in a special field marked with marker APP1, which actually is TIFF file without graphical information.

The EXIF directory, where the metadata are saved, entirely follows TIFF convention. For the fields in the directory are determined kind (by tag), type, number of information elements and information itself. In EXIF specification, there is 118 tags, divided in categories: attribute information from TIFF (tags relating to image data structure, recording offset, image data characteristics, other); IFD attribute information (tags relating to version, image data characteristics, image configuration, user information, related file information, date and time, picture-taking conditions,

other); GPS attribute information (tags relating to GPS); and interoperability IFD attribute information (attached information related to interoperability).
The large number of tags is linked to technical details of taking a picture from particular digital camera, that is why this standard, in comparison with the rest, has bigger influence. If there is inconsistency in the same duplicated fields in several standards, then they are synchronized with EXIF fields.
The consortium of the biggest world news agencies International Press Telecommunications Council (IPTC) in Great Britain is developed and supported 3 metadata standards for digital images [3]: Information Interchange Model (IIM) from 1991, IPTC Core and IPTC Extension. IPTC Core and Extension are parts of *IPTC Photo Metadata 2008* standard for professional use of news and stock photos. IPTC Core provides the same metadata set as IIM, but the technical realization is based on Adobe XMP technology. IPTC Extension improves and adds new metadata to IPTC Core. IPTC is also widespread metadata standard, but it is older and is displaced gradually from XMP. IPTC is used in JPG, TIFF, PNG, MIFF, PS, PDF, PSD and DNG image files.
The storage of IPTC metadata in various file formats is different – for example in TIFF files the place for saving tags can be pointed from EXIF field IPTC-NAA, while in JPEG files metadata are saved in a field, marked with marker APP13.
Metadata from this standard aim to give mostly what is documented, from whom, where and for whom. In contrast to EXIF, IPTC metadata are added subsequently, but not during the creation of the image itself. For that reason their priority is lower in the case of difference in the content of duplicated fields.
XPM (Extensible Metadata Platform) of Adobe Systems Inc. [1] standardizes defining, creation and processing of extended metadata. Addition of metadata become in the file itself. XMP is using in a lot of PDF-editor, photo and photo editor programs. XMP standard defines some base schemas, with which can easy be described the history of the file, passed over a lot of steps of processing – from taking a picture, through scanning, photo processing, till final image. XMP allows each software, used in working process, to add its metadata, which in the end are the part of the document history.
XMP metadata are presented as ordinary ASCII coded text on the base of XML.
The biggest advantage of this standard is that, it is created with the possibility for extension. It enables users to add their own metadata without destroying the main metadata structure. XMP allows file, compound with some other files, to inherit and contain their metadata. XMP is developed in such way that is able to be integrated in a huge number of popular formats as PDF, JPEG, JPEG 2000, GIF, PNG, HTML, TIFF, Adobe Illustrator, PSD, PostScript and Encapsulated PostScript. In TIFF, in EXIF directory, there exists a special field (entry), which contains pointer to XMP metadata. In JPEG file, XMP metadata is contained in the field with marker APP1 – the same, in which EXIF metadata is saved.
XMP standard schema includes the following metadata groups: Dublin Core schema, XMP Basic schema, XMP Rights Management schema, XMP Media Management schema, XMP Basic Job Ticket schema, XMP Paged-text schema and XMP Dynamic Media schema. Lots of the software products have their tags as Adobe PDF schema and Photoshop schema. Even whole EXIF and IPTC standards are included. This means that it is possible to have whole set of duplicated metadata.

XMP is an attempt of Adobe to standardize the many heterogeneous and to great extent old methods for adding metadata. For the present this leads to the opposite – instead of replacing other formats with XMP metadata format, all formats exists at the same time with XMP. In this way a bigger variety and heterogeneity are created, as well as the problems with synchronization of duplicated fields in different standards appeared. Metadata Working Group is formed, composed of the big producers of software and hardware, which is attempting to impose mechanisms for metadata concordance.

4 Relationship between Metadata and Content

The work is part of the researches, carried out in the frame of the Project D002-308 *"Automated Metadata Generating for e-Documents Specifications and Standards"*, granted from Bulgarian National Science Fund. The *main goal* of the Project is creating and studying of technologies, methods and tools for automated specifying of documents in different electronic format (textual, graphical, etc.), content (cultural heritage artifacts, learning materials – incl. results from carried out e-learning, spatial information systems, scientific publications, etc.) and location (local multimedia repositories, Internet sites, etc.). The Project scientific *tasks and activities* are organized in 4 work packages (WP):

WP1. Standards of e-documents and tools for their automated generating;
WP2. Automated metadata generation from text documents;
WP3. Automated metadata generating from multimedia documents;
WP4. Automated creating and testing of digital repositories in different areas.

This paper presents the first efforts in WP1 and WP3.

Digital images are created by digital video cameras, photo cameras, scanners, video digitizers, etc. During the recording of the digital image, a number of metadata in different formats are saved. Even in the most of the cases, the metadata in several formats together are saved. Using of metadata to a great extent can facilitate cataloguing, sorting, searching and working with photo images.

A number of technical characteristics (as picture taking conditions), saved as metadata, bring *information about the content and the context* of the photo image. For example, the speed of taking a picture shows if the object in the image was moving (in case of high speed) or not (in case of low speed).

Therefore metadata can be used as criteria for *realization of different searching according to content and context* of the photo images. Combination of the searching by two or more criteria can be used for more precise finding of photo images.

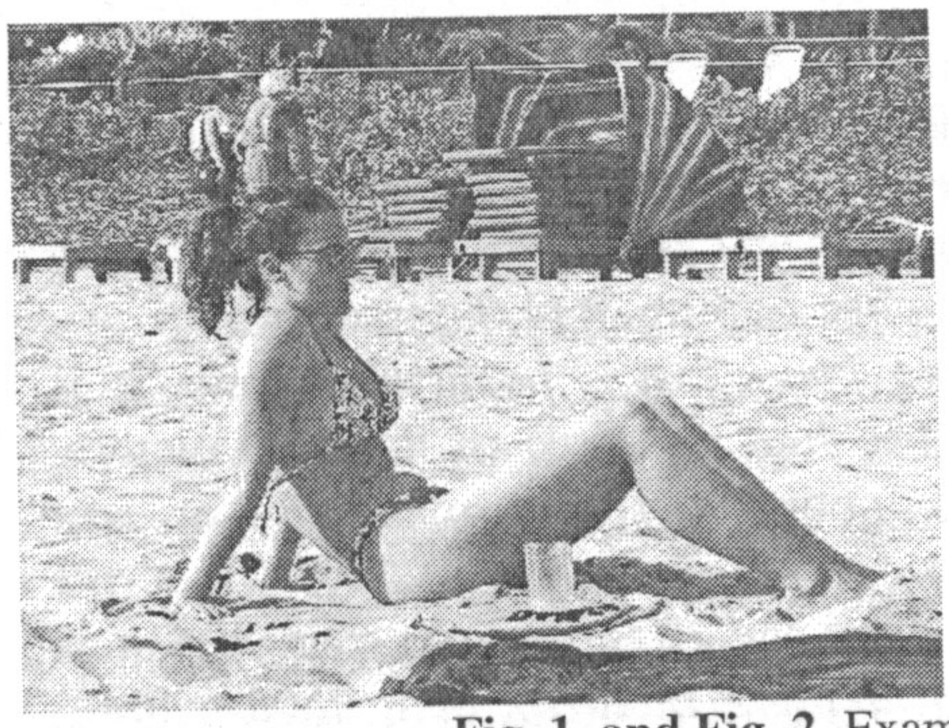
For example, if we want to find *digital photo images of a particular event*, it is possible to do this by searching of metadata for date and time of taking a picture, event in the image, image title, keywords, content of the image and/or text description.

If ISO speed rating, F-number and exposure time are examined, in that case it is possible to determine the *weather and time of taking a picture* (night; total eclipse, crescent, half, gibbous and full moon; showers; clouds; shadows; open shade or heavy overcast; sunset or after sunset; day; weak, bright or hazy sun; etc.), *source of*

the light (candle lit close-ups; Christmas, bright florescent, neon, away from city, dim ambient artificial, cloudy-bright or average lights; flash; spotlight; starlight; bright street lamps; campfires; bonfires; fireworks; burning buildings; brightly lit home interiors at night; bright daylight; extremely bright; etc.) and *image content and context* (home interiors; school or church auditoriums; fairs; amusement parks; floodlit buildings; fountains; monuments; indoor sports; stage shows; circuses; ice shows; football; baseball; brightly lighted nighttime streets; bottom of rainforest canopy; store windows; landscapes; skylines; sand; snow; etc.) – altogether *30 different types of lighting situations* are known in photography [5].
Particularly useful is the searching of photo images with similar characteristics, for example when creating a learning course to illustrate the learning materials with images of different animals, of which have been taken a picture almost from equal distance with similar quality (through using the metadata for distance to the subject, resolution over X and Y).

5 Software System Extracting Metadata

The work presents software system for metadata extraction from digital photo images. The extracted metadata are located in DB with the aim of doing image searching through different criteria. The system is realized with Visual C# and DB management system SQL Server.
The software system is realizing extraction of metadata (the respective metadata standards are in brackets) from the following file formats: JPEG (EXIF, IPTC and XMP), TIFF (EXIF, IPTC and XMP), GIF (XMP), PNG (XMP), BMP, DNG (EXIF, IPTC and XMP). There are proposed different kinds of searching and combinations of them – daylight or night photo, portrait, panoramic landscape, wild animals, snow or sand landscape, sport event, photos from one photographer, etc.
For example, the photo image on Fig. 1. is extracted with ISO speed rating = 100, F-number = 22 and exposure time = 1/125 sec, and using the information from [5] these values give exposure value = 16, which corresponds to the lighting situation: „Subjects in bright daylight on sand or snow".



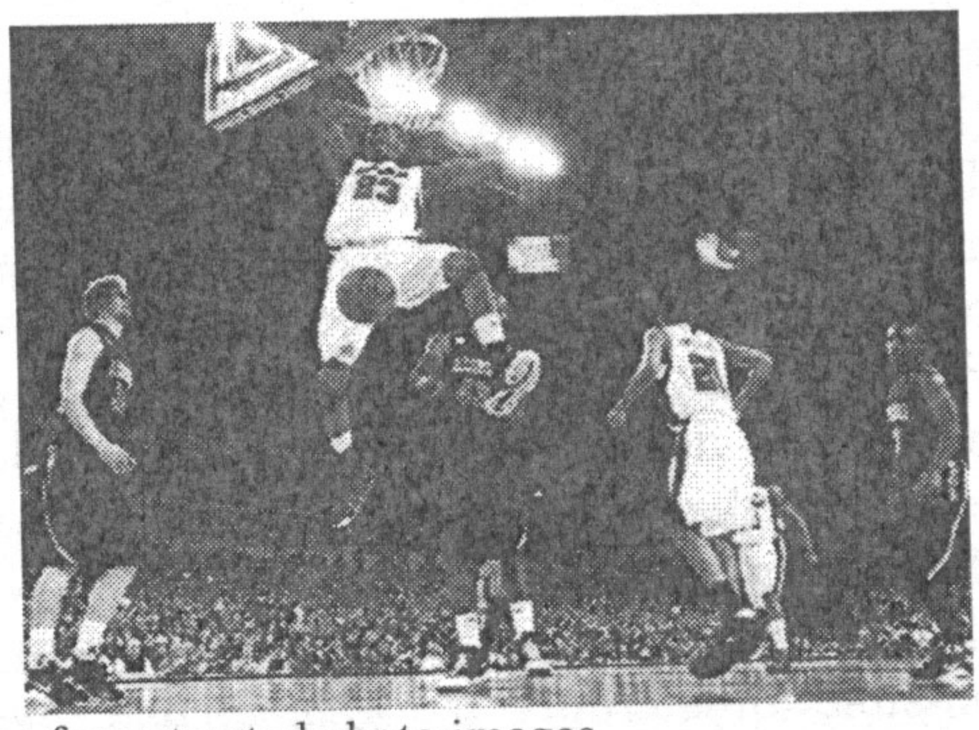


Fig. 1. and Fig. 2. Examples for extracted photo images.

The photo image on Fig. 2. is extracted with ISO speed rating = 200, F-number = 1.4 and exposure time = 1/125 sec, for which exposure value = 7 and according to [5], it corresponds to the lighting situation: „Bottom of rainforest canopy. Brightly lighted nighttime streets. Indoor sports. Stage shows, circuses". In case of Fig. 2., if in addition of three used characteristics are examined also remote distance to the subject and the subjects in motion, the probability for extracting the photo image of indoor sport is increased.

As an additional opportunity, the software program gives *histogram of the image*, which helps the quality of the image to be assessed by the user. The histogram presents distribution of the tones in the image according to their brightness – on the left part are dark tones and on the right part are light tones. The user can understand if the photo image is correctly exposed (if the image is too light then the histogram will have a p□□k on the right or if the image is too dark, the p□□k will be on the left).

6 Conclusions and Future Work

With the development of the image file formats, at the same time formats for saving image metadata are developed. The standardization of metadata formats is also so important, as file format standardization – it provides information interoperability between a number of platforms, operating systems and different software.

Working with files, containing raster graphical information, analyzing the content is a difficult task. Even something elementary for human eye recognition, can appear unachievable for program recognition. That is why, the metadata of the digital photo images are from particular importance, because they can give some information about the content of the image.

The realized system for metadata extraction can be updated and used for *more intelligent searching of digital photo images by content in Internet*. Another application, the system can find in education, as the part of metadata, describing digital images, are identical with metadata of SCORM standard for learning materials. Therefore extracted metadata of the digital images can be used for *automated filling in of SCORM metadata*, if the learning material is a digital image.

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