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UNDERSTANDING AND INTERPRETING ETHNOLOGICAL ARTEFACTS USING SEMANTICALLY ANNOTATED IMAGES

Abstract. Ethnographic Museum in Belgrade, in addition to museum collections, possesses digitized collections of photo negatives and images. Usually, negatives and images were taken during of curators' field researches. Predominant motifs of images are scenes from the life of the rural population: jobs in the household, farming, animal husbandry, crafts, annual celebrations, rituals and ceremonies, weddings. One of the digitized image collections is semantically annotated by sets of metatags: title, description, keywords, location, author, date of creation and corresponding categories. Semantic annotation is applied using: Dublin Core Schema, UNESCO Thesaurus and CIDOC Conceptual Reference Model. Technical processed and semantically annotated images are ready to be inserted into the Museum Information System's database. Semantic images annotation was a part of a project that was realized in the Ethnographic Museum in Belgrade. The aim of the project was linkage museum objects with a collection of photo negatives and images. The project's object was semantic images annotation the Collection of Petar Ž. Petrović. The collection includes about 1,200 images, created during the period of 1923-1937. A motive of the project comes from the fact that acquisitions of museum objects extract them from their natural and functional surroundings. During the scientific and expert processing, museum professionals partially establish connections to their environment data. Better results can be achieved if they use the same standards and vocabularies: for processing museum objects and also, for processing image collections. Concept of applying the same standards and vocabularies proves its strength in searching data about museum objects. Corresponding results to search terms are data about some museum objects, and in addition, results contain a list of images which possibly can explain its natural and functional surroundings. It is important to emphasize that images from a resulting list are not images of the unique museum object, included in the museum collection. Images and objects are connected exactly by terms from used vocabularies. This approach did it possible to represent contexts of more than one museum objects, only by one image and vice versa: native class of museum objects could be presented by more than one image. For example, the context of a museum object "ceramic pot" could be explained and interpreted by images where motives are: making a pot ("ceramic round", "crafts"), using a pot ("jobs in the household", "preparing food"), functional roles in the household ("kitchen utensils", "pottery"). Uniformity and consistency of semantic images annotation could be achieved if the image collection is processed as a whole, by establishing uniform subject criteria. Comparing results with objectives of the project, we realized that the applied concept of using the same standards and vocabularies, for annotating images and describing museum objects, contribute to comprehensive understanding and interpretation of environmental context of museum objects. Petar Ž. Petrović's image collection was a sufficiently representative sample. Therefore, it is possible to conclude that the applied concept can be used for semantic annotation of any other image collection in order to semantically link images and objects from the fund of the Ethnographic Museum in Belgrade.

Keywords. semantic annotation, museum objects, images, digitalization, standards, vocabularies

1. Background and introduction

Ethnographic Museum in Belgrade was founded in 1904. Since the establishment, thanks to the first curators, Sima Trojanović and Nikola Zega, the collection and protection of ethnographic objects are carried out professionally and systematically. That is why the Museum collection contains about 60,000 rare and representative artefacts of folk cultures from Serbia and other parts of the former Yugoslavia.

In addition to the Museum collections, Museum has an important collection of photo images (approximately 40000), consisting of glass photographic plates, negatives and photos. Photo material was collected continuously: the oldest photo was taken in 1904, the last one in 2015. Only models of cameras and photo holders of record were changing.

Activities of the systematic digitalization Museum began in the late nineties of the twentieth century, by introducing the Museum Information System (MIS). In addition to the "Central Catalogue", one of the priorities of MIS was the development of information subsystem "Photo Archive". The goal of the information subsystem "Photo Archive" is to support efficient digitalization, systematic scientific and expert processing and long-term protection of photo collections.

Ethnographic Museum in Belgrade has two different collections of images. The first one includes images of registered and protected Museum's items. They are captured in the Museum indoors.

The second collection includes images taken somewhere outdoors. Those images could show some kinds of ethnographic objects, within the scope of the Museum. The value of this second image collection comes from the fact that images were taken on the ground, on authentic settings, usually during curators' study tours and researches. Thanks to this fact, images show various, everyday objects in places where they are made and/or in surroundings where they are used. Images are partially described using the principle of free provenance, but without consulting domain ontologies. Therefore, it was concluded that the digitization and protection of images could be improved if images are fully semantically annotated. The goal of semantic images annotation is to connect cultural objects (ethnological museum objects) with their authentic and natural surroundings.

Images of both collections are inserted in database of MIS and they are, at the logical level, connected. Otherwise, physical connections are sporadic, as it is impractical to make all of the m:n connections between corresponding images. The solution of the issues is to use the same vocabularies for image annotation, as well as for annotation of museum objects. If so, connecting museum objects with images from their authentic surroundings will significantly help people and machines to understand and interpret museum's items.

Regarding to our research and experience from some other our multidisciplinary projects in the field of semantic image annotation, in this article we present project's results of semantic annotating image collections of Petar Ž. Petrović, obtained between 1923 to 1937.

2. Using semantic annotated images to connect museum objects with their natural surrounding

Processes of acquisition and scientific processing of museum objects are unique and standardized. They do not depend on the fact how an object came to the Museum. The general activity diagram and resulting data classes are shown in the Figure 1.

The Figure 1 contains only data classes, relevant to connect objects with their original surrounding: history and description, keywords and images items. Images of objects are created in a museum surrounding. Therefore, object's connection with its natural surrounding is established only by a descriptive, textual data class: the history of the object. The history of an object is created during the acquisition process, but also can be updated later, during the scientific and technical processing of an object. A complete set of data about the object is entered in the "Central Catalogue", which is part of MIS.

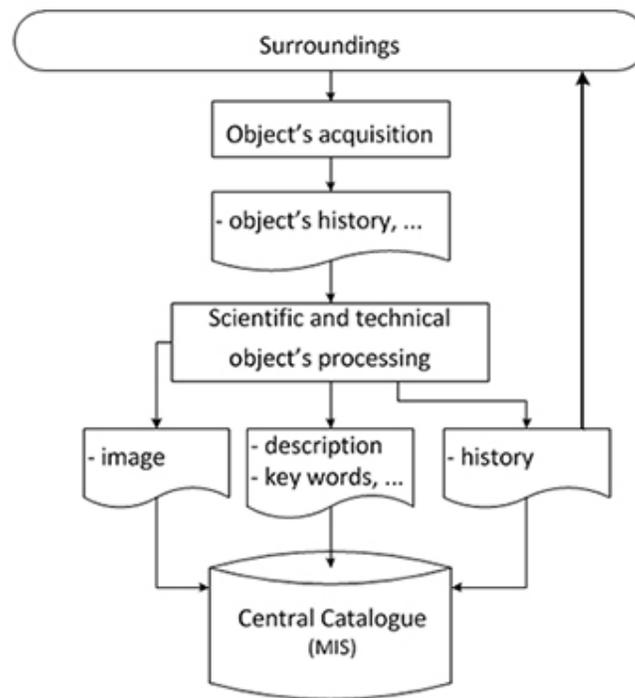


Figure 1: Processes of registration museum objects in the "Central Catalogue" of MIS

Institutions for protection of cultural properties often have valuable and important collections of images, including negatives and digitized materials. Available photo collections:

- are classified in, so called "study collection";
- are used as illustrative material;
- and sometimes have a status of a cultural property (depending on the type of cultural institution and importance of images, or an image).

The general activity diagram and resulting data classes are shown in the Figure 2. Processes of scientific image processing and a connection with the acquisition and scientific processing of museum items are shown in Figure 2.

Arranged and processed images, usually include the following information: an image description, a title, author data, date and place of imaging, and sometimes keywords in advance..

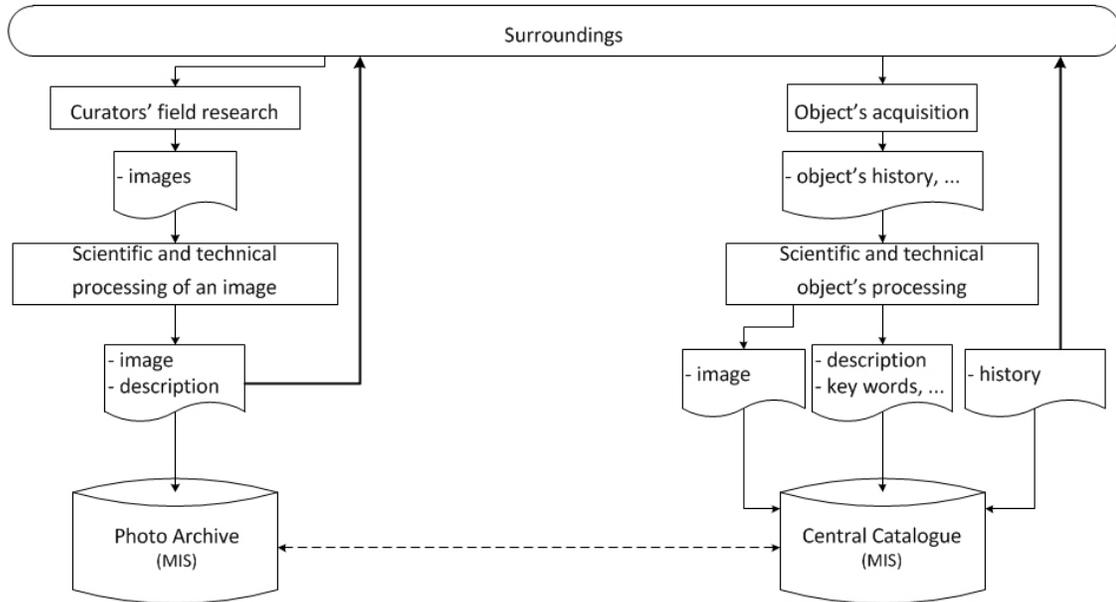


Figure 2: Processes of image registration in "Photo Archive" and a connection "Photo Archive" and "Central Catalogue" of MIS

Image from a surrounding
Scutcher, Okruglica, Svrlijig
(Photo Archive, No. 4340), year 1924



Image of the museum object
Scutcher, RačaKragujevačka
(Central Catalogue, No. 28926), the first half
of the XX century



Figure 3: Semantically unrelated images of scutchers:
the first one was taken on the ground, the second one was taken in the Museum

A visual association, between an image and a surrounding, in which it was taken, establishes an image itself, and eventually an image description, saved as additional, text information. A complete set of information about an image is entered

into the "Photo Archive", which is part of MIS. Unfortunately, connection between "Photo Archive" and "Central Catalogue" is weak (Figure 2), as processed images usually are not associated with museum objects, which visually could represent

An example of semantically unrelated image of a museum object, taken in the Museum, with an image of the same type of object, but taken in its natural surroundings, is shown in Figure 3.

Regarding the images, shown in Figure 3 we can conclude:

- **The image of Museum object "Scutcher", from the "Central Catalogue"**
The image was taken in the Museum. Besides the presentation of the construction and materials, used for making the item (wood, metal), it does not carry any other additional information, or an object's association to its authentic surroundings.
- **The image of the object "Scutcher", from the "Photo Archive"**
The photo was taken in a natural environment and visually is very rich. It presents: object and background in which the object is used; a person that uses the item and person's clothing; a manner of item using, technology processing of hemp (hemp bundle, extract the fibers, and oakum as well).
Note: The image does not display the item "Scutcher" from the Museum collection, but it presents just the same kind of object on the ground.

It is obvious that the Museum image of the "Scutcher" is not sufficient to fully describe, understand and interpret the object. The same is true for other museum objects, which are not shown here.

The observed problem can be solved by semantic linking museum objects with corresponding images from the museum collections of images. In order to provide the required functionality, we adapted the model shown in Figure 4 to satisfy new requirements. The improved new conceptual and enriched models of scientific processing of museum objects and images from the "Photo Archive", with added semantic relationships, not detailed, are shown in Figure 4.

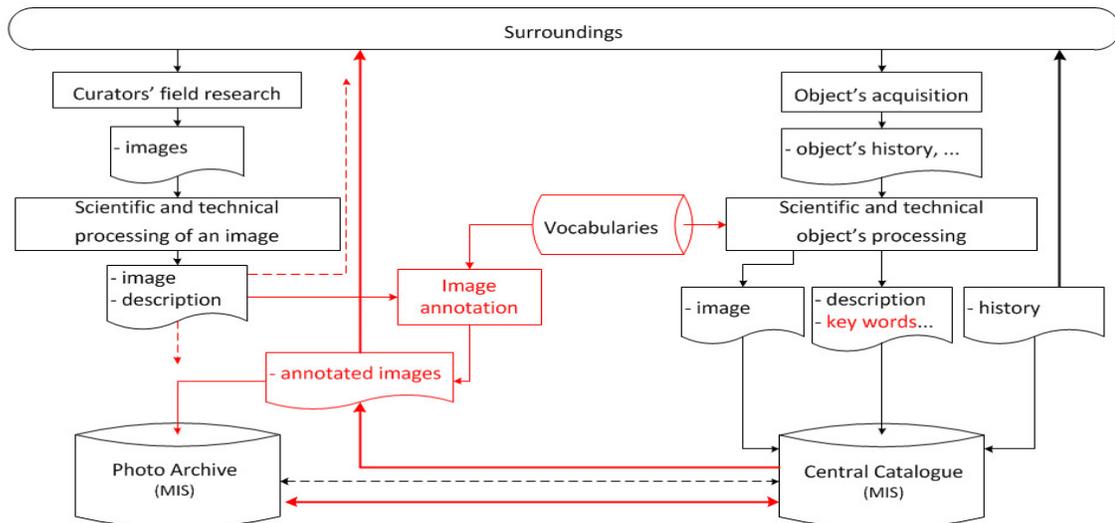


Figure 4: Enriched models of scientific processing of museum objects and images from the "Photo Archive", with semantic relationships

Transformations of the initial model (Figure 3) into the rich, semantic model (Figure 4) were carried out in accordance to CIDOC Conceptual Reference Model [1]. Starting from the nature of museum objects of the collection of Ethnographic Museum

in Belgrade, we have used, at least, the following concepts: E5 - Event, E7 - Activity, E12 - Production; E71 - Man-Made Thing, etc. Those concepts are described by Property Names, such as: P11 - had participant (participated in), P14 - carried out by (performed); P46 - is composed of (forms part of), etc.

Semantic connection of museum items and images of the same types of objects, imagined in their natural surroundings, is implemented as follows:

Scientific and technical processing of images from the authentic surrounding

- The processes of scientific and technical image processing are carried out by the activities of the "Semantic image annotation". "Semantic image annotation" is done exclusively using the concepts from referent and published professional vocabularies. Selected concepts, that semantically describe the content of an image, are inserted as metatags in the header of the image.
- Semantic annotated images are inserted into the database of "Photo Archive".
- The connection of an image, with surroundings where it was taken, will be set up by created metatags.

Scientific processing of Museum items

Keywords allocation to Museum items is improved. Keywords are not allocated arbitrarily any more, but only by using the same vocabularies, which are also used for semantic annotation images from the ground.

Establishing strong links between Museum items and images from authentic surroundings

Strong link, between the museum objects and images from the surrounding ("Photo Archive" – "Central Catalogue"), was established by using unique vocabularies: for semantic annotation images from the museum collection ("Photo Archive"), as well as for allocation keywords to museum items ("Central Catalogue").

We tested an efficiency and a functionality of the model shown in Figure 4, in the project of semantic annotation Petar Ž. Petrović's image collection. The collection contains about 1200 images, which were taken between 1923 and 1937.

3. Understanding and interpretation of ethnological objects using annotated images

Semantic annotation of the Petar Ž. Petrović's image collections was done according to the model, presented in Figure 4. At the beginning of the project, we selected reference vocabularies and schemas. Having in mind the type of museum items and corresponding images, semantic tagging were done according to the Dublin Core Schema [2], UNESCO Thesaurus [3] and CIDOC Conceptual Reference Model [1]. The process of semantic annotation of individual images was realized by the following steps:

- Reviewing and updating existing data of image: a title, a headline, information about an author, a date and a place of imaging.
- Analyzing a visual content of images.
- Creating IPTC [4] metatags, using concepts from the above schema and chosen vocabularies. IPTC metatags are entered in the header of the image, using free software tools. Example of created metatags is presented later in this article.

We semantically annotated copies of every image from the collection:

- **Archival copies of images**

Archival copies of images are not technically processed and do not change. They are permanently protected and preserved.

- **Operating images**

Operating images are copies of archival images. They are marked by a visible watermark of the Ethnographic Museum and they are to be used by Museum's curators and other clients. Those images could be processed anyway.

- **Images inserted in MIS database**

They are technically processed, dimensions and resolution are adapted for display on a computer monitor. They are available from the "Central Catalogue" and "Photo Archive" of MIS.

Comparing project's results with initial goals, we concluded:

- The digital image collection of Petar Ž. Petrović is semantically annotated and permanently protected by archival copies.
- Copies of semantically annotated images (operating images) are prepared for everyday use.
- Copies of semantically annotated images are ready for insertion into MIS database.
- Copies of semantically annotated photos, additionally marked by Museum's watermark, are available for sharing and publishing at the Museum's website.

Special and unique result of the new methodological solution (Figure 4) is possibility to use semantically annotated image from the "Photo Archive" to establish link of a museum item to its authentic background. This means that scientific and expert processing of museum items could be more precise, more accurate, and more efficient. An example of such valuable semantic linking objects and images is illustrated in Figure 5 and Figure 6.

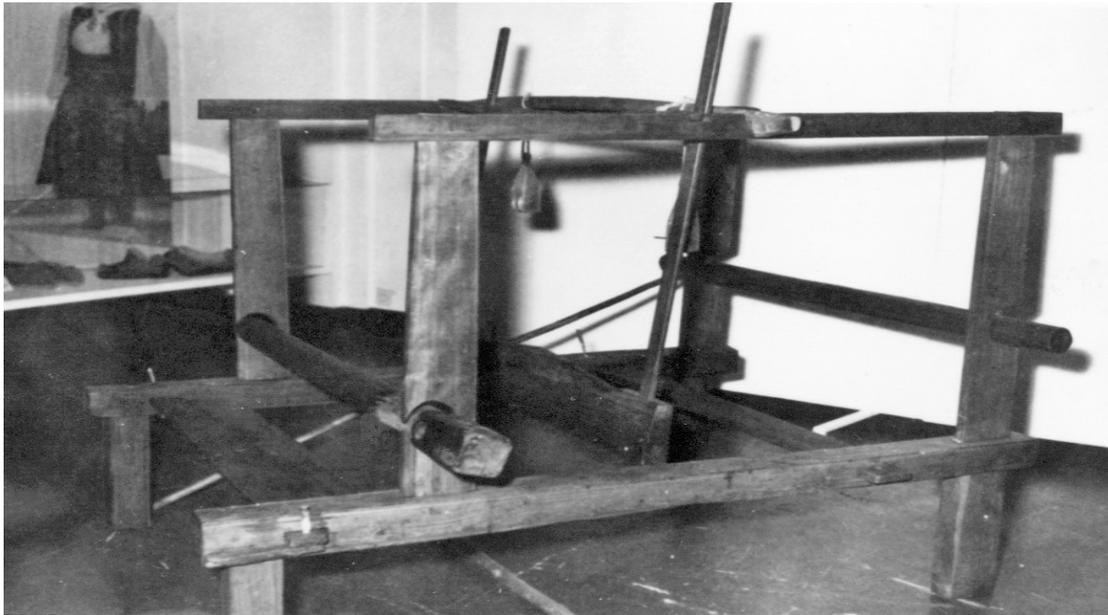


Figure 5: Image of an object from the museum collections – "Weaving loom", Bosilegrad (Central Catalogue, No.24596), 1968



Figure 6: Authentic image of "The weaving loom and a weaver Zagorka Ljubic from Višnjica, Belgrade"(Photo Archive, No.10217), year 1928

Based on the analysis and comparison of images (Figure 5 and Figure 6) we can conclude:

- **The image of the museum item "Weaving loom", from the "Central Catalogue"**

The first image (Figure 5) was taken at the Museum. It presents a construction and materials used for the object's production, but does not carry any additional information, or links between the Museum item and its authentic surroundings, function and usage.

- **The Image "Weaving loom and a weaver", from the "Photo Archive"**

The second image (Figure 6) was taken in the authentic environment and it is visually very rich. It shows: an object and a surrounding in which the object is used; a person that uses the object, her age and sex; her clothing; way of using the object, reels with a thread for weaving. **Note:** Displayed image does not show just the same "weaving loom", but only the same type of object: weaving loom.

Scientific processing of a museum's item can be enriched by additional concepts, if it is semantically linked with an image, taken in authentic surroundings. In the case of presented images, additional information about geographical distributions and socio-economic aspects of objects are available:

- It is obvious that shown looms are identically constructed. Models, and probably a manufacturer, are the same. A geographic distribution of objects

(Višnjica, Belgrade vs. Bosilegrad, the Southeast Serbia) indicates the existence of: "serial" production, wide demand and sales of those looms.

- If we accept the previous assumptions, it could be concluded that the weaving was a significant socio-economic and production activity. Also, the weaving was predominantly characteristic of the rural population in Serbia, until the middle of the XX century.

Visual "positioning" museum items in the context of their authentic surroundings, as illustrated by the presented images, obviously raises the level of understanding, interpretation and presentation them. Conclusions, about the museum item "Weaving loom", were made only on the basis of a single additional image of the weaving loom. More semantically annotated images of the same kind of an object, taken in its authentic context, significantly help us to understand and expertly interpret a museum item in a comprehensive way. Also, this is a chance to publish item's data by additional, enriched and more attractive contents.

4. Metatags and techniques of semantic image annotation

There are two sets of metatags available for semantic image annotation:

1. International Press Telecommunications Council (IPTC) and
2. Exchangeable image file format (Exif)

IPTC metatags are mostly descriptive in nature and describe:

- Headline,description;
- Keyword, subjectcode;
- Predefined categories (according to the Dublin Core Schema);
- Sub-categories;
- Contact (author), copyright and
- Data about an image (date of creation, intellectual genre, scenes, location, city, region, state, country and country code)

Exif metatags are mostly technical data about a camera and shooting parameters of an image:

- Shooting parameters (exposure, aperture, ISO, focal length, lighting, flash, etc.);
- Camera (model lens);
- GPS data;
- Postproduction software, etc.

Specific values of metatags assign experts and IT specialists, who deal with standards, vocabularies and tools for semantic image annotation. The most accurate choice of metatags is obtained if an image collection is treated as a whole.

Corresponding metatags are inserted in the image header, in a space range reserved for those data. Inserting metatags in image headers is done by using private, free or commercial tools. The Figure 7 illustrates an example of a form for embedding IPTC tags to the image of the "The weaving loom and a weaver Zagorka Ljubic from Višnjica, Belgrade" (Figure 5), using commercial software.

Metatags, allocated to an image, are bounded to the image. They are a part of the image, and therefore, they are portable with the image. Reading, updating and deletion of metatags is possible to perform by using custom software, or some of specialized software tools.

All IPTC	
Content	
Title	Tkalja za razbojem, Ljubić Zagorka, 1928.
Headline	Tkalja za razbojem, Ljubić Zagorka, 1928.
Description	Tkalja za razbojem, Ljubić Zagorka, 1928.
Description Writer	
Keywords	antropologija, mladi, odeća, okućnice, radna odeća, tkački stan, zanati, zanatski proizvodi, žene sa sela ...
IPTC Subject Code	1019000 običaji i tradicija; 14024000 ljudi; 14024004 odrasli;
Category	Economy, Business and Finance
Supplemental Categories	1019000 običaji i tradicija, 14024000 ljudi, 14024004 odrasli ...
Contact	
Creator	Petar Ž. Petrović
Job Title	fotograf, kustos
Address	Studentski trg 13.
City	Beograd
State/Province	Beograd
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Web URL(s)	http://www.etnografskimuzej.rs
Copyright	
Copyright Notice	©2015 Etnografski muzej u Beogradu
Rights Usage Terms	Uz saglasnost Etnografskog muzeja u Beogradu
Image	
Date Created	31-Dec-28 09:45:31
Intellectual Genre	arhivski materijal
IPTC Scene Code	100100 poziranje;
Location	Višnjica

Figure 7: The example of a form for metatags annotation using commercial software

In this project we use bespoke software that embed metatags into images' headers in XMP format. The Figure 8 represents a part of the resulting XMP. Some of the keywords (dc:subject) are intentionally, and for illustration purposes only, left in Serbian "understandable" words (mladi, odeća, tkački stan, zanati, etc.), others illustrate using RDF resources (<http://skos.um.es/unescothes/C00517>, <http://skos.um.es/unescothes/C00941>, etc.) to link our metatags to SKOS UNESCO Thesaurus [3]. Obviously there exists a temporary language problem. In this moment corresponding Serbian terms are not included in used vocabularies.

```

<x:xmpmetaxmlns:x="adobe:ns:meta/" x:xmptk="XMP Core 5.1.2">
<rdf:RDFxmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
<rdf:Descriptionrdf:about="" xmlns:dc="http://purl.org/dc/elements/1.1/">
  <dc:title>Tkaljazarazbojem, LjubićZagorka, 1928.</dc:title>
  <dc:description>
    Devojka u narodnojnošnji, ZagorkaLjubićizselaVišnjica
    sedi i pozirazarazbojem. Na razboju je zasnovanapreda,
krajrazboja
    suvitlazanamotavanjevune. Celafigura.
    Scena je snimljena u dvorištu, pored kuće.
  </dc:description>
  <dc:publisher>Etnografskimuzej u Beogradu</dc:publisher>
  <dc:subject>
  <rdf:Bag>
    <rdf:li>mladi</rdf:li>
    <rdf:li>odeća</rdf:li>
    <rdf:li>okućnice</rdf:li>
    <rdf:li>radnaodeća</rdf:li>
    <rdf:li>tkačkistan</rdf:li>
    <rdf:li>zanati</rdf:li>
    <rdf:li>ženesasela</rdf:li>
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  </dc:subject>
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  <dc:rights>Etnografskimuzej u Beogradu</dc:rights>
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  <xmpRights:UsageTerms>
    UzsaglasnostEtnografskogmuzeja u Beogradu
  </xmpRights:UsageTerms>
</rdf:Description>
</rdf:RDF>
</x:xmpmeta>

```

Figure 8: A part of the example of metatags embedded into image header in XMP format

5. Archiving images and linked open data

Digitized images (including negatives, photographic plates and slides) facilitate the use, allow creating permanent archives and are an important form of image protection. It is preferable to archive RAW format of images, if it is available. Security level of digitized images, and hence the degree of protection, depend on the reliability of media storage. Some of the possible media for image archiving are:

- **DVD, flash**
Experience teaches us that those media are unreliable.
- **Discs of computers, servers, and external drives**
These media are relatively reliable, if we frequently make backup copies. However, there is the same question again: "How to keep up those backup copies?"
- **Private and public image repositories on the Internet (Internet clouds)**
The safest choice, but after serious check and acceptance conditions of using someone's resources.

We recommend archiving the zero generation of digitized and semantically annotated images, without any additional technical processing. Instead, operational

copies will be processed and used, regarding the purpose. One of those copy is a part of MIS database, so images are ready to be semantically connected (by relationships m:n) with protected Museum's items. To do this, the plan is to obtain a new issue of existing MIS applications very soon, as this is a matter of programming routine. At the same way, some another copies of digitized and semantically enriched images could be published on the Internet: on the Museum's Web site, or to some of appropriate Internet clouds.

Some years ago began a global trend of presentation and democratization of national cultural heritage. Presentation of cultural heritage is obtained by using semantically annotated images, connected to open, thematic vocabularies, which are available on the Internet. Several projects were initiated. One of them is "Europeana Project" [5]. It includes galleries, libraries, archives and museums (GLAM institutions). Aprecondition for inclusion in the project is such as: Institution shave to deliver semantically annotated images of cultural property for public and free usage, in the form of Linked Open Data (LOD). "Linked Open Data is a way of publishing structured data that allows metadata to be connected and enriched, so that different representations of the same content can be found, and links made between related resources." [6] This means:

- Acceptance of the Creative Commons (CC) [7] license-the legal instruments which determine the conditions under which the photos will be used.
- Establishing connections with open vocabularies (GettyVocabularies [8], UNESCO Thesaurus, WordNet [9], or own one).
- Resource Description Framework (RDF) [10] is to be:
 - Serialized as XML/RDF, N-Triple, N-Quads, Turtle, N3, JSON-LD.
 - Available on the Web using HTTP and URI.

In addition to wide promotion of cultural heritage, LOD images are one of possible ways to archive our images, so far.

6. Conclusion

Is it correct a well-known phrase: "An image says more than 100 words."? In order to answer to this question it is necessary to post an additional question: "Who can understand an image without description: people, computers?". No doubt, in general case, it is true that an image says more than 100 words, but if we assign some meaning to the image. In this article we presented project's results of image annotation Petar Ž Petrović's image collection.

The main project's objective was to improve understanding and interpretation of museum objects, by semantical connections Museum's items with images from Museum's image collection. To do this, we expended existing models of "Central Catalogue" and "Photo Archive", by adding semantic concepts, which connected them. Established links allow us to better explain and understand some museum objects, with the help of images that present the same type of objects, but in their authentic surroundings.

Conducting the project, we semantically annotated Petar Ž Petrović's image collection, using Dublin Core Schema, UNESCO Thesaurus and CIDOC Conceptual Reference Model. Thanks to this, annotated images are ready to be public as LOD.

Metatags are embedded in headers of images, and as they are an integral part of images, metatags are portable with images as a whole. This means that our annotated pictures are self-explanatory, and therefore, they are ready for: distribution, presentation on Museum's Web site and within cultural projects such as GLAM, etc.

The achieved results motivate us to semantically annotate the rest of image collection. In this case, it can be expected that the most of the museum items will be associated with some images from an authentic environment. Thanks to the established semantic relationships, scientific and technical processing of museum items will be easier and more efficient, and the presentation of objects and images from the museum collections more complete and more attractive.

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