Design and Implementation of Semantic Search Engine on Image Annotation of Bird Anthology

I. El-Feghi
University of Tripoli, Faculty of Engineering
Department of Electrical and Electronics Engineering
Tripoli - Libya
idrise@ee.edu.ly

A. Abugarain
University of Misurata
Faculty of Information Technology
Misurata- Libya
A.Abugarain@yahoo.com

Abstract_In this paper we propose a novel algorithm for image retrieval based on automatic annotation. Ontology is one of the most essential components in semantic search systems. The main idea of the propose algorithm is to build two core ontologies (bird ontology and image ontology) for addressing the robustness of the system. The bird ontology is used to collect and store information or metadata about birds domain. Bird ontology is use to handle keyword problems. It is also designed to provides the image with main information or the bird annotation automatically. The second ontology is for image that is constructed to describe the image features. The system is tested on knowledge base of birds containing more than 500 images. The system was tested using different attributes such as feather color, distribution, family name and parts of image. All tested were performed using random queries. Test results have shown that the proposed system can perform accurate queries and correct retrieval with an average accuracy of more than 91% was obtained.

IndexTerms___ annotation, ontology, semantic, Image retrieval

I. INTRODUCTION

In real world the image is considered as a major information source. Image represents features of objects like their color, shape and other attributes. Search engine is one of the most popular applications on the World Wide Web (www). The search engine is special site on the www, which is designed to the find the information that stored on other sites on the www. The image search engines are a type of search engines or search services, which allows users to search on the web for image content [1].

This project introduces an approach that focus on content description index based on Resource Description Framework (RDF) standard to web images in order to achieve converting unstructured information search into structured information search. The search engine has the characteristics of self-learning as users amount increases, the knowledge base for semantic content of images accumulates, which makes the search engine more and more intelligent for search and semantics reasoning[2].

Image search engines for both the conventional web and the semantic web involve the same set of high-level tasks: discovering and harvesting Images, processing search queries from users, ranking search results, caching and archiving images, and providing human interfaces.

The aim for this project is to design and build a semantic search engine that can improve the recall and accuracy of text based image search for semantically annotated images. To reach this goal, we must first identify exactly the image domain and build the domain ontologies.

Ontologies are successful for representing domain concepts, and relations in a structured semantic web. Semantic web ontology and metadata languages provide a new way to annotate and retrieve images [3]. In this paper we will be building ontologies based on the text annotation to design and develop a semantic image search engine. The project will involve design and development of semantic image search engine (SISE). This system uses to annotate and retrieve images using semantic web techniques, another aim is attempt to use Arabic and English words in SISE.

II. SEMANTIC WEB

The Semantic Web is a vision for the future of the Web in which information is given an explicit meaning, making it easier for machines to automatically process and integrate information available on the web. One of the major objectives of the semantic web is to support more efficient discovery, automation, integration, interoperability, and reuse of data [4,6].
The Semantic Web will be built on XML’s ability to define customized tagging schemes and RDF’s flexible approach for representing data. The next element required for the semantic web is a web ontology language which can formally describe the semantics of classes and properties used in web documents. The semantic web aims at representing information in the WWW in a way such that machines can use it for automation, integration and reuse knowledge across applications [4].

### A. Ontology

Ontology is a formal representation of the knowledge by a set of concepts within a domain and the relationships between these concepts. It is used to reason about the properties of that domain, and may be used to describe the domain. The following are some of the reasons to develop an ontology:

- To share common understanding of the structure of information among people or software agents.
- To enable the reuse of domain knowledge.
- To make domain assumptions explicit.
- To separate domain knowledge from the operational knowledge.
- To analyze domain knowledge.

### B. Ontology components

Contemporary ontologies share many structural similarities regardless of the language in which they are expressed. Most ontologies describe individuals (instances), classes (concepts), attributes, and relations[5].

- **Individuals**: instances or objects (the basic or "ground level" objects)
- **Classes**: sets, collections, concepts, classes in programming, types of objects, or kinds of things.
- **Attributes**: aspects, properties, features, characteristics, or parameters that objects (and classes) can have.
- **Relations**: ways in which classes and individuals can be related to one another.

### C. Metadata

Metadata is information about information, which is widely used in real-world for searching. For example, you want to borrow some books on

### D. Resource Description Framework (RDF)

RDF data model is based upon the idea of making statements about Web resources in the form of subject-predicate-object expressions, called triples in RDF terminology. The subject denotes the resource, and the predicate denotes traits or aspects of the resource and expresses a relationship between the subject and the object.

![Figure 1. RDF graph data model to make statements about any resource](image)

### III. PROPOSED SYSTEM

The main idea in the proposed system is to build two core ontologies (bird ontology and image ontology) for addressing the usability problems. The bird ontology is constructed to store the bird information or metadata about birds domain. The formal definition and domain knowledge is derived from the internet, scientific books and experts, bird ontology is used to handle keyword problems. Bird ontology provides image ontology with main information about the bird annotation in the image. The second ontology is for is constructed to describe the image features. The important information in the image. The bird in the image (actor) and information about the actor are stored in bird ontology by expert.

### A. Domain concepts

In this paper the main domain divided into three disjoint domains:

1. Bird domain.
2. Distribution domain.
3. Image domain.

![Figure 2. The Initial Class Hierarchy](image)

Bird domain and distribution domain they describe bird, its name, family, color, distribution and flying ability. But image domain describes a known bird in the image, bird state, image background and part.

### B. Bird ontology

It provides semantic information of taxonomy definition for the target domain and handles the classification of bird species.
The metadata in this ontology represent main source knowledge domain. It describes bird and its family and where it should be found in and its flying ability and feathers color and etc.

C. Semantic triples

The Ostrich is a flightless bird native to Africa. It is the only living species of its family Struthionidae.

```
<Bird rdf:about="#ostrich">
  <rdf:typ rdf:resource="&owl;Thing"/>
  <hasBirdName>ostrich</hasBirdName>
  <hasDistribution rdf:resource="#africa"/>
  <hasFeathersColor rdf:resource="#black"/>
  <hasFlyingAbility rdf:resource="#flightless"/>
  <hasFamily rdf:resource="#struthionidae"/>
</Bird>
```

Figure 4. Ostrich is an example of individuals of Bird describe in RDF/XML

The triples Ostrich has Family Struthionidae, Ostrich hasDistribution Africa, Ostrich hasFlyingAbility flightless and Ostrich hasBirdName ostrich can be equivalently represented in RDF/XML as fig4.

IV. BIRD ONTOLOGY DESIGN

Bird description ontology is purely based on text and it is used to encapsulate high-level narrative bird description. By this ontology, certain bird is associated with its domain knowledge. That is why this ontology works better than single keyword on capturing semantic interpretations from different context. Several classes have been defined like “Bird”, “Color”, “Family”, “Distribution concepts” and “Flying Ability” in this domain.

In this ontology, every node is a concept defined about the organization. For each concept, should be there are a set of attributes used to specify the corresponding concept. For instance, for the concept “Bird”, the attributes of has name, has family, and has feathers color are shown by fig 7., and help explain the corresponding concept. In a complete ontology definition, there would of course be attributes for all the other concepts, including “Family”, “Color”, etc. and then would likely be many more concepts and attributes.

```
<hasFamily rdf:resource="#struthionidae"/>
```
fig9.illustrate the relations between different concepts are also simplified, the “IS-A” is a relation. When concept has an “IS-A” relation to another concept, this means that the second concept is more general than the first concept. If concept A has relation “IS-A” to concept B, we call concept A as a subconcept and call concept B a superconcept. For instance, in the ontology the main characteristic of “IS-A” relation is that all the attributes of a superconcept can be inherited by its subconcepts. Subconcepts normally have more attributes than superconcepts and as a result, correspondingly subconcepts are more specific.

A. Image ontology

It provides semantic information about image as main element (bird) and image background, bird state in the image. Image ontology clusters images according with attributes as bird(actor), image background, bird feathers color in the image.

![Figure 4. OWLViz Displaying the Asserted Hierarchy for imageconcepts](image)

Image ontology represents main ontology for image search engine, in the proposal system all queries about image. Image ontology was developed to cover basic information about image. A number of classes have been determined to describe image like “Background”, “Image”, “part” and “state” in this domain ontology. Bird ontology provides image ontology with main information about the bird in the image.

![Figure 5. The imageconcepts Class Hierarchy](image)

Any image must be contain bird and background, and that bird has several features as its feathers color, its state and its part in that image.

![Figure 6. The Class Description View Showing Description Of Image](image)

Any image must be has a background from background concept, and it must be contain bird which has feathers color from color concept etc. as fig 12.

![Figure 7. Ostrich is example of individuals of Image describe in RDF/XML](image)

The triples image of the bird ostrich Image hasImBName ostrich, the bird in the image has feathers color black hasFeatherscolor black, the image hasBackground grass and Image hasBName ostrich can be equivalently represented in RDF/XML as fig 13.

![Figure 8. The hierarchy for image concepts(Image Ontology)](image)

V. EXPERIMENTAL RESULTS

In this section we design and test the interfaces that will be used in the proposed system to annotate bird and annotate image.

A. Bird annotation

As mentioned above in the bird ontology there are several properties, these properties identify or
classify the bird, including its family, distribution, feathers color, name and flying ability.

Figure 9. User interface for bird annotate

On this screen, user should be write the bird name, and can select its family, distribution, feathers color and the bird flying ability form combo boxes to annotate the bird as fig 15. The user for this screen must be expert in the birds domain, because this screen used to annotate the bird with correct information. the system will use that information to annotate images.

B. Image annotation

User uses this screen to annotate his image. system will be classify that image according with image ontology. The image must be contain bird otherwise that isn’t bird image. fig16.illustrates the image annotation screen, the right part shows the images that get from the web. The left part there are number of combo-boxes to help the user to describe the images using ontology vocabularies.

Figure 10. User interface for Image annotate

User will not use his information to annotate that image. User need to load his image via browse button and he just select the bird name from combo-box. User only describe what is seeing in the image when he annotate it, and select what is suitable from the combo-boxes. The bird ontology will provides the image annotation with information about the bird in that image.

C. Image retrieval

Through semantic annotation, both images and retrieval queries can be formalized queries. In semantic annotation, the semantic meanings of images and queries are described based on combination of concepts defined in an ontology. In image retrieval, the goal is to determine the similarity between images and a retrieval query. To achieve this objective in ontology-based image retrieval, we implement similarity comparison in two steps: extraction of combined concept entities and similarity comparison between images and a retrieval query.

Figure 11. The whole hierarchy for domain concepts and showing relation between image and bird

The user describes image using ontology vocabularies from annotation interface. And he will uses the combo-box to select the name from known bird names to define the bird in that image. All birds have information in the bird ontology as we a mentioned above, then the bird ontology provides image annotation with predetermined bird annotation. The users can use bird information with image information to construct image retrieval query.

Figure 12. User interface for Image retrieval (user uses open search)

Based on the ontology, a system was implemented to support semantic image retrieval. The system provides the user with the following semantics-based facilities. Users can write Arabic or English words, and the system identifies this word according to ontology.
concepts, after that images are cluster according to that concept and retrieve that images as result.

**Figure 13.** The results about the query that is ‘green’

**Figure 13.** The results about the query that is ‘stand’

**Figure 14.** The results about the query that is ‘powerful’

The top left box shows the part uses to write query. The ellipse at the top in the middle box shows how the system clustered results, according color as fig 20 or according state as fig 21 or according family, background, fling ability. The right part shows the selected image from the result list.

VI. CONCLUSIONS

This system built two ontologies bird ontology and image ontology. These ontologies were used to handle the keyword problems. The first bird ontology is for bird, it is constructed to store the bird information or metadata about birds domain. Bird ontology provides image ontology with predetermined information about the bird in the image. The information about the actor are stored in bird ontology by expert. So user donot need to know more information about birds to annotate it or to retrieval images. Users can annotate image just when the name of bird in that image is known. The bird ontology will provide all information about the bird to that image for annotation. The second is constructed to store visual the image features, the important information in the image is that the bird in the image (actor) and the user will use ontology’s vocabulary for image annotation. This makes annotation much easier.

While implementing the system, usability was taken into account by ensuring that the end users are satisfied and happy with the system. The aim of the project was to produce a system that improved image retrieval and provided solutions to the current issues affecting the existing system.

The testing methods included a questionnaire and observation. Once the system was designed, it was tested on the retrieval of the annotated image. The system was able to correctly retrieve images with accuracy of above 91%

References