Semantic Image Retrieval Based on Ontology and SPARQL Query

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ABSTRACT
The main objective of this paper is how to use the ontology for semantic image annotation and search in huge collection of images. We have presentenced a framework for applying the semantics to enhance image retrieval. The entire problem is considered in two levels. First, An ontology is created to define the semantic space. Secondly, Natural language sentences are converted in to SPARQL statements and the relevant images are accessed using SPARQL query. The ontologies are represented in RDF form and these are based on existing data standard and knowledge corpura. Since the RDF structure provides the formal way of annotating the images, the image retrieval task is simplified as compared with earlier approaches. Retrieval is done by using the keyword (thesauri) description. We also show that we are able to retrieve desired images using the SPARQL query language (7).

KEYWORDS
Information retrieval, Semantic Web, Image retrieval, Ontology, Thesaurus, RDF and OWL.

1. INTRODUCTION
Present Web is an ocean of tons of web pages which are added on the internet on a daily basis, and this cause's information explosion. Keyword based search lacks in meaning and relationships among the data and also the machines are not able to understand data. Therefore, effective search or retrieval of information on this massive information resource becomes highly crucial. The main goal of this paper is to find an image or set of images that best satisfy a user's information need within image collection.

Ontology provides the way to organize the web information in structured way. The web contents can be understood by the computer as well as the user. There are hundreds of millions of images available on the current World Wide Web. In this paper, we propose a retrieval method which is based on the keyword-based annotation structure, and ontology guided reasoning. Image retrieval using our proposed approach has been implemented using protégé. Images are retrieved using the content description of the images by SPARQL query.

The rest of this paper is organized as follows. In section II, we discuss ontologies and its usage. Section III presents the various types of image retrieval. Section IV describes the ontology in image retrieval. In section V we present the image annotation in this work. In Section VI give about searching of an image, Section VII and VIII gives the information regarding searching an image in test environment and SPARQL query respectively.

2. ONTOLOGY
Ontology is a formal, explicit specification of a shared conceptualization. Ontology is simply a knowledge representation method. Ontological engineering is a larger scale than knowledge engineering and operates on a bigger scale than knowledge engineering. Machine understandable content of Semantic Web is defined in ontologies and machine processing of Semantic Web content happens via agents. Ontology is a description (like a formal specification of a program) of the concepts and relationships that can exist for an agent or a community of agents. It is used by agents when trying to make sense of each other.

3. OVERVIEW OF IMAGE RETRIEVAL
The process of retrieving and displaying relevant images is based on user's queries from the web or image database. Generally Image retrieval methods are classified into two types. They are

Text-Based Image Retrieval (TBIR)

Content-Based Image Retrieval (CBIR)

1) Text-Based Image Retrieval (TBIR)

The image is annotated by using text descriptions like Creator, Place, Date, Time, objects. The image retrieval is done by using one or more textual descriptors. The high-level retrieval involves retrieval of an image based on the name of objects, emotions and actions that can be associated with the image.

2) Content-Based Image Retrieval (CBIR)

Extraction of images based on image content. CBIR uses low level features such as color, texture, shape and object location. The various levels of CBIR are

Level 1: Retrieval by primitive features such as color, texture, shape and spatial location.

Level 2: Retrieval of objects of given type. Example: find the picture of the flower.

Level 3: Retrieval of abstract attributes that involves high level reasoning. Example: 'Find picture of a baby smiling'.

We are proposing a method for image retrieval based on the high level features (i.e. Text Based search) and low level features.

4. ONTOLOGY BASED IMAGE RETRIEVAL
Content-based retrieval is an efficient technique that considers low-level features of image data, the role of using some textual keywords to describe the content of an image to support the retrieval system. The ontology based image retrieval uses knowledge representations which combine the features of text based image retrieval and content-based image retrieval. The main purpose on ontology is to represent the image in semantic manner. Hence the image is represented in machine understandable manner, this leads to retrieval task easier.

5. OUR APPROACH
We have proposed an idea for image retrieval by which a user

can have high accuracy in image retrieval. We have created a general ontology hierarchy. The image collection is having 2000 images. We have categorized the things into two major divisions from which the every thing are represented. The images are mapped to ontology with complete relationship and content description of the image. For example, since "mammals" is a subcategory of "animals", an image annotated with the keyword "mammals" is found using the keyword "animals". The same idea of enlarging a keyword with related terms in order enhances access rate.

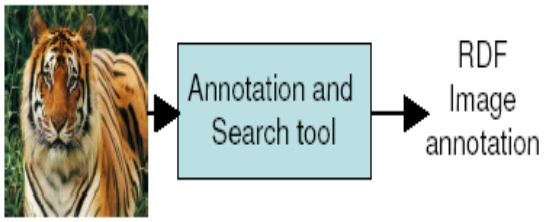

Fig.1 Annotating an image

5.1 Annotating An Image

Image annotation is process of relating unknown image to the named class. That is mapping the unknown image to one of a number of known classes. Fig 1 shows the snapshot of annotating an image using protégé. The image then inherits the class properties and annotation of its assigned class. Our approach is based on the idea of image annotation using ontologies. High-level concepts are efficiently stored and automatically mapped to visual features or objects which are extracted by various image analysis techniques. The ICONCLASS is used in extracting the low level visual features of an image.

5.2 Ontology Development

Ontology model is constructed for providing shared semantic interpretation of image contents. For example leaf class Tiger has six instances as many as the images of Tiger in our database. The image is connected to its corresponding class in the ontology by assertion property. Here the owl thing is the super class of all the classes. Under which every other classes can be created, here we divided the whole things into two major sub-classes. Those are Living things and Non-Living things. Under Living things we categorized all the living things like animals and plants into separate subclasses. And from that, animals are again categorized into Herbivorous, Carnivorous etc., Plants are also categorized into landside living plants and water living plants. The representation is shown below.

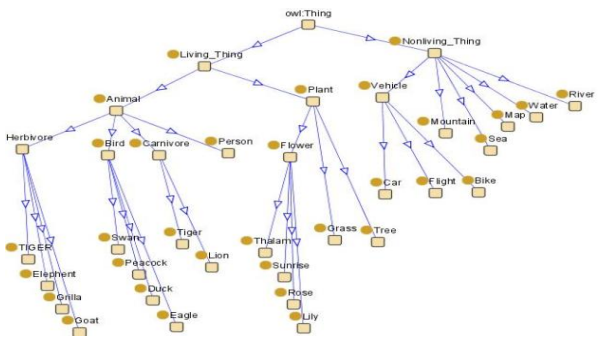

Fig 2- Ontology Structure

PROTÉGÉ is used in building a perfect ontology hierarchy and can represent exact interconnection relationship with those created structure and also we can upload images with their elaborate descriptions and mapping it to the concern classes in the hierarchy. The image representation and retrieval is carried out by three steps. First step is to create classes in ontology and complete relationship with that hierarchy. Second step is to upload images with their complete description about the images represented. Third step is to retrieve the images by SPARQL query.

5.3 Creating Individuals:

The high-level narrative information of image descriptions from external information source is collected and encapsulated into classes and instances. In creation of individuals assertion types are included so that every related image to a particular class will get displayed without missing Fig.3 shows the screen shots of annotation interface. In this scenario the user is annotating the image representing aElephent in the forest. The figure also shows the slots for denoting additional information about an image. These are added by means of data type properties. The four elements are linked to the subtrees in the ontologies. The properties are Creator, Theme, Location and Time. The ontolgies makes it easier for people to select the correct option. The domain knowledge can be extended to cover more slots.

Here for the swan (swimming in water) image, we have asserted the classes like non-living things, water. So that it will not get eliminated from searching for one of these things. The images are uploaded through individual editor in which the path of the particular image is copied in the name field and respective Creator, Place, Date, Color, Texture and Shape details also added additionally.

5.4 Image Ontology

Image Ontology is constructed using Class, Properties and instances. A nouns class hierarchy of image which is also instances of leaf classes representing images. Common descriptions arranged for class hierarchies (data type properties).Object properties are used to connect instances of semantic classes with instances from classes containing description. The Image is annotated to more than one class by using assertion property. Other general properties are added to classes as necessary (Such as bird has two legs).

The Protégé is used in creating classes, Properties, Instances and mapping the images to its concerned classes. The RDF/XML codes are automatically generated by the protégé. Internally the codes represent the RDF graph. The meta of an image is added. A separate class is created for the meta data about low level features of an image. These are used in accessing the general concepts of an image. Forms are used to design the labels or frames. When a new instance is created, these labels hold the image and its annotation information. We can create slot for holding multiple labels in order to provide more information about images that will provide additional information for annotation and retrieval. Protégé provide the slots for creating Image, Label, Web pages, Date, Time etc.

The high-level narrative information of image descriptions from external information source is collected and encapsulated into classes and instances. In creation of individuals assertion types are included so that every related image to a particular class will get displayed without missing Fig. 3 shows the screen shots of annotation interface. In this scenario the user is annotating the image representing a Elephant in the forest.

The figure also shows the slots for denoting additional information about an image. These are added by means of data type properties. The four elements are linked to the sub trees in the ontologies.

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6. SEARCHING AN IMAGE

Given an unknown image, the ontology is searched to retrieve the images most similar to it. A search engine enables the user to search for one or a combination of tags and/or keywords within a sentence or document, and as the ontology allows word meaning to be queried, it is possible to formulate such semantic queries. Controlled vocabularies are used to describe the images in order to ease the retrieval.

Semantic web ontology techniques and metadata languages contribute to this tradition by providing means for defining class terminologies with well-defined semantics and a flexible data model for representing metadata descriptions. One possible step to take is to use RDF Schema for defining hierarchical ontology classes and RDF ontology. The ontology together with the image metadata forms an RDF graph, a knowledge base, which can facilitate new semantic information retrieval services. Specifically the subject in the RDF specification is taken for checking various meaning. More complex queries can be formulated, e.g., by using Boolean logic.

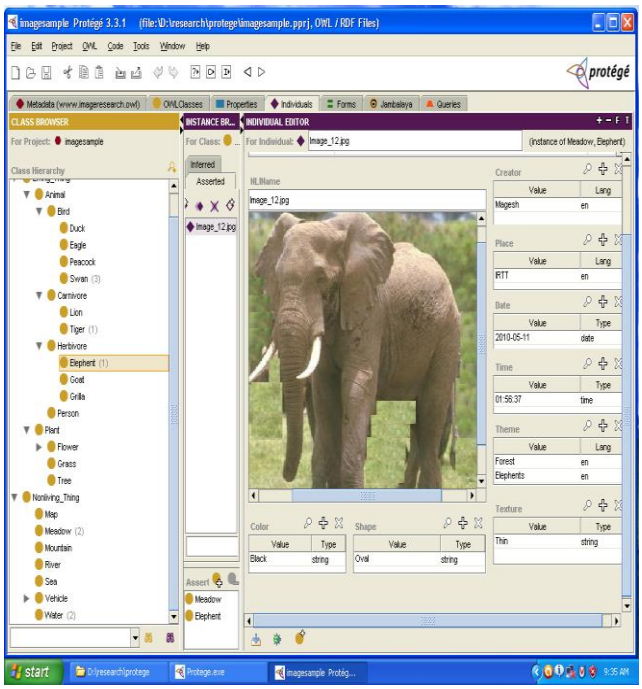


Fig 3- Linking Image with ontologies (Image Annotation

Agent can handle the environment by the representation of these image data in a high-level formalism. An image is annotated by a set of categories (Slots or labels) that describe it. The searching process start from root node from the tree. Here it is Owl : Thing. Every class is connected to the root node by using inheritance relation. The meaning of the image is identified by indexing to class. The queries are converted in to its equivalent formal structures (RDF) using the relationship(predicates), These queries are compared with the ontological structure. Knowledge base is used for this purpose. The image with same category is easily identified and retrieved.

7. TEST ENVIRONMENT

High-level semantic indexing neglects low-level features that characterize images and parts of them. Recognition of an object in a scene can be easily handled by previous knowledge on the context or the interpretation of an image.

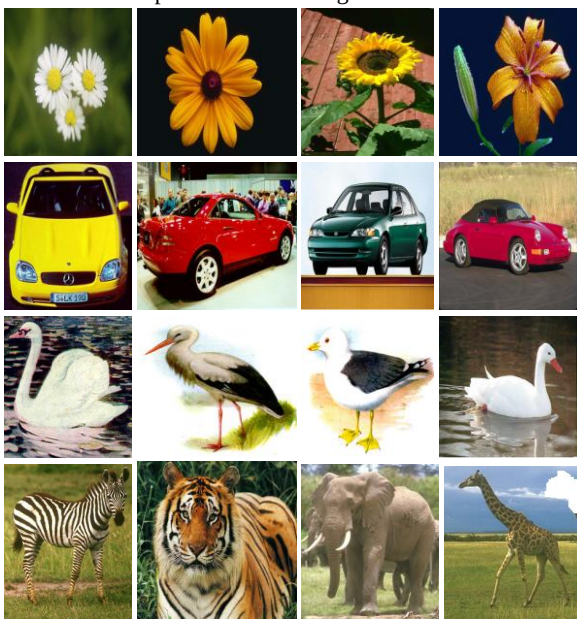


Fig 5- Sample Images

8. SPARQL QUERY

By giving an image as query this tool will search with the existing set of labeled images (trained images).The querying image must be placed among the existing categories .If there are any ambiguous images they are placed to the closest category of images. The query may be in the form an image, text-based or combination of two or more categories. This is an automated stage. For example the query is a car, then we check for the images which mainly come under the children of class car.

The semantic ontology model together with image instance data can be used in finding out relations between the selected image and other images in the repository. These images are recommended to the user. They do not necessarily match the filtering query but that are likely to be of interest. Simply the image retrieval is done by using query form or APARQL (7). SPARQL is based on SQL and has the capabilities for querying visual graph patterns along with their conjunctions and disjunctions. The following questions can be answered by our ontological system. SPARQL gives image references as its output.

1. Find Subject, Predicate and Object nodes.

```
SELECT   ?S  ?P ?O
WHERE { ?S  ?P ?O  .
          }
 LIMIT 6
```

Subject	Predicate	Object
Eagle	rdfs:subClassOf	Bird
SimpleInstance Image_10.jpg	Color	White
Sunrise	rdfs:subClassOf	Flower

SimpleInstance (Image_10.jpg	rdf:type	Swan
SimpleInstance Image_12.jpg	Theme	Forest
SimpleInstance Image_12.jpg	Theme	Elephents

2. Find sub classes of bird.

```
SELECT    ?x
WHERE {   ?x    rdfs:subClassOf   :Bird  }
```

Duck

Eagle

Peacock

Swan

Find the picture of birds

```
SELECT  ?x ?y
WHERE { ?x  rdfs:subClassOf  :Bird  .
          ?y   rdf:type ?x
        }
```

Find the picture of birds with white color

```
SELECT  ?y  ?x
WHERE { ?x rdfs:subClassOf  :Bird  .
          ?y :Color  "White" }
```

5. Find the creators of Swan Images.

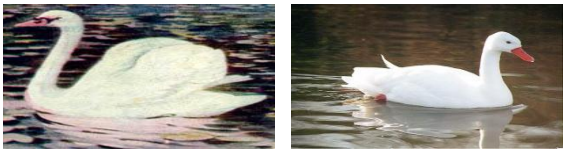
```
SELECT DISTINCT ?name
WHERE { ?x  rdf:type :Swan .
            ?x :Creator ?name    }
```

Magesh

Aswinth

6. Find the picture of Swan

```
SELECT   ?x
WHERE { ?x  rdf:type  :Swan    }
```



7. Find the picture of Car with red color

```
SELECT    ?x  ?y
WHERE {  ?x rdf:type  :Car .
      ?x  :Color  "Red" }
```

8. Find the image created by MrAswinth

```
SELECT    ?x   ?IName
WHERE {  ?x   :Creator ?IName ;
FILTER regex(str(?IName), "Aswinth")  }
```

9. CONCLUSION

Thus we have created Ontology for collection of images with complete relationship, which enhance the retrieval of images at a faster rate when compared to ordinary retrieval. Protégé interface provides RDF/XML code by utilizing the annotated image and relationship. Thus providing the generated code of RDF/XML format, we have used SPARQL query to retrieve images and accuracy has been achieved through ontological structure that we have engineered. Ontology-enriched knowledge base of image metadata can be applied to constructing more meaningful answers to queries than just hit-lists.

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