



INCORPORATING ONTOLOGY AND SPARQL FOR SEMANTIC IMAGE ANNOTATION

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Abstract— This paper proposes a technique to construct Image Ontology using low-level features like color, texture and shape. The resulting ontology can be used to extract the relevant images from the image database. Retrieving relevant images from an image database is one of the challenging tasks in multimedia technology. More researches are being done in this area, among them Content-Based Image Retrieval (CBIR) is a note-worthy technique. Interestingly, a semantic approach provides effective and meaningful results in image searching. Construction of an Image Ontology using low-level features is more appropriate than the other techniques. In this paper, an algorithm is proposed for constructing an image Ontology using low-level features, and meaningful results in image searching. Semantic searching approach uses Image Ontology for a better representation and organization of Images. Besides the representation of the image properties, relationships among the several images can also be organized using image ontology. The objective of this paper is to create ontology using protege software and to provide semantic annotation for image using SPARQL query language. OntoViz and OntoGraph are used for generating graphical representation of Ontology.

Index Terms—Ontology, Semantic Web, SPARQL, Protege, RDF, OwlViz, OWL and Image annotation.

I INTRODUCTION

Since semantic searching gives a good result in the field of images retrieval, it is being widely used. Semantic searching provides results that are more appropriate and relevant to a user than using the traditional keyword searching. The efficiency of “Semantic searching” depends upon the ontology. Ontology is a representation of properties and relationships among the images. The ontology should be constructed using

human understanding on images. The low-level features like color, texture and shape, directly reflects a basic human understanding of images. Hence, the ontology should be constructed using these low-level features. So, it is considered more useful for semantic based image retrieval. Ontology construction becomes inefficient if the feature count becomes too high or too low. Resource Description Framework (RDF) framework for describing and interchanging metadata that provides intelligent access to heterogeneous and distributed information. Web Ontology Language (OWL), is widely used to construct domain ontology. The Semantic Web is a collaborative movement led by the World Wide Web Consortium (W3C) that promotes common formats for data on the World Wide Web by the inclusion of semantic content. The major approaches in image search are annotation-based and content-based. The former is based on image metadata or keywords that annotate the visual content [1]-[2]. A well known example that falls into this category is Images Google Search. The metadata that a search engine of this kind typically relies on refers to the properties of the image itself or to its content. Examples of image properties include the name of the image, its creation date, copyright information, image format, resolution and so on. On the other hand, content metadata correspond to the properties of the entities depicted, such as persons and objects. The Semantic Web provides a common framework namely Resource Description Framework that allows data to be shared and reused across application, enterprise, and community boundaries. RDF is for representing the knowledge resources on the web and uses the web identifier URI (Uniform Resource Identifier) to identify

the resources. RDF Schema is to represent the webresource and SPARQL (Standard Protocol for RDF Query language) is to extract information from RDF graphs for machine understandable representation. Agents are programs for a specific purpose carrying meaningful information from one machine to another and Semantic Search engines and browsers are for semantic traversal.

II. VISION OF SEMANTIC WEB

The vision of Semantic Web is the idea of having data on the Web defined and linked in a way that it can be used by machines not just for display purposes, but for automation, integration and reuse of data across various applications. Ontology is used in the domain of Knowledge Representation "to categorize the kinds of things existing". The main objective is to create a common vocabulary of terms to describe as much knowledge about the world as possible in the particular domain, and also to subdivide this knowledge in a coherent class hierarchy, so as to create a shared knowledge representation language. The domain knowledge is analyzed using various models such as Observation models, Relationship model and Perceptual models of real-life concepts and events. The Description Logics (DL) based on reasoning in OWL and querying provides probabilistic reasoning to cope up with the uncertainties that are inherent to multimedia data processing.

III. BUILDING ONTOLOGY USING PROTEGE

Ontologies provide shared and common understanding of a domain and make metadata interoperable and ready for efficient sharing and reuse. It is used by people and machines. Ontologies provides knowledge representation about the world describe the OWL with domain individuals, classes, attributes, relations and events. Logical support in form of rules. Rules are considered to be a major issue in the further development of the semantic web [6]. Semantic Web requires much more expressive power than using ontology languages like XML, XMLS (XML Schema), RDF, RDFS (RDF Schema and OWL (Web Ontology Language) used to describe the semantics and reasoning of resources/metadata which are available on the web and also identify the relationship between them. The Protege platform supports two ways of modeling ontologies frame-based and OWL, each with its own user interface [7]-[8]. The semantic web uses a famous vocabulary is Friend of a Friend (or FOAF), to describe the relationships people have to other people and to The mango tree can be classified based on the cultivation, name of mangoes and nutrients. Fig.3 shows the annotation of hand bag based on the object properties such as handler type, ring type, etc. The bags are further subdivided. into 50 categories based on brand name, purpose, and price. Perception of bag from the ontology provides information such as handler type,

represent the surrounding "things". The Resource Description Framework depicts FOAF as intelligent agents that is used to make sense of the huge social network; people have with each other, their jobs and the items important to their lives. The social network is very vast in number; human interpretation of the information may not be the best way of analyzing social network. FOAF is an example of how the Semantic Web attempts to make use of the relationships within a social context. The name "ontology" is derived from Greek philosophy and means "the study of the nature of being". The challenge is to provide a framework for specifying the syntax (e.g. XML) and semantics of all of these languages in a uniform and coherent way.

A. The reasons for developing ontology are:

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

B. Language Support for Ontology:

OWL is used to publish and share sets of terms called ontologies, supporting advanced Web search, software agents and knowledge management. OWL is built on top of RDF. It is used for processing information on the web. Designed for the interpretation of computers rather than being read by people.

C. How to Build Ontology?

Step 1: Determine domain and scope.

Step 2: Enumeration of important terms.

Step 3: Define classes and class hierarchies

Step 4: Define Object properties, Data properties and Annotation properties.

Step 5: Define properties restrictions (cardinality, value-type)

Fig.1 shows the Earth ontology which is developed using OWL Classes such as Living thing and Non Living thing. The classes are subdivided as subclass of living thing such as flower, animal, bird, plant, tree where as subclass of non living thing are mountain, river, bags, building, furniture, sea. Fig.2 shows the annotation of mango tree from the subclass of tree.

accessories, bugler type, Ring type, brand name, material type. Fig.4 shows the properties namely object, data and annotation associated with earth class and its subclass.

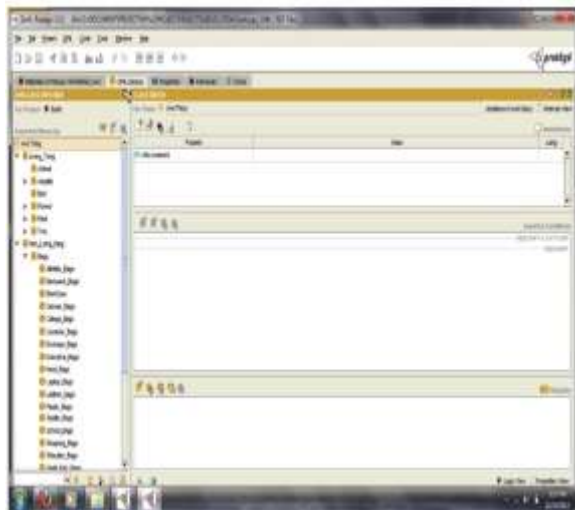


Fig.1: Earth Ontology

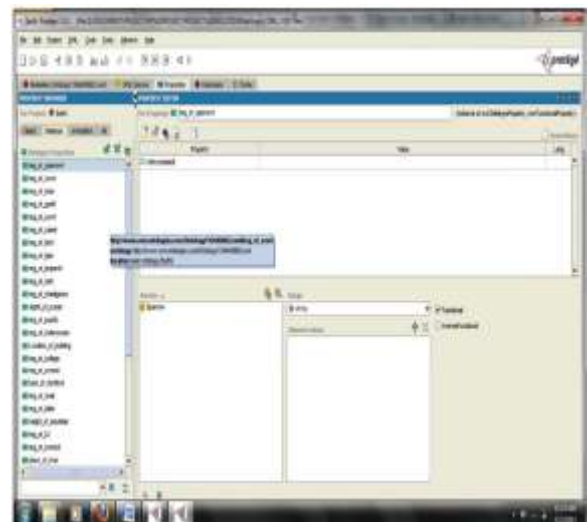


Fig. 4: Illustration of Properties for Earth Ontology

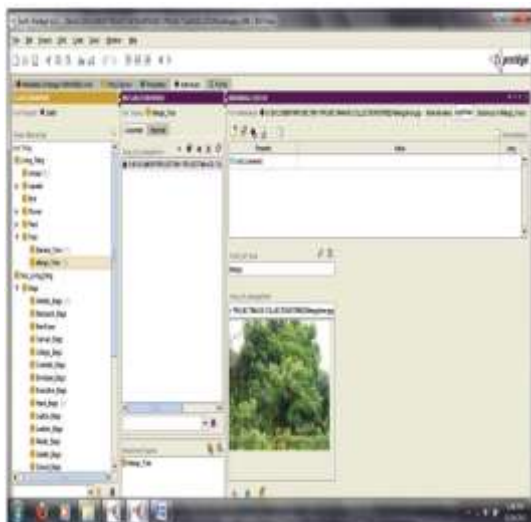


Fig. 2: Ontology annotating image of mango Tree

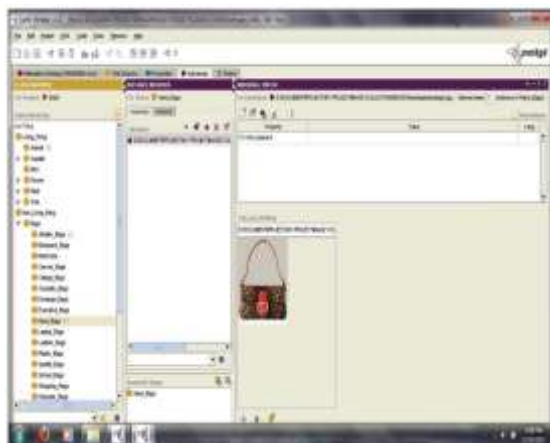


Fig. 3: Illustration of Subclass of bags with annotation of Hand Bag image.

IV. IMAGE ANNOTATION USING SPARQL

A query language is used for querying RDF graphs known as SPARQL which stands for "Simple protocol and RDF query Language", which is basically an RDF query language that defines a data access protocol and standard query language to be used with the RDF data model. SPARQL works for any RDF mapped data source. SPARQL query language has some similarity with SQL constructs and some tools are available as open source like TWINKLE 2.0, Jena Framework with ARQ [9] processor on which SPARQL can be executed and tested. SPARQL Query can also be used to retrieve data from RDFS as well as from OWL. Ontology tool like Protégé which involves Query processing, Optimization and Execution. "Query Processing" is the internal steps carried out in Query Engine for the evaluation of the Query and requires some transformation and rewriting methodologies for the execution without changing the outcome of the query [10]-[11]. "Query optimization" defines some of the rules for rewriting query which transform execution structure of query. "Query Execution" is the step in which query engine evaluates the SPARQL query by generating the QEP (Query Execution Plan)[12]-[13].

SPARQL, a query language designed to gather data from multiple sources and speed the development of Web 2.0 applications, creating a standard web service for anything that asks a question. The fact that an entity belongs to a class is expressed by the type predicate from the standard namespace RDF. The sub-class of another class is expressed by the subclass of predicate from the standard namespace rdfs. For the other entities, we are using the default namespace ":".The SPARQL language specifies four different query variations for different purposes. The SELECT query used to extract raw values from a SPARQL endpoint, the results are returned in a table format. CONSTRUCT query used to extract information from the SPARQL endpoint and transform the results into valid RDF.ASK query used to

provide a simple True/False result for a query on a SPARQL endpoint. DESCRIBE query used to extract an RDF graph from the SPARQL endpoint, the contents of left to the endpoint to decide based on what the maintainer deems as useful information. Fig.5 shows the SPARQL query which gives the representation of the subclass of Living_Thing such as plant, animal, flower, tree.

Fig.6 shows the SPARQL Query result of annotating the river subclass with name of river based on their location [l-ijj l S].

1. Find the subclass of Bag.

SPARQL syntax:

Find Subject, Predicate and Object nodes.

```
SELECT ?S ?P ?O
```

```
WHERE { ?S ?P ?O
```

```
}LIMIT 5
```

SPARQL query:

```
SELECT ?x
```

```
WHERE { ?x rdfs:subClassOf :Non_Living_Thing }
```

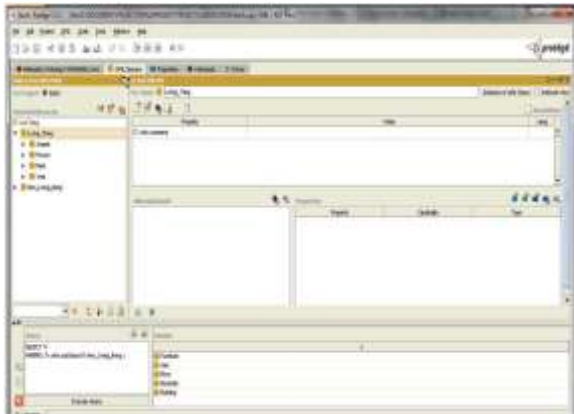


Fig.5: SPARQL Query results illustrating subclass of living

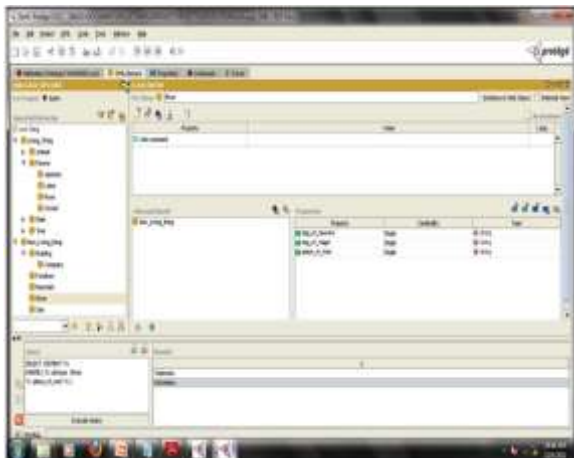


Fig.6: SPARQL Query results illustrating Rivers

across Tamilnadu

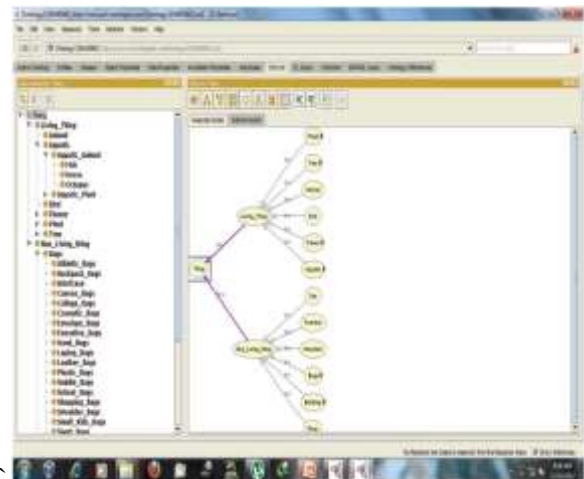


Fig.7: Taxonomical relationship of class with its subclass

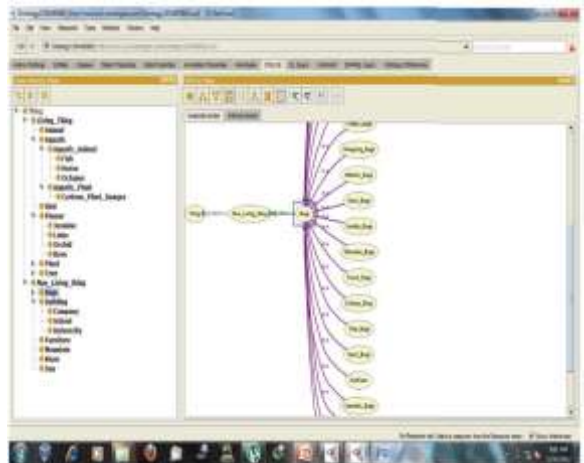


Fig.8: Taxonomical relationship of bags with its subclass

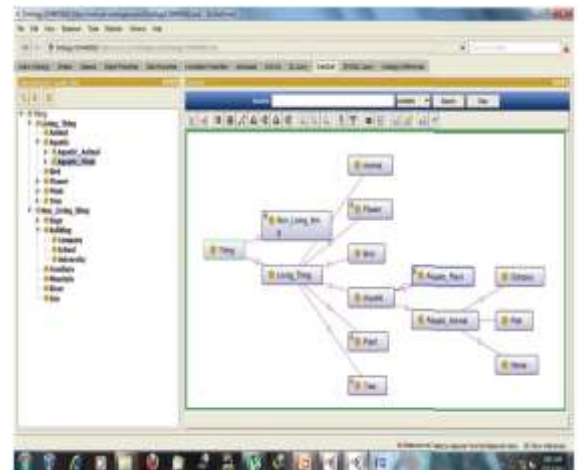


Fig.9: Illustration of OntoGraph for Earth Ontology

V. ONTOLOGY VIZUALIZATION USING OWLVIZ AND ONTOGRAF

Protege 4.2 and GraphViz supports two ontology viewing tools namely OWLViz and OntoGraf. OWLViz: shows only classes hierarchy but doesn't show relationships and properties. OntoGraf shows classes with hierarchy and relationships, but does not print the relationship names on the graph. The tool is configurable or flexible. Taxonomy is a central part of most conceptual models. Properly structured taxonomies gives substantial order to elements of a model, it is useful in presenting limited views of a model for human interpretation, and plays a critical role in reuse and integration tasks. Properly constructing taxonomy providing insights that have been focused on the semantics of the taxonomic relationship (also called is-a, class inclusion.) [30], on different kinds of relations (generalization, specialization, subset hierarchy) according to the constraints involved in multiple taxonomic relationships (covering, partition, etc.), on the taxonomic relationship in the more general framework of data abstractions, or on structural similarities between descriptions. Fig.7 shows the visualization of earth class with its subclass living thing and non living thing and it is further subdivided with respect to the domain. Fig.8 shows the taxonomical relationship of Bag class with its subclass such as athletic bags, backpack bags, briefcase, canvas bags, college bags, saddle bags, hand bags etc.,

VI. VISUALIZING ONTOLOGY USING RDF

RDF is a framework for describing objects which can range from physical objects such as planets, people, or countries, to virtual objects, such as blog posts or wiki pages, to abstract objects, such as the definition of a document or a chat message. Ontology is an object definition system, which can be implemented using RDF modeling [16]. RDF is used to represent information and to exchange knowledge in the Web. Web search relay on ambiguity, complexity and misinterpretation of Linked Data among Semantic Web communities, about what is Linked Data? Linked Data is relatively easy to grasp because it is simple concept with ability to observe, name, investigate, and describe objects in the real world. Linked Data objects are distributed data objects that have a uniform style of identifier [17]-[18]. A good example is the use of a Hypertext Transfer Protocol (HTTP)

Internationalized Resource Identifier (IRI) as a uniform style of identifier. Recommended changes are the separation of webbased Linked Data from the Semantic Web, the separation of RDF from RDF/XML, and the increased overall understanding of distributed data and internationalized data. The concepts, frameworks, ontologies, and technologies are in place to handle it [19]-[20]. Ontology provides the knowledge base for semantically annotating the multimedia contents and to

define web resources more precisely and make them more amenable to machine processing.

A. Sample RDF for Bag class:

```
<rdfs:Class rdf:ID="Athletic_Bags">
<rdfs:subClassOfrdf:resource="#Bags"/>
</rdfs:Class>
<Athletic_Bags rdf:ID="Athletic_Bags_2">
<property_41
rdf:datatype=" &xsd:string">lock</property_41>
<rdfs:comment
rdf:datatype="&xsd:string">hasHandleType
</rdfs:comment>
</Athletic_Bags>
<rdfs:Class rdf:ID="Backpack_Bags">
<rdfs:subClassOfrdf:resource="#Bags"/>
</rdfs:Class>
<rdfs:Class rdf:ID="Bags">
</owl:DatatypeProperty>
<rdfs:Class rdf:ID="Cosmetic_Bags">
<rdfs:subClassOf rdf:resource="#Bags"/>
</rdfs:Class>
<Hand_Bags rdf:ID="Hand_Bagsl ">
<img_of_handbag 1 rdf:datatype=" &xsd:string" >
D:\DOCUMENT\PROJECT\MYPROJECT\IMAGECOLLECTIONS\BAGS\Handbag\handbag5.jpg
</img_of_handbag 1>
<buckleshape
rdf:datatype="&xsd:string">Circle</buckleshape>
</Hand_Bags>
```

VII. COMPARISON OF IMAGE SEARCH

Fig.10 shows the images retrieved from GoogleImages for the query "Images of handbags with white color and ring type bugler". Most the images retrieved for the query are irrelevant. The major complexity with existing image search is the lack of information on the particular domain, how to locate the accurate data in repository. Text based image retrieval are user friendly but suffers from low performance problem. The semantically rich ontology addresses the need by complete descriptions of image and improves the precision of retrieval. The high-level concepts of image descriptions from external information source is collected and encapsulated into classes and instances. Assertion types are incorporated to related image to its respective class [33]. Ontology works better with the combination of image features.

Though there is a trade-off between the complexity and performance, incorporating ontology for semantic web is a viable choice for improving the efficiency and accuracy of multimedia content search.

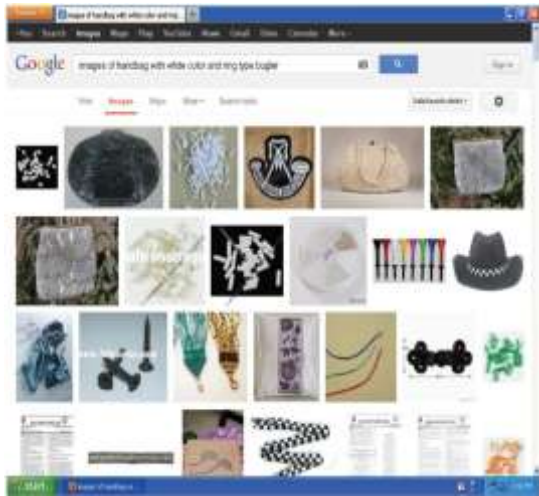


Fig 10: Google Images Results

VII. CONCLUSION

This paper gives the overview of developing Ontology and how to generate SPARQL query. SPARQL was used to extract the knowledge with respect to user perception. SPARQL has a simple query generation methodology which supports text retrieval and image retrieval based on subject, predicate and objects of specific domain ontology. The OWLViz and OntoGraf are used to show the relationship between class and subclass. The generated Resource Description Framework code for bag class was shown with their object properties, Data properties and annotated with relevant image. Integration of ontology and SPARQL for semantic web improves efficiency of image search. Future work can be proposed with spatial domain in ontology that shorten the gap between interpretation of machines and humans in retrieving Images.

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