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# Applications of Ontology and Semantic Web in Image Retrieval and Research Issues

T.Kanimozhi , Dr.A.Christy

*Faculty of Computer Science, Sathyabama University. Sathyabama University, Chennai.*

*Abstract:***The Users in many professional fields are finding obstacles to access and manipulate remotely-stored images in the database. The growth of image database creates a major problem in locating a desired image. Semantic web plays a vital role in information access by addressing information needs at semantic level such as processing users queries, linking to domain and integrating the knowledge base using available sources such as OWL, RDFs and SPARQL. The significant advances semantic technology paves way for developing and applying ontology to the problem of semantic search. The paper focus on the possibility of incorporating ontology for semantic web in major areas such as agriculture, food information, food security, military, ocean technology, biotechnology and geospatial technology. The comprehensive survey on the image retrieval reports that the content-based image retrieval, semantic image retrieval and ontology techniques playing a active role in current scenario. The searching mechanism can be optimized efficiently using ontological approach for getting desired results within the domain.**

*Keywords* – **Ontology, Semantic web, Image retrieval, SPARQL, Protégé.**

## I. INTRODUCTION

Ontology plays an important role in Semantic Web applications. However, building ontology remains as a challenging task since it is time consuming and expensive. Several studies have been proposed for reusing existing ontology. Challenging task in building ontology for semantic web (1) locating domain ontology for reuse, (2) incorporating the concepts into the domain using object oriented approach,(3) grasping the knowledge from discovered ontology, (4) using a common forum to share the domain knowledge. An adaptive strategy is needed for searching and selecting domain ontology. Semantic Web relies on ontology based generic search engines and predefined ontology features to locate existing domain ontologies and to integrate data sources. The data sources provide ontologies specific concepts that enable their easy location over the Semantic Web. Finally, a set of criteria including semantic coverage, codification language, modularity and open availability are used to select the best reusable set of ontology for the domain. The application of the ontology in the agriculture domain is demonstrated and the promising results are reported as graph [1].The objective of semantic annotation is to describe the semantic content in images and retrieval queries. It requires a common framework to represent the understanding of the semantic meaning in images and retrieval query and to standardization the representation. We can compare semantic similarity between images and a retrieval query. The semantic web can annotate the images in particular domain using the resources such as Ontology Languages (OWL), Resource Description Framework (RDF) and SPARQL.

## II. ONTOLOGY AND ITS APPLICATIONS

Ontology search mechanism plays an important role in the discovery and usage of ontology. The disadvantage of the traditional search can be overcome with the proposal of semantic web. Semantic web is also called the intelligent web or next generation web or Web 3.0. Semantic web is approach towards understanding the meaning of the contents. Semantic information is stored in the form of ontology . Today Ontology are the backbone of the semantic web. Information extraction and retrieval is benefitted with advent of ontology. Semantic data is published in the form of language like RDF, OWL, and XML. After obtaining the semantic information from the plain text next step is finding the required information [2].

### *2.1 Emotional Annotation using Ontology*

Current emotionally annotated databases image as a single stimulus that is semantically described within a single tag from an unsupervised glossary. This semantic corpus does not have an internal knowledge framework defining semantic relations between different concepts nor prohibits usage of different keywords designating the same concept. For example, if a picture portrays an man hitting the dog using car it may be tagged as "man", "dog", "car" and "hitting", "dog_hit" etc. Synonyms like "punch" or "beat" would be interpreted as different tags. Since this corpora has no semantic similarity measures there are no criterions to estimate relatedness between concepts. This represents a huge defect in the retrieval process, because a user's search query has to lexically match the keywords stored in the database [3]. All these limitations in practice dictate that a person working with a contemporary emotionally annotated database has to be a well trained expert in all its keywords, semantics and the annotated pictures. This type of skills is hard to acquire; even if one would possess them, it would be applicable only to a single domain, since the next database uses different keywords with different semantics.

The data from internet are dispersed in multiple documents or web pages. Most of them are not properly structured and organized. It becomes necessary to organize these contents in order to improve the search results by increasing the relevancy. The information extraction techniques and the ontology developed for the domain together discovers new knowledge. In an intelligent image retrieval process, different type of indexing schemes has been applied starting from text based, keyword annotated, field based, structure based, content based to ontology based. Still, image retrieval is in its infant stages only because of the *semantic disparity*.

*2.2 Limitations of Ontological Approach*

The current ontology search engines adopt keyword-based search mechanism. It is difficult to clearly represent users search requirements because the number of the keywords input by a user is usually few. Extending the input keyword(s) by using WordNet will increase the recall rates and decrease the accuracy rates, because it enlarges the search scope imprecisely. Most of current systems use WordNet as a lexical resource to build concept ontology. However, as the most important feature of WordNet is to group words into synset (set of synonyms) and connect them through hypernymy / hyponymy (ISA) and metonymy (PARTOF) relationships, the ontology generated from WordNet can onlycome with concepts and their hierarchical relationships [4]. Secondly, these systems do not implies the using of ontology reasoning with the goal of searching and retrieving complex images based on the complex query formulated in a symbolic language. For example, in a traditional system if a user queries " people using car" the text system looks for the words "car" and "people" and does not understand the meaning of "using". The spatial context of identified regions, objects, scenes and faces is not encoded within the index. This means theses systems cannot return semantically accurate results for queries involving spatial prepositions such as "next to", "on", "beside" "against" etc. In addition to querying properties which are in the "top" "bottom" "center" "left" or "right" of an image.

*2.3. Resolving ambiguity*

How to resolve the ambiguity of concepts that are extracted from visual stream with the help of identified concepts from associated textual stream. The disambiguation is performed at the concept-level based on semantic closeness over the domain ontology. The semantic closeness is a function of the distance between the concept to be disambiguated and selected associated concepts in the ontology. In this process, the image concepts will be disambiguated with any associated concept from the image and/or the text. The ability of the text concepts to resolve the ambiguity in the image concepts is varied. The best talent to resolve the ambiguity of an image concept occurs when the same concept(s) is stated clearly in both image and text, while, the worst case occurs when the image concept is an isolated concept that has no semantically close text concept. WordNet and the image labels with selected senses are used to construct the domain ontology used in the disambiguation process.

## III. RESEARCH ISSUES

Object-based image retrieval becomes an important research issue in retrieving images on the basis of the semantics of images. However, most existing object-based image retrieval systems are based on single object matching, with its main limitation being that one individual image region (object) can hardly represent the user's retrieval target especially when more than one object of interest is involved in the user query. An important aspect of the system is that users are allowed to formulate a query based on multi objects of an image. Current search engines face the problem of Limited Resource Languages ie., with few language resource, the user gets difficult to from a query. A query for "grenivka" (Slovenian for "grapefruit") produces only 24 results, of which only 9 are images of grapefruits. Yet translating the query into English produces tens of thousands of images with high precision. Ontological reasoning is a vision of a future where machines are able to reason about various aspects of available information to produce more comprehensive and semantically relevant results to search queries. The ontology based object oriented approach provides an in depth knowledge on the domain and the relationships between disparate pieces of information in order to more accurately analyze and retrieve information [5].

## IV. ONTOLOGY FOR MILITARY APPLICATION

Ontology for military applications. The use of ontology has attracted much attention within the military field since it focus on the domain knowledge to be incorporated within different systems. ONTO-CIF: A core ontology for military intelligence created to support intelligence analysis. It provides a generic description of the application field and its enrichment is needed in order to fit specific tasks[6]. One of the first models developed to support situation awareness is the SAW (Situation Awareness) ontology. SAW models a *situation* as being composed of *entities*, interacting in order to achieve one or several *goals.* By using SAW it is impossible to identify the spatio-temporal context of actions as space and time concepts are not considered. Coping with these limitations, CONON (CONtext ONtology) ontology described in [8] offers a conceptual description for situation awareness having the *context* as central element. The context is an aggregation of four features: *local coordinates*, *persons* and *objects* along with their respective *activities*. The first one is proposed by [7] and it creates a single ontology by using automatic procedures able to translate entities of the JC3IEM model (Joint Command and Communication Information Exchange Data Model), [9] as ontological entities. The translation is carried out thanks to transformation rules established by domain experts. The outcome is a large size ontology (7900 entities), having a good quality as it relies on a commonly accepted model. A new approach for identifying a particular task of the command and control process (intelligence analysis) and building a core ontology, highlighting only main concepts related to this task. The ontology is developed to have an appropriate specialization level to describe fundamental aspects of military intelligence, while remaining on a manageable scale, for ease of use.

*4.1. Construction of ONTO-CIF*

*Phase 1:* Acquisition and analysis of knowledge sources. This phase aims to create a collection of relevant knowledge sources to support ONTO-CIF development. For this work NATO standardization are documents. A set of five notions corresponding to *Event*, *Place*, *Organization*, *Person* and *Equipment are used as* the central element of domain. Collected documents provide definitions of pentagram notions (i.e. an equipment is defined as '*any item of materiel used to equip a person, organization or place to fulfill its role*'), and descriptions of entity associations. The analysis conclude that there are no standardized taxonomies for military intelligence, although the AIntP-3 resource [10] was developed to facilitate exchanges of military data.

*Phase 2:* Glossary of terms construction. This phase consists on the selection of domain specific terms. The glossary is created by including relevant terms naming concepts, instances, attributes or concept associations, along with their synonyms. At this stage of the ontology construction, several terms can refer to the same notion, and the same term can define both a concept and a relation.

*Phase 3:* Domain conceptualization. The goal of this phase is to model domain concepts, to identify relations holding between them and to define formal axioms. The pentagram is the starting point of this phase, therefore we create a basic ontological structure composed of: *Person*, *organization*, *Equipment*, *Locations* and *Events*. Then this can be gradually enriched using glossary of terms. For instance, *Geographical area* and *Vehicle* are added as specific types of *Location*, and respectively *Equipment*.

4.2. *Discussion*

Difficulties of ONTO-CIF modeling are related to its manual construction. In this approach ontology was constructed using less number of textual documents. The outcome coverage is also a critical aspect. The ontology having a satisfactory domain coverage, as the sources used for knowledge acquisition are validated by domain experts and widely exploited within the application field. This outcome will be used to define semantic similarity of HUMINT messages, offering this way a semantic-based application framework [11].

## V. ONTOLOGY CREATION USING PROTEGE

Ontology provide shared and common domain knowledge forum for making metadata interoperable and ready for efficient sharing and reuse. It is used by people and machines. It 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 development of the semantic web [15]. It can be used in ontology languages & will act as a means to draw inferences, to configure systems, to express constraints, to specify policies, to react to events/changes, to transform data, to specify behavior of agents, etc. 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 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. The strategy that translate the various languages into a common 'base' language providing them with a single coherent model theory[12].

*A. The reasons for developing ontology are:*

1. To share common understanding of the structure of information among people or software agents
2. To enable reuse of domain knowledge
3. To make domain assumptions explicit
4. To separate domain knowledge from the operational knowledge.
5. 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).

## VI. SEMANTIC WEB AND ITS APPLICATIONS

Early contribution to image retrieval were focused mainly on reliable extraction of specific semantics, e.g. differentiating indoor from outdoor scenes, cities from landscapes, and detecting trees, horses, or buildings, among others. These efforts posed the problem of semantics extraction as one of supervised learning: a set of training images with and without the concept of interest was collected and a binary classifier trained to detect the concept of interest. In generic terms, unsupervised labeling leads to significantly more scalable (in database size and number of concepts of interest) training procedures places much weaker demands on the quality of the manual annotations required to bootstrap learning, and produces a natural ranking of keywords for each new image to annotate. On the other hand, it does not explicitly treat semantics as image classes and, therefore, provides little guarantees that the semantic annotations are optimal in a recognition or retrieval sense[29][32].

*5.1 Semantic Annotation and Classification*

The semantic annotation of images creates a conceptual understanding of the domains that the image represents, enabling software agents, i.e. search engines, to make more intelligent decisions about the relevance of the image to particular user query. The Semantic Web aims at machine agents that thrive on explicitly specified semantics of content in order to search, filter, condense, or negotiate knowledge for their human users. A core technology for making the Semantic Web happen, but also to leverage application areas like Knowledge Management and E-Business is the field of Semantic Annotation, which turns human interpretation into a machine understandable form[33].

*5.2 Semantic Web for Cricket*

Domain ontology is used during information extraction, creating the OWL files and inference. First step in designing the ontology is identifying the different classes in the particular domain. Class in the ontology may have number of instances. Instance may belong to none, one or more classes. Class may be a subclass of another class. All classes are subclasses of owl: Thing the root class. In the cricket domain identified classes are Ball, Event, Inning, Location, Match, Over, Player, Series, Stadium, Team, etc. After identifying the classes next step is identifying the properties of the classes. Class characteristics are specified by Properties. They are attributes of instances and sometimes act as data values or link to other instances. Properties can be object properties or data type properties. Data type properties are relations between instances of classes and RDF literals whereas Object properties are relations between instances of two classes. Identified Object properties in cricket domain are ballBy, ballTo, hasInning, hasMatch, hasOver, hasPlayer, hasStadium, etc. Datatype properties are hasBall, hasName, hasCity, hasDate, hasEvent, hasRR, hasRRR, etc. Protégé is used for ontology design [13].

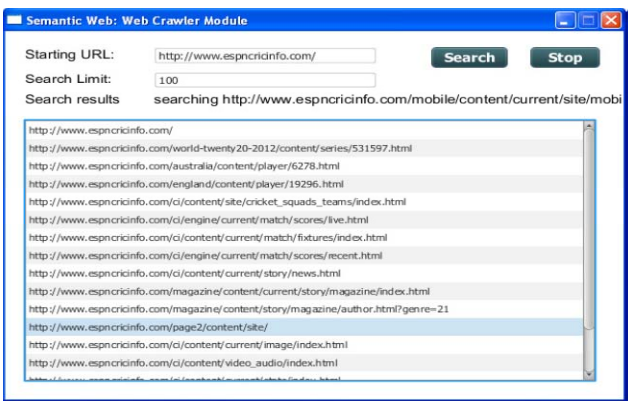


Fig.1 Web Crawling.

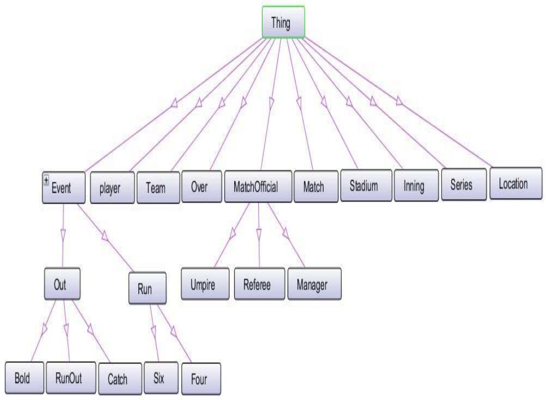


Fig.2 The class hierarchy in cricket domain.

The semantic information retrieval framework and its application to Cricket domain. The system is implemented using the most cutting edge technology like Ontology, OWL,Inference, information extraction, Ontology development and mapping, SPARQL. Considerable increase in the performance of the system using domain specific information extraction is observed. With the help of inference, performance is further improved. Very complex query asked by the user can be answered using SPARQL. Graphical user interface made easy to construct the SPARQL query otherwise it is very complicated to write the query. System is able to achieve the greater precision and recall values[14][15]. With the successful implementation of the system for cricket domain, we can extend the system for other domain with the changes in the domain ontology and information extraction. System can be extended for storing the semantic information from multiple languages. The concept of semantic information retrieval can be applied for image retrieval also [16].

## VII. PROSE DESCRIPTION OF IMAGE DOMAIN

In the current literature of knowledge management and artificial intelligence, several different approaches to the problem have been carried out of developing domain ontology from scratch. All these approaches deal fundamentally with three problems: (1) providing a collection of general terms describing classes and relations to be employed in the description of the domain itself; (2) organizing the terms into taxonomy of the classes by the ISA relation; and (3) expressing in an explicit way the constraints that make the ISA pairs meaningful. Though a number of such approaches can be found, no systematic analysis of them exists which can be used to understand the inspiring motivation, the applicability context, and the structure of the approaches[17][18]. In this paper, we provide a framework for analyzing the existing methodologies that compares them to a set of general criteria. In particular, we obtain a classification based upon the direction of ontology construction; bottom-up are those methodologies that start with some descriptions of the domain and obtain a classification, while top-down ones start with an abstract view of the domain itself, which is given a priori. The resulting classification is useful not only for theoretical purposes but also in the practice of deployment of ontology in Information Systems, since it provides a framework for choosing the right methodology to be applied in the specific context, depending on the needs of the application itself [19][20].

## VIII. SPARQL

SPARQL works with the W3C's Resource Description Framework (RDF) for representing data and the Web Services Description Language (WSDL). Traditional query languages such as SQL are designed for accesses to a single source of data, and have not performed well when the results from several sources need to be merged. SPARQL can create a single query for multiple sources and combine the results [21][22]. 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.

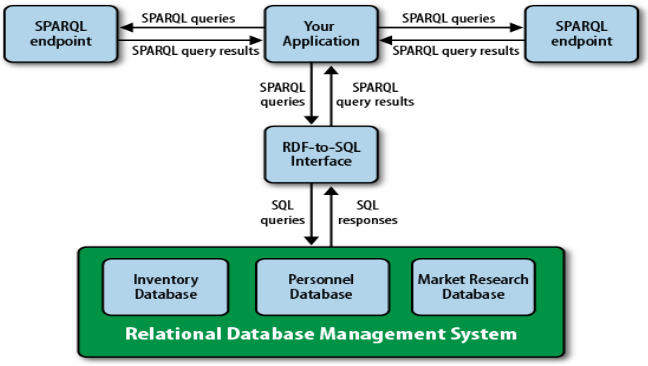


Fig.3 A framework to access database using SPARQL Queries

SPARQL Icon Ontology is used for a collection item without its own custom image, which is controlled through the icon ontology defined by schema graph , icon instance data in graph and rules in graph Together, the icon schema graph and instance data define various generic display classes: vpi:Thing, vpi:Person, vpi:Place, vpi:Book, vpi:Music etc and associate an icon with each, e.g. vpi:ThingIcon, vpi:PersonIcon etc. The default icon set generated by describe? S from where {?s ?p ?o } is shown below[23][24].

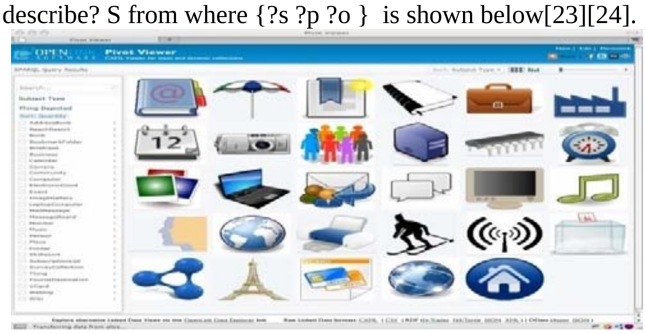

Fig.4 SPARQL Icon Ontology Results

The set of predefined display classes includes Address Book, Beach Resort, Book, Bookmark Folder, Briefcase, Business, Calendar, Community, Electronic Good, Event, Image Gallery, Mail Message, Message Board, Music, Person, Place, Ski Resort, Subscription List, Survey Collection, Thing, Tourist Destination, VCard, Weblog, and Wiki. The semantic ontology model together with image instance data can be used in finding annotations and relation with query image and other images in the repository [25][26]. There are several tools and APIs that already provide SPARQL functionality, and most of them are up to date with the latest specifications[27][28]. A brief list includes:

- ARQ, a SPARQL processor for Jena
- Rasqal, the RDF query library included in Dave Beckett's comprehensive Redland framework
- RDF::Query
- twinql, a SPARQL processor for Lisp written by Richard Newman
- Pellet, an open source OWL DL reasoner in Java, that has partial SPARQL query support
- KAON2, another OWL DL reasoner that has partial SPARQL support.

My SPARQL query tool Twinkle offers a simple GUI interface to the ARQ library, and supports multiple output formats and simple facilities for loading, editing, and saving queries[30][31].

## IX. THE CHALLENGE OF FOOD PRODUCTION AND DISTRIBUTION

Food security in India is adversely affected by several abiotic, biotic, and sociopolitical situations. The current position may worsen in the future if timely and appropriate actions are not planned and executed. The pressure of human population and land for cultivation, climate change, government policies of public distribution and marketing of food grains, and lack of a participatory approach—all are contributing to slow down the availability of foods. The factors influencing the need for a second Green Revolution are crop productivity, food distribution, food production, food security. land use, biological factors, Farm Inputs and Labor Supply**.** Schemes such as Rashtriya Krishi Vikas Yojana, the National Horticulture Mission, and the National Food Security Mission have been introduced to maximize returns to farmers by getting states to increase their investment in agriculture and food stocks. ). Both private and public investments are being designated for achieving food security—from the corporate sector, NGOs and international agencies (viz., International Alliance Against Hunger, ActionAid International, Oxfam International, Right to Food Campaign, World Food Program, International Fund for Agricultural Development, etc.), and national alliances. In this context, the National Food Security Mission may provide an excellent opportunity for states to leverage funds to promote agricultural growth and introduce a second Green Revolution. This would empower people and their participation would make it possible for them to feed themselves with assured food security [34].

## X. CONCLUSION

Building ontologies using protégé software to provide semantic interpretations of image contents. Semantic web data . In CBIR systems images are retrieved using keywords of the concept or object. Ontology provides unified approach to bridge human perception to low-level visual feature descriptions of image. Ontology Web Language (OWL) is used to build ontologies. Ontology can be built in two ways: generic and domain specific. Ontology can be used in various applications such as geospatial imaging, military, medial image retrieval. High conceptual representation is used for accessing images from various perspectives. The thirst in domain knowledge is fulfilled by ontology which depict the domain concepts and their relationships using object oriented approach. The Ontological approach of domain interpretation provides a shared and common forum that can be communicated across people and application systems. Ontology incorporated with SPARQL,ontoviz and ontograph automate the results of various application will facilitate image annotation and increase the efficiency and accuracy of image retrieval.

## XI. FUTURE WORK

The paper deals with the some current applications of ontology and semantic web in prominent areas. Our future contribution will be focused on metadata formats and thesauri suitable for describing ontology in the domain such as agriculture, food industry, aquaculture, environment and rural areas. These include the Dublin Core (DC), Metadata Object Description Schema (MODS), Virtual Open Access Agriculture and Aquaculture Repository Metadata Application Profile (VOA3R AP) and the AGROVOC thesaurus. The need of metadata description in various research fields paves way for ontological approach. The metadata are to describe the content and properties of the domain. One of the most suitable metadata formats is the VOA3R AP that is partially patterned on the DC and combined with the AGROVOC thesaurus. As a result, an effective description, availability and automatic data exchange between and among local and central repositories should be attained. The knowledge and data presented in the present paper were obtained as a result of the following research programs and grant schemes: the Grant No. 20121044 of the Internal Grant Agency titled „Using Automatic Metadata Generation for Research Papers“, the Grant agreement No. 250525 funded by the European Commission corresponding to the VOA3R Project (Virtual Open Access Agriculture & Aquaculture Repository: Sharing Scientific and Scholarly Research related to Agriculture, Food, and Environment),http://voa3r.eu and the Research Program titled „Economy of the Czech Agriculture Resources and their Efficient Use within the Framework of the Multifunctional Agrifood Systems“ of the Czech Ministry of Education, Youth and Sport [35].

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