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Framework for Image Retrieval using Protégé

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Abstract: ***Image Retrieval (IR) is the elementary requirement in present scenario as huge amount of images of different types are being added in database from different sources. For retrieval of the particular image, different kinds of processing are required to extract the relevant features from them. The Text Based Image Retrieval (TBIR) adopts the method of appending descriptions and keywords to the images which act as an alternative for the annotation words in providing exact or similar results. In order to overcome the limitations of traditional methods, the trending research study named Content Based Image Retrieval (CBIR) can be adopted. The ideology of CBIR relies on retrieving similar images from the training set using the image features like shape, texture and color. A hybrid approach named semantic based image Retrieval (SBIR) is proposed for the efficient retrieval of images by including the semantic descriptions from TBIR and the low level features of CBIR to reduce the semantic gap. In this paper, the tool named protégé is elaborated to handle the accurate results basing on RDF and OWL.***

Keywords: ***Content Based Image Retrieval (CBIR), Image Retrieval (IR), OWL, Protégé, RDF, Semantic Gap, Semantic Based Image Retrieval (SBIR), Text Based Image Retrieval (TBIR).***

I. INTRODUCTION

A. Image Retrieval:

Image retrieval can be explained as a process of identifying, searching and retrieving the similar images or images from the large repository of digital images. An active research on image retrieval was carried out since 1970 [5]. The ideology of this research is to maintain the images and retrieve an image or sequence of images relevant to a specific query. The multiple domains like Computer Graphics, Information retrieval, Database Management and user behavior which were developed as separate platforms and are interrelated for drawing important contributions.

An English idiom “a picture is worth a thousand words,” can also be stated as “an image is worth 1000 words”. Unfortunately, these 1000 words may differ among various users basing on their knowledge on the image context. The major issue is existing among the communication between information source or user and image retrieval system, as different users may pose different formats of query basing on the requirement and knowledge they consists on the images[1]. Now a day, the internet is taking diverse forms and raises the importance of developing an effective and efficient methodology to manage large image databases or repositories for the retrieval.

B. Image Retrieval Systems:

The general purpose image retrieval systems are:

i) Text Based Image Retrieval (TBIR)

ii)Content Based Image Retrieval (CBIR)

iii) Hybrid Approach – Semantic Based Image Retrieval (SBIR)

i) Text Based Image Retrieval (TBIR):

TBIR is the generalized web image retrieval system, in which the text is appended or linked with the image to describe the image contents [6] as shown in fig-1. The examples are Google and Yahoo Image Search engines. Even though these search engines are fast and robust, sometimes they may fail in extracting relevant images. The TBIR is easy to implement and the search and retrieval of image is fast but manual annotation is impossible in case of large database and inaccurate as same word can be referred for many objects (polysemy problem) [3].

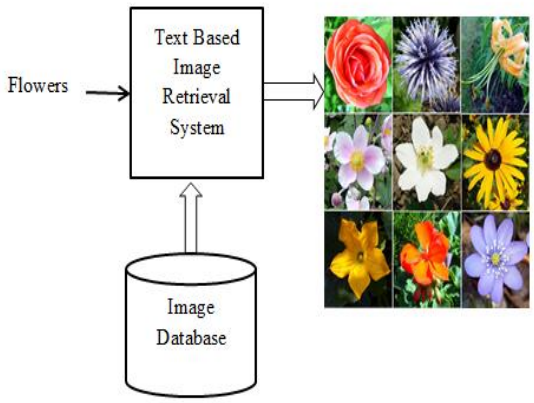

Fig. 1: Text Based Image Retrieval

ii) Content Based Image Retrieval (CBIR):

The CBIR method is introduced by T.Kato in late 1990’s, where it has been proposed as an alternative for text based image retrieval.IBM has made initiative first by introducing Query- by – image content(QBIC). The context of CBIR includes Data collection, Feature database generation, searching the database, rearranging and indexing the images in the database for the efficient retrieval [10]. The fig-2, presents the method of image retrieval using CBIR. The features in this method include texture, shape, spatial attributes and color which are retrieved automatically and the similar images are retrieved basing on the distance metrics among the features.

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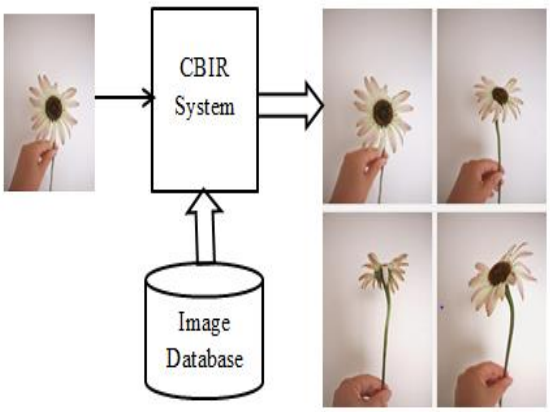

Fig. 2: Content Based Image Retrieval

1. CBIR Methods

Query Methods: Various querying techniques used in image retrieval process are Query by semantics, Query by example, Query by region of Interest (instead of complete image), querying by numerous example images, querying by sketch, querying by features of image.

The Major Methods classified are:

- Query by Semantics (Text)
- Query by Example (Image)
- Query by Sketches

***Query by Semantics*:**

Semantic retrieval initiates the query by composing the verbal phrases like “red color roses". These kind of phrased formats may be difficult for the retrieval process as there may be persons with a name red or rose or a red color rose image. Therefore sometimes the features were also added with semantics for the efficient retrieval. Some of the basic features we can have are “Color, shape, texture”. Therefore in some cases, the image retrieval needs to include human feedback to recognize higher-level concepts.

Query by Example:

Querying is done via example query image and the relevant images are displayed using some properties like color blobs or general shapes.

Querying by Sketch:

This method is similar to that of example method but here the outlines of an example image is considered and with respect to that the relevant images are displayed using some algorithms like cross domain matching analysis.

iii) Hybrid Approach:

The trending research of image search includes fusion of text descriptions with the basic attributes of the web images ie. the visual features are appended with the text descriptions like keywords[12]. In this approach, the textual features and visual features are joined for providing the efficient result [8]. The general approach in this method includes frequency-of-occurrence of keywords in order to provide automatic indexing.

The next approach includes images and texts as an equivalent data. It tries to identify the correlation among the visual features and textual descriptions in an unsupervised manner estimating the collaborative distribution of features and posing annotations as statistical inference in a graphical approach [11].

Therefore, the combination of text and content based image retrieval approaches may not achieve the efficient retrieval of images on the web. The features of CBIR can be appended to improve the efficiency of image retrieval. These hybrid features also enhance the retrieval technique i.e., it adapts the combinations of color and texture, texture and shape features. This hybrid approach is based on semantics, therefore it can also be termed as a Semantic based image retrieval (SBIR).

II. PROPOSED SYSTEM

A. Semantic Based Image Retrieval (SBIR):

The idea of Semantic Based Image Retrieval is to perform retrieval based on high level features (text based search) and low level features. The automatic image annotation is adopted in order to reduce the semantic gap. The keywords are used to annotate the images using ontologies. The ontologies define the properties of the concept and the relationships among them as defined by Brewster et al. As a part of research in semantic web, the web ontology languages have been proposed. The languages like XML, RDF, RDF Schema, OIL and DAML+OIL are the earliest forms of web ontology languages, where as OWL is the latest standard language recommended by W3C. The combination of OWL with RDF (RDF/OWL) can precisely specify the instances and their constraints in ontology. The RDF notations are used to exchange the knowledge on Web and to represent the information on web. As the next level in precedence, the OWL plays important role in publishing and sharing the sets of terms namely ontologies supporting the advancement of Web search, Knowledge management and software agents. The ontologies are evaluated using the Ontology query languages by allowing the expressions of ontologies. These queries can be considered as a basis for the inference actions which are used by the knowledge management applications. The current forms of ontology Query language include SPARQL, On-to-QL, DQL (DAML+OIL), TRIPLE, SERQL, RDQL, N3 etc.

The W3C presented the SPARQL query language to process the query ontologies constructed using RDF2 and the support has been extended to support OWL formats. The norms and usage of SPARQL is similar to that of SQL and is also based on SQL. The SPARQL also provides the capability of querying or generating Visual graph patterns along with conjunctions and disjunctions.

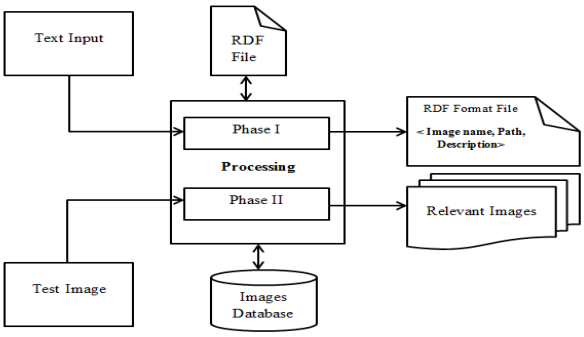

Fig 3: Proposed System Architecture

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In our proposed system we can retrieve the result either by using text or image as input. Depending on the type of input we provide, the processing takes place. If we provide text as input, Phase I is carried where it converts the text data into RDF format and after matching it displays the file with the fields specified. For example image name, Path and Description etc. If we provide image as input, Phase II is carried where it converts the image basing on the contents and from the database a relevant image is retrieved as result.

III. IMPLEMENTATION

3.1 Construction of Image Ontology using Protégé:

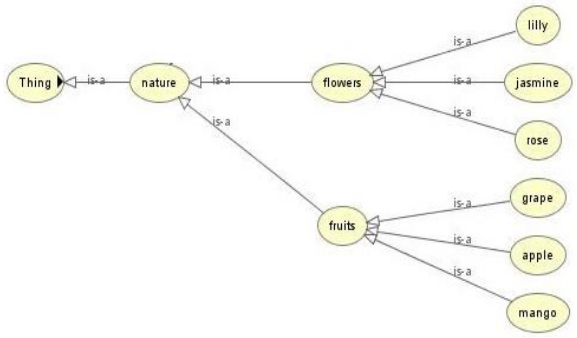

Fig 4: Structure of Classes and Instance

The construction of ontology for image is done by identifying class, properties and their instances. The tree structure is constructed as a class hierarchy as shown in figure 4. The Semantic web platform named PROTÉGÉ is used in constructing ontological hierarchy which can be used in representing the interconnection or relationships among classes using their properties.As an example, the ontology created for the nature image domain is considered. The main elements managed by ontology based semantic annotation are ontologies (Metadata), annotations (relations between metadata and data) and documents (image data). The image ontology is composed of components and models which maintains the all necessary information about images in ontological database [2][4].

3.2 Semantic Image Annotation

The figure-5 presents the annotation for the rose image in an ontological format. The High level and visual features of the image are represented using labels. The slots and labels are used to annotate. the image with their values, the class hierarchy generated enhances the annotations in association with the images. The images which fall under same category can be identified easily and retrieved with the help of features. The set of mathematical operations like Union, Cardinality, intersection etc can be applied on the ontology. By annotating the image to the class, the semantic image indexing is performed [11]. The current query languages used for semantic web are SPARQL, TRIPLE, OntoQL, RDQL, N3 and Versa. In our paper we concentrate on SPARQL as it has been adopted by W3C as a platform to process or query ontologies developed using RDF this could support OWL format.

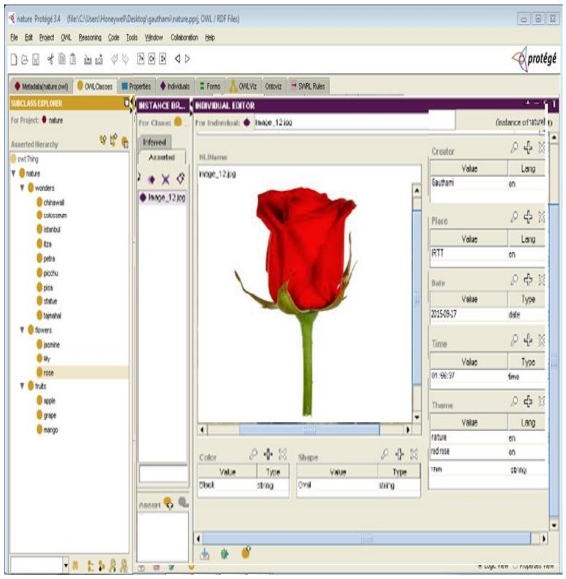

Fig 5: Specifying the images with ontologies.

3.3 Image Search:

The image ontological database is constructed using visual features and low level features as annotations. The database is formatted using owl file structures which stores the image and its associated features in RDF form and similar images are retrieved using the Owl file.

3.4 Semantic Image Retrieval using SPARQL:

The RDF query language named SPARQL is used to manipulate and retrieve the data organized in RDF format. In SPARQL, the query is presented in the triplet pattern which consist of subject(S), predicate (P) and object (O) <S, P, O> providing the semantic relationships among the data. The retrieval of image is carried with the help of user interface where the query word is entered as input which is then transformed into SPARQL format and applied on the images in the database. The system returns the relevant image for the given query format after performing the RDF pattern match [9] [7]. Finally the similar images are displayed to the user basing on the ranking.

Sample representation of RDF and OWL files:

Let us consider the example of project “image”.

A. Sample RDF for Dataset “image”:

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```
<rdf:RDF
xmlns="http://www.semanticweb.org/chandana/ontologies/201
5/8/untitled-ontology-10#"

xml:base="http://www.semanticweb.org/chandana/ontologies/2
015/8/untitled-ontology-10"

xmlns:image="http://www.semanticweb.org/chandana/ontologie
s/2015/8/image#"
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:owl="http://www.w3.org/2002/07/owl#"
   xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-
schema#">
  <owl: Ontology
rdf:about="http://www.semanticweb.org/chandana/ontol
ogies/2015/8/image"/>
   <!-- // Object Properties  -->      .....
</owl: ObjectProperty>
   <!-- // Data properties  -->        .....
</owl: DatatypeProperty>
   <!-- // Classes  -->                 .....
  <owl:Class rdf:about="&image;desc"/>
   <owl:Class rdf:about="&image;iname"/>
    <!-- // Individuals -->             .....
</owl:NamedIndividual>
```

- **Sample OWL for Dataset "image":**

```
<? xml version="1.0"?>
<! DOCTYPE Ontology [
  <!ENTITY xsd "http://www.w3.org/2001/XMLSchema#" >
  <!ENTITY xml "http://www.w3.org/XML/1998/namespace" >
  <! ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema#" >
  <!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns#"
>
]>
<Ontology xmlns="http://www.w3.org/2002/07/owl#"

xml:base="http://www.semanticweb.org/chandana/ontologies/2
015/8/image"
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:xml="http://www.w3.org/XML/1998/namespace"
   xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"

ontologyIRI="http://www.semanticweb.org/chandana/ontologie
s/2015/8/image">
  <Prefix name=""
IRI="http://www.semanticweb.org/chandana/ontologies/2015/8
/untitled-ontology-10#"/>
  <Prefix name="owl" IRI="http://www.w3.org/2002/07/owl#"/>
  <Prefix name="rdf" IRI="http://www.w3.org/1999/02/22-rdf-
syntax-ns#"/>
  <Prefix name="xsd"
IRI="http://www.w3.org/2001/XMLSchema#"/>
  <Prefix name="rdfs" IRI="http://www.w3.org/2000/01/rdf-
schema#"/>
  <Prefix name="image"
IRI="http://www.semanticweb.org/chandana/ontologies/2015/8
/image#"/>
  <Declaration>                .....      </Declaration>
  <ClassAssertion>             .....      </ClassAssertion>
  <ObjectPropertyAssertion>  .....
</ObjectPropertyAssertion>
  <DataPropertyAssertion>  .....      </DataPropertyAssertion>
  <DataPropertyDomain>  .....         </DataPropertyDomain>
  <DataPropertyRange>  .....          </DataPropertyRange>
</Ontology>
```

IV. RESULTS

Phase I:

Search using Annotations / Search by Text:

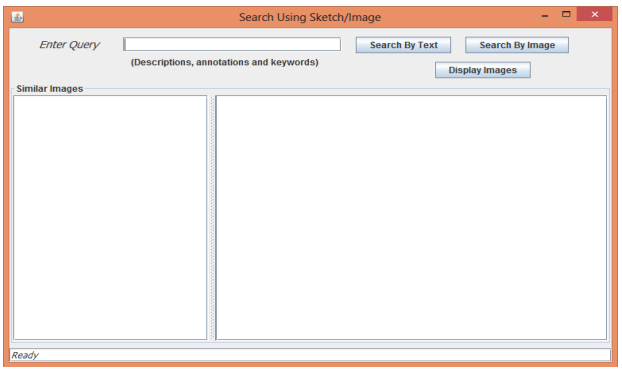

Fig 6: Reads the annotations

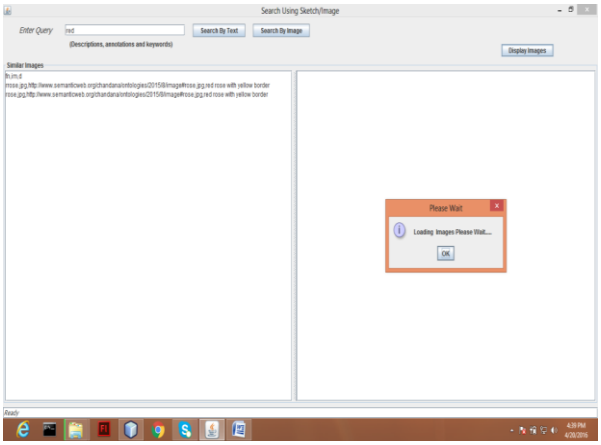

Fig 7: Generates the RDFs

When a text query i.e. description/annotations/keywords is entered in the search bar and click on the Search by Text button, the processing of phase I is carried out where it generates the relevant RDF file and finally displays the images that are matched as shown in figures 6 – 9.

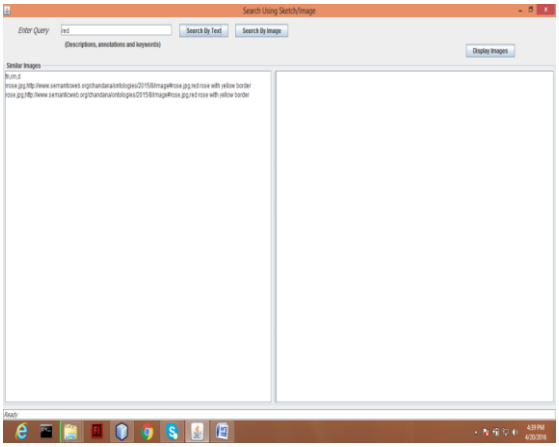

Fig 8: Retrieves the images basing on the RDF generated

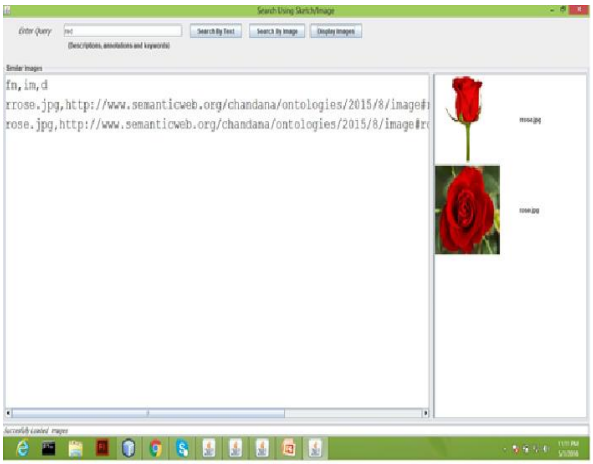

Fig 9: Displays the resultant images

Phase II: Search using Images / by Example:

When a image query i.e. Sample image is entered in the search bar and click on the Search by Image button, the processing of phase II is carried out where it displays the sample image and finally displays the images that are matched as shown in figures 10-12.

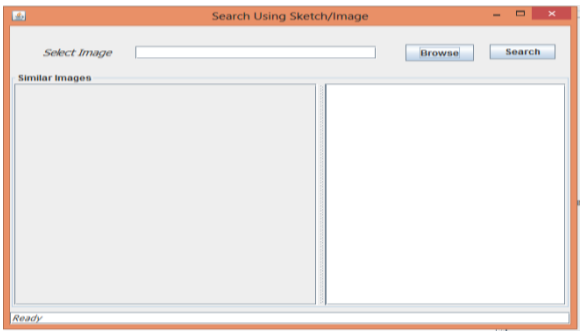

Fig 10: Query Image as Input

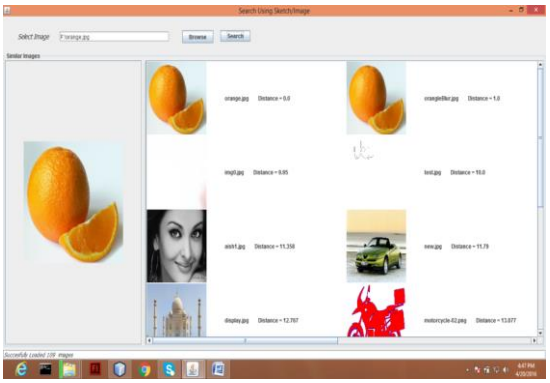

Fig 11: Displays the sample image (query image)

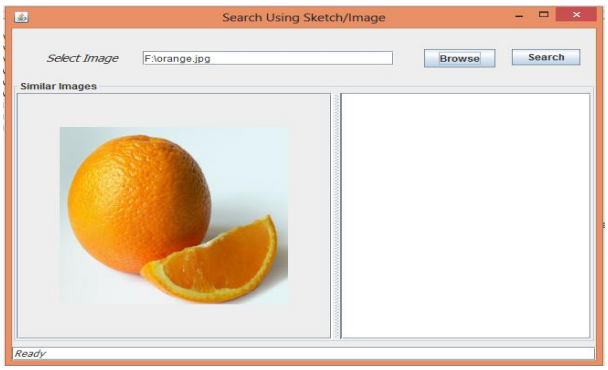

Fig 12: Displays the resultant images

In Figures 9 and 12 we can see the distance factor, where the distance ranges between 0-1 are the exact match for the query been passed.

V. EVALUATION OF PERFORMANCE FOR PROPOSED SBIR SYSTEM

The retrieval performance is a challenging task in a Semantic Based Image Retrieval (SBIR) system. There are different methods for measuring and evaluating the performance of a system has been implemented and used. The measures like Precision and Recall are used to evaluate the system accuracy. The formulae for finding Precision and Recall values are given as follows:

Precision measures the ratio of the total similar mages retrieved relevant to the query from the total set of image retrieved from the database.

Precision=

$$\frac{\text{Number of similar images retrieved}}{\text{Total number of images retrieved.}}$$

Recall measure is defined as the fraction of the all relevant images.

$$\text{Recall} = \frac{\text{Total Number of relevant OR similar images}}{\text{Number of relevant images retrieved.}}$$

High precision means more relevant images are obtained whereas the high recall value indicates that some relevant images were missed.

VI. CONCLUSION:

The TBIR system is easy to implement and the search and retrieval of image is done using keyword, the retrieval is fast but manual annotation is impossible in case of large database. In CBIR systems images are retrieved using features like shape, color, spatial and texture. The similar images are retrieved based on the distances calculated between the features. In the paper, the SBIR proposes an approach for image retrieval by combining the high level features with low level features. The proposed approach retrieves the relevant images in an efficient manner. The implementation results demonstrate that this system effectively retrieves the images which resembles similar to that of query image from ontological database. For retrieving the result, SPARQL query is used in semantic image retrieval system. Protégé interface provides an RDF/XML notation by employing the annotated image and their relationship and further extended to support OWL format.

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