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An Ontology BasedMultimedia Information Retrieval System for Community Question Answering(CQA) System Using Text Based Query

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Abstract

Information retrieval in present decade moving next level by providing multimedia data along with textual content for easy understanding of concepts.The Community Question Answering (CQA) services have become quiet popularity over the past 10 years;it helps the user to get information from a comprehensive set of well-answered questions. Text based Information retrieval system cannot exposes enough attention for understanding concept corresponding to given query. It will take more time to read, understand and also linguistic problems that prevent the user for continues reading of the document or the user may not have enough time to read the entire document.To address the limitations in the existing system, the proposed information retrieval system works on multimedia data such as text, audio, video and image for the any given query based on semantic analysis of text, image audio and video using ontology. The user query has been mapped, classified and modified according to retrieve text document, image, audio and video without affecting its content and meaning. The semantic details of query enhanced for mapping with text document ranking and the images, audio and video data retrieved by analysis of the metadata of its internal representation. The performance of our proposed work increased with multimedia contents by of users in compared with the existing text based CQA.

Key Words: Information retrieval, multimedia, query, web.

1. Introduction

In the present information age, information retrieval over online is become integral part of one third of the people around the world. The query generating by the people around the world needed to combine for analyze to seek the pattern of relationship occurred globally. Multimedia information retrieval along with textual data is a challenging work. Forecast the requirement of people from their query analysis and retrieve the correct multimedia document is possible. Text REtrieval Conference (TREC) started in 1992 contributed by US department of defense aims to support and co-ordinate IR research community by providing infrastructure, organizing, collecting and fusing data from different domains to fulfill the above said task. The TREC evaluates the result with different data set and also sponsor for non-English IR and speech reorganization.

The ultimate aim of the multimedia information retrieval (MIR) is to reach, evaluate and retrieve a multimedia data such as text, images, and audio and video in digital form which is relevant tothe user requests. The CQA included the provision that provide answers and includes the space forthe users where they can share their views, answers, opinion and value the answers. The CQA is an alternative way to retrieve information over online with the following futures.Information seekers can post their queries on the forum of any topic and can obtain answers from other participants. In the CQA, the influence of domain expert's participants, there is a possible to post and retrieve better answers compared to search engines. The answer is generated from human experts of corresponding domain which is better than the automated question-answering system. Finally, huge amount of question-answer pairs augmented in the repositories that are easy to protect and searching of answers.

The limitations in the present Community Question Answering (CQA) system provide only textual answers and understanding the conceptual meaning is complicated or time consuming process.Reading a paragraph is a time consuming and makes the user monotonous for further readings. Sometimes, the linguistic understanding also makes the problem worse. Textual answers cannot provide sufficient answer for all types of queries in the forums, and also cannot be efficient. To address this issue in CQA system and providing multimedia data for the given query collectively is a challenging task. The autonomous multimedia QA system not yet reached to provide sufficient answers to the any given query. The diagnosis of critical queries and retrieval of related textual and media contents still need to optimize. To address these limitations, the enhanced,concept based semantic processing is needed to retrieve multimedia answers.

In this research work, we proposed a model that restructured by semantic analysis using ontology for textual answers withmultimedia contents in CQA. This work contributes by providing direct answer to the queries and enhancing

the community-contributed answers with multimedia contents. The ontology plays a major role for semantic ranking of textual documentsand appropriate multimedia answers using metadata about the multimedia file.For testing the proposed method, limited set of audios (wav), images (jpg) and videos (avi) files have been handled and the performance of the proposed work shows better than the existing textual CQA.

Ontology

Ontology is represented in triples such that O= { C, P, I}, C – Defined as concepts represented as classes, P – Set of property defines relationship between classes and I – set of instances. Ontology is capable of overcome the limitations of various methods to represent complete knowledge base. From the different conceptual definitions, ontology is capable of holding collections of concepts defined by different environment about a common object or thing. In ontology, concepts represented in classes and semantic relationship between concepts defined in properties. These two important parameters of ontologies play a vital role in represent knowledge.

The Ontology is a distributed, domain specific knowledge base, used in machine automation, artificial intelligence and information retrieval. This feature utilized by IR engineers to improve retrieval performance. The goal of ontology is knowledge sharing and reuse. It should ensure to fulfill its design criteria such as description, concept,reusability and extensibility to fulfill the ontological commitments. These criteria provide relevance of ontology and completeness. Many tools existing to develop and deploy ontologies globally like protégé and OntoEdit. The protégé tool is developed by Prinston University, which can create ontology with different additional properties. In this proposed research two ontologies Apple.owl and Computer.owl created for sample experiments using protégé 4.1tool.

The WordNet Ontology and Wu and Palmer Semantic Distance Measurement

WordNet Ontology is developed by Princeton University; it is a lexical analyzer used in natural language processing (English) contains around 1,50,000 ‘synsets’ and their semantic relations. It also provides many meaning full information about the domains such as ‘synonym’ , ‘coordinated terms’, ‘hypernyms’ , ‘hyponyms’, ‘holonyms’, ‘meronyms’, ‘domain’ and ‘domain terms’. The WordNet ontology used to compare the two terms based on the semantic imminence using Wu and Palmer semantic distance measurement techniques. The similarity between two concepts is measured using Wu and Palmer similarity measurement techniques using the following equation

$$\text{Wu} - \text{Palmer}\ \ \sigma(\text{A},\text{B}) = \frac{2 * \delta(\text{A} \wedge \text{B}, \rho)}{\delta(\text{A},\ \text{A} \wedge \text{B}) + \ \delta(\text{B},\ \text{A} \wedge \text{B}) + 2 * \delta(\text{A} \wedge \text{B},\ \rho)}$$

Where ρ – is the root concept of the hierarchy, δ(A,B) is the number of intermediate edges between a concept A and B, $A \wedge B = \{ C \in O; A \leq C \wedge B \leq$

C}. WordNet with Wu-Palmer measurement techniques returns the value for two same terms as '1', semantically intimate terms return nearby to '1' and move closer to '0' otherwise.

2. Literature Review

In the information retrieval system, query is the only way to the user to express their requirements via texts. Removing the noise such as stop words, punctuation, symbols and other typographical errors from the query is called query pre-processing. Removing stop words from information corpus before ranking is mandatory carefully, because some terms in a document look like a stop word but may playan important role in document ranking.

Analyze the wealthy of word meaning and information it is going to convey is important to define. The term based sampling using Kullback-Leibler divergence measure[1] which determines the amount of information a word contains. No informationor less information if a word conveys, it is being treated as stop word. The stop words are evaluated[2] successfully using LSI techniques to ensure the word as stop word. In their work, four refinements are used such as 1) TF-Term Frequency, number of times a term presents, 2) Normalized TF, normalizing the term frequency by total number of tokens, 3) Inverse Document Frequency (IDF), the hypothetical idea of IDF is presents of keywords in all the document is not used for relevant ranking or provide lesser probability for ranking. In vice-versa, the terms in lesser document have higher value of relevant.

Document ranking is the ultimate aim of Information Retrieval (IR) system. From the beginning, the tf, tf-idf, svm, svd, clustering, similarity search and other techniques all are meant for filtering the document to select one among better from document repository. Now the emerging of semantic web, semantic similarity becomes the part of document ranking. The semantic similarity between words is important for IR (Document ranking). WordNet is an oracle for IR engineers that plays a major role in Natural Language Processing (NLP), text classification and even for text clustering in a document.Three clustering methods have analyzed using WordNet[3], ascending hierarchical, a SOM-based and an ant-based clustering method experimented with corresponding similarity measurement such as Euclidean distance, Manhattan distance and cosine distance. Likewise, WordNet is used to compute thesimilarity between concepts using edge-counting based method[4]. Similarlyan enhanced version of affinity propagation clustering algorithm called Seeds Affinity Propagation clusteringhave proposed [5]. Their proposed work is categorized into Tri-set computation, similarity computation, seeds construction, and messages transmission. In community question answering system, the multimedia answers include not only text content, image, audio and video for easy understanding of users. Image retrieval for corresponding query is based on image content defined in colors, textures and shapes basedsimilarity measures are used to determine how similar or dissimilar corresponding to the image in

the database collections [6]. A novel approach MMQA (Multimedia Question Answer0) generation by which user can get answer in textual as well as media form. The approach includesthree components such that 1) Answer medium selection 2) Query generation for multimedia search, 3) Multimedia data selection & Presentation. Initially it will predict whether it's necessary to add multimedia data along with textual answer and if it will require then which type of class data should be added. Data can be of following classes: text, text + image, text + image + video. Then media data will be add to enhance original textual answer. After this we have to generate informative queries and second component will extracts three queries from the question, answer, and the QA pair. According to query,the third component will collect images and video and then final answer representation is done [7]. The review of various image retrieval methods and its pros and cons has been analyzed [8] for image retrieval.

The clustering technique is used to cluster the positive images using text based query. This can be accomplished using weighted K-NN graph in which the weight of the given edge is an exponentially decreasing function of the distance between images and an interaction parameter[9]. Better results can be obtained if the graph is pre-processed in order to remove outliers[10]. Anunsupervised setting for a query-dependent re-ranking and this approach is consistent with the clustering hypothesis followed by [11] that assumes that the set of the relevant images forms the largest cluster. Image retrieval using Block Truncation/Coding (BTC) [12] is a novel image retrieval method with Gabor wavelet co-occurrence matrix. The image properties such as texture, color, shape, correlation and spatial relation are considered in the method and converted into Eigen values. This BTC is possible to apply both color images and grayscale images.

In CBIR, the Query By Example was the most popular one but the obstacle for CBE is the Semantic Gap between text based query with image. The query by concept[13] is proposed to minimize semantic distance between textual query for image. In their proposed method, the semantic gap has been rectified, even though not yet completed, and based on their test data set. To address the limitation in query by concept with textual representation, We proposed, a QBC using Ontological concepts mapping with image attributes along with metadata of the image for retrieval.The CBIR is not efficient in last ten years because of its poor retrieval quality and usability [14], and it has been replaced by QBE. The QBE is takes the image as model and compare it the images in the database. The most similar images will be retrieved as result. The QBE is inefficient due to its comparison nature and also takes long time to finding the corresponding images. The query for the QBE is an image, so retrieving images for text based query is not feasible here. Query by concept (QBC) takes concept as the query and searches for images with the same concept [15].The two major approaches for QBC technique are Monotonic Tree Approach(MTA) and automatic annotation techniques for query-by-concept in image retrieval system[16].

The Multimedia Question Answering (MMQA) system consists of three major components, such as query enhancement, text and multimedia object ranking and presentation. These approaches figure-out the type of multimedia contentto be added to get an elaborated textual answer using ontology. The MMQA collectsanswers from community expert members from the web to enrich the answer. Processing a large set of question- answer pairs and adding them to a dataset. The users can find multimedia answers by comparing their questions with those in the dataset. The approach MMQA is different from rest of the MMQA research takes efforts to provide direct question answers with image & video data with community-contributed textual answers [17].

In the CQA system, map the query to a few relevant concepts instead of all concepts. In addition, searching with text and image inputs is effective and it is possible to determine the number of related concepts using a language modeling approach [18].The common MMIR should includes a) development of a truly video QA system, b) presentation of a robust lingual passage retrieval algorithm c) development of a large-scale lingual video QA corpus or system evaluation, and d) comparisons of top-performing retrieval methods under the fair conditions is the major contributions of information retrieval [19].

Image searching and re-ranking is a challenging work and [20]proposed a classifier for all the predefined semantic attributes. Based on the classifiers, the image is represented by an attribute feature which consisting of responses from these classifiers. A hyper graph is used to define the relationship between images by integrating low-level visual and attribute features and it is used to perform arranging images in descending order. Its basic principle is that visually similar images should have similar ranking scores. In this work, a visual-attribute hyper graph learning approach to simultaneously explore information sources. A hyper graph is constructed to model the relationship of all images[21].From the query, the scheme identifiesthe visual concepts and search its top ranked images from famous search engines andestablishes a probabilistic network to figure out the relationship between query and crawled images. The network seamlessly integrates three layers of relationships, i.e., the semantic-level, cross-modality level as well as visual-level. Based on the derived relevance scores, a new ranking list is generated. Extensive evaluations on a real-world dataset to characterize the complex queries achieved performance [22].MMQA research attempts to directly answer questions with image and video data on community-contributed textual answers and thus deal with more complex questions [23].

A novel set of features for representing rhythmic structure and strength is proposed for audio retrieval. The performance of that feature sets evaluated by training statistical pattern recognition classifiers using real world audio collections. Based on the automatic hierarchical genre classification, two graphical user interfaces for browsing and interacting with large audio collections have been developed [24].The music can be classified into three

broad categories: such as rock, classical and jazz. Feature extraction process and particular choice of features is used for spectrograms and Mel Scaled campestral coefficients (MFCC). The work used the texture of texture models to generate feature vectors and these features are capable of capturing the frequency-power profile of the sound as the song proceeds[25].

Human intervention is deployed to learn the weight offline to name the result for few queries before re-ranking online. Based on the results of human naming of independent query, the testoutcomes on web image search dataset with 353 queries demonstrate that the method outperforms the existing supervised and unsupervised re-ranking approaches [26]. Audio synthesis and recognize can make any spoken words in video or audio media subject to text indexing. Audio recognition accuracy varies dramatically depending on the quality and type of data used, but the system is quite useable in speech recognition [28].

For image search, a novel query suggestion scheme named Visual Query Attributes Suggestion (VQAS) with Query By Example (QBE) is perform withgiven a query image and informative parameters are advised to user as complements to the query. These parametersconvey the visual properties and key components of the query. By selecting some suggested attributes, the user can provide more precise search intent which is not captured by the query image[28].

The knowledge structure and models are different facets of QA events, and used in conjunction with successive constraint relaxation algorithm to achieve effective QA. This approach extends to perform event-based QA by uncovering the structure within the external knowledge. The results obtained on TREC-11 QA corpus indicate that the new approach is more effective and able to attain a confidence-weighted score of above 80% [30]. They made a survey about text and content based image retrieval system. Image retrieval is performed by matching the features of a query image with those in the image database. It can be classified as text-based and content-based. The text-based Image retrieval applies traditional text retrieval techniques to image annotations. The content-based Image retrieval apply image processing techniques to first extract image features and then retrieve relevant images based on the match of these features. Feature extraction is the process of extracting image features to a distinguishable extent to extract[6].

Audio retrieval on the other hand using text based query is proposed using machine learning approach forsearching audio content via textual metadata. Here, they handled a generic sound, which includesvastflavors of sound effects, animal voices and natural scenes[31]. In similar to the query by example for images, there is possibility for search music pieces based of web documents and searching for relevant music chunks by providing description of text based queries. In their proposed work, inspects audio-based similarity measurement for text-based ranking, either by directly modifying the retrieval process or by performing post-hoc audio based re-ranking. Searching for relevant music

objects by issuing descriptive textual queriesimproves ranking quality by including relevant tracks.

In the video data retrieval (as content) [32], (as object)[33], for characterizing the segmented chunks of incoming video stream into meaningful pieces for represent motion.For extracting the video segment, the quantized pixel difference is identified among all frames and combines them. The two dimensional matrix is used to represent combined motions of segment. The Using the MPEG-7 motion activity descriptor [34], the video segment description is obtained from the movement action in the video. In their work, the key-frames are acquired by dividing the equal cumulative motion activity and selected the frames at the half-way point of each sub-segment. The empirical relationship among the motion activity of a segment established for selecting videos.

3. Ontology Based Multimedia Information Retrieval

The Query Analysis

The query is a set of string or text given by the user to the CQA that commonly reflects the requirements of concepts. Before start to answering, it is necessary to enhance the query to predict or understand what exactly the user expects from CQA. The query has been divided into set of independent string and removes the stop words to identify concepts. The stop words are carefully removed using standard stop words from Text Retrieval Conference (TREC). After removing the stop words, the concepts have been enhanced using ontology to rank the multimedia content. The proposed work enhances the CQA with relevant multimedia content to easily understand concepts or theory with in short period of time.

The result of each query includes text, image, audio and video content to easy understandingby the users in community web sites. The query fired by the users issemantically enhanced according to the text, image, audio and video objects with ontology and all contents such as text, image etc., are handled independently. The Textual content ranked, and imagesare compared with existing image dataset and audio object ranked using wave (.wav) using metadata search. Image can be recognized by its content, the content can analysis by predefined image pattern along with metadata. This approach is built based on enhanced multimedia information QA for CQA system. Figure 1show and the detailed proposed work and the description given in consecutive headings.

Retrieving the media information such as image and video, this proposed work utilized the ontology. The ontological concepts along with the metadata about the multimedia files provide the strong semantic relationship between the query

and multimedia contents. This approach determines which type of media file should be added to the textual answer. By processing a large set of QA pairs and adding them to a pool, our approach can enable a novel multimedia question answering (MMQA) approach as users can find multimedia answers by matching their questions with those in the pool.

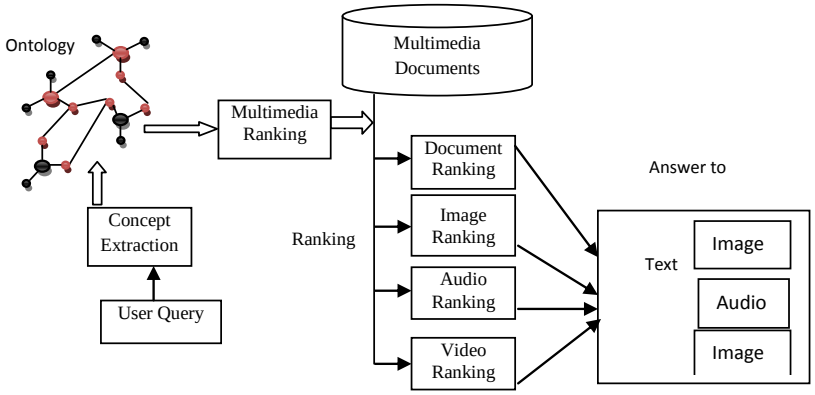

Fig. 1: Architecture Diagram

Text Document Ranking Using Ontology

The text retrieval for a given query have enhanced based on ontological concepts and the information corpus have been semantically calculated using WordNet ontology and Wu-and-Palmer semantic distance measurement technique. The average semantic value of each textual answer has been verified and the highest valued document/content have provided as answer to the given query. The two queries have been taken for verification. “Details about computer” and “Apple fruit”. Consider the first query, “Details about computer”. After removing the stop words, the concept term in the query is ‘computer’. It has been enhanced using ontology and the concepts ‘computer’, ‘hardware’, ‘memory’,’processor’, ‘hard disk’, ‘software’. Using these keywords, the text content in the CQA is ranked to provide better content for easy understanding. In the second query, ‘Apple fruit’, the detains of Apple fruit is enhanced as ‘sweeter’, ‘seed’, ‘red color’, ‘healthy’. Based on the enhanced terms, using WordNet, the content of CQA is ranked to provide better content. The ranking of the contents in the CQA, each conceptual terms in the enhanced query is compared with the concepts in the CQA for measuring the semantic distance between the query concept and contents in the CQA[34]. Similarly all the concepts in the CQA are compared and total is computed. Similarly, all the enhanced query terms are compared with concept in the CQA are calculated and the accumulated value is considered for ranking the contents.

Image Retrieval by Query by Concept Using Ontology

In the image retrieval, the query has been conceptually mapped with ontologyto improve the search. The query enhanced and the enhanced terms are collectively used to analyze metadata of the image and the maximum identical

image of those satisfied metadata has checked with the existing images in the database. The pixel representation of images is compared and verified using nearest neighbor method image searching and the equal or nearer to the existing image, is considered as output image corresponding to the given query.In this image retrieval process, the ontological concepts and annotations of the image have been considered to rank the image for retrieval. For experimental evaluation,15 sample image dataset has been stored in database and the retrieval performance has been verified.

Audio Retrieval

The proposed audio ranking is divided into two categories such as metadata analysis using ontology and content analysis using DWT. The metadata such as file format, size, owner and textual description about the content are verified before content analyze. The high similar metadata audio file is transfer to content analyze. The audio files are divided intomultiple equal sizes of segments and stored into the database. The retrieved audio files are segmented and compared using DWT with the existing segments.

Audio indexing and retrieval algorithm is used to locate similar audio segments in the database. A new boundary detection technique based on audio shot is used for audio segmentation. Subsequently, the method is employed to convert the audio shot sequence to audio word sequence, which utilizes a self-learning audio shot dictionary[36]. In our work, the metadata about the object have semantically verified using ontology for ensuring type of file, when created etc., for enhanced retrieval. The text query based audio object ranking is done by using Discrete Wavelet Transform(DWT) to validate and retrieve audio objects along with metadata of the audio object corresponding to the given query. In DWT, Short Time Fourier Transform is used to overcome the problem related to its frequencies and time resolutions properties.In the context of audio object retrieval, the sample audio for each sampled queries are compared using the DWT. The two WAV are compared sample-by-sample, and calculate an average per-sample difference. To speed up the retrieval process, the random sample comparison is used. In random sample, the entire audio object has been virtually divided into multiple chunk samples of same size and each sample are compared randomly and the most average WAV object have selected for retrieval. The maximum equivalent or most similar audio object can be retrieved for providing answer to the given query.

Video Retrieval

In the video object retrieval and ranking based on the metadata of that object and the video object has been divided into frames and each fame are considered as independent of images. The frames are virtually grouped as 24 images considered as samples for comparison. Each image frames of the video compared with existing images in the database and the nearest neighbor method for comparing each frames for evaluating semantic relationship with query concepts. Any subset of the video frames matched with existing images, the

video is considered as semantically relevant to the query. The one more important considerations in the video retrieval is the audio data trapping corresponding to the each frame. The audio bit in each frame is grouped from 24 frames and evaluated using DWT by comparing with existing audio object in our database. All the contents are evaluated for ranking using ontology, and provide it to user in combined manner even though the evaluation are made independently of each media type. In MM question answering system, the user feedback is evaluated for generating better contents and enriches the knowledge of the ontology for future retrieval.

4. Experiment Results and Performance Analysis

To test out the proposed multimedia QA by evaluating text, image, audio and video, we manually identify 2 queries and developed an ontology using protégé corresponding to query concepts with semantically related multimedia classes, properties and other detailsalong with 15 text contents, images, audios and video objects. We manually labeled the description of text, images, audio and video as either relevant or relevant. We further manually annotate whether all the contents are semantically relevant. We illustrate the top results for two example queries shown in the given figure2 and 3. The result ensures that the proposed method retrieved semantically relevant text, image, audio and video contents for the corresponding query.

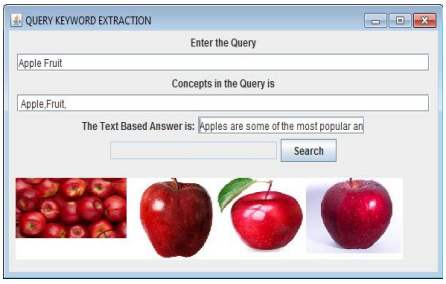

Fig. 2: Output for the Query Apple

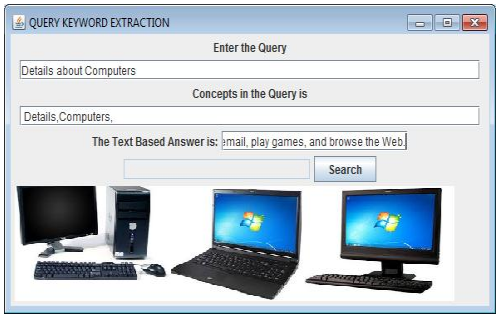

Fig. 3: Output for the Query Computer

5. Conclusion and Future Work

In this paper, we attempted the CQA for text based query and ontology as background knowledge for enriching the result to easy and better understanding of concepts with-in short period of time. Unlike text based document ranking, the multimedia object ranking includes text, image, audio and video using annotation of multimedia objects with the help of ontological concept representations. The multimedia objects such as image, audio and video are ranked corresponding to the content of the object using common ontology corresponding to query concepts. This research aims to retrieve multimedia answers to the given query and proposed approach is works based on the group of answers to retrieve relevant answer using ontology from the community of web sites like blog and forum. For a given query, this proposed work find out the appropriate ontology for enriching the original text based answers. Image and audio has been recognized based on trained dataset, by analyzing with metadata search based on samples. Finally video object evaluated corresponding to the query and all the objects that semantically related are together provided to output/answer to the given query. In our future work, further improvebetter query expansion using ontology to retrieve relevant segments from a video.

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