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OntoImVid-ontology based semantic image/video processing

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***Abstract*---**The rapid increase in the available amount of video data is creating a growing demand for efficient methods for understanding and managing it at the semantic level. Domain ontology is used to define high level semantic concepts and their relations in the context of the examined domain. A low-level features and video content analysis algorithms are integrated into the ontology to enrich video semantic analysis. OWL is used for the ontology description. Rules in Description Logic are defined to describe how features and algorithms for video analysis should be applied according to different perception content and low-level features. OntoImVid structure is created from both image and video semantic analysis results. Proposed OntoImVid combines the image and Video retrieval in same semantic retrieval technique in efficient manner.

***Keywords*---**ontology, low level features, description logic, semantic analysis.

Introduction

Ontology is one of the most common knowledge representation model used extensively in information retrieval as it represents the knowledge in terms of machine readable, understandable and processable information hierarchies. Typically, a computational ontology mainly consists of high level concepts or classes formed through the aggregation of domain specific terms, along with their attributes and relations. Ontology can be employed for semantic based information retrieval which is all about retrieving accurate results through query expansion, terms disambiguation resolution, document classification and enhancing IR model.

Many efforts have been undertaken to represent metadata of video data using ontologies. According to L. F. Sikos, there are four types' approaches: 1) low-level video descriptions, 2) high-level video description, 3) administrative metadata, and 4) spatiotemporal annotations. The first type is related to video quality, e.g., camera motion, loudness, and video frame rate. The second type describes the video content. The third type presents video metadata such as that for a director and a scriptwriter. The fourth type describes spatiotemporal information in the video. For instance, Dublin Core and Media Resources 1.0 ontologies describe the first and third type of information. To describe the fourth information, we used Media Fragments URI 1.0. All three resources are used widely in the semantic metadata domain.

Early video retrieval systems often represented video clips using a collection of (low-level) observable attributes provided by various modalities. These low-level characteristics, such as histograms in the HSV, RGB, and YUV colour spaces, Gabor texture or wavelets, and structure via edge direction histograms and edge maps, may be recovered from video reliably and automatically. However, because the semantic meaning of video information cannot be conveyed in this manner, these systems' success with this method to video retrieval for semantic inquiries was restricted. Several researches have proven the difficulties of meeting information demands with such basic elements.

The semantic web has reworked the process of turning web information into a more structured format so that the user's web query may be returned with more accuracy, as well as offering an intelligent system to combine data from many sources. Fundamentally, the semantic web's power is based on its effective ontological linkages to adequately express information suited for machine-readable format Ontologies are data models that are used to link concepts based on their potential referred to entities i.e., classes and relationships.

Ontology-based query expansion models are classified into three types: manual query expansion, user assistance-based query expansion, and automatic techniques. The ontology-based QE strategy is built on domain ideas that are semantically linked and interconnected. As a result, ontology represents domain characteristics. Several domain dependent ontologies exist in different domains of business, agriculture, law, medical, and many more (Raza et al., 2019). Such ontologies are kept in a vast repository if DARPA Agent Markup Language is used (DAML).

The remainder of the paper is organized as follows. In Section II, a detailed description of the proposed knowledge-assisted analysis system for semantic video object detection is given. Sections III describe the developed ontology framework and its application to the Formula One domain respectively. Experimental results are presented in Section IV. Finally, conclusions are drawn in Section V.

Literature Survey

Sharma N et al [1] proposed an IoT ontology-based remote patient monitoring system that can help contain the spread of virus and treatment using sensory 1D

Biomedical Signals such as ECG, PPG, temperature, and accelerometer. IoT solutions in the medical domain provide a seamless environment by monitoring remote patients and providing medical help to distant locations by integrating different 1D biomedical signal into a single domain. During the COVID-19 pandemic situation, remote patient monitoring has become an absolute necessity as medical services fell short of pharmaceutical help. The research work aims to provide information regarding Corona Patients/suspected Corona patients in any locality to cohorts (colleagues, family members, visitors etc.).

Three leading technologies are used to develop the IoT patient monitoring application described in their paper: RFID, microcontrollers, and sensors. Along with that, the ontology related to COVID-19 may be incorporated. Here, the efficiency of the proposed model is validated in terms of accuracy and power consumption. During simulation of the proposed model, it becomes evident that the model gives an accuracy of 96.33 %. Additionally, it is also observed that the model is also efficient in terms of power consumption.

Alam A et al [2] developed a layered architecture for large scale distributed intelligent video surveillance video retrieval while exploiting deep-learning and semantic approaches called IntelliBVR. The proposed IntelliBVR is composed of four layers. Author then explain the technical details of each layer. In the Knowledge Curation Layer, we show the proposed ontology for large-scale videos. Finally, they show to evaluate the proposed IntelliBVR and demonstrate some preliminary results. The IntelliBVR is an ongoing research work under the SIAT project. In the future, they are going to extend the mining layer to object tracking. The current ontology needs an extension for further complex situations so that can be used in the cloud under the as-a-service paradigm. In this release, we do not discuss the semantic rules for advance reasoning. In the future, we are also going to write about how to pen rules after its extension to complex events in a multi-stream environment. Furthermore, in the future, they are also going to evaluate IntelliBVR against different real-world scenarios.

Hawalah A [3] presented the enhanced Arabic topic-discovery architecture (EATA), which provides a semantic ontology-based approach to enhance Arabic text classification. The lack of studies in the Information retrieval domain for the Arabic language has motivated us to present a novel approach in improving the traditional classification algorithms to cope with the challenges in processing the Arabic language. In this paper, author proposed a semantic enhancement model to improve the Arabic classification and topic-discovery technique, which utilizes the rich semantic information in the Arabic ontology. A semantic clustering mechanism is suggested to capture the semantic relations between the potential topics that can be mapped onto the textual content. They set up a mathematical model to compute the importance of such clusters and reflect it on the encompassed topics. Finally, they have conducted an experiment to validate the effectiveness of the EATA. The results show that the classification performance of the proposed framework is much better than the traditional classification algorithms.

Vizcarra J et al [4] elaborated a methodology aimed at representing and indexing the semantics of human behaviors recorded in video data. The contribution was

able to generate ontology-based RDF knowledge graphs with explicit knowledge (ontologies and knowledge bases). Their approach integrates multimodal human behavior annotations, such as actions, conversations, and DNN detector outputs (feature extraction, object detection, and body posture tracking). They prioritized the representation and integration of explicit knowledge to index the semantics of human behaviors, which is not, covered in traditional end2end approaches. As a result, the representation as knowledge graphs was more detailed. The content was well-structured that conceded video indexing.

Filali J et al [5] discussed an image classification and annotation approach and It relies on training visual-feature classifiers according to the taxonomic relationships between image categories. Concepts are extracted from image categories and taxonomic relationships between them are created to build the ontology, which represents the semantic information associated with the training images. Secondly, two ways of training feature classifiers are applied, the first one consists in training hypernymy classifiers using training images of super-categories that included images of their sub-classes. The second way is performed by training hyponym classifiers using only images of sub-categories.

Asim MN et al [6] discussed that Semantic based information retrieval is facing multifarious problems such as unavailability of semantic knowledge sources, evaluation benchmarks, datasets, fast IR methods, and inevitable evolution of domain. Likewise, multimedia information retrieval is yet to overcome the challenges of semantic gap which does exist between the keywords of user query and features of multimedia resources. Another major bottleneck in multimedia IR is the lack of high dimensional indexing algorithms which are indispensable techniques for highly dimensional multimedia features.

On the other hand, cross-lingual information retrieval is also lacking significant resources such as corpus, ontologies, and lexicons for several renowned languages (e.g Urdu). In addition, cross-lingual information retrieval is still unable to surpass the problem of knowledge representation which would prove a major hurdle for several researchers and practitioners. Considering all aforementioned problems, a reasonable research in machine translation, automatic ontology learning from unstructured text, and the semantic information annotation and extraction is required to excel in the field of information retrieval.

Kaoura G et al [7] introduces a new approach for the confrontment of ASD. The fact that a user may enter the system from wherever he/she desires (either from home during his free time and for free or from any other place) is added value to the application, helping practically to the health management problem. The possibility of on time and in-time process of many information regarding comportment, antecedents, the individual's environment etc, provides the background for the right decision making by an individual for another one. The ontology contributes to the more accurate descriptive depiction of the clinical image of individuals facing ASD and to the presentation of the proposed interventions.

Additionally, through the Primary Diagnosis tool that has been developed, the possible finding of indications of ASD is innovative since it could awaken not only

parents and relatives but also specialists and teachers that may identify the indications through the questions applied. So, it has a consultative role for the individuals involved and can be a useful tool on the hands of the specialists, contributing to the effectiveness of their work, since it is based on key-user's method by using their professional experience and providing it to the user.

Shanshan S et al [8] developed an improved hybrid ontology-based recommendation system for online learning resources and used collaborative filtering and SPM to provide more accurate recommendations. Ontology is used to represent the knowledge of learners and learning resources, and collaborative filtering technology is used to generate lists of preliminary recommendations. The application of the SPM method makes the final recommendation more consistent with the general order of learning. Through using learners' sequential access patterns and ontology domain knowledge, the proposed hybrid recommended approach could help alleviate the cold start and data sparsity problems. Their improved hybrid recommendation algorithm is proposed for predicting and recommending online learning resources for learners. Recommended e-learning resources include assignments, quizzes, and notes in text, image, audio, and video format, which meet the most needs in the e-learning environment.

Wang M [9] discussed the first generic framework based on ontology to improve utility O&M. Author developed a domain ontology for modelling lifecycle underground utility information. They built a user interface for users to apply developed functions without domain knowledge and also facilitated activities and decision making in utility O&M by ontology query and reasoning.

Jain S et al [10] have defined the fuzzy membership for all types of semantic relationships present in the ConceptNet Ontology by assigning semantic weights to each of these relationships. The proposed fuzzy membership function uses these Semantic weights and ConceptNet edge weights for calculating the membership value which is further used as edge weight between different concepts in the fuzzy ontology. By applying proposed fuzzy membership among the different concepts, most related concepts in the particular domain can be identified and thus query is expanded. By integrating the Query Expansion process with the current search engines, semantic web can be created to deal with the context of the query. We have evaluated the proposed framework on various parameters like precision@10, MAP, MRR, R- Precision and total no of documents retrieved on popular search engines and found better results as compared to previous research works. Precision has been improved 10% after query expansion. Total number of documents is also reduced with the help of query expansion to almost 1/1000 number of documents for each query on different web search engines.

Narayanasamy et al [11] concentrated on the use of semantic web technologies in healthcare, virtual communities, and how the information retrieval task was performed effectively to find hidden knowledge and establishes a strong contribution by utilising ontological sources such as Wiki data, DBpedia, and Schema.org. The introduction of semantic web technologies has created a simple application interface for reducing hidden linkages among possible real-world entities and increasing concept compatibility. It has been proposed that

combining the semantic web with artificial intelligence might open the way for a unified method to dealing with unstructured data disambiguation challenges. The semantic web technologies have given many opportunities to transform the unstructured or semi-structured data formats into some standard structured format using the RDF schema and OWL frameworks.

Ayman Alahmar et al. [12] established a novel automated CP standardisation strategy that strikes a balance between machine involvement and domain experts' management. The experimental findings show that the suggested strategy reduces the SNOMED CT search space by a high proportion, saving domain experts time and allowing them to more efficiently discover the proper standardised CP words. The suggested standardisation technique may be applied to additional ontologically represented domains, such as clinical/medical terminology in EMRs and drug prescriptions. The focus of this study was on the standardisation of initial local CP words that exist in SNOMED CT but are not correct in the opinion of domain experts.

As a result, one of the primary tasks in the provided technique was to use semantic relatedness to search the SNOMED CT ontology for concepts that were semantically related to the original SNOMED CT terms. The fundamental disadvantage of this study is that no local CP words or abbreviations were addressed because they do not exist in any terminology system. Their future research in this area will focus on standardising this form of local CP term. In these circumstances, the beginning word is not found in the SNOMED CT ontology.

The purpose of information retrieval is to integrate these rating features fiD and provide a ranked list of documents that meet the information needs of users. Traditionally, relevance-based probabilistic models rank items by ordering the conditional probability that each page is relevant to the current query. Most well-known text retrieval methods, such as the BIR model, start by inverting the positions of y and D according to the Bayes rule and calculating the generative probability of document D in relevant and irrelevant documents. However, in fact, the underlying model assumptions of these techniques, such as the term independence, may be erroneous.

Discriminative models, on the other hand, may directly represent the classification border and often make less model assumptions. Moreover, it is possible for retrieval systems to provide different types of ranking features from completely irrelevant sources including both query dependent features and query-independent features.

Proposed Methodology

RDF stands for Resource Description Framework and is a standard for describing web resources and data interchange, developed and standardized with the World Wide Web Consortium. RDF is a directed graph composed of triple statements. An RDF graph statement is represented by: 1) a node for the subject, 2) an arc that goes from a subject to an object for the predicate and 3) a node for the object. Each of the three parts of the statement can be identified by a URI. An object can

also be a literal value. This simple, flexible data model has a lot of expressive power to represent complex situations, relationships, and other things of interest, while also being appropriately abstract.

OWL classes correspond to description logic (DL) concepts, OWL properties to DL roles, while individuals are called the same way in both the OWL and the DL terminology. In the beginning, IS-A was quite simple. Early attempts to build large ontologies were plagued by a lack of clear definitions. Members of the OWL family have model theoretic formal semantics, and so have strong logical foundations. Description logics are a family of logics that are decidable fragments of first-order logic with attractive and well-understood computational properties.

Framework

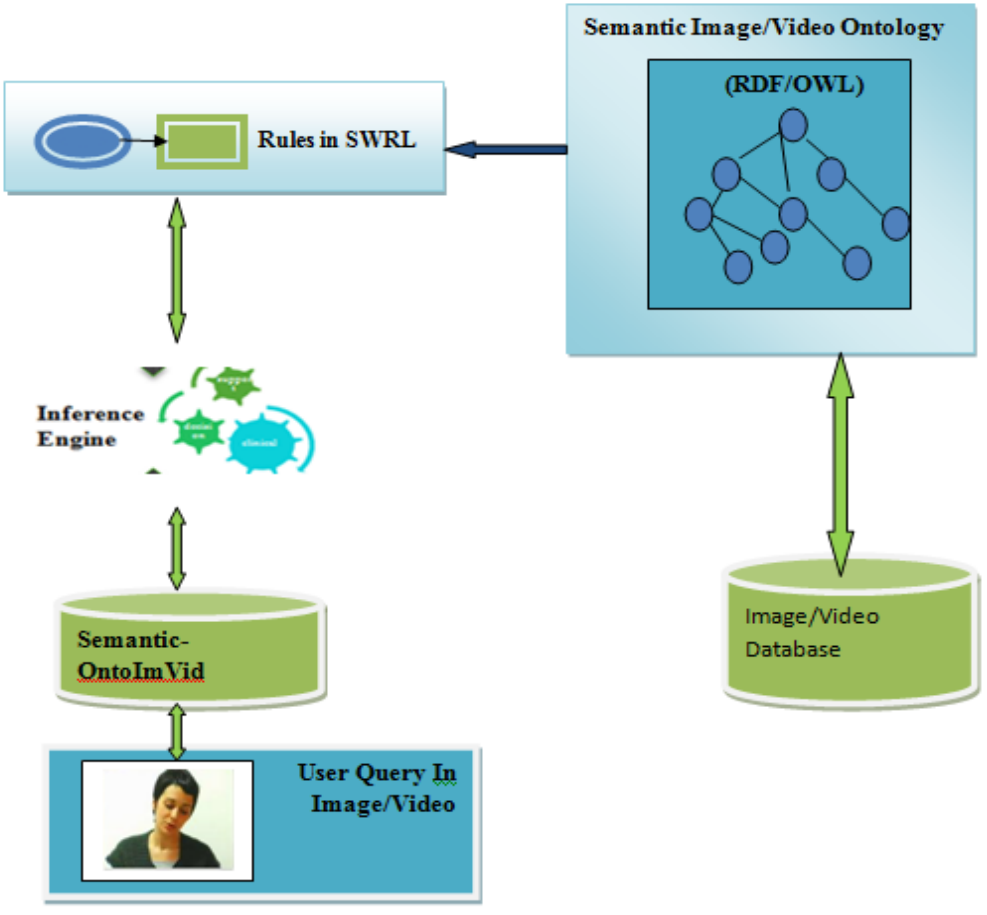

Fig 3.1 Proposed Frame work

Instance: An instance is an object. It corresponds to a description logic individual.

Classes: A class is a collection of objects. A class may contain individuals, instances of the class. A class may have any number of instances. An

instance may belong to none, one or more classes. A class may be a subclass of another, inheriting characteristics from its parent superclass.

Once the image or video database was fed to Ontology platforms to create RDF/OWL structures, rules were generated in SWRL. Rules from SWRL when passed into the inference engine create an OntoImVid that offers support in providing classification, documentation, storage and retrieval of the image or video database.

A DROOL is a forward and backward chaining Inference based Rule Engine, which accesses the rule-based approach to translate the logic from the machine. This logic is external and can be applied to the results to make the decision. SWRL rules are executed with the help of a rule engine. These queries are then passed on to SQWRL to process the queries and a final OntoImVid structure is obtained for each user query with all relevant image or video annotation details. User interface used by user can access such data through this proposed OntoImVid model to detect image/video accurately.

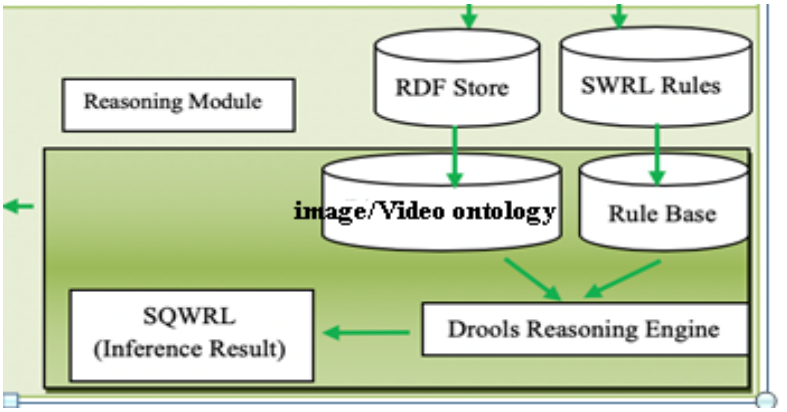

Fig 3.2 OntoImVid Creation

Processed information from the classified results as obtained from Image Ontology and Video Ontology is then provided to the SWRL for further processing. A query is created for the defined class, which helps in segregating the details of the Images and Videos. Rule set (query) is then created for the corresponding class. Classes and class hierarchies have to be defined to create a structure of a Semantic Image and Video based Ontology (OntoImVid). Illustrating properties of classes (slots) and defining facets of the slots is also essential to finally create instances. All these steps and processes were carried out to create the OntoImVid.

Result and Discussion

The classified results from Image retrieval and Video Retrieval phase are provided to the SWRL for the creation of structure of OntoImVid. The figure 4.1 shows the ontology created for image retrieval scheme. The following figure 4.2 shows the ontology created for video frames.

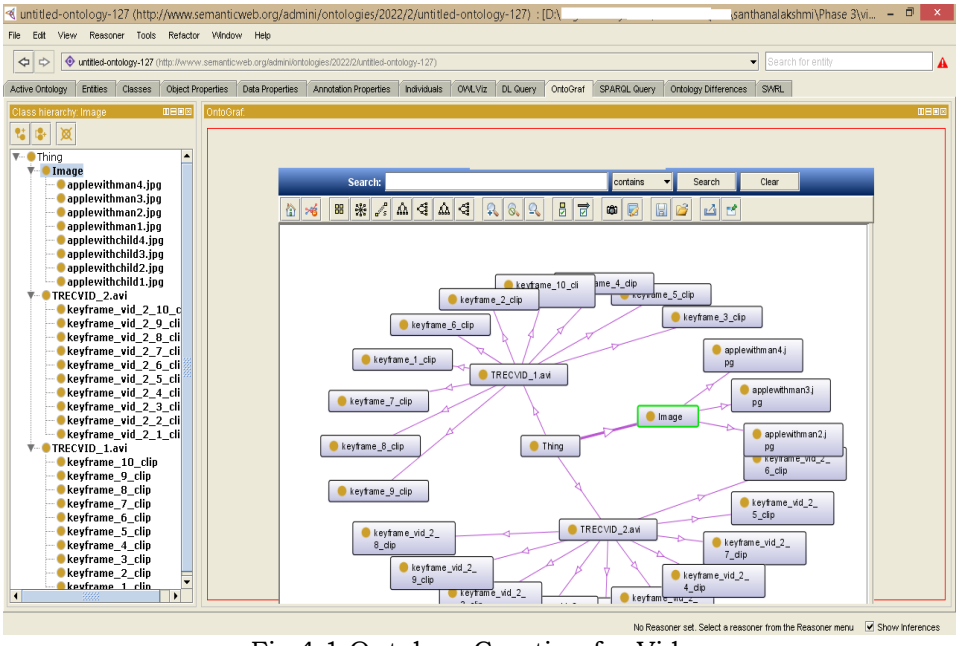

Fig 4.1 Ontology Creation for Video

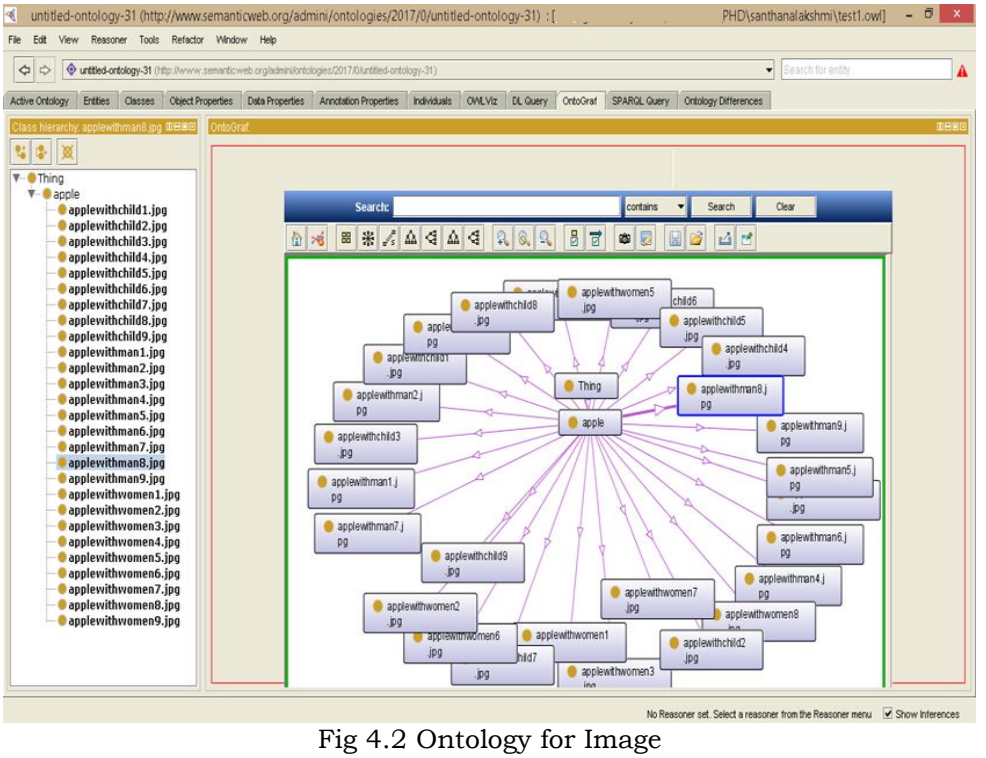

Fig 4.2 Ontology for Image

In Image retrieval scheme, the image summarization concept is implemented using a clustering algorithm called k-medoids.the k-medoids are the most sensitive to find the k-cluster in the object. The image annotation is mainly used

for the low level features of an image can hardly define under the semantic concept. In the image annotation the main problem occurs due to the semantic gap. Image keyword is derived under the unidirectional graph. The unidirectional graph is defined under the relationship of images and keywords. for the better annotation. The CBIR is used for image retrieval. The retrieval of image is similar to the user defined pattern and denoted as a color, shape, texture. CBIR technology is mainly used in semantic image retrieval.

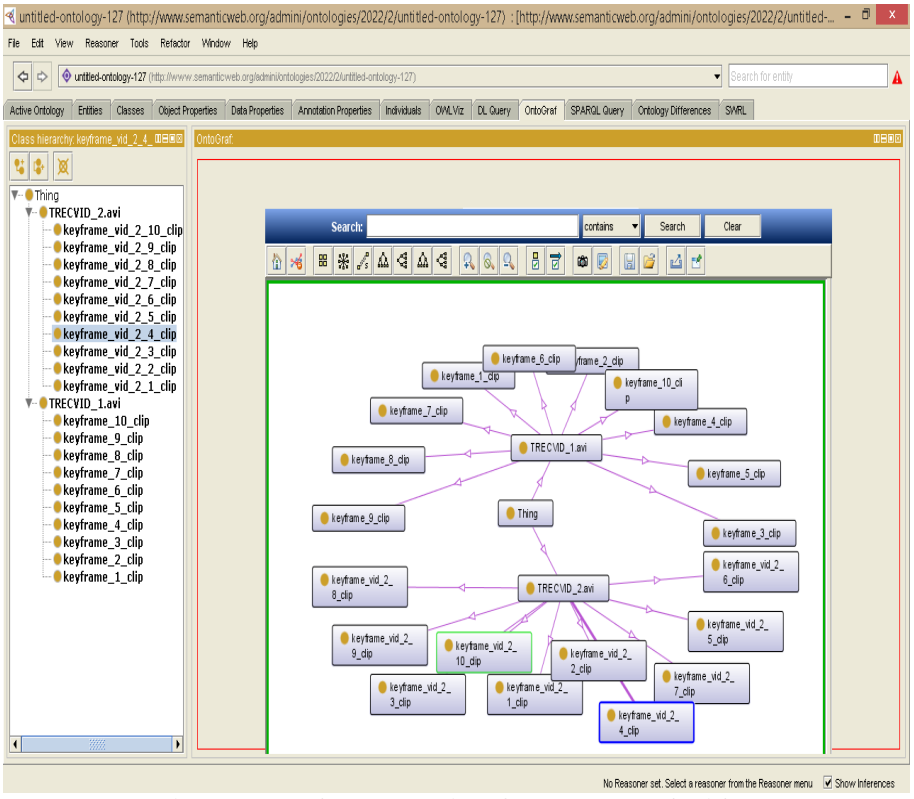

Fig 4.3 Ontology Creation for Image and Video

NLP extracts the keyword from user given query text. Based on extracted keyword, similarity is measured by Jaccard similarity coefficient measure. Adoptive Kernel Based SVM classification is used to classify images. Classification is done by modifying RBF which performs classification based on kernel point. Scenic name, label words, the image is used as a reasoning condition for image retrieval. Improvement of this approach is, it deals with both textual and image input, fast query response, semantic output for user specified query, the retrieved result seems to be more concrete and it is associated with query image and keyword retrieve.

During Video retrieval, many algorithms have been established in these areas in order to perform different video recovery tasks. We have built a recovery system with different characteristics of the query video framework. In this system we have suggested. Experimental results demonstrate that incorporation of derived characteristics enhances video indexing and retrieval. This is demonstrated by the

finding that multiple features produce effective and efficient system as precision and recall values are improved. The suggested system may be used widely, such as retrieving criminal databases, biological information, etc. Furthermore, we want to improve the system through the integration of new features and techniques and may also be extended to social platforms.

TABLE I Comparison of Ontology Creation Time with Type

Ontology Type	OWL/RDF Creation Time(ms)
Imvid ontology	98
Image Ontology	138
Video Ontology	150

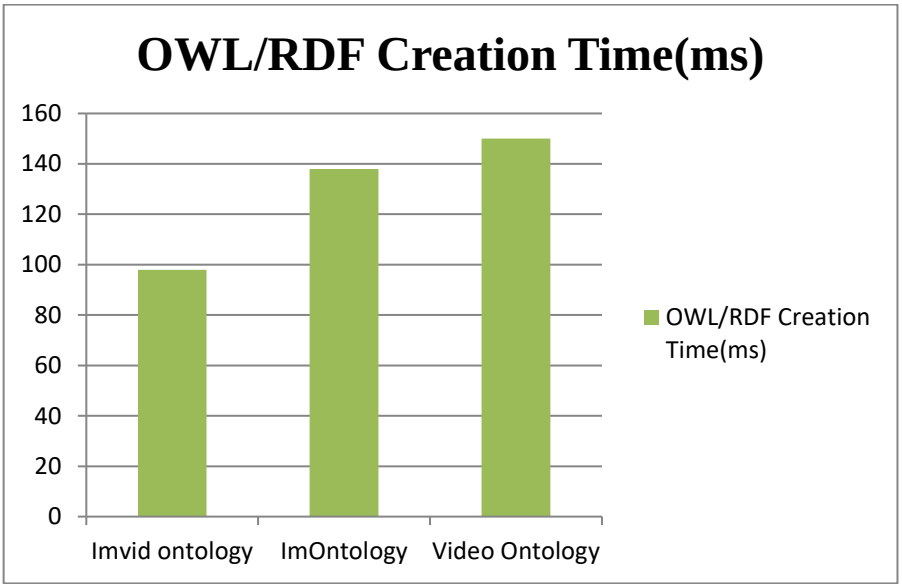

Fig 4.4 OWL/RDF Creation Time for Ontologies

Table I depicts the ontology creation time for Image Ontology, Video Ontology and ImVid Ontology. The above graph shows much lesser creation time is taken for proposed Imvid ontology scheme.

TABLE II Memory for Ontology Creation

Ontology Type	OWL/RDF Creation Used Memory(Mb)
Imvid ontology	245
ImOntology	386
Video Ontology	518

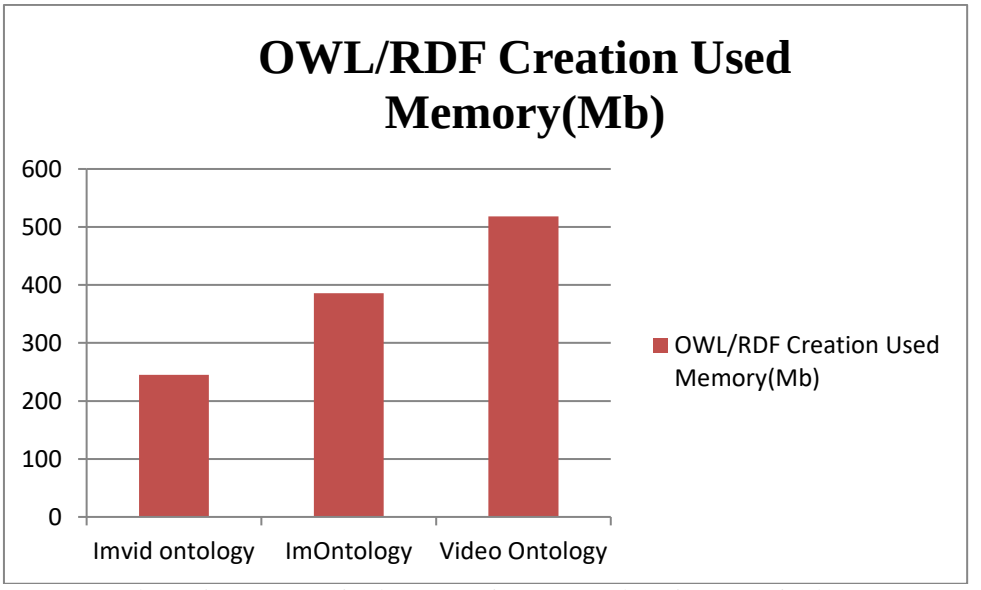

Fig 4.5 Memory during Ontology Creation for Ontologies

The above mentioned ontology results are combined and produced new ontology of OntoImVid by using proposed methodology for better performance in retrieval of both image and video.

Conclusion

Traditional video retrieval methods handle the notion of concepts implicitly. They extract low-level features from the video data and map this to a user query, assuming that the low-level features correspond to the high-level semantics of the query. Features can stem from textual resources that can be associated to video, like closed captions, or speech recognition results. The proposed Semantic Image/Video retrieval scheme OntoImVid combines image retrieval and video retrieval in same technique. The ontology created from image and video frames are processed and retrieved. In the video retrieval paradigm, user queries may consist of example videos, natural language text, or both. Although current practice suggests that combining concept detectors with traditional text and image retrieval techniques yield improved performance, they might equally well hurt performance as none of these techniques is perfect yet.

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