Exploration and Management of Web Based Multimedia Information Resources

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Abstract- **WWW is a huge multimedia information resource. It is composed of diverse heterogeneous unorganized information resources. Information resources include multimedia data from different diversities. Information exploration services are required for searching and browsing of multimedia information resources. Browsing mechanisms are satisfactory when information is organized in proper hierarchies. Search mechanisms are independent of organizations with in information resources. They just interact with object indexes for searching and only keep track of information objects with in information resources. Organization of only document indexes is required. Search mechanisms are ideal for the exploration web information resources. Mostly existing search mechanisms available for exploration of web resources are mono-modal. They perform search with in single modality of information. Combined search on more than one multimedia object types is at early stages of development. We explore with the help of multimedia object analysis that search with in all the subsets of multimedia object types is possible by using only four index types, two models of interactions and fifteen possible modes at most.**

Keywords: information resources, World Wide Web multimedia, organization, management, browse, multimodal search.

I. INTRODUCTION

Every day we interact with multimedia objects and search, browse, visualize, manage and store them. Our information needs are satisfied by the exploration of multimedia objects. Multimedia information retrieval system includes exploration and information management services [1]. Multimedia objects are managed with in multimedia digital resources [2]. Browsing of multimedia objects is strongly dependent on organization of information with in multimedia digital resources. Multimedia objects are searched by using their multimodal representations or indexes [3]. Multimedia information needs are well defined and to satisfy these needs, the diverse multimedia information recourses are available. There are challenges in existing multimedia information management; browsing and multimodal search mechanisms. These challenges motivate researchers to investigate new search, browse and information management techniques.

More than one modalities of information are associated with multimedia objects [3]. Multidimensional nature of multimedia object makes research in multimedia information retrieval systems more attractive and challenging. The field is immature and there are certain unresolved issues to be investigated in existing multimodal search, browse and information management techniques. Browsing of multimedia objects is strongly influenced by information organization. Searching of multimedia objects requires management of underlying multimodal representation of multimedia object types. Existing available multimodal search mechanisms have limitations. They cannot address appropriate multimodal representations of multimedia object types. Searching with in multiple media types using their multimodal representations is mostly not supported by existing search mechanisms. Limitations in existing multimodal search mechanisms require further investigation so they better fulfill multimedia information needs. In this article we discuss information exploration services, their association with information organization and propose a multimodal search framework for the exploration web based multimedia information resources.

II. INFORMATION EXPLORATION

Information exploration is a fundamental aspect of almost all information retrieval systems. Information exploration generally consists of three types of services; searching, browsing and information visualization [4]. Searching, browsing and visualization are distinct concepts but collectively fulfill user information needs in almost all types of information retrieval systems.

Search is an approach in which required information is quickly identified using keywords [4]. Generically information search can also be defined as a task in which user specifies information contents and system searches against them with in its information object representations. Due to unavailability of keywords user better navigates information using available contextual information about information organization [4].

Browsing as defined an "an approach to information seeking that is informal and opportunistic, and depends heavily on the information environment" [5]. More broadly we analyze that

K. Elleithy (ed.), *Innovations and Advanced Techniques in Systems, Computing Sciences and Software Engineering,* 500–506.
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browsing is an activity in which user narrow down object spaces or domains[1] to fulfill his information needs.

Information visualization services enhance information exploration. They have beneficial effects on searching and browsing tasks [4]. Information visualization is defined as "a process, it transforms data, information, and knowledge into a visual form exploiting people's natural strengths in rapid visual pattern recognition" [6]. We define information visualization as a technique to decrease gap between human perception and information presented to the user.

Modern information retrieval systems mostly provide integrated searching, browsing and visualization services [4, 7]. ACM digital library for text retrieval and open video digital library for video retrieval [8] are good examples of integrated searching and browsing services. By using these information retrieval systems users browse collections, narrow down object domains and finally perform search with in selected object domains. Browsing techniques are mostly used to narrow down document domains that assist in more satisfactory, accurate and efficient retrievals.

III. BROWSING ,SEARCHING ASSOCIATION WITH INFORMATION MANAGEMENT TECHNIQUES

World Wide Web is a huge information resource. It consists of heterogeneous and distributed information resources. Diverse information resources collectively make WWW an information giant. Due to diversities in information resources available on WWW, information retrieval systems also show variance. Main aim of information retrieval systems is to retrieve useful information. Each information retrieval system whether it is general purpose, media specific or domain specific search engine, digital library or digital museum must be constituted by following three hierarchical layers.

- *Interaction Layer:* Provides Searching, browsing and information presentation interfaces.
- *Indexing Layer:* Provides Object modeling or indexing mechanisms
- *Organization Layer:* Provide mechanism for Objects organization with in information resources.

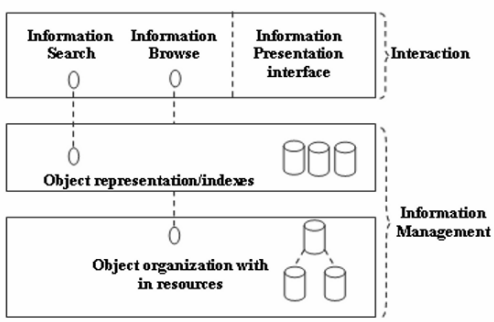

Fig 1: Browsing, Searching Mechanisms and their Association with Information Management Techniques.

[1]Object spaces or domains are actually underneath document organization with in collections

First layer is for user interactions and last two layers cover information management mechanisms. Information search interface interacts with object representation and constitutes information search mechanism. Information browsing interface interacts with object organization with in repositories and constitutes information browsing mechanism. Importance of each layer depends upon type of information retrieval system developed, its operational domains and user behaviors. E.g. organization layer is absent in general purpose search engines.

Search engines using searching and browsing mechanism retrieve useful information. Search engines, if follow search approach then interacts with object models, and if follow a browse approach then interacts with object organizations with in repositories. Byron Marshall categorizes search engines as directories and indexes [1].

In directory based search engines information is categorized in predefined categories or cluster of objects. User browses these predefined clusters to fulfill his information needs. This directory based approach is also called top down approach because user starts interaction from highest level of organization [1]. Directory based approach is basically browsing and it is strongly influenced by the organization of objects with in data repositories. Browsing strategies consider object spaces organized as predefined structures or hierarchies. Information retrieval systems that incorporate browsing mechanisms must be aware of object organizations with in object spaces. In yahoo[2], IEEE[3], ACM[4], OVDL[5], WOMDA[6], Digital south Asia Library[7] and Hermitage Museum[8] documents are organized in the form of clusters or categories. User is able to browse with in these categories and some times browsing accomplish information needs with out any search task. DSpace is an open source system. DSpace provides basic features required for the construction of digital libraries [9]. Data model of DSpace addresses object organization with in digital repositories. Data model is constituted by different object types. DSpace provides searching and browsing services because data is organized in proper hierarchies.

Indexed based search engines are not concerned with object organizations with in repositories. They interact with document representations or models. We explore that for index based search engines underlying object spaces are considered flat. In flat object spaces organization of objects with in repositories is not important. Information management techniques for indexed based search engines keep object indexes along with their source links or URLs. Indexed based approaches are also called bottom up approaches [1]. We can also categorize them as information searching mechanisms.

WWW is a massive information resource. It is aggregation of different information resources. Information organization

[2] http://www.yahoo.com
[3] http://www.ieeeexplorer.org a
[4] http://www.portal.acm.org
[5] http://www.open-video.org
[6] http://www.hcu.ox.ac.uk/jtap/
[7] http://dsal.uchicago.edu
[8] http://www.hermitagemuseum.org

with in its each constituent is mostly heterogeneous. Due to this heterogeneous organization of web resources they are mostly accessible via search mechanisms provided by general purpose search engines like Google[9], altheweb[10], and AltaVista[11] not by browse mechanisms. Mostly users are able to browse searched results. Top down browsing with in web resources is mostly not possible. However researchers try to provide exploration of web resources using browsing techniques. Relational browser categorizes web sites in to topics and provides their topic wise browsing [10]. Open Archive Initiative Protocol for Metadata Harvesting (OIA-PMH) harvest metadata of distributed repositories in a centralize location. So this centralized location provides searching and browsing mechanism of remote repositories metadata from a centralize location. University of Illinois Library at Urbana-Champaign (UIUC) is a Digital Gateway to cultural heritage materials. This project is based on OAI-PMH and harvest metadata from thirty nine metadata providers which includes museums, archives, academic and public libraries, historical societies, consortiums, and digital libraries resources. UIUC provides searching and discovery services [11].

Search, browse and information management mechanisms are interrelated. Clear distinction of search, browse mechanism and their association with information management techniques is necessary. During our investigation the following observations are made:

1. Browsing mechanisms are strictly dependent on information organization in data repositories. Browse mechanisms are based on the philosophy of top down or directory based approaches.
2. Searching mechanisms are independent of information organization in data repositories. Search mechanism interacts with object models or indexes and just keeps track of information object source URLs. They are based on the philosophy of bottom up approaches.
3. Information management techniques for search mechanisms manage indexes and only keep track of information objects by considering underlying information organization as flat.
4. Knowledge management techniques for browsing mechanisms must organize information objects in highly structured hierarchies. Information organization is mostly not flat.
5. Search mechanisms are satisfactory for the exploration of web resources; however browse mechanisms have application in the investigation of web resources. Searched results can be organized in browse-able clusters that ease their explorations.

IV. EXISTING INFORMATION EXPLORATION SERVICES

Multimedia information retrieval system research shows great advancements in recent years [12, 13, 14]. Researchers try to investigate new mechanisms for the exploration of multimedia digital information resources. Researchers deviate from mono-modal search mechanisms to multimodal search mechanisms [3, 15]. Interaction and modeling of a single modality for exploration of web resources is not sufficient to fulfill multimedia information needs. Recent research in multimedia information retrieval systems introduces new services for the exploration of web based multimedia information resources. Recent exploration services broadly classified into web based and non web based services. We discuss only existing web based exploration services.

Web based information exploration services are accessible via web. They can be broadly classified into research in general purpose, media specific and domain specific search mechanisms for digital information resources available on WWW. Information seekers are aware of this research because they mostly interact with information retrieval systems accessible via WWW.

A. General Purpose Search Engines and Information Exploration Services

Google, altheweb, AltaVista and lycose[12] are examples of general purpose information retrieval systems. All these information retrieval systems operate on web information resources. They are not constructed for a particular domain and provide search mechanism for more than one multimedia object types.

Evaluation: Existing search mechanisms available on WWW have limitations. By using general purpose search mechanisms like Google, altheweb, AltaVista and lycose user is able to formulate query and visualize results for one media type at a time. Our investigation reveals that indicated general purpose search mechanisms adopt mono-modal search mechanisms. They can only perform search with in text modality. Information retrieval functionality is mostly provided by using text present on page having multimedia object and file attributes associated with multimedia objects like file type, size, format and color. Existing general purpose search engines give illusion that they can perform search with in modalities of multimedia objects but their working is totally dependent on text retrieval techniques and pre-recorded attributes of multimedia objects. Due to this reason information needs are partially satisfied by using these search mechanisms.

B. Media and Domain Specific Search Engines and Information Exploration Services

Media specific and domain specific search mechanisms are also available on the WWW. They mostly provide mono-modal search mechanisms for specific domains [3]. ACM and IEEE are educational digital libraries. They provide specialized search mechanism for text retrieval with in particular educational domains. Terrasgalleria[13] provides specialized search mechanism for images. Digital South Asia Library provides retrieval facility for cultural heritage data of South Asia. Data is mostly stored in the form of images and

[9] http://www.google.com
[10] http://www.altheweb.com
[11] http://www.AltaVista.com
[12] http://www.lycose.com
[13] http:// Terrasgalleria.com

search facility is provided by annotated text modality. Open Video Digital Library (OVDL) provides search and browse mechanisms for video documents for pre-stored specified video repository. Video documents are organized in the form of cluster of genres like documentaries, educational, lectures, ephemerals, and historical. Each genre is a browse-able collection. Browsing mechanisms are provided by using video document genre, time, color (black or white), and sound (sound or silent). Search mechanisms are provided by using text modality of speech transcripts and bibliographic records. Hermitage Museum is accessible via web and provides searching and browsing of image based museum objects. User is able to browse collections and search using texture and color of image modality. WOMDA operates on multimedia data like manuscripts of poems, diaries, letters and information available in the form of audio, video and images revolves in the age of First World War poet Wilfred Own. WOMDA holds its own archives of data and also encourages public to upload related information [16]. Data is managed in the form of browse-able collections. WOMDA provides search facilities of audio, video, images and manuscripts using annotated text modality.

Evaluation: Domain specific and media specific search mechanisms provide advance search mechanisms. They provide search with in different multimedia modalities and information domains. Media specific search mechanism provides search facility with in a particular type of multimedia. They perform specialized search with in one multimedia type. User is mostly able to formulate query and visualize results for a specific multimedia type. These search mechanisms cannot discuss unification of search approaches for varying multimedia types. They are usually not expandable for multiple multimedia object type's retrieval. Their integration in general purpose search mechanisms that facilitate unified retrieval of all multimedia object types is not approachable. Domain specific search mechanisms rarely provide search with in multiple multimedia object types. Mostly they perform search with in specified domains and particular media types. However some search mechanism provides search with in domain specific multiple multimedia object types [16]. It is explored that their retrieval model is totally based on accompanying text modality of multimedia object types. Due to their limitation they operate for a specific type of media or with in specified domains and user information needs are partially satisfied.

V. USABILITY ISSUES OF EXISTING MULTIMEDIA SEARCH

We have a scenario of multimedia information need that elaborate usability problems in existing search mechanisms. Suppose Mr. X wants information about FIFA World Cup 2006 irrespective of which media type information belongs; this information exists in the form of text documents, video clips, audio files and posters. Existing search mechanisms cannot support retrieval of all these object types in one complete search. Existing search mechanisms either general purpose or media specific cannot support retrieval of subsets of more than one object types with in one complete search. By using existing search mechanisms user is enforced to perform separate searches for all types of objects so information needs are always partially satisfied.

Advance multimedia information retrieval techniques [17, 18] have been investigated in recent years. It is required that researchers should enhance these techniques by investigating and resolving the limitations. These advance retrieval techniques discuss basic indexing mechanism for multimedia data types. Their unification with in information retrieval frameworks is mostly not addressed, so satisfactory multimedia retrieval is not possible. Usable unification of these techniques in proper information retrieval framework should provide foundations for enhancement in general purpose web based search mechanisms to satisfy multimedia information needs.

VI. USABLE UNIFIED MULTIMODAL SEARCH FRAMEWORK FOR MULTIMEDIA INFORMATION EXPLORATION

To overcome usability problems in existing search mechanisms we investigate and propose an ontological based usable unified multimodal framework. The unified multimodal search framework will help users to retrieve multimedia information in a usable way. The framework is explained with the help of following multimedia object analysis.

A. Multimedia Object Analysis

Multimedia object or document in context of multimodal search mechanism is an interactive artifact that can be modeled or indexed, searched, browsed, visualized and retrieved. Multimedia objects can be classified into text, audio, video, images and graphics [19]. We investigate that multimedia objects have close interrelations. Audio, video, image, graphics and text are five basic multimedia object types. Image and graphics are interchangeable. We place graphics in broad category of image types. In this article hereafter we refer multimedia object types as image, audio, video and text. They can be represented interchangeably. Multimedia objects can be expressed as supersets and subsets of each other. Video can be decomposed into audio objects and visual streams. Audio object is composition of speech and sound. Speech can be represented as text objects and their context. Text consists of keywords and their context. Visual stream of video can be decomposed into scenes and their context. Scene is a video clip of continuous images having some specific context. Image objects can be decomposed into objects and their context. Fig. 1 depicts that video artifact is composition of text; image and audio object types. Video object owns all features of other multimedia object types.

Top down analysis of above hierarchy shows that video object type is decomposed into audio, image and text multimedia object types at intermediate levels and finally represented as

1. Text keywords and their context
2. Image objects and their context

Bottom up analysis of Fig. 1 shows initially text keywords, their context and image objects, their context composes

image/graphics, audio and text object types and finally interpreted as video object type.

B. Multimodal Search Mechanism: Usable Unified Approach

We investigate from multimedia object analysis that video is a superset of all other multimedia objects. Video can be represented as audio and images. Textual representation of audio speech is possible [17]. Image and graphic objects can be represented by using content based image and textual annotation techniques [20, 21].

Video object is a multidimensional object. Its each dimension represents some specific searchable modality. Its dimensions include image modality, accompanying text modality and speech transcript modality. Image based modality is searchable via content based image indexing techniques [17].

Thijs Westerveld investigates that ordinary keyword based search by stemming and removing stop words from textual representation of speech transcripts along with combination of content based image search gives satisfactory video retrievals [17]. Advance text based indexing techniques have been investigated in recent years [22, 23].

Solution that provides search mechanism for video objects by using almost all of its modalities is a super solution for multimedia object types. Solution that provides search mechanism for text, image and audio objects are subsets of video search mechanism. Video search mechanism is a comprehensive method that incorporates image and text search mechanisms. Constitutes of video search mechanisms can be used for searching all multimedia object types.

1. Text objects can be searched by video search mechanism used for searching accompanying text and speech transcript modalities.
2. Video search mechanism used for searching image modalities can be used for searching image objects.
3. Audio speech transcripts and video speech transcripts are equivalent. Video search mechanism for searching video speech transcripts can be used for the search of audio objects.

Indexing text, accompanying text, speech transcript and image modalities are sufficient for searching with in all subsets of multimedia object types. By using image and text modalities multimedia information user formulates queries for all multimedia object types which enable the user to perform search with in all modalities of information.

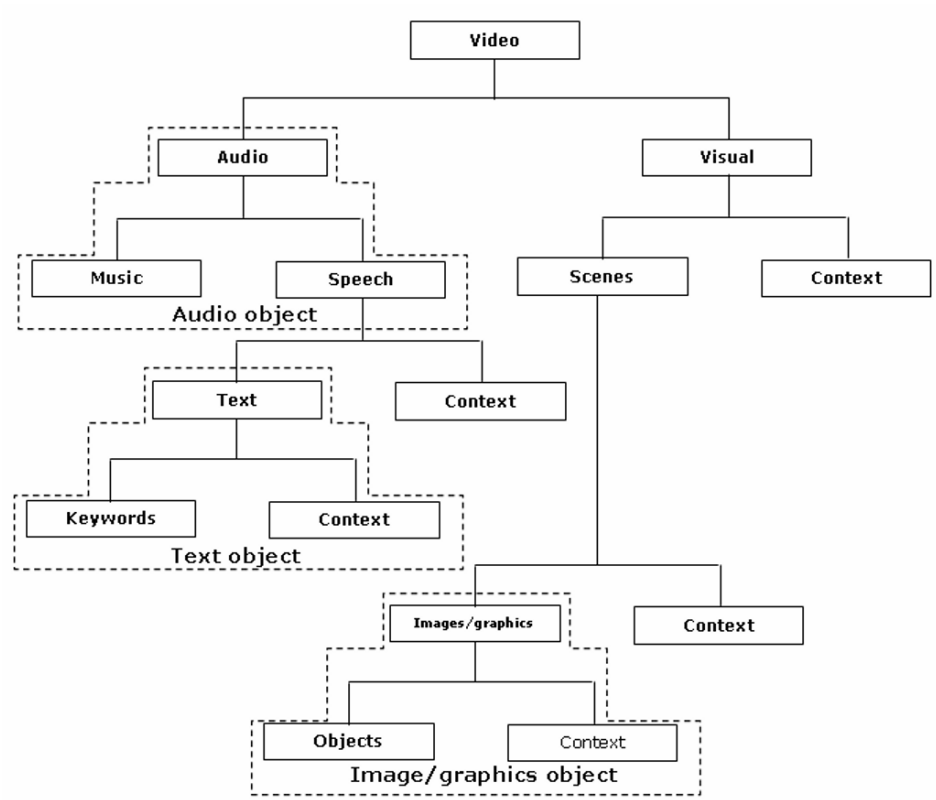

Fig2: Multimedia Object Decomposition Hierarchy, dotted region represents occurrence of text, audio, image/graphics object types with in video object type.

Modes	Multimedia object types	Indexes Involved in search	Modals of Interaction
1	Text	o Text Based Index	o Keywords
2	Image	o Accompanying Text Index o Image Feature based Index	o Keywords o Visual Image
3	Audio	o Accompanying Text Index o Vocal/Speech based index	o Keywords
4	Video	o Accompanying Text Index o Image Feature based Index o Vocal/Speech based index	o Keywords o Visual Image
5	Text, Image	o Text Based Index o Accompanying Text Index o Image Feature based Index	o Keywords o Visual Image
6	Text, audio	o Text Based Index o Accompanying Text Index o Vocal/Speech based index	o Keywords
7	Text, video	o Text Based Index o Accompanying Text Index o Vocal/Speech based index o Image Feature based Index	o Keywords o Visual Image
8	Image, Audio	o Accompanying Text Index o Vocal/Speech based index o Image Feature based Indexes	o Keywords o Visual Image
9	Image, Video	o Accompanying Text Index o Vocal/Speech based Index o Image Feature based Index	o Keywords o Visual Image
10	Audio, video	o Accompanying Text Index o Vocal/Speech based Index o Image Feature based Index	o Keywords o Visual Image
11	Text, Image, Audio	o Text Based Index o Accompanying Text Index o Vocal/Speech based Index o Image Feature based Index	o Keywords o Visual Image
12	Text, Image, video	o Text Based Index o Accompanying Text Index o Vocal/Speech based Index o Image Feature based Index	o Keywords o Visual Image
13	Image, Audio, video	o Accompanying Text Index o Vocal/Speech based Index o Image Feature based Index	o Keywords o Visual Image
14	Audio, video, Text	o Text Based Index o Accompanying Text Index o Vocal/Speech based Index o Image Feature based Index	o Keywords o Visual Image
15	Text, Audio, video, Image	o Text Based Index o Accompanying Text Index o Vocal/Speech based Index o Image Feature based Index	o Keywords o Visual Image

Table 1: Possible modes, indexes and models of interaction used in multimodal search framework

Searching with in subsets of multimedia object types is possible. Four multimedia object types can be represented in 2^4=16 combinations or subsets; one subset is empty so there are total fifteen combinations.

Searching with in subsets is possible by four index types, two models of interaction and fifteen modes at most. Four possible index types are:

1. Text based index for text artifacts.
2. Speech transcript text index for audio and video object types.
3. Image feature based index for image and video object types.
4. Accompanying text based index for audio, video and image objects having accompanying textual information.

We explain fifteen combinations in Table 1. User is able to formulate query for any subset of multimedia object types by using only text based and image based interactions or query formulation mechanisms. Our proposed multimodal search mechanism provides search mechanism with in all the subsets of multimedia objects types by using fifteen possible modes or layers. Table 1 demonstrates modes, possible index types and interactions against each mode of multimodal search mechanism.

A search mechanism that incorporates specified four possible index types and two models of interaction provides search facility with in all possible subsets of multimedia object types. Fig. 2 demonstrates a multimodal search mechanism that has the capability of searching with in any subset of multimedia objects types. One combination of multimedia object types, mode or a subset is activated at a time using four possible index types and two models of

interaction at most. Fig. 2 demonstrates this multimodal search framework.

First dotted rectangle represents two interaction mechanisms via keywords and images; second dashed rectangle represents possible modes or subsets. One mode is activated at a time. User is able to perform search with in any subset of multimedia object types by using these fifteen modes. Third rectangle represents possible four index types. Search is always performed with in theses four index types at most.

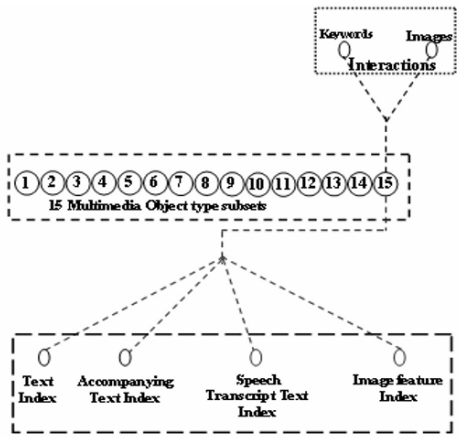

Fig 3: Framework for Multimodal Search Mechanism.

VII. CONCLUSION

Search and browse mechanisms are required for the exploration of multimedia information resources. Organization of web based information resources is unknown so they are mostly not browse-able. Search mechanisms are frequently used for the exploration of web based multimedia information resources. Existing search mechanisms whether they are general purpose, media specific or domain specific partially fulfill user information needs. User is able to perform search with in one media type at a time and they are mostly mono-modal. We investigate from multimedia object analysis that searching with in multiple multimedia types is possible. We have proposed a usable unified multimodal search framework by using two modalities of interaction, fifteen modes and four possible index types at most. By integrating our proposed search framework in web based search engines multimedia information users are able to perform multimodal search in all possible subsets of multimedia object types. Over proposed search framework provides web based multimedia information exploration service.

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