

# Multimedia Databases

Oya Kalipsiz

Yildiz Technical University, Computer Science Department

Yıldız Istanbul, Turkey

e-mail: [kalipsiz@yildiz.edu.tr](mailto:kalipsiz@yildiz.edu.tr)

## Abstract

*A multimedia database is a controlled collection of multimedia data items such as text, images, graphic objects, video and audio. A multimedia database management system (DBMS) provides support for the creation, storage, access, query and control of multimedia database. The requirements of multimedia DBMS are; multimedia data modeling - multimedia object storage - multimedia indexing, retrieval, browsing and multimedia query support. This paper discusses a general framework for multimedia database systems and describes the requirements and architecture for these systems.*

**Key Words:** *Multimedia Tools and Techniques, Multimedia Data Type, Database Management Systems, Multimedia Database Systems*

## 1. Introduction

Multimedia concerns the presentation of mixed modes of information (text, data, image, audio, and video) as digital signals. Some of the multimedia applications are; home applications (home, shopping and information system vs.) - video conferencing - education (distance learning, Just-in-time training) - digital libraries - virtual reality - telemedicine. Multimedia communication is concerned with the technology required to manipulate, transmit and control these audio-visual signals across a networked communications channel [1].

Multimedia systems need a delivery system to get the multimedia objects to the user. The first media used for distribution were magnetic and optical disks.

Internet, as well as TCP/IP protocol suite or Net BIOS on isolated or campus LANs, became the next vehicles for distribution. The rich text and graphics capabilities of the

World Wide Web browsers are being augmented with animations, video and sound.

The major technologies relevant to multimedia may be summarized as [2]:

- compression technology
- video servers (server structure- disk organization and scheduling- video file systems)
- networks(internet- tokenring- ethernet- switched ethernet- ATM)
- data transmission techniques
- cable systems
- authoring systems
- Database systems.

A database is a collection of related data. A database management system (DBMS) is a general-purpose software system that facilitates the processes of defining; constructing and manipulating databases for various applications. Multimedia database contains different data types such as text, images, graphic objects, animation sequences, video and audio. The different data types might require special methods for optimal storage, access, indexing and retrieval. A multimedia database management system provides a suitable environment for using and managing multimedia database.

A multimedia DBMS requires traditional DBMS capabilities - media integration, composition and presentation - information retrieval capabilities - huge capacity storage management - multimedia interface and interactivity - multimedia query support. Normally, individual objects in an image or video frame have some spatial relationship between each other. These relationships produce some constraints when searching for objects in a database. Relational or object oriented data models have been proposed to cope with these constraints in the multimedia databases. An object oriented database management system is more suitable for developing multimedia applications.

This paper reviews:

- Multimedia data types and data compression
- Architecture, design and query in multimedia database system.
- Object oriented multimedia databases
- Multimedia data in World Wide Web

## 2. Multimedia Data

Media is divided into two classes: continuous and discrete. Continuous media such as audio and video, change with time. Discrete media are time independent. Common examples of discrete media are text (formatted and unformatted), still images and graphics [1].

### 2.1 Multimedia data types

To understand the requirements that multimedia database must satisfy, we need to know the types of multimedia data. Common multimedia data types found in a multimedia database are as follows [3], [4], and [5]

- Text
- Graphics: drawings and illustrations encoded using high-level descriptions like pic and postscript files.
- Images: pictures and photographs with encoding defined by standard formats such as JPEG and MPEG.
- Animation
- Video
- Audio

Combining basic multimedia data types creates composite multimedia data.

### 2.2 Multimedia data characteristics

Characteristics of multimedia data can be summarized here

- **Lack of structure:** Multimedia data tend to be unstructured. Therefore standard data management tasks such as indexing and content-based search and retrieval is not readily available.
- **Temporality:** Some multimedia data types such as video, audio and animation sequences have temporal requirements that have implications on their storage, manipulation and presentation. In the same way, images, video and graphics data have spatial constraints in terms of their content.
- **Massive Volume:** Multimedia data such as video and audio often require a large storage device.
- **Logistics:** Non-standard media can complicate processing. For example, a multimedia database application requires to use compression algorithms [6], [3].

### 2.3 Data compression methods

Data compression can be defined as a means of reducing the size of blocks of data by removing unused and redundant material. Several types of redundancy can be exploited within compression methods: redundancy in scale - redundancy in frequency - temporal redundancy - stereo redundancy - spatial redundancy.

Some of coding techniques for multimedia systems is entropy, source and hybrid coding. Entropy is defined as the average information content of given data. It defines the minimum number of bits needed to represent the information content without information loss. Entropy coding tries to come as close as possible to this theoretical lower limit. Examples of entropy coding methods are run-length coding, Huffman coding and arithmetic coding.

Source coding processes original data such that a distinction between relevant and irrelevant data is possible. Entropy coding is a lossless technique; source coding is often a lossy process.

Hybrid coding such as JPEG, MPEP video, MPEP audio uses a combination of entropy coding and source coding techniques [1].

The most video clips in multimedia databases and digital libraries will be stored in compressed formats like motion JPEG and MPEG. The manipulation, access and management of compressed data streams without full decompression is an area of active research [7].

## 3. Multimedia Database Management System

The development of multimedia computing systems can benefit from traditional DBMS services such as:

- Data independence (data abstraction)
- High level access through query languages
- Application neutrality (openness)
- Controlled multi-user access (concurrency control)
- Fault tolerance (transactions, recovery)
- Restriction unauthorised access and modification of stored data (privacy).

Also, multimedia objects have temporal and spatial relationships that must be taken into account for synchronization and display of information. These relationships should be modeled explicitly as part of the stored data. Thus, even if the multimedia data is stored in files, their relationships need to be stored as part of the metadata in some DBMS [3], [8].

### 3.1 Multimedia DBMS requirements and architecture

Multimedia DBMS architecture meets the multimedia data requirements (figure -1) [3]. Developing a variety of multimedia database applications requires a powerful and flexible general-purpose hypermedia development environment

Multimedia databases have special requirements such as:

- Traditional DBMS capabilities
- Huge capacity storage management
- Information retrieval capabilities
- Multimedia query support
- Media integration, composition and presentation
- Multimedia interface and interactivity

### 3.2 Query in multimedia database

The query is one of the most important parts of DBMS. Multimedia query languages must deal with complex spatial and temporal relationships inherited in the wide range of multimedia data types. Powerful query languages could help manipulate multimedia DBMS and maintain the desired independence between the database and the application.

Multimedia data queries can be subdivided into following types:

- keyword querying
- semantic querying
- visual query
- video query

**Keyword querying** only uses well-defined queries.

**Semantic and visual querying** designed to use the fuzzy query method. Visual query language is useful, because it can formalize complicated queries. Future multimedia retrieval systems will have to support access to information at different semantic levels to reflect diverse application needs and user queries.

**Video query** as digital video databases become more and more spread, finding video in large databases becomes a major problem. Because of the nature of video, accessing the content of such databases is inherently a time-consuming operation.

The indexes such as bibliographic, structure and content data are identified in order to satisfy the queries. Bibliographic data category includes information about the entire video and traditional metadata. A video query is more complicated than a traditional query of text databases. In addition to text, a video clip has visual and audio information as well as the dynamics associated with the presentation of such information.

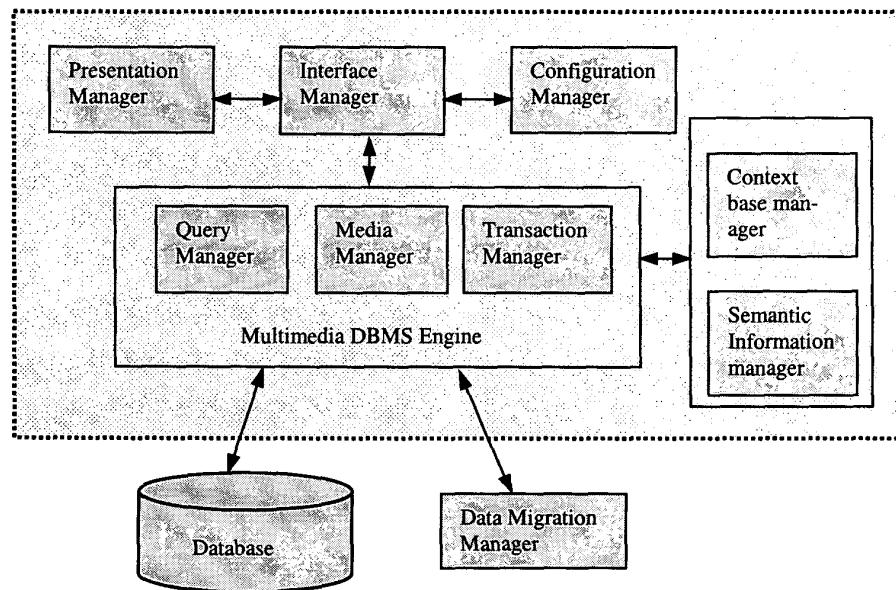


Figure 1: The architecture for Multimedia DBMS

In any video retrieval system, most important concerns are:

- A query to be natural and easy to formulate
- The user-computer interface assist in the query-formulation process
- The search results be presented in an organized and sensible fashion
- The search is performed quickly.

The sequence of stages of a video query is navigating - searching - browsing and viewing [9]. **Navigating** is the stage at which the user decides which category of video is to be searched. Navigating is the capability to use meta-data. **Searching** is the most important part of query. The result of search is a list of candidate units that satisfy the constraints of the query. In the **browsing** stage: representations of video should be displayed and a user can quickly understand the video content. In the **viewing** stage: the usual functions of videocassette players and capabilities like semantic fast-forward should be available.

**3.2.1. Content -based indexing and retrieval.** Users of video-retrieval systems want to find videos on the basis of the semantic content of the video. Content-based image retrieval systems typically let users desired images from a collection on the basis of primitive features representing color, texture or shape [9], [10].

A retrieval system should embed a semantic level reflecting as much as possible the one human refers to during interrogation. The most common way to enrich a visual information retrieval system's semantics is to annotate pictorial information manually at storage time through a set of external keywords describing the pictorial content [11].

Content-based image retrieval systems potentially have a wide application in areas such as engineering and architectural design, medical imaging, law enforcement, and journalism, fine art and fashion [12]. Content-based search of an image database is well suited for searching scientific databases such as satellite-image, medical and seismic-data repositories. In these systems, the volume and diversity of information do not allow the a priori generation of exhaustive indexes.

## 4. Object Multimedia Database

Data model must isolate users from the details of storage device management and data structures. In object-oriented data modeling approach, a database is considered as a collection of objects where each object represents a physical entry, a concept, an idea, or an event. In classical record-oriented data models, data is viewed as a collection of record types, each having a collection of records stored

in a file. In an object-oriented system, real-world objects are represented directly by database objects. Object identity is maintained via an object identifier. The interface between an object and rest of the system is defined by a set of messages. A method, which is a body of code to implement, each messages. A method returns a value as the response to the message. The process of classification involves classifying similar objects into object classes. A subclass inherits both data attributes and methods from its superclasses in the hierarchies [13, 14, 15].

Multimedia data models capture the static and dynamic properties of the database contents. The static properties include the objects, their attributes and the relationships between the objects. Dynamic properties include interaction between the objects, operation on objects and user interaction. Relational and object-oriented data models are used for multimedia database.

Object database management systems (ODBMS) have provided better capabilities to manage more complex data requiring user-defined data types. Supporting multimedia data will require changes to ODBMS's software, as well as operating systems, computer hardware and networks [16].

Some typical applications that might use an ODBMS to manage multimedia data are listed as:

- Data repositories: Data repositories do not need to understand the stored data formats because they don't operate on the data. The objects are stored as binary large objects. Examples of data repository applications are pseudo repository, electronic mail, and healthcare information systems.
- Intelligent data management: ODBMS can query multimedia object content. Examples for Intelligent data management are multimedia editing - engineering design workflow - presentation environments.

ODBMS technology provides an extensible data model, which gives designers the ability to support dynamic schema changes. It gives easy hierarchical relationships like classification, generalization and aggregation between multimedia objects.

## 5. Multimedia Data in World Wide Web

As web application grows, the need for an efficient and dependable multimedia database will become essential.

Access to various large visual databases over the Internet plays an increasingly important role in numerous applications such as geographic information systems, medical information systems and distributed publishing.

Web users differ from users of conventional database applications in the following ways [17]:

- They may not have prior experience in using the application's interface

- They expect effective and efficient navigation methods that minimize the amount of interaction with system.
- They may have very diverse demands of the same database.

A distributed geographic information system (GIS) may present a single database images to the user and provides transparent data access. Most web-based GISs are stand-alone. To integrate a collection of web-based GISs into a system provides more transparent and efficient access [18].

Zhang et al [19] presents an approach to designing an integrated metaserver that supports global content-based query access to various visual databases. Given a visual query, the system returns a ranked list of potentially relevant database sites. Then, users can follow the path recommended by the system, starting with the highest ranked sites. This system contains visual databases at remote sites, a metaserver and a set of visual display applications at the client machines.

## 6. Conclusion

The capabilities of existing multimedia DBMS can be evaluated by their ability to support special functionalities required of a DBMS to manage multimedia data. The display of multimedia objects must be coordinated so that the display meets dynamic, temporal and spatial constraints.

Future trends and potential research topics in multimedia DBMS include:

- content-based and querying of multimedia objects
- synchronizing and timeliness issues for multimedia data
- demand for efficient buffer management
- Quality of Service (QoS) negotiation
- effective query method for spatial and temporal data
- development of application specific query languages
- Performing indexing, retrieval and browsing directly on the compressed data.

## References

- [1] Kuo F.- Effelsberg W.- Garcia-Luna-Aceves J.; *Multimedia Communications*, Prentice Hall, 1998
- [2] Flynn R. - Tetzlaff W. ; "Multimedia an Introduction", *IBM Journal Res. Dev.* Vol.42 No.2, March 1998.
- [3] Adjeroth D., Nwosu K.; "Multimedia Databases Management - Requirements and Issues", *IEEE Multimedia*, July-September 1997.
- [4] Berra B., Nwosu K., Thuraisingham B.; "Multimedia Database Systems - A New Frontier", *IEEE Multimedia*, July-September 1997.
- [5] Pazandak P., Srivastava J.; "Evaluating Object DBMSs for Multimedia", *IEEE Multimedia* July-September 1997.
- [6] Kemp Z.; "Multimedia and Spatial Information Systems", *IEEE Multimedia* Winter 1995.
- [7] Held G.; *Data and Image Compression*, John Wiley&Sons Ltd., 1996
- [8] Apers p., Blanken H., Houstma M. (editors), Blanken H.; *Multimedia Databases in Perspective*, Springer Verlag, 1997.
- [9] Bolle R. - Yeo B. - Yeung M.; " Video Query: Research Directions", *IBM Journal Res. Dev.* Vol.42 No.2, March 1998.
- [10] Castelli V. et al ; "Progressive Search and Retrieval in Large Image Archives", *IBM Journal Res. Dev.* Vol.42 No.2, March 1998.
- [11] Colombo c. et al ; "Semantics in Visual Information Retrieval", *IEEE Multimedia*, July-September, 1999.
- [12] Boardman J., Eakins J., Graham M.; "Similarity Retrieval of Trademark Images", *IEEE Multimedia*, April-June 1998.
- [13] Elmasri R., Navathe S.; *Fundamentals of Databases Systems*, The Benjamin/Cummings Pub.Comp., 1989.
- [14] Korth H., Silverschatz; *Database System Concepts*, Mc Graw Hill, 1991.
- [15] Gray P. - Kulkarni K. - Paton N.; *Object-Oriented Databases*, Prentice Hall, 1992.
- [16] Özsu T. - Iglinski P. - Szafron D.; "An Object -Oriented SGML/HyTime Compliant Multimedia Database System", *ACM Multimedia 97*.
- [17] Miller R., Tsatalos O., Williams J.; "DataWeb: Customizable Database Publishing for the Web", *IEEE Multimedia*, October - December 1997.
- [18] Wang F.J., Jusoh S.; "Integrating Multiple Web-based Geographic Information Systems", *IEEE Multimedia*, January-March, 1999.
- [19] Chang W., Zhang A., Sheikholeslami; "NetView: Integrating Large-Scale Distributed Visual Databases", *IEEE Multimedia*, July-September 1998.