Data elements for Multimedia systems or Multimedia elements

- Facsimile
- Document Images
- Photographic Images
- Geographic Information System Maps
- Voice Commands and Voice synthesis
- Audio Messages
- Video Messages
- Full motion stored and live video
- Holographic images
- Fractals

Facsimile: Facsimile transmission is also known as run-length encoding is a medium level of compression that can be easily achieved in software. It has been estimated that for a reasonably true representation and acceptable legibility a 200 dpi is essential, which is contrasting with laser printers which supports maximum of 400 dpi. This follows CCITT Group 3 compression standards

Document Images: for serious storage of document images in electronic form with adequate reproduction quality the requirement starts at 300 dpi. Group 4 compression standards are followed in this format which reduces the size to 75 kbytes which less than an uncompressed A-Size (8 ½ inch X 11 inch) image. The goal of document imaging is to seriously image text book size of data

Photographic images: Photographic images are used frequently for imaging systems that are used for identification such as security badges, fingerprint cards, photo identification systems, bank signature cards, patient medical histories, and so on. The requirements of photographic images are much more intense than those for typed documents. Photographic images require proper handling of soft shades and tones. A resolution of 600 dpi is essential for reproducing a photographic image on a laser printer. High resolutions are preferable.

Geographic information systems Maps: Known as GIS systems, maps are created in GIS systems are being used widely for natural resource and wild life management as well as urban planning. Two kinds of technologies are used for storage and display of geographic images. Raster storage is used storing data and for displaying raster image is mapped vector for displaying the data

Voice Commands: Voice commands are primarily an input voice recognition consideration. Voice commands allow hands free-usage of computer applications by allowing command entry via a short voice commands rather than a keyboard or a pointing device.

Voice synthesis and audio messages: voice synthesis is easier to achieve than voice recognition. The initial attempts used fully stored messages or actual voice clips that were strung together. Another approach is to break down the message completely to a canonical form based on phonetics.

Audio messages are substitute for text messages. Computers equipped with micro phones can record a audio message and embed it in or attach it to an electronic mail message. Compression techniques attempt to manage the storage more effectively

Holographic images: Holography is defined as the means of creating a unique photographic image without the use of lens. The photographic recording of the image is called hologram, which is an unrecognized form of pattern of stripes and whorls but which when illuminated by coherent light as by a laser beam, organizes the laser light into a three dimensional representation of the original objects. Holographic images extend the concept of virtual reality by allowing the user to get "inside" a part such as engine view and its operation from the inside.

Fractals: Fractals started as technology in the early 1980s but has received serious attention only recently. This technology is based on synthesizing and storing algorithms that describe the information. Fractals are regular objects with a high degree of irregular shape. Fractals are the decompressed images that result from a compression format that uses arithmetic algorithms to define repeated patterns in the image.

Multimedia Applications:

The rapid evolution and spread of GUIs has made it possible to implement multimedia applications widely accessible to desktop users in an office environment.

Document Imaging

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The first major step toward multimedia systems originated in document image management. Technologies developed for imaging are an indispensable ingredient in the applications that will evolve to create the efficient combination of text, image, sound, and video for the attractive target called multimedia.

Document imaging makes it possible to store, retrieve, and manipulate very large volumes of drawings, documents, and other graphical representations of data. The workflow defines the sequence for scanning images, performing quality checks, performing data entry based on the contents of the images, indexing them, and storing them on optical media. Real-time image decompression and display place special demands on image-processing hardware.

Image processing and image recognition :

Unlike document image management, image processing involves image recognition, image enhancement, image synthesis, and image reconstruction. The original image is not altered in a document image workflow management system. An image processing system, on the other hand, may alter the contents of the image itself. Examples of image processing systems applications include recognition of images (as in factory floor quality assurance systems), image enhancement (as in satellite reconnaissance systems), image synthesis (as in law enforcement suspect identification systems) and image reconstruction (as in plastic surgery design systems). Image synthesis and reconstruction may use a combination of bitmaps (in some compressed form) and complex arithmetic algorithms to calculate drawing entities, including shading and color variations. Image processing systems may combine the technologies of full-motion video images. Video camera output used for image processing, requires special processors to perform optical recognition on images at high speed. Recognition of objects requires very high levels of processing power. Some applications of image recognition include optical character recognition (OCR), zip (or PIN) code recognition at post office.

Image Enhancement

Increasing the sensitivity and contrast makes the picture darker by making borderline pixels black or increasing the gray-scale level of pixels. Or it may be more complex, with capabilities built in the compression boards or programmed in software.

These capabilities might include the following:

- **Image calibration**: The overall image density is calibrated, and the image pixels are adjusted to a predefined level.
- **Real-time alignment**: The image is aligned (rotated by small angles) in real-time for skewing caused by improper feeding of paper.

- **Gray-scale normalization**: The overall gray level of an image or picture is evaluated to determine if it is skewed in one direction and if it needs correction.
- **RGB hue intensity adjustment:** Too much color makes a picture garish and fuzzy. Automatic hue intensity adjustment brings the hue intensity within predefined ranges.
- **Color separation**: A picture with very little color contrast can be dull and may not bring out the details. The hardware used can detect and adjust the range of color separation.
- **Frame averaging**: The intensity level of the frame is averaged to overcome the effects of very dark or very light areas by adjusting the middle tones.

Image Animation: Computer created or scanned images can be displayed sequentially at controlled display speeds to provide image animation that simulates real processes. The multiple bit-plane capability of decompression and display hardware is used to decompress and save successive images in successive bit planes. The basic concept of displaying successive images at short intervals to give the perception of motion is being used successfully in designing moving parts such as automobile engines.

Image annotation: It can be performed in one of two ways: as a text file stored along with the image or as a small image stored with the original image. The annotation is overlayed over the original image for display purposes. It requires tracking multiple image components associated with a single page decompressing all of them, and ensuring correct spatial alignment as they are overlayed.

Optical Character Recognition:

Optical character recognition (OCR) technology is used for data entry by scanning typed or printed words in a form, Initially starting out as dedicated OCR scanners, OCR technology is now available in software (i.e. it does not require dedicated controller boards) and has the capability to decipher a large number of printed fonts used in many document image applications.

Handwriting Recognition

Handwriting recognition has been the subject of intense research for a long time. Originally, this research was performed for CAD/CAM systems for command recognition. Multimedia systems will use handwriting recognition as another means of user input. Handwritten memos using pen-based machines may be interpreted and read out when they are a part of a complex document or a mail message. As with most other multimedia technologies, the full use of this medium will continue to evolve as increasingly powerful hardware and software open new avenues for using this technology.

Non-Textual Image Recognition

While verbal communication is the principal mode by which we exchange information, psychologists have long known that our comprehension of facial expressions, posture, and gestures represents important additional input which plays a major role in interpersonal communication. Computer scientists also recognize the profound transformation of the human-machine interface that could be achieved by multimedia interfaces which allow these inputs in addition to text. Image recognition has become a major technology component in the designing, medical, manufacturing fields.

Full-Motion Digital Video Applications:

Full-motion video is the most complex and the most demanding component of multimedia applications. Full-motion video has applications in the games industry and training, as well as the business world.

The same technologies are being used to support full motion video in sophisticated multimedia games and entertainment systems as in business applications such as multimedia messaging and other multimedia applications like engineering simulations. Some core requirements are as follows:

- Full-motion video clips should be sharable but should have only one sharable copy- users may have their own copies of the message or design manual but storing duplicated video clips requires substantial storage.
- It should be possible to attach full-motion video clips to other documents such as memos, chapter text, presentations, and so on.
- Users should be able to take sections of a video clip and combine the sections with sections from other video clips to form their own new video clip. In other words, editing should be possible.
- All the normal features of a VCR metaphor, such as, rewind, fast-forward, play, and search should be available.
- It should be possible for users to move and resize the window displaying the video clip.
- Users should be able to adjust the contrast and brightness of the video clip and also the associated sound.
- Users should be able to suppress sound or mix sound from other sources.

Electronic Messaging:

A multimedia-enabled electronic messaging system requires a sophisticated infrastructure consisting of the following to support it:

- Message store and forward facility
- Message transfer agents to route messages to their final destinations across various nodes in a multilevel network.
- Message repositories (servers) where users may store them just as they would store documents in a filing cabinet
- Repositories (servers) for dense multimedia components such as images, video frame, audio messages, and full-motion video clips
- Ability for multiple electronic hypermedia messages to share the same multimedia components residing in various repositories on the enterprise network
- Dynamic access and transaction managers to allow multiple users to access, edit, and print these multimedia messages
- Local and global directories (or name and address books) to locate users and servers across an enterprise network
- Automatic database synchronization (replication) of dynamic electronic messaging databases
- Automatic protocol conversions and data format conversions
- Administrative tools to manage enterprise-wide networks

A Universal Multimedia Application

The concept of multimedia applications is centered around the vision of a universal application that works on a universal data type. This means that the application manipulates data types that can be combined in a document, displayed on a screen or printed, with no special manipulations that the user needs to perform.

A document of this type may be a phonebook, a color brochure with pictures and drawings, a memo, a phone message, a video - phone message, or live teleconferencing. The application is truly distributed in nature in that the components of the document may be from sources distributed on various nodes of a corporate network. An important consideration for such a universal application is the methodology for dissemination of the information on a network.

Standardization and communications conventions are directed towards the representation of knowledge in rich and complex ways that allow the user of the knowledge to manipulate it and perform functions such as cutting and pasting it in other applications. Cooperative operation of multimedia applications is a prerequisite for such seamless operation at the user level

. It is obvious that maintaining all of these windows requires a substantial amount of CPU power, and DSP (Digital Signal Processing) assistance is necessary to manage the multiple simultaneous decompressions for the JPEG, MPEG, CCITT Group 4, and Windows metafiles. While this perspective of a multimedia application may sound illusive, it is important to note that all of the technologies needed to set up an integrated environment of this nature are available and in use individually and in various combinations.

Viewer Interactive live Video :

The entertainment industry has been at the forefront of viewer-interactive video games. The games produced with this technology allow the player to become a participant in the game. A live camera is used to project the player into the scene. When combined with technologies used to create a sense of virtual reality, viewer interactivity can become very realistic.

The key difference between full-motion video and viewer-interactive video is that full motion video, by its basic definition, is playback of stored video clips, while viewer interactive video is live. It may be possible to manage decompression and display of stored video clips more easily than to do the same with live video.

A frame-grabber system used in a GUI environment such as Microsoft's Windows allows the user to display multiple images at one time and allows a detailed comparison of two live videos. Uses such as manufacturing, simulation, and comparison of healthy organs versus diseased organs (e.g., measurement of heart muscle deterioration) are examples of such applications.

Audio and Video Indexing: Indexing is a feature well known to users of VCRs. Most VCRs provide a means of marking a position on tape. Indexing may be provided in authoring systems in the simplest implementations as a meter based on tape length, a measurement of time calculated from the tape length and tape speed, and, in some of the more sophisticated units, by actually placing an electronic index marker permanently on tape.

Evolving Technologies For multimedia Systems:

Hypermedia Documents:

Technical and business documents are increasingly being compiled, written, and distributed in electronic form. The availability of fast-networks has allowed this transformation to computer-based electronic hypermedia documents. Hypermedia documents by definition contain, in addition to text, embedded or linked multimedia objects such as image, audio, hologram, or full-motion video. The network speed and computing efficiency with which these hypermedia documents can be manipulated has special implications for multimedia applications such as messaging. Hypermedia has its roots in hypertext.

Hypertext:

Hypertext implements the organization of non sequential data by natural associations of information. Hypertext systems allow authors to link information together, create information paths through a large volume of related text in documents, annotate existing text, and append notes that direct readers to bibliographic information or to other reference material. Hypertext allows fast and easy searching and reading of selected excerpts through text spanning up to hundreds of thousands of pages.

Hyperspeech:

Accelerating trends such as multimedia and cellular-phone networks stimulated the development of general purpose speech interfaces. Speech synthesis has been used in a limited form only. However, expectations make speech synthesis and indexing of speech an important component of multimedia systems. For example, a mail message can be used to generate a hyperspeech file that a user can begin to navigate on a selective basis. Instead of having to listen to a synthesized recording of the entire message, a user can jump from concept to concept, following a variety of threads of thought. By using this approach, a user can get a synopsis of a report in a very short time and effectively respond to the issues quickly.

HDTV and UDTV:

Among the better-know television broadcasting standards are NTSC, PAL, SECAM, NHK and others. These standards range resolutions from 525 lines for NTSC to 819 l lines for the French standards. An 1125- line digital HDTV (High-Definition TV) has been developed and is being commercialized while UDTV (Ultra-Definition TV) is developed by NHK of Japan featuring approximately 3000 lines.

3-D Technologies and Holography:

Three-dimensional technologies are concerned with two areas : pointing devices and displays. 3-D pointing devices are essential to manipulate objects in a 3-D displays system. 3-D displays are achieved using holography techniques. The development of 3-D pointing devices and system is an important component in the progress towards multimedia systems.

Digital Signal Processing (DSP):

The use of digital signal processor (DSP) chips continues to grow rapidly, outpacing the overall use of ICs. DSP chips are also used in applications such as the European digital cellular telephone system, digital servos in hard disk drives, and fax/data modems. A typical DSP operating system architecture would contain the following subsystems:

- Memory management: DSP architectures provide dynamic allocation of arrays from multiple segments, including RAM, SRAM and DRAM.
- Hardware-interrupt handling: A DSP operating system must be designed to minimize hardware interrupt latency to ensure fast response to real-time events for applications, such as servo systems.
- Multitasking: DSPs need real-time kernels that provide preemptive multitasking an user-defined and dynamic task prioritization.
- Inter-task synchronization and communication: Mechanisms for inter-task communication include message queues, semaphores, shared memory, and quick response event flags.
- Multiple timer services: The ability for the developer to set system clock interrupt managed timers to control and synchronize tasks, needed for most real-time applications.
- Device-independent 1/0: DSP operating systems should support two fundamentally different forms of program interaction with underlying devices, an asynchronous data stream for passing data between program and device, and synchronous message passing for passing control messages between the device and the program.

Objects for Multimedia systems

Text

Text is obviously the simplest of data types and requires the least amount of storage.

Text data types can be made fields in a database that can be indexed, searched and sorted.

Text is the basic element of a relational database.

Text is also the basic building block of a document.

Hypertext is an application of indexing text to provide a rapid search of specific text strings in one or more documents.

Hypermedia document is a basic complex objects of which text is a subobject(images, sound, video etc.,).

IMAGES

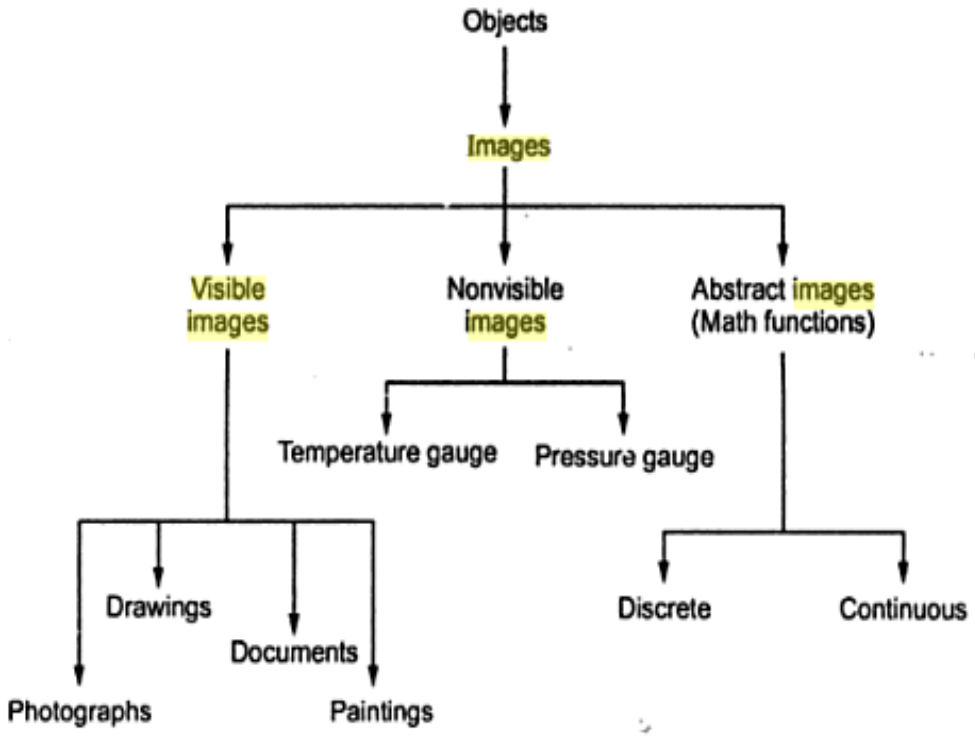
Image object is a subobject of the hypermedia document object

Image object includes all data types that are not coded text and do not have temporal property

All objects are represented in graphics or encoded form

Examples-- document images, facsimile, fractals, bitmaps, still pictures , etc.

Image Hierarchy



Visible

This Group of images includes

Drawing (blueprints, engg drawings, space maps for offices, town layouts etc.,)

Documents

Paintings

Photographs

Still frames captured from a video camera.

Multimedia systems – compression algorithm depend upon type and source of image , so information about compression method should be part of the image.

Non-Visible

Images that are not stored as images but displayed as a images – example pressure gauges, metering display etc.

Abstract Images

It is a computer generated images based on some arithmetic calculations -- ex.. Fractals.

The **discrete functions** result in still images

Continuous functions used for animated images– image fading , dissolving into another image

Audio and voice

Information are stored in compressed form in audio and voice objects

Type-- music, speech, voice commands, telephone conversation etc.

Audio object needs to store following information.

- The length of the sound clip
- Its compression algorithm
- Play back characteristics
- Any sound annotations associated with the original clip.

Full-motion and live video

Most processing and storage intensive components .

It is a pre-stored video clip and live video by its definition is live and must be processed while being captured by the camera.

Storage and processing perspective

Video server needs use of different technologies

- Database storage
- Network media and protocols
- Decompression engines
- Display engines.

MULTIMEDIA DATABASES

Images, sounds and movies can be stored, retrieved and played by many databases. Multimedia databases will become a main source of interaction between users and multimedia elements. **Multimedia system provides the following benefits**:

- Significant reduction of the time and space needed to file, store and retrieve documents in electronic form rather than paper form
- Increased productivity by eliminating lost or missing file conditions using automatically maintained indexing provided by a data management system
- Providing simultaneous document access to multiple users for display on screen as well as hardcopy print
- Improvement of multidimensional information flow within the organization
  Reduction of time and money spent on photocopying by reducing the need for distributing multiple paper copies
- Facilitation of rapid and correct responses to requests for information through stored visual interaction
- Conversion of paper-based information into a manageable, strategic asset that allow easy inclusion in other reports and documents

MULTIMEDIA STORAGE AND RETRIEVAL

Multimedia storage is characterized by a number of considerations. They are:

(i) Massive storage volumes

(ii) Large object sizes

(iii) Multiple related objects

(iv) Temporal requirements for retrieval

Massive Data Volumes

A single multimedia document may be a combination of different media Hence indexing of documents, films and tapes is more complex. Locating massive data volumes requires searching through massive storage files.

Storage technologies

There are two major mass storage technologies used currently for storage of multimedia documents.

(i) Optical disk storage systems. (ii) High-speed magnetic storage.

Advantages of Optical disk storage systems:

(i) Managing a few optical disk platters in a juke box is much simpler than managing a large magnetic disk.

(ii) Optical disk storage is excellent storage system for off line archival of old and infrequently referenced documents for significant periods of time

Multimedia object storage

Multimedia object storage in an optical medium serves its original purpose, only if it can be located fast and automatically. A key issue here is random keyed Access of various components of hypermedia database record. Optical media provides very dense storage.

Speed of retrieval is another consideration. Retrieval speed is a direct result of the storage latency, size of the data relative to display resolution, transmission media and speed, and decompression efficiency. Indexing is important for fast retrieval of information. Indexing can be at multiple levels.

Multimedia document retrieval

The simplest form of identifying a multimedia document is by storage platter identification and its relative position on the platter (file number). These objects can then be grouped using a database in folders (replicating the concept of paper storage in file folders) or within complex objects representing hypermedia documents.

The capability to access objects using identifiers stored in a database requires capability in the database to perform the required multimedia object directory functions. nother important application for sound and full motion video is the ability to clip parts of it and combine them with another set. Indexing of sound and full-motion video is the subject of intense debate and a number of approaches have been used

DATABASE MANAGEMENT SYSTEMS FOR MULTIMEDIA SYSTEMS

Since most multimedia applications are based primarily on communications technologies, such as electronic mail, the database system must be fully distributed. A number of database storage choices are available.

The choices available are:

- Extending the existing relational database management systems, (RDBMSs) to support the various objects for multimedia as binary objects.

- Extending RDBMSs beyond basis binary objects to the concepts of inheritance and classes. RDBMSs supporting these . features provide extensions for object-programming front ends and/or C++ support.
- Converting to a full fledged object oriented database that supports the standard SQL language.
- Converting the database and the application to an object oriented database and using an object-oriented language, or an object-enabled SQL for development.
- Multimedia applications combine numerical and textual data, graphics from GUI front-ends, CAD/CAM systems and GIS applications, still video, audio and full-motion video with recorded audio and annotated voice components.
- Relational databases, the dominant database paradigm, have lacked the ability to support multimedia databases. Key limitations of relational database systems for implementing multimedia applications system from two areas: the relational data model and the relational computational model. RDBMSs have been designed to manage only tabular alphanumeric forms of data (along with some additional data types stored in binary form such as dates).

RDBMS EXTENSIONS FOR MULTIMEDIA

- Binary Large Object (BLOB) is a data type which has been adapted by most of the leading relational databases. BLOBs are used for objects such as images or other binary data types.

- The relational database is extended to access these BLOBs to present the user 'with a complete' data set. Extended relational databases provide a gradual migration path to a more object-oriented environment.
- Relational database tables include location information for the BLOBs which may be stored outside the database on separate image or video servers.
- Relational databases have the strength of rigorous set management for maintaining the integrity of the database

OBJECT-ORIENTED DATABASES FOR MULTIMEDIA

In object databases, data remains in RMS or flat files. Object databases can provide the fastest route to multimedia support. Object programming embodies the principles of reusable code and modularity. This will ease future maintenance of these databases.

Object database capabilities such as message passing, extensibility, and the support of hierarchical structures, are important for multimedia systems. ODBMSs are extensible. They allow incremental changes to the database applications.

Extensibility:

Extensibility .means that the set of operations, structures and constraints that are available to operations are not fixed, and developers can define new operations, which can then be added as needed to their application.

Object-oriented software technology has three important concepts. They are:

- **Encapsulation: It** is the ability to deal with software entities as units that interact in pre-defined and controllable manner, and where the control routines are integral with entity.
- **Association**: It is the ability to define a software entity in terms of its differences from another entity.
- **Classification**: It is the ability to represent with a single software entity a number of data items that all have the same behaviour and the same state attributes. Object orientation helps to organize the software in a more, modular and re-usable manner.

- **Encapsulation** allows for the development of open systems where one part of the application does not need to know the functioning of other part. It also provides autonomy;
- **Autonomy** means we can interface to a variety of external programs can be built in one class of objects and the storage of the data in another class of objects.

DATABASE ORGANIZATION FOR MULTIMEDIA APPLICATIONS

Data organization for multimedia systems has some key issues. They are:

(l) Data independence

(2) Common distributed database architecture

(3) Distributed database servers·

(4) Multimedia object management.

Data Independence Flexible access by a number of databases requires that the data be independent from the application so that future applications can access the data without constraints related to a previous application. Key features of data independent designs are:

1. Storage design is independent of specific applications
2. Explicit data definitions are independent of application programs
3. Users need not know data formats or physical storage structures
4. Integrity assurance is independent of application programs
5. Recovery is independent of application programs

Common Distributed Database Architecture The insulation of data from an application and distributed application access present the opportunity to employ common distributed database architectures. Key features to note are:

1. Multiple independent data structures in system (server)
2. Uniform distributed access by clients
3. A single point for recovery of each database server
4. Convenient data reorganization to suit requirements
5. Tunability and creation of object classes
6. Expandability

Distributed Database Servers Distributed database servers are a dedicated resource on a network accessible to a number of applications. The database

server is built for growth and enhancement, and the network provides the opportunity for the growth of applications and distributed access to the data.

Transaction Management for Multimedia Systems

Multimedia transactions are very complex transactions. We define a multimedia transaction as the sequence of events that starts when a user makes a request to display, edit, or print a hypermedia document. The transaction is complete when the user releases the hyper-media document and stores back the edited versions or discards the copy in memory (including virtual memory) or local storage

Multimedia Systems Architecture