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System Architecture for On-line Broadcast Archives

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Consumer friendly delivery of multimedia digital services is drawing world attention. Broadcast archives are valuable multimedia resource centres, stocking audio and video materials of interest to a vast population across the globe. There is great potential of using these archival material for on-line access of information in respect of the material and also to some extent direct delivery of the material itself. The present paper describes the system architecture and implementation issues of an On-Line Broadcast Archives Management system (OL-BAMS) which entails all the functions of storage and dissemination taking advantage of emerging technology.

BROADCAST archive is a valuable collection of music, film, talks, sound effects, video clips, still picture etc. The archival material is in video or audio form generally stored in analogue format on disks/tapes apart from paper scripts, albums etc. There is a growing need for systematic access to recorded material by making them available rapidly, conveniently, economically and with precision.

The progress of digital technologies in production, storage and transmission of audio (Digital Audio Broadcasting-DAB) and Television (Digital Video Broadcasting-DVB) is rapidly changing the established concepts of broadcasting. Digital video/audio provide a way for greater channel efficiency, better quality, and interactivity. The emergence and adoption of MPEG-2 as the world standard for compression has brought the digital multimedia broadcasting into the realm of reality. The trend towards digital broadcasting, a scale of economy saving in storage space and lossless multicopy production with the adoption of MPEG-2 standards for video and AC-2/AC-3 standards for audio compression, availability of inexpensive RAID, OD, CD etc as storage devices, use of Expert System and Hypermedia a information retrieval systems, have made the management of broadcast archives a very challenging and rewarding job.

Information system plays an important role in providing new forms of customer service, new distribution channels, rearranging organisation boundaries, redesigning business processes and enabling companies to capture global economies of scale[1-7].

It is in this emerging scenario that the broadcast archives management needs a new methodology. This paper will describe a Mass Information System for Broadcast Archives Management System (BAMS). This will encompass delivery of a large variety of visual material - ranging from history, science, and technology to natural history, world cultures, music and fine arts etc from digital multimedia archive.

OLBAMS has four main functions viz, Archives Management (AM), Information System Management (ISM), Transport Management (TM) and Finance Management (FM). The AM is responsible for converting the existing catalogues and material into digital form. ISM is responsible for putting it on-line and providing all computer facilities for on-line access. TM is responsible for network operations for the delivery. The FM is responsible for accounting functions. These functions are performed with the help of various equipment or sub-systems. The functions of the OLBAMS are depicted in Fig 1.

METHODOLOGY

In recent years object-oriented approach has received attention from the computer and information system industries[8]. Using the object-oriented approach, analysts model the system being investigated by identifying a set of objects in conjunction with the attributes and the methods (i.e. internal operations and messages) that manipulate the object data or request services from other objects. There are various task-analysis methods such as Task System Design[9], GOMS[10] and Task-Analysis for Knowledge Description[11] for object oriented modeling. GOMS is a human cognitive model which encompasses four sets of components: goals, operators, methods for achieving the goals and selection rules. The term task solver has been used for method[12] and the same shall be used in this paper to analyse the task and development of a model.

SYSTEM ARCHITECTURE

The on-line broadcast archive management system has four task solvers which could be represented as objects with goals as attributes. The administration of Broadcast Archives Management is realised by the help

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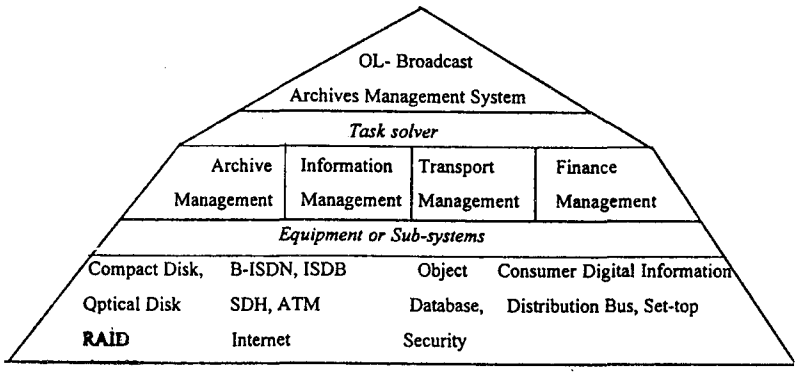

Fig 1 Functions of on-line broadcast archives management system

of four task solvers viz, AM, ISM, TM and FM who have pre-defined goals. The analysis of BAMS results in defining the clear goals of these task solvers in administering services such as encoding, data updation, retrieval and display, video/audio-on-demand, delivery of programmes on-line or off line, realisation of money for the services provided etc.

The goal of Archives Management (AM) task solver

- Converting the existing analogue material into digital form (encoding and compressing).
- Storing it on direct access storage device (DASD) such as compact disk (CD), optical disk, (OD), video disk servers.
- Providing a catalogue of each recording in two parts viz audio/video (A/V) clips in a digital form and information (minimum data list) viz title, singer, composer, theme, category etc as per a format. In certain cases, graphics for photos/album etc is also required to be stored in compressed form.

The goal of Information System Management (ISM) task solver

- To provide an hyperlink/expert system (ES) based information retrieval system for multimedia data viz text, graphic, stills, video, audio etc.
- To provide multiple server-based distributed database for multimedia information as well as on-line digital video/audio for broadcast as well delivery using other means.
- To provide facility for access control, security, charging system for uses/payment of royalty, copyrights etc.

The goal of Transport Management (TM) task solver

- To provide system for delivery which could be a mix of Asynchronous Transport Mode (ATM), Synchronous Digital Hierarchy (SDH), Integrated Services Digital Broadcasting (ISDB), B-ISDN, internet etc for on-line information access/delivery of full video/audio.

The goal of Finance Management (FM) task solver:

- To charge the users as per uses access.
- To make payment for royalty.
- Other accounting functions.

The conceptual overview of the model has been depicted in Fig 2.

SYSTEM IMPLEMENTATION

The operation part of each task solver object contains a set of processes called 'operators' in the GOMS model. These operational processes are messages to task objects. The operation part of a task solver object usually also contains a set of selection rules that control the users decision path, while accomplishing the goal. Interface description specify the dialogue between user and computer. The system implementation of various modules are now discussed.

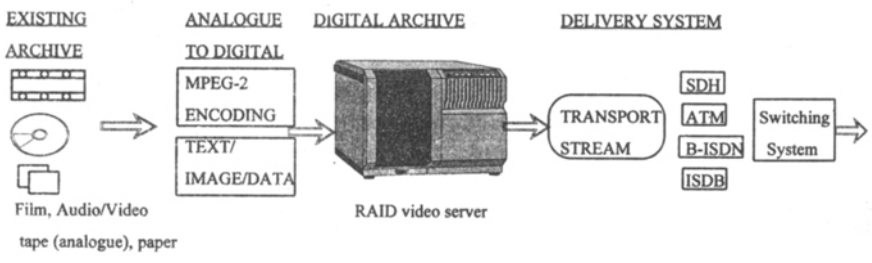

Fig 2 Conceptual view of on-line BAMS model

Material Transfer and Storage Considerations

The Joint Photographic Experts Group (JPEG)[13] and the Moving Picture Expert Group (MPEG)[14] have developed compression standards for still images, and full motion pictures. The MPEG-2 standard has been extended to encompass HDTV[15]. For source coding (voice coding system), both MPEG-2 audio and Dolby AC-3 can be used. For video, the recommended coding system is MPEG-2, and multiplexing is also MPEG-2. The photos, albums etc can be coded using JPEG standard.

Using above, the analogue disk/tape is transformed in the digital form. Signal processing allows enhancement of quality, where required. The suitable clippings are also stored in digital form viz. AVI, FLI, MOV, QT etc.

Video disk servers for video-on-line which can serve MPEG-2 programs on high band-width networks are already available. 32 GB Redundant Array Inexpensive Disk Drives (RAIDs) provides approximately 3.5 hours of high-quality, randomly accessible video using 4:2:2 Studio Profile compression for non-linear playback. An illustrative object for this task solver is shown in Fig 3. The system can be made completely computer controlled with functions such as load, rewind, play, record etc being performed through computer instructions.

Information system considerations

The obvious candidates for the archives are minimum data list, audio/video (A/V) clips, audio/video programmes and stills stored in the digital form. For this type of multimedia data, it is important to be able to link various type of data efficiently so that users have access to large amount of related but unstructured information almost instantaneously, either by browsing or querying system. The system is called Hypermedia Archives Information Retrieval System (HAIRS). Hypermedia is a method of storing and retrieving discrete pieces of data. The data objects can be text, pictures, sound, video or a combination of these. A logical view of the multimedia data stored in the information-base is shown in Fig 4. The darken structures and text represent the video/audio data which is priced. It may be seen that while user can get an access to the excerpt free of cost and download it to his PC or Set-top, he may need authorisation to access the full video.

An overview of H-AIRS

A system architecture for H-AIRS is given in Fig 5. The Information-base consists of schema object and multi level object oriented data base. An interface manager is responsible for parsing the request and generating an internal representation which is handled by an object manager. The object manager has five major modules, the schema manager, the browser, the query manager, the transaction manager and the presentation

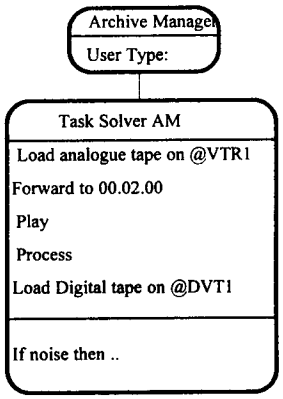

Fig 3 Objects for archive manager

manager[16]. The storage manager is responsible for storage and manipulation of the object oriented representation of multimedia material. The browser helps scan the data-base by user. The query manager processes the query by translating it into an appropriate language. The transaction manager is responsible for managing the transactions on objects. The presentation manager transforms the query in appropriate form.

Design Details of H-AIRS

The nodes are conceptual data objects viz voice, text, video, images or graphics. The interface manager's view of the data-base is a collection of nodes connected via various type of links. There are three types of nodes. Basic nodes store multimedia object for executing certain procedures. Organisational nodes are links or meta nodes. Inferential nodes are meant for intelligent information retrieval and are basically the rule nodes[17]. Links connect different nodes. The basic links are move-to/zoom/pan/view/links. Organisational links or indexed/object links. Inferential links are associated with rule nodes.

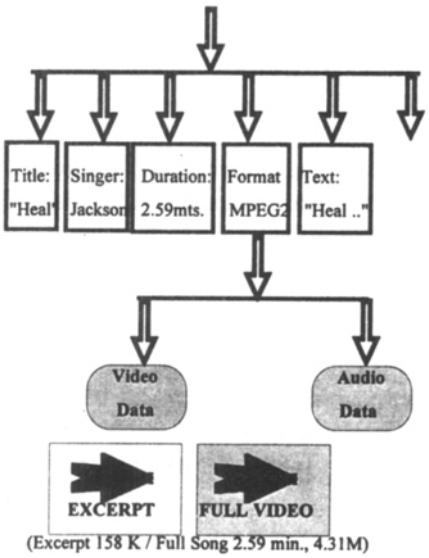

Fig 4 A logical view of multimedia data

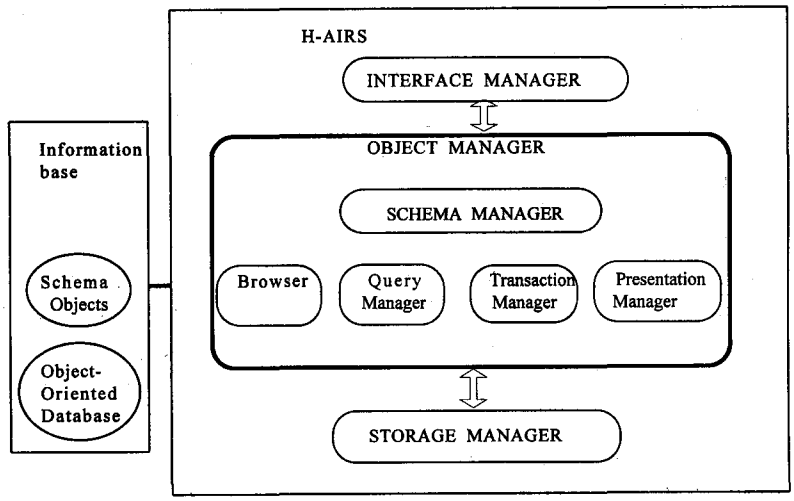

Fig 5 System architecture of H-AIRS

dexed/object links. Inferential links are associated with rule nodes.

Information Retrieving, browsing and updates

Information retrieval is facilitated by the index nodes. When a user issues a request to retrieve a document, the interface manager scans the index text nodes using some key words specified in the query. From the index text nodes, appropriate index nodes are accessed. From the index nodes, concept nodes such as text, sound, video and mixed media nodes relevant to the query are accessed. When the data contained in a node has to be displayed, the data and the corresponding data objects are retrieved. Further mapping may be necessary so that the requests on the data objects are transformed into requests on files which contain them such as digital video, digital audio are pure text files. Eventually the corresponding files are retrieved and the contents are displayed/played. The operating system security feature for file access ensures that the file is not opened by unauthorised user.

If a user wants to browse a network of nodes to obtain all the information about a specific item, a few key words result in opening a window from which he can traverse from one node to other by clicking on a link.

The update operation is given to an update processor which parses the request and passes on to multimedia manager which is responsible for transforming the logical request into requests on file.

A Session

The query by video browser takes to screen shown in Fig 6. The basic VB interface consists of four screens: Category Screen, Video Shelf Screen, Query Shelf Screen and Text-output screen. The category screen presents to the user a predefined set from which to choose movies. This is the first screen presented to the user. Hindi Film, Sports, Horror etc are examples of the categories. When the user queries for a certain category, the system presents a shelf containing videos available in the specified category. The user can then choose a video from this shelf. If the user is not happy with the choices presented, a query can be formulated via the query interface. The user can customize a query by specifying specific movie attributes of the desired movie. Director, Actor, Producer, etc are examples of attributes that can be specified by the user to build a query. When the user builds a query, all videos that conform to the query are displayed on a Text-output screen. The user can use this screen to generate a summary and look at a poster of the video. After this selection the user gets a new screen giving details of movie and by clicking the object, can watch or download the digital file. User can also use the query screen to find the audio.

Transport system considerations

The digital multimedia can be delivered through terrestrial, cable or satellite. The cable network (DVB-C) system has the same core as satellite system (DVB-S) except that the modulation technique is based on Quadrature Amplitude Modulation (QAM) rather than Quadrature Phase Shift Keying (QPSK). No inner code forward error correction (FEC) is used. Channel coding for digital terrestrial broadcasting is OFDM[18].

The delivery of the information system can also be through a mix of ATM, SDH, B-ISDN, internet etc. One prospect for Consumer Digital Information Distribution (CDID) is a digital bus to the home. This is equivalent to a LAN connected through routers or gateways. The archive is accessed trough satellite, terrestrial and cable networks on this CDID bus.

Fig 6 A session with the H-AIRS

Finance management issues

Their can be various type of services viz. free-to-air broadcasting, subscription service and on-line information service. However, these can be managed using available software or developing new ones.

CONCLUSION

Archive is an important component of radio and TV broadcasting. With the advent of a number of broadcasting channels using satellite, terrestrial and cable network, the archival material has got a very high commercial value. Viewer/listeners may be interested in accessing a variety of programmes either using on-line information super-highway or through conventional channels. However, an on-line information system is a must to access the information about the meterial and also to view/listen the clips. An automated system with a multimedia archival support may be a solution. A hyperlink based retrieval system has specific advantages. The present paper is an attempt to provide the direction for designing such a system. The bottom line is that the characteristics of mass IS are the voluntary use and a high degree of uncertainty exists about the users and their requirements. The user must gain substantial benefits to accept the system. The only way to success may be the step-wise implementation of services by observing and analysing the user behaviour. This evolutionary development and the diffusion process may take some years. But the potential benefits for the broadcast organisations are high. To quote Bill Gates, 'Whatever problems direct access to unlimited information may cause, the benefits it will bring, will more than compensate[19]'.

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