Multimedia 2^{nd} Assignment

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***Abstract*— This assignment contains information about limitations of Workstation Operating Systems, Multimedia File System and Information Representation System, MPEG Motion Video Compression Standard in detail and comparing its various variants, various applications areas of Multimedia technology and its detail for medical, entertainment, manufacturing, business and education areas brief description about intelligent Multimedia system and various lossy compression and lossless compression algorithms.**

I. Introduction

Multimedia being a media and content form uses a combination of different content forms. The term is used in contrast to media which use only rudimentary computer display such as text-only, or traditional forms of printed or hand-produced material. Various aspects of Multimedia concern are discussed in this assignment.

This assignment also discuss about MPEG Compression and the various standards being formed by MPEG. Limitation of various Workstation Operating System due to various aspect including Real time synchronization, Deadline Recovery etc. are discussed in this assignment.

In the ahead sections various topics like Multimedia File System which covers the requirement of Multimedia File System and the features are discussed. It also covers Information Representation System which contains key concept about information system, it's crucial role in communication and standards.

Next Part covered is Application Area of Multimedia that includes the various application areas like Medical Science, Education Business etc. Also various Lossy and Loseless Compression techniques for Image compression are discussed in this assignment. The last topic covered is Intelligent Multimedia system that covers the Combined application of Expert System and Multimedia Application.

II. MPEG Motion Video Compression Standard

The Moving Picture Experts Group (MPEG) is a working group of experts that was formed by ISO and IEC to set standards for audio and video compression and transmission. It was established in 1988 by the initiative of Hiroshi Yasuda (Nippon Telegraph and Telephone) and Leonardo Chiariglione, who has been from the beginning the Chairman of the group. The first MPEG meeting was in May 1988 in Ottawa, Canada. As of late 2005, MPEG has grown to include approximately 350 members per meeting from various industries, universities, and research institutions. MPEG's official designation is ISO/IEC JTC1/SC29 WG11 - Coding of moving pictures and audio (ISO/IEC Joint Technical Committee 1, Subcommittee 29, Working Group 11).[1]

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A. Standards

Various MPEG standards are represented in tabular form below.[1] The MPEG standards consist of different parts.

TABLE I
MPEG groups of standards[1]

Acronym for Standard	ISO/IEC Standard	Description	First Public Release
MPEG-1	ISO/IEC 11172	Coding limited to 1.5 Mbit/s	1993
MPEG-2	ISO/IEC 13818	Generic coding of digital media	1995
MPEG-3		Incorporated in MPEG-2	
MPEG-4	ISO/IEC 14496	Coding of audio and visual objects	1999
MPEG-21	ISO/IEC 21000	Multimedia framework	2001
MPEG-7	ISO/IEC 15938	Multimedia content description interface	2002
MPEG-A	ISO/IEC 23000	Multimedia application format	2007
MPEG-B	ISO/IEC 23001	MPEG systems technologies	2006
MPEG-C	ISO/IEC 23002	MPEG video technologies	2006
MPEG-D	ISO/IEC 23003	MPEG audio technologies	2007
MPEG-E	ISO/IEC 23004	Multimedia Middleware format	2007
MPEG-V	ISO/IEC 23005	Media context and control	2011
MPEG-M	ISO/IEC 23006	MPEG extensible middleware	2010
MPEG-U	ISO/IEC 23007	Rich media user interfaces	2010

1) MPEG-1 (1993): Capable of codeing of videos and audios up to about 1.5 Mb/s (ISO/IEC 11172). This was the first MPEG compression standard for audio and video and is used on Video CD, SVCD and can be used for low-quality video on DVD Video.[1]

2) MPEG-2 (1995): Provides Generic coding of moving pictures and associated audio information (ISO/IEC 13818). Transport, video and audio standards for broadcast-quality television. MPEG-2 standard was considerably broader in scope and of wider appeal supporting interlacing and high definition.[1]

3) MPEG-3: MPEG-3 dealt with standardizing scalable and is capable of multi-resolution compression and was focused for HDTV compression.[1]

4) MPEG-4 (1998): Coding of audio-visual objects (ISO/IEC 14496). MPEG-4 uses further coding tools with

additional complexity to achieve higher compression factors than MPEG-2. [1]

5) MPEG-7 (2002): Multimedia content description interface. (ISO/IEC 15938)

6) MPEG-21 (2001): Multimedia framework (ISO/IEC 21000) MPEG describes this standard as a multimedia framework and provides for intellectual property management and protection.

Moreover, more recently than other standards above, MPEG has started following international standards. Each of the standards holds multiple MPEG technologies for a way of application.(For example, MPEG-A includes a number of technologies on multimedia application format.)

7) MPEG-A (2007): Multimedia application format (ISO/IEC 23000).[1]

8) MPEG-B (2006): MPEG systems technologies (ISO/IEC 23001). [1]

9) MPEG-V (2011): Media context and control (ISO/IEC 23005). [1]

10) MPEG-M (2010): MPEG eXtensible Middleware (MXM) (ISO/IEC 23006). [1]

11) MPEG-U (2010): Rich media user interfaces (ISO/IEC 23007).[1]

III. Limitation of Workstation Operating Systems

workstations had offered higher performance than desktop computers, especially with respect to CPU and graphics, memory capacity, and multitasking capability. They are optimized for the visualization and manipulation of different types of complex data such as 3D mechanical design, engineering simulation (e.g. computational fluid dynamics), animation and rendering of images, and mathematical plots. Various falls in the category and each is dicussed with its limitations.[2]

A. Limitation of Windows NT

- Windows NT does not have a good reputation in term of server stability.[3]
- Costs of applications usually higher than that of Unix.[3]
- Window is costly.[3]

B. Limitation of Linux Distributions

- Hard to choose.
- Very Hard.
- Expertise needed to run.
- Hardware incompatibilty.

C. Limitation of Solaris

- Hard to operate.
- Very Difficult manitainence.[4]
- Expertise needed to run.
- Hardware incompatibilty.[4]

IV. Multimedia File System

Multimedia Applications and Systems are getting more and more involved in our everyday lives. Their main purpose is to deal with various media types like pictures, video data, audio data and text. Video and audio belong to continuous media data. Pictures and text belong to discrete media data. When most people refer to multimedia, they generally mean thecombination of two or more continuous media. In practice, the two mediaare normally audio and video, that is, sound plus moving pictures.[5]

A. File System Requirements

Various Requirement for File system to be efficient are as explained below.[5]

- Storing/retrieving multimedia files.
- Guarantee a sustained level of service.
- Maintain high throughput.
- Support RT and non RT requests.

B. Various File Systems

Various File Systems are.

1) Punched Cards: The standard punched card, originally invented by Herman Hollerith, was able to solve the basic Purpose of text information storage was indeed a big achievement but it's flaws lead to further advancement in field of File system. Some retail applications are given below.[5]

2) Window File System: Possibility of WFS (Window File System) and LFS (Linux File System) was possible due to only the most remarkable invention of magnetic storage devices which is having the files systems with remarkable storage properties with the various parmaters like seek time, latency time in an improved manner. WFS includes mainly FAT and NTFS file system for efficient storage and retreival of multimedia files. Main Goal of WFS were following.[5]

3) Linux VFS (Virtual File System): This abstraction from actual filesystem operations gave Linux the flexibility to support all kinds of filesystem implementations. Today there is a wide variety of supported physical filesystems (ext2, ext3, vfat, xfs,reiser, ..) as well as network (nfs, smbfs,..) and others (procfs,ramfs, devfs) integrated into the Linux kernel.[5]

V. Information Representation System

Information systems is an applied discipline and its aim is to improve practice. Information systems research must therefore be both relevant and rigorous. It must be relevant in that the outcomes of the research should be usable and useful in practice, and accessible to practitioners. It must be rigorous in that it is soundly based in theory and undertaken in a systematic way using appropriate research methods.[6]

This balance is desirable but difficult to achieve. Many understanding of representation in Information System had been built upon the Philosophical Postion and Semiotic Theory.[6]

The physical and empirical levels concern the physical media and use of the physical media for communication of symbols. They are not generally considered to be in the

domain of information systems. The four semiotic levels that are of interest in representation in information systems are the syntactic, semantic, pragmatic, and social levels.[6]

A. Need of Information Representation System

- To transmit mutlimedia.
- To represent multimedia.
- For better storage.[6]

VI. Intelligent Multimedia System

Intelligent systems will act as our assistants and play a variety of roles in this capacity. These systems are unlikely to become truly sentient in the foreseeable future; however, utilizing artificial intelligence techniques, they will exhibit behavior that mimics intelligence within limited realms of activity. Natural language interactions with these systems are likely to be possible within the narrow areas of their expertise, but unrestricted natural language dialogues are still beyond our technological capabilities. An intelligent system must help refine and create knowledge-it should have many of the qualities of coach, tutor, and colleague, encouraging the learner to question, conjecture, create, and experiment. In multimedia computer systems, intelligent agents could perform several functions.[7]

- Monitor multimedia databases and capture relevant new information.
- Filter incoming multimedia messages.
- Assist the user in identifying and searching appropriate multimedia databases as well as downloading data from these databases.
- Help the user create new intellectual works from retrieved and original information.[7]

VII. Lossy Compression Algorithms

lossy compression can be thought of as an application of transform coding in the case of multimedia data, perceptual coding: it transforms the raw data to a domain that more accurately reflects the information content. For example, rather than expressing a sound file as the amplitude levels over time, one may express it as the frequency spectrum over time, which corresponds more accurately to human audio perception.[8]

A. JPEG Compression

The name "JPEG" stands for Joint Photographic Experts Group, the name of the committee that created the JPEG standard and also other standards. It is one of two sub-groups of ISO/IEC Joint Technical Committee 1, Subcommittee 29, Working Group 1 (ISO/IEC JTC 1/SC 29/WG 1) titled as Coding of still pictures. The group was organized in 1986, issuing the first JPEG standard in 1992, which was approved in September 1992 as ITU-T Recommendation.[10]

1) Encoding: Many of the options in the JPEG standard are not commonly used, and as mentioned above, most image software uses the simpler JFIF format when creating a JPEG file, which among other things specifies the encoding method. Here is a brief description of one of the more common methods of encoding when applied to an input that has 24 bits per pixel (eight each of red, green, and blue). This particular option is a lossy data compression method.

In the second step, it is required to find a similar block so that the IFS can accurately represents the source, so a sufficient number of candidate blocks for D_i need to be considered. On the other hand, a large search with many blocks may become costly. This bottleneck of searching for similar blocks makes fractal encoding much slower.

B. Vector Quantization

Vector quantization is a classical quantization technique from signal processing which allows the modeling of probability density functions by the distribution of prototype vectors. It was originally used for data compression. It works by dividing a large set of points (vectors) into groups having approximately the same number of points closest to them. Each group is represented by its centroid point, as in k-means and some other clustering algorithms.

1) Applications: Vector quantization is used for lossy data compression, lossy data correction and density estimation. Lossy data correction, or prediction, is used to recover data missing from some dimensions. It is done by finding the nearest group with the data dimensions available, then predicting the result based on the values for the missing dimensions, assuming that they will have the same value as the group's centroid. For density estimation, the area/volume that is closer to a particular centroid than to any other is inversely proportional to the density (due to the density matching property of the algorithm).

C. Fractal compression

Fractal compression is a lossy compression method for digital images, based on fractals. The method is best suited for textures and natural images, relying on the fact that parts of an image often resemble other parts of the same image.

1) Encoding: A challenging problem of ongoing research in fractal image representation is how to choose the f1,...,fN such that its fixed point approximates the input image, and how to do this efficiently. A simple approach for doing so is the following.[11]

- Partition the image domain into blocks R_i of size sxs.
- For each R_i, search the image to find a block D_i of size 2sx2s that is very similar to R_i.
- Select the mapping functions such that $H(D_i) = R_i$ for each i.

VIII. Lossless Compression Algorithms

Lossy Compression Algorithms are applied to have compression of audio, video and still images with purpose to have a compressed output with no loss of information. This is applicable only when one can comprise for compression

rates but not for information loss. Various Algortihms are explained below.

A. Huffman Encoding

Huffman coding uses a specific method for choosing the representation for each symbol, resulting in a prefix code (sometimes called ”prefix-free codes”, that is, the bit string representing some particular symbol is never a prefix of the bit string representing any other symbol) that expresses the most common source symbols using shorter strings of bits than are used for less common source symbols. Huffman was able to design the most efficient compression method of this type: no other mapping of individual source symbols to unique strings of bits will produce a smaller average output size when the actual symbol frequencies agree with those used to create the code. A method was later found to design a Huffman code in linear time if input probabilities (also known as weights) are sorted.[13]

1) Compression: The technique works by creating a binary tree of nodes. These can be stored in a regular array, the size of which depends on the number of symbols, n. A node can be either a leaf node or an internal node. Initially, all nodes are leaf nodes, which contain the symbol itself, the weight (frequency of appearance) of the symbol and optionally, a link to a parent node which makes it easy to read the code (in reverse) starting from a leaf node. Internal nodes contain symbol weight, links to two child nodes and the optional link to a parent node. As a common convention, bit ’0’ represents following the left child and bit ’1’ represents following the right child. A finished tree has up to n leaf nodes and n 1 internal nodes. A Huffman tree that omits unused symbols produces the most optimal code lengths.[13]

B. Shannon Fano Encoding

In ShannonFano coding, the symbols are arranged in order from most probable to least probable, and then divided into two sets whose total probabilities are as close as possible to being equal. All symbols then have the first digits of their codes assigned; symbols in the first set receive ”0” and symbols in the second set receive ”1”. As long as any sets with more than one member remain, the same process is repeated on those sets, to determine successive digits of their codes. When a set has been reduced to one symbol, of course, this means the symbol’s code is complete and will not form the prefix of any other symbol’s code.

1) ShannonFano Algorithm: A ShannonFano tree is built according to a specification designed to define an effective code table. The actual algorithm is simple.[14]

- For a given list of symbols, develop a corresponding list of probabilities or frequency counts so that each symbols relative frequency of occurrence is known.
- Sort the lists of symbols according to frequency, with the most frequently occurring symbols at the left and the least common at the right.
- Divide the list into two parts, with the total frequency counts of the left part being as close to the total of the right as possible.
- The left part of the list is assigned the binary digit 0, and the right part is assigned the digit 1. This means that the codes for the symbols in the first part will all start with 0, and the codes in the second part will all start with 1.
- Recursively apply the steps 3 and 4 to each of the two halves, subdividing groups and adding bits to the codes until each symbol has become a corresponding code leaf on the tree.

C. LZW Coding

LempelZivWelch (LZW) is a universal lossless data compression algorithm created by Abraham Lempel, Jacob Ziv, and Terry Welch. It was published by Welch in 1984 as an improved implementation of the LZ78 algorithm published by Lempel and Ziv in 1978. The algorithm is simple to implement, and has the potential for very high throughput in hardware implementations.

1) Encoding:

- A high level view of the encoding algorithm is shown here
- Initialize the dictionary to contain all strings of length one.
- Find the longest string W in the dictionary that matches the current input.
- Emit the dictionary index for W to output and remove W from the input.
- Add W followed by the next symbol in the input to the dictionary.
- Go to Step 2.

IX. Multimedia Application Areas

Multimedia can be used in various areas resulting into a lot of useful applications. Multimedia can be used in entertainment, corporate presentations, education, training, simulations, digital publications, museum exhibits and so much more. With the advent multimedia authoring applications like Flash, Shockwave and Director amongst a host of other equally enchanting applications, one’s multimedia end product is only limited by one’s imagination.

A. Multimedia in Education

Multimedia combines several media and hence is extensively used in the field of education and training. Even in conventional method we use audio visual for imparting education, where charts, models etc. were used. Now a days the classroom need is not limited to that conventional method rather it needs audio and visual media. The software package named computer aided instruction is available that provides a friendly interactive method of learning.[16]

B. Technology

Multimedia had a wide application in the field of science and technology. Whether it is an industry or the case of sciences all are benefited by its use. The multi media application and beneficial for researchers as well as over the world. The multimedia system is capable of transferring audio, and clips in addition to the regular text.[16]

C. Multimedia in Training

There various systems and intelligent tutoring systems available to train the students in many areas starting from the mathematics of a primary sudden to a difficult surgical process for a medical student. The tutorials contains enough number of videos sequences clarify.[16]

D. Multimedia in Business

The business application of multimedia includes, product demos, instant messaging. One the excellent applications is voice and live conferencing. A multimedia can make a audience come live. It is widely used in programs. Such a program can be used by a mechanic and peoples. There are a number of easy to use authoring programs and tools that can even let workers to create their own program. There are a number of applications available that slow to run more smoothly and effectively.[16]

E. Multimedia in Games

One of the most exciting applications of multimedia is games. Now a days the live internet pay to play gaming with multiple players has become popular. Generally most of the video games need joystick play.[16]

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