DATA COMPRESSION (CODING)

Compression in Multimedia systems is subject to certain constrains;-

- The quality of the coded and later on encoded data should be as equal as possible to make cost effective implementation possible
- Complexity of the techniques used should be minimal
- The processing of the algorithm must not exceed certain time span i.e. for each compression tech., there are other requirements that differ from those other techniques. One can distinguish between the requirements of an application running in a "dialogue" mode and in a "retrieval" mode

In dialogue mode means an interaction among human users via multimedia info. And a retrieval mode means retrieval of multimedia info by a human user from a DB. e.g. HTML db & HTML doc.

In dialogue mode applications the following characteristics requirements based on human perception must b considered;-

- End to End delay – shouldn't exceed 150ms for compression and decompression. A delay in the range of 50ms should b achieved to support face to face dialogue application e.g. video conference. The overall End to End delay traditionally comprises any delay in the h/w, in the involved communication protocol processing at the end system and in the data transfer from and to respective I/O devices

In retrieval mode applications the following demands;-

- Fast forward and backward data retrieval with simultaneous display should b possible. This implies a fast search for the info in multimedia db
- Random access to single image and audio frames of a data stream should b possible, making the access time less than 0.5s
- Decompression of images, video or audio should b possible without a link to other data units. This allows random access and editing

For both dialog and retrieval mode the following requirements apply;-

- To support scalable video in different system, it's necessary to define a format independence of frame size and video frame rate.
- Various audio and video data rates should be supported.
- Must be possible to synchronize audio and video data as well as with other media
- To make an economical solution possible, coding should b realized using software (for a cheap and low quality solution) or VLSI (for a high quality solution)

- Should be possible to generate data on multimedia system and produce this data on other system. The compression technique should be compatible.

COMPRESSION TECHNIQUE IN MULTIMEDIA SYSTEM

For their use in multimedia we can distinguish then among;-

- Entropy
- Source
- Hybrid

Most mms use hybrid

1. Entropy

It's a lossless process that is used regardless of the media specific characteristic. The data stream to be compressed is considered to be a simple digital sequence & the semantics of the letter is ignored. The decompression process regenerates the data completely. Run-Length is an example of entropy encoding that is used for data compression on file system. E.g. CDEEEEEEFK to CDE!6FK

2. Source coding

It's a lossy process that takes into account the semantics of the data. The degree of compression that can b reached by source coding depends on the data content.

In case of lossy compression technique, one way relation between the data stream and the encoded data stream exists; the data streams r similar but not identical.

A content prediction technique can make use of partial redundancies within still images. Other techniques perform transformation of the partial domain into the freq. domain by using the discrete cosine transformation (DCT). Key feature of DCT is low freq.

The following steps describes a typical sequence of operation in image compression

a. preparation

   Includes analog to digital conversion & generating an appropriate rep. of the info. An image is divided into 2 blocks of 8X8 pixels & rep. by a fixed No. of bits per pixel.

b. processing

   This is actually the first step of the compression process which makes use of sophisticated algorithm. A transformation from the time domain to the freq. domain can b performed using DCT. The case of motion video compression interface, coding uses a motion vector for each 8X8 block.

c. quantization

Processes the results of the previous steps & specifies the granularity of the mapping of real nos. into integers. It results in a reduction of precision.

d. entropy encoding

Usually the last step (not all times)

Compresses a sequential digital data stream without data loss e.g. a seq. of zeros in a data stream can b compressed by specifying the no. occurrences followed by occur itself.

Uncompressed pic ⟶ prepare pic ⟶ process pic ⟶ quantized ⟶

⟶ entropy encoding ⟶ compresssed pic

Symmetrical technique applications e.g. dialog application, should b characterized by more or less the same cost for encoding and decoding.

In the case of asymmetrical technique, the cost of decoding process is less costly than the encoding process and this is used for applications that;-

- Compression process is performed only once and sample time is available.
- Decompression is performed frequently and needs to be done quickly.

RUN LENGTH ENCODING

It's a type of entropy encoding

It's used where samples imgs, audio and video data streams often contain sequence of the same bytes. A substantial reduction of data can b achieved by replacing these repeated byte sequence with the No. of occurrences. This coding is indicated by a special flag that doesn't occur as a part of the data stream itself.

If a byte occurs at least for consecutive times, the No. of occurrences is counted. The compressed data contains this byte followed by the special flag and the No. of bits occurrence. This allows the compression of between 4 and 259 bytes in 3 bytes only e.g.

Uncompressed data ABCCCCCCCCDEFGGG

Run-Length encoded ABC!8DEFGGG

DIATOMIC ENCODING

Variation of run-length encoding based on a combination of 2 data bytes.

This technique determines the most frequently occurring pairs of bytes.

According to analysis of the English language, the most frequently occurring pairs are;-

(blanks are included in the pairs)

"e", "c", "a" and "s"

"e", "t", "th", "a", "s", "re", "in", "he"

Replace of these pairs by special single bytes that do not occur anywhere else in text leads to a data reduction of more than 10%

HUFFMAN TECHNIQUE

Huffman coding is an entropy encoding algorithm used for lossless data compression.

Determines the optimal code using the minimum no. of bits given the characters that must be encoded together with the probability of their occurrence, thus the length (no. of bits) of the coded characters will differ in text, the shortest code is assigned to those characters that occur most frequently.

To determine the Huffman code it's useful to construct a binary tree, the leaves (nodes) rep. the characters that are to be encoded. Every node obtains the occurrence probability of one of the character belonging to this subtree. Zeros and 1 are assigned to the branches (edge of the tree). E.g.

1) A, B, C, D, and E have the following probability of occurrence

P(A) = 0.16

P(B) = 0.51

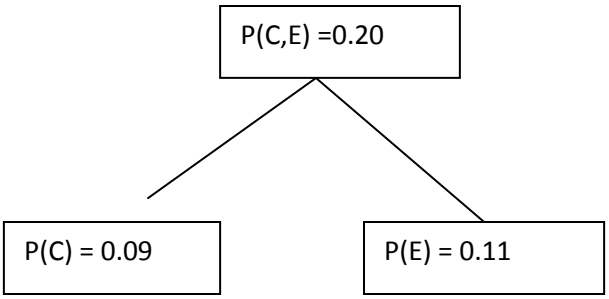
P(C) = 0.09

P(D) = 0.13

P(E) = 0.11

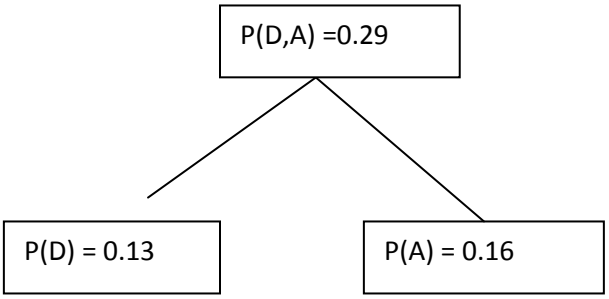
To construct the binary tree, we first take the least two probabilities, in the example above it is C and E

P(C) = 0.09 and P(E) = 0.11

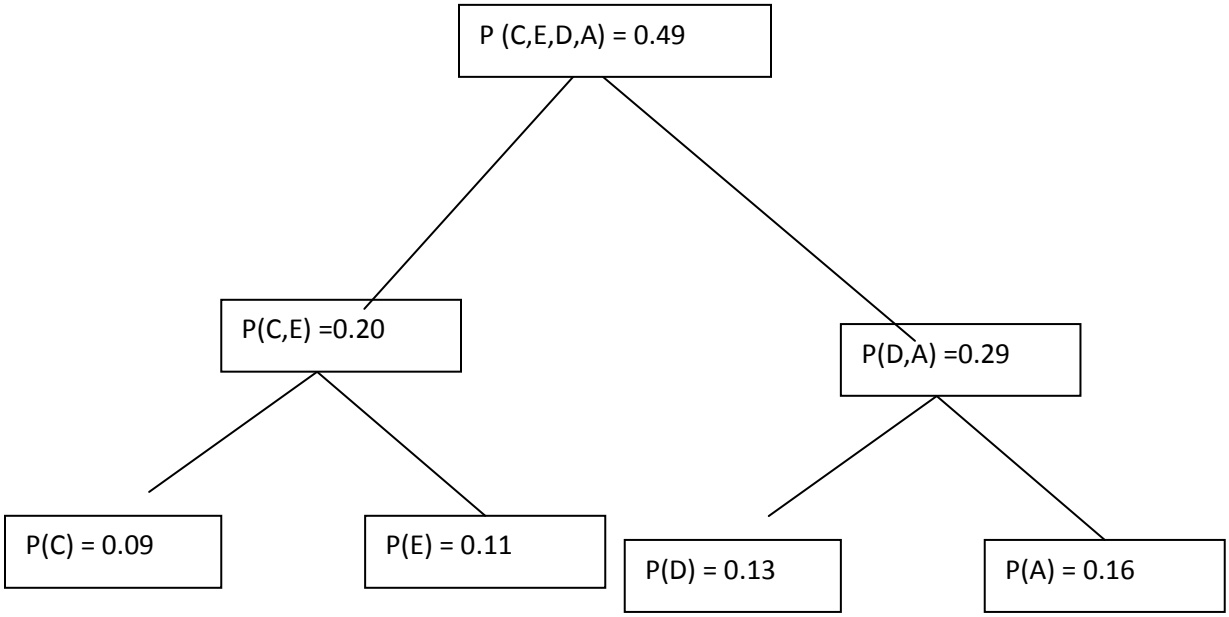


We take the next TWO least probabilities;

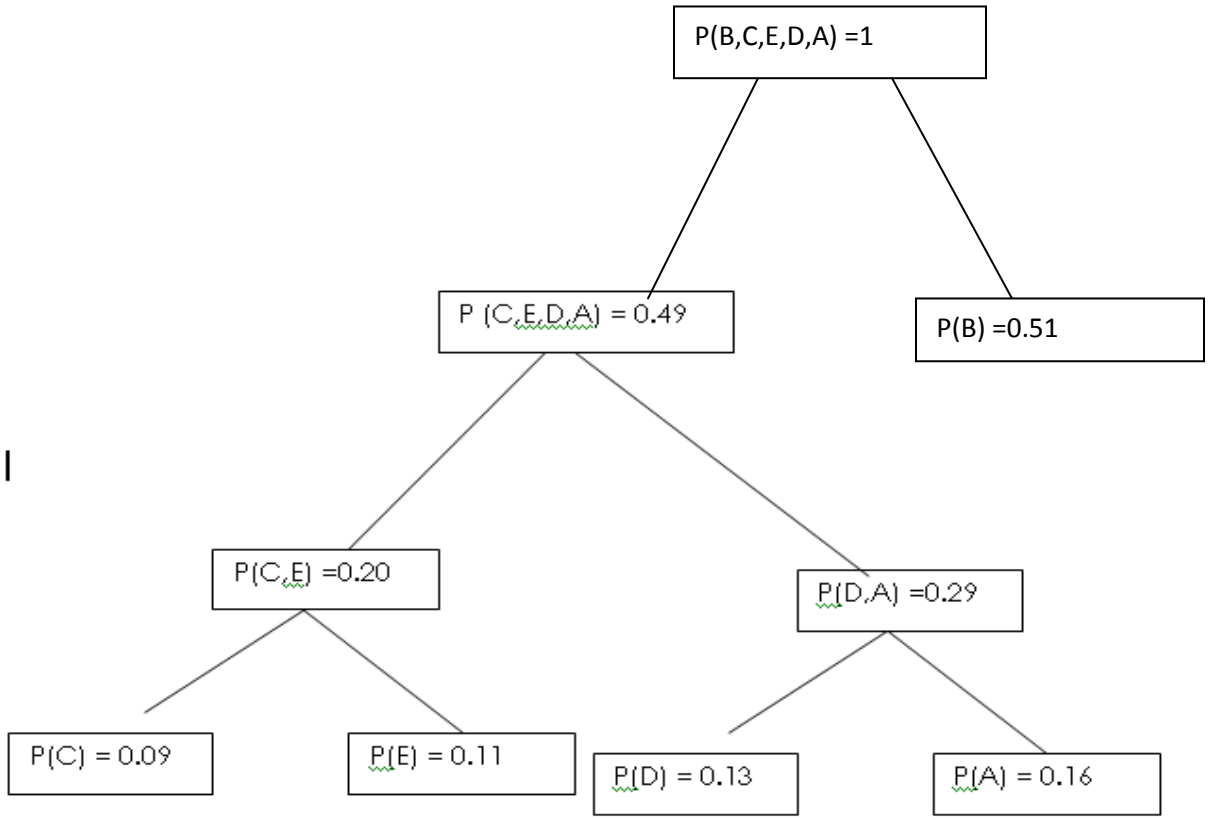
P(D) = 0.13 and P(A) = 0.16



Then we combine the above;



At last we combine the whole tree;



Note: Complete the steps by assigning the codes.