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Case Study - 1

JPEG Image Compression and Decompression by Huffman Coding

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Abstract:

Image compression is considered an application performed for the compression of data in digital format images. Digital images are comprised of a large amount of information that requires bigger bandwidth. Image compression techniques can be generally categorized into two types: lossless & lossy techniques. DCT (discrete cosine transform) can also be used for compressing an image and also approaches like Huffman encoding, and quantization & such steps are required for the compression of images with JPEG format. The format JPEG can be used for both RGB (colored) & YUV (grayscale) images.

The DCT is considered to be a mathematical function that will transform an image of digital format from spatial to the frequency domain. It is very much easy to implement Huffman encoding & decoding for minimizing the complexity of memory. In this technique, the analog image pixels are transformed into discrete image pixels, and therefore compression is performed. On the receiving side, the pixels are decompressed to obtain the actual image. The PSNR (PSNR is considered a majorly used quality measuring parameter in sections of image compression.) is computed for analyzing the quality of the image.

The general mode using DCT is the JPEG baseline coding system. JPEG compression will minimize the size of the file through minimal image degradation by eliminating the least required information. This method eliminates the information having higher frequency i.e. sharp transitions of intensity & color hue. The process for minimizing the information in the transform domain is termed quantization. Though, it is referred to as a lossy image compression method as the final image & actual image are not similar. The information of lossy compression will be lost while missed is affordable. Sequential steps will be performed for JPEG compression.

Huffman coding is considered a lossless data compression algorithm. The motive behind this is allocating variable-length codes for inputting characters; the length of allocated codes is constituted over the frequency of associated characters. The most frequently used character will be having smallest code & least frequent character will be having biggest code. Huffman coding is considered some of the most prominent techniques for the elimination of redundancy in the coding. It has been implemented in several compression algorithms, incorporating image compression. It makes use of statistical characteristics of alphabets in a source stream & further generates associated codes for such alphabets. These codes have a variable code length while making use of an integral number of bits. The alphabetical codes processing higher probability for occurrence has short length than the codes for alphabets possessing lesser probability. Hence it is considered over the frequency of occurrence of a data item (pixels or small blocks of pixels in images).

It requires a lesser number of bits for encoding frequency-used information. The codes will be accumulated in a code book. A code book will be made for every image or set of images. Huffman coding is considered the most optimal lossless schema for the compression of a bit stream. It operates by firstly making calculations of probabilities. Defining permutations $\{0,1\}^n$ by allocating symbols, termed as A, B, C, D. The bit stream may seem as AADAC.

Now the symbols are allocated newer codes, the higher will be the probability, the lower will be the number of bits in the code. These codes serve as an outcome of the Huffman coder in form of the bit stream.

Now stopping point of the code must be known & point for starting a new code. This problem is solved through the enforcement of a unique prefix condition: no code is a prefix of any other code. The initial codes are referred to as 01; 11; 001; 101; 0000; 10001; 1001. In the Huffman coding schema, shorter codes are allotted to the symbols that are incorporated on a frequent basis & longer codes to those which seem to occur less frequently.

Huffman Coding Algorithm works as a bottom-up approach. Algorithm Steps of the Huffman Coding algorithm are shown below:

Generating a series of source reductions: combining two minimal probability symbols to a single symbol; it is repeated till a minimized source having two symbols is obtained.

Coding every reduced symbol: starting from the smallest source & coming back to the actual source.

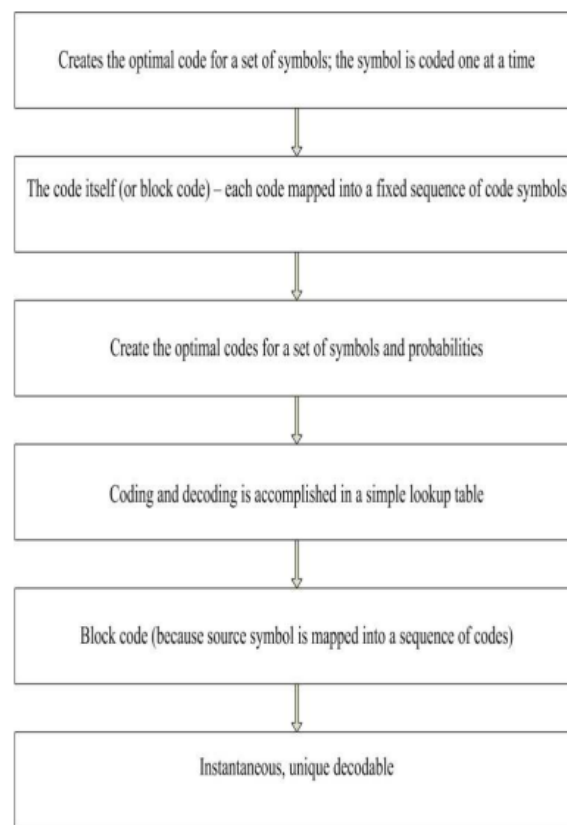


Image compression is an important technique for reducing the size of the image and for sending it in low size. Image has many types of this lossy compression that is widely used in network-related applications. The applications of lossless compression are file image/video/audio compression, big-size file data zip, and much more.