INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Department of Electronics & Electrical Communication Engineering

Dual Degree (4thyear)

Visual Information and Embedded System Engineering

(VIPES)

EC69211 – Image Processing Laboratory

Mini Project

Image Compression

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Introduction:

Before beginning to process larger photos or films, image compression is a crucial step in the field of image processing. An encoder performs the task of image compression and produces the compressed version of the image. Mathematical transformations are essential to compression operations.

A flow chart of the process of the compression of the image can be represented as:

Basic steps in image compression:

- Applying the image transform
- Quantization of the levels
- Encoding the sequences.

Transforming The Image:

What is a transformation (Mathematically):

It is a function that maps from one domain (vector space) to another domain (other vector space). Assume, T is a transform, f(t):X->X' is a function then, T(f(t)) is called the transform of the function.

We generally carry out the transformation of the function from one vector space to the other because when we do that in the newly projected vector space, we infer more information about the function.

Transforms in Image Processing:

The image is also a function of the location of the pixels. i.e. I (x, y) where (x, y) are the coordinates of the pixel in the image. So, we generally transform an image from the spatial domain to the frequency domain.

$$(f * g)(t) \triangleq \int_{-\infty}^{\infty} f(\tau)g(t-\tau)\,d\tau.$$

Finding convolution in the frequency domain after the transformation:

$$(f*g)(t)=F(s)G(s)$$

Quantization:

The process quantization is a vital step in which the various levels of intensity are grouped into a particular level based on the mathematical function defined on the pixels. Generally, the newer level is determined by taking a fixed filter size of “m” and dividing each of the “m” terms of the filter and rounding it its closest integer and again multiplying with “m”.

Basic quantization Function: [pixelvalue/m] * m

So, the closest of the pixel values approximate to a single level hence as the number of distinct levels involved in the image becomes less. Hence, we reduce the redundancy in the level of the intensity. So thus, quantization helps in reducing the distinct levels.

Symbol Encoding

The symbol stage involves where the distinct characters involved in the image are encoded in such a way that the no. of bits required to represent a character is optimal based on the frequency of the character's occurrence. In simple terms, in this stage codewords are generated for the different characters present. By doing so we aim to reduce the no. of bits required to represent the intensity levels and represent them in an optimum number of bits.

There are many encoding algorithms. Some of the popular ones are:

- Huffman variable-length encoding.
- Run-length encoding.

In the Huffman coding scheme, we try to find the codes in such a way that none of the codes are prefixes to the other. And based on the probability of the occurrence of the character the length of the code is determined. To have an optimum solution the most probable character has the smallest length code.

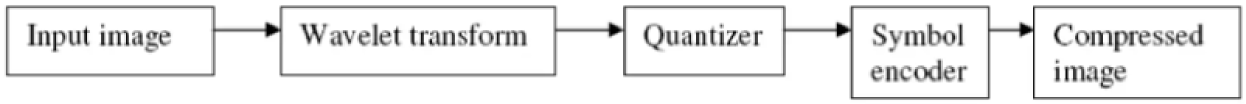
Run-length encoding (RLE) is a form of lossless data compression in which runs of data (sequences in which the same data value occurs in many consecutive data elements) are stored as a single data value and count, rather than as the original run.

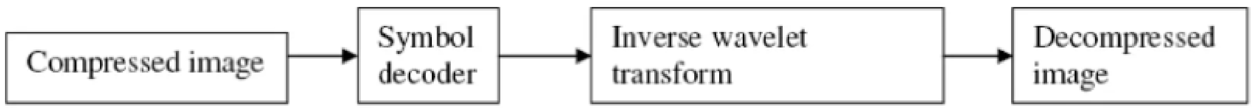
The mechanism of quantization helps in compression. When the images are compressed it's easy for them to be stored on a device or to transfer them. And based on the type of transforms used, type of quantization, and the encoding scheme the decoders are designed based on the reversed logic of the compression so that the original image can be re-built based on the data obtained out of the compressed images.

Compression Ratio:

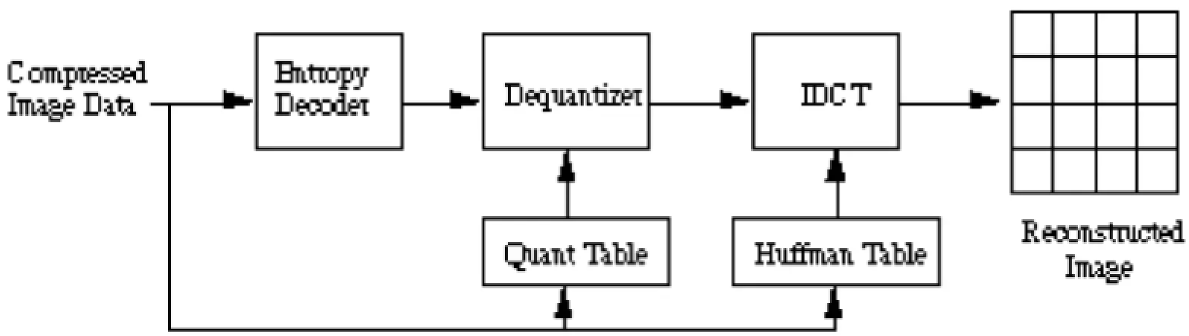
Compression ratio is defined as the ratio of original size of the image to the compressed size of the image.

Block Diagram of Transform coding system:

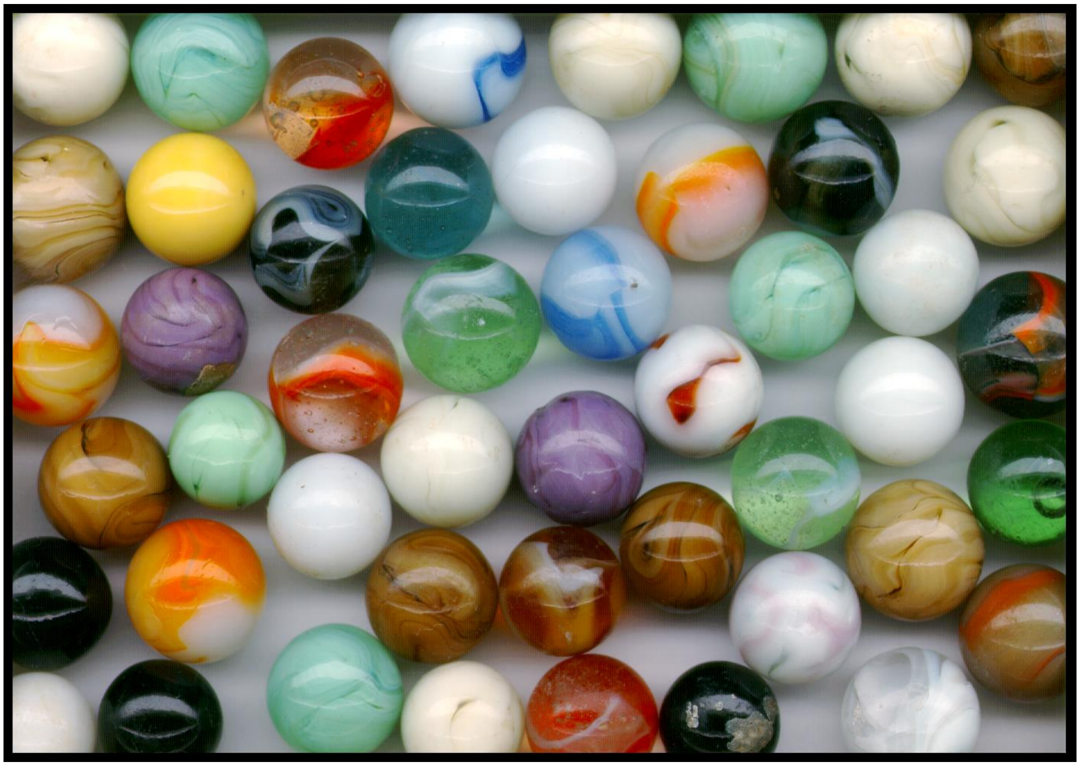




JPEG decoder:



Input Image:



Discussions:

- Transformation makes it easy to know what all the principal components that make up the image and help in the compressed representation.
- Transformation makes the computations easy.

Major steps involved in JPEG coding involve,

- DCT (Discrete Cosine transform)
- Quantization
- Zigzag Scan
- DPCM on DC components
- RLE on AC components
- Entropy coding

Lossless compression can recover the exact original data after compression. It is mainly used for compressing database records, spreadsheets or word processing files whereas Lossy compression will result in certain loss of accuracy in exchange for a substantial increase in compression. Lossy compression is more effective when used to compress graphic images and digitized voice.