Compressed Image Processing

- Abstract
- Introduction
- Methods of Compressing Images
- Lossless and Lossy Image Compression
- Predictive and Transform Image Compression
- Run Length Encoding (RLE)
- Properties of Image Compression
- Block Diagram of Image Compression
- Detailed Description of The Block Diagram
- Different Types of File Formats
- Conclusion
- References

Abstract:

Image processing has gone through many years of research and development. Many techniques/ methods have been developed which can be applied to compress images. Compressed Image processing addresses the problem of reducing the amount of data required to represent an image. This paper gives the overview of the invention of image compression. Also various methods of image compression, coding the image data into a compact form are discussed.

An imaging apparatus receives a stream of image data compressed according to a token based compression algorithm. The token dictionary is decompressed and processed according to desired standards such as optimizing for a particular image output device. After revision, the revised tokens are stored in a revised dictionary which is accessed upon decompression of image content. When the image content is decompressed the locations in the compressed or coded input data stream refer to locations in the revised dictionary which are extracted and output either to hard copy or for further processing.

This paper reports some pioneering work in this direction to show that compressed image processing could well become a new research area and challenge right through the next century

Image Compression

Introduction:

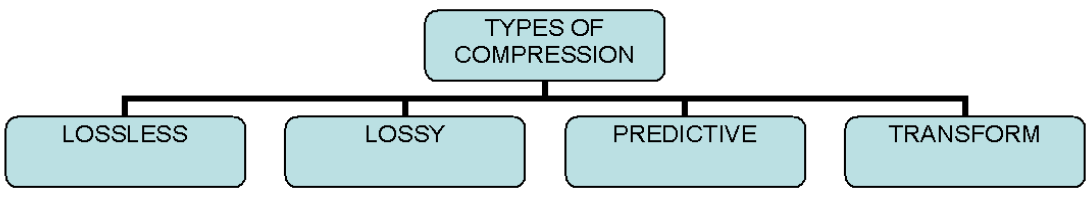
Image compression is minimizing the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level. The reduction in file size allows more images to be stored in a given amount of disk or memory space. It also reduces the time required for images to be sent over the Internet or downloaded from Web pages

Image compression is important for web designers who want to create faster loading web pages which in turn will make your website more accessible to others. This image compression will also save you a lot of unnecessary bandwidth by providing high-quality image with fraction of file size.

Image compression is also important for people who attach photos to emails which will send the email more quickly, save bandwidth costs and not make the recipient of the email angry. Sending large image attachments can be considered offensive. This makes people very upset because the email takes a long time to download and it uses up their precious bandwidth.

Furthermore image compression plays a major role in many important and diverse applications including televideo conferencing, remote sensing, document and medical imaging, hazardous waste management application and the like.

METHODS OF COMPRESSING IMAGES:



LOSSLESS AND LOSSY IMAGE COMPRESSION:

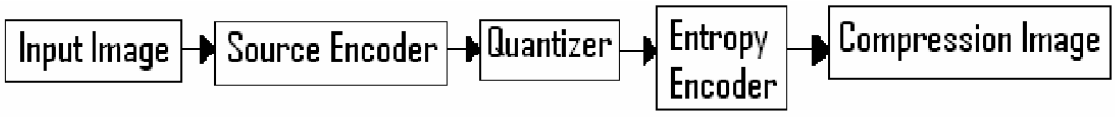
There are several different techniques in which image files can be compressed. A text file or program can be compressed without the introduction of errors, but only up to a certain extent. This is called *lossless compression*. On the other hand, *lossy* compression reduces a file by permanently eliminating certain information, especially redundant information.

A typical lossy image compression system is shown in the following figure. There are three components for the encoder namely Source Encoder, quantizer and entropy encoder.

Source encoder (linear transforms):- A variety of linear transforms have been developed which include Discrete Fourier Transforms (DFT), discrete cosine transforms (DCT), discrete wavelet transform (DWT) and many more each with its own advantages and disadvantages.

Quantizer: - A quantizer simply reduces the number of bits needed to store the transformed coefficients by reducing the precision of those values. Since this is a many-to-one mapping, it's a lossy process and is the main source of compression in an encoder. The quantization performed on individual coefficient is known as scalar Quantization (SQ), and that performed on group of coefficients together is called Vector Quantization (VQ).

Entropy encoder: - Entropy encoder further compresses the quantized values losslessly to give better overall compression. It uses a model to accurately determine the probabilities for each quantized value and produces an appropriate code based on these probabilities so that the resultant output code stream will be smaller than the input stream.



PREDICTIVE AND TRANSFORM IMAGE COMPRESSION:

In predictive coding, information already sent are available is used to predict future values, and the difference is coded. Differential Pulse Code Modulation (DPCM) is an example for predictive coding.

In transform coding, first the image is transformed from its spatial domain representation to a different type of representation using some well known transform and then codes the transformed values (coefficients).

The above figure represents a typical data compression system.

Methods of compressing images:-

RUN LENGTH ENCODING (RLE)

The repeating characters are called runs. Run-Length encoding(RLE) is a very simple form of data compression in which runs of data are stored as a single data value and count, rather than as the original run and taking advantage of repetitive data. This is most useful on data that contains many such runs; for example, some graphic images such as icons and line drawings.

RLE performs lossless data compression and is well suited to palette-based iconic images. It does not work well at all on continuous-tone images such as photographs. This works very well for images with solid backgrounds like cartoons

Properties of Image Compression:

There are a few important properties of image compression schemes:

Scalability generally refers to a quality reduction achieved by manipulation of the bitstream or file (without decompression and re-compression). Other names for scalability are *progressive coding* or *embedded bitstreams*. There are several types of scalability:

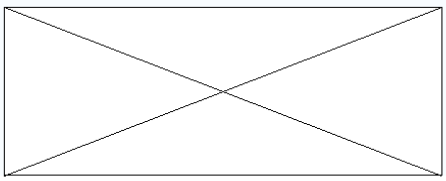
- Quality progressive or layer progressive: The bitstream successively refines the reconstructed image.
- Resolution progressive: First encode a lower image resolution; then encode the difference to higher resolutions.
- Component progressive: First encode grey; then color.

Region of Interest Coding: Certain parts of the image are encoded with higher quality than others. This can be combined with scalability (encode these parts first, others later).

Meta Information: Compressed data can contain information about the image which can be used to categorize, search or browse images. Such information can include color and texture statistics, small preview images and author/copyright information.

Processing Power: Compression algorithms require different amounts of processing power to encode and decode. Some high compression algorithms require high processing power.

TYPICAL BLOCK DIAGRAM OF IMAGE COMPRESSION

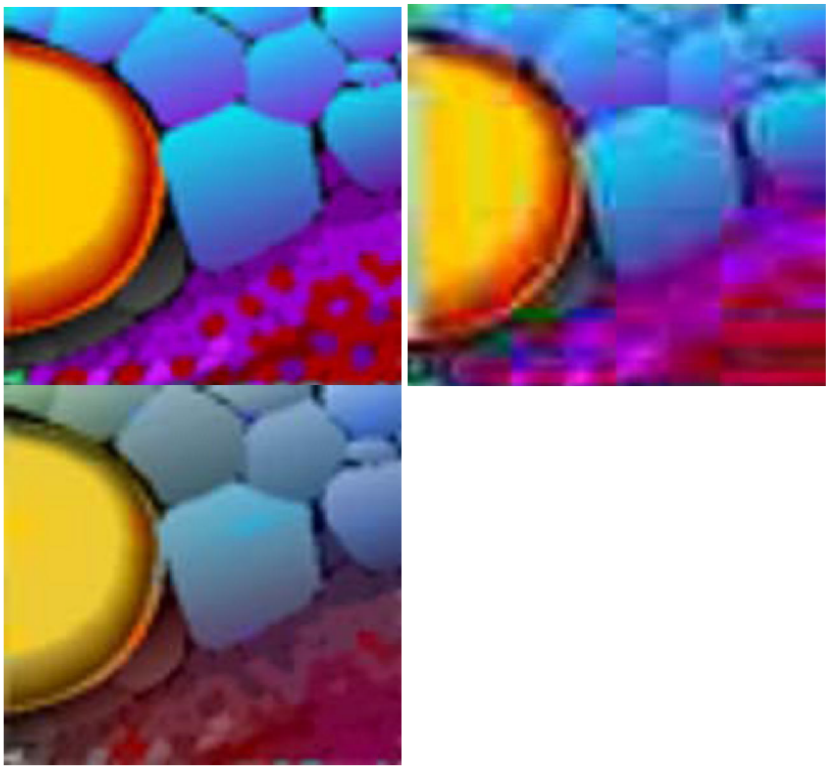


Description:

The figure shown above is a schematic block diagram of the system suitable to practice an aspect of the present methods of compression.

BACKGROUND OF THE IMAGE COMPRESSION:

The present method relates to the digital image processing arts. It finds particular application in conjunction with processing text symbols in a token based compression system, and will be described with particular reference thereto. However, it is to be appreciated that the code is applicable to image output processing of any token based or symbol dependent compression technique.



Typically image output data streams or bitmaps are optimized for particular printers or output devices. However, it is known that not all print engines respond identically even when driven by the same bitmap. The result is that a black and white image on printer A will look somewhat different than the same image produced by printer B. Technology has been developed that receives a bitmapped representation of an entire image or page, recognizes it was produced or generated for a particular printer, and converts or optimizes the bitmap for output on another printer. Typical conversions include morphological operations such as thickening or thinning lines and the like. Unfortunately, when compressed files are routed, the image is typically entirely decompressed, then processed as needed for optimization on a particular output device.

The present technique contemplates a new method and apparatus to process compressed digital image data which overcomes the above-referenced problems and other.

BRIEF DESCRIPTION OF THE DRAWINGS:

The image compression method may take form in components and various arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating the preferred embodiments, and are not to be construed as limiting the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS:

With reference now to shown figure, an imaging apparatus 10 such as an image output device, printer, server and the like, receives a stream of image data 12. The data is preferably compressed according to a token or pattern matching process such as JPEG or other compression techniques which store single copies of patterns in a document. Those skilled in the art, however, will appreciate that the teachings here are equally applicable to other pattern-based substitution processes. Included in the stream of image data 12 are coded image content data 14 or representations and a decoding pattern dictionary 16 or database. The coded image content data 14 carries a token identifier that points to or represents a particular token in the dictionary 16. The dictionary 16 contains image patterns substitutable for the coded image content data 14 upon output processing. For example, a document may be compressed by storing only a single electronic representation of the letter “a.” The coded image content data 14 includes an identifier instead of an entire bitmap representation anywhere the letter exists in the document. The identifier indicates a location in the decoding pattern dictionary 16 containing a single stored instance of an output-ready representation of the letter. Those skilled in the art will appreciate that in addition to text patterns for individual letters, similarly groups of characters also repeat frequently enough to usefully contribute to compression schemes. Likewise, other repeating image characteristics compressed by a token or pattern matching process will benefit from the teachings of the present invention.

A decompression processor 20 within the apparatus 10 receives the image data 12. In one embodiment, the processor 20 first identifies and decompresses only the decoding pattern dictionary 16. Because the decoding pattern dictionary 16 ideally includes only single instances of tokens or patterns, it will typically be smaller than the coded image content data 14. A dictionary image processor 22 revises or performs image output processing on individual image patterns in the decoding pattern dictionary 16. The revision includes conventional image quality improvements, anti-aliasing, morphological operations such as edge enhancement, dilation, erosion and others that are readily implemented by those skilled in the art. Alternatively, the revision processing includes selective gray-scaling, color matching, font substitution and other image processing which tends to be output device specific. In the illustrated embodiment of the invention, the apparatus 10 replaces substantially all of the original image patterns in the decoding pattern dictionary 16 with their respective revised image patterns before the coded content 14 is decoded.

With continued reference to shown figure, to produce a hard copy output of the compressed digital image, the apparatus 10 then decompresses or decodes the coded image

content data 14. The coded image content data 14 is parsed and a token identification corresponding to a location in the decoding pattern dictionary 16 is extracted. The decompression processor 20 then enters a revised dictionary 24 with the location 26 and returns with the revised image pattern 28 to be output or otherwise further rendered 30.

SUMMARY OF THIS METHOD:

In accordance with embodiment of the present technique,

- The method of processing compressed digital image data includes receiving the digital image data compressed according to a defined pattern matching technique.
- This method further includes replacing the revised image patterns in the dictionary.
- The method further includes decoding or decompressing the coded image content data with the revised image patterns in the dictionary.
- The decoding includes parsing the coded image content data, and extracting from the data a pattern location corresponding to a location in the dictionary. The processed image pattern at the extracted location is then output.
- The processing includes converting the image patterns to grayscale and morphological operations on the image pattern in the decoding pattern dictionary.
- In an image processing system which receives image data compressed by a pattern matching process, a method of decompressing the image data includes adjusting at least one pattern in a database of stored post-compression patterns where the adjusting is responsive to characteristics of a desired output mechanism or operation.
- the adjusting includes image processing a plurality of post-compression patterns received with the image data such as morphological processing or grayscale processing and also includes image processing a first instance of each input pattern location received, for example during real-time decompression operations.
- A method of manipulating a data stream in a xerographic image output device includes receiving the data stream including an output pattern dictionary and a coded portion referencing identifiable patterns in the output pattern dictionary. Image processing is applied to an output pattern in the dictionary and the output pattern is replaced with the image processed output pattern.
- An image processed output pattern corresponding to a symbol location in the data stream is output.
- The image processing includes adjusting the output pattern for a particular image output device.

Advantages:-

One advantage of this method resides in consistently processed image output tokens for each instance of a designated compressed token.

Another advantage of this method resides in reduced image output processing times.

Other benefits and advantages will occur to others skilled in the art upon a reading and understanding of the following detailed description.

DIFFERENT TYPES OF FILE FORMATS:

Lossy compression is usually based on techniques by removing details that the human eye typically doesn't notice. After this *RLE* or Huffman coding can be used to compress data. Mostly used lossy compression method is transform coding such as *discrete cosine transform* (DCT, used in JPEG) or *wavelet transform* (used in JPEG 2000). Other popular methods are color quantization (reducing the color space) and chroma subsampling. Also fractal compression is used but it's not so popular.

Images are stored in different formats depending on the application and requirements of the user. Some of the most commonly used formats are discussed below:

BMP is an uncompressed image format used in Windows and it eats lots of space.BMP uses rle to compress 8-bit data which is effective in graphics but much less effective in continuous tones like photos.

JPEG is the most widely used image format that uses lossy compression methods such as DCT and chroma subsampling. It also uses lossless methods such as RLE and Huffman coding but it doesn't actually allow to save in lossless format. JPEG is especially good for natural images.

GIF uses lossless compression algorithm LZW. So it reduces the file size without degrading the visual quality. But GIF allows only to use 256 colors so it is not suitable for natural photographs which consist from millions of colors. GIF is especially good for artificial images that contain sharp-edged lines and few colors

PNG uses also a lossless compression called DEFLATE that uses a combination of the LZ77 dictionary coder and Huffman coding. PNG offers better compression and more features than GIF but it doesn't support animation that GIF does. PNG allows to use millions of colors in pictures.

TIFF format is a flexible and adaptable file format. It can store multiple images in a single file. You can choose which compression algorithm to use. TIFF can be used as a container for JPEG or you can choose to use lossless compression such as RLE or LZW. Because TIFF supports multiple images in a single file, multi-page documents can be saved as single TIFF file rather than as a series of files for each scanned page.

There are also SVG graphics which are used to create vector graphics. It is not actually a compression algorithm but it's an XML based markup language. Instead of specifying the color of every pixel as in raster graphics (JPEG, GIF, PNG), SVG uses mathematical expressions to specify coordinates of shapes. SVG images can be extremely small. The image is also scalable because it is vector-based, so you can enlarge the image and it will still look great.

Conclusion:

The underlying basis of the reduction process is explained using a simple code compression technique. Various techniques of compression are also discussed in this paper.

There are other methods of compressing like Huffman coding, DCT, DWT, fractal, modified Huffman coding, *LZW*, *arithmetic* coding, *LZ77* dictionary coder etc.

Image compression research aims at reducing the number of bits needed to represent an image by removing the redundancies as much as possible.

Definetly Image Compression has a great scope of development which inturn has many important and diverse applications including televideo conferencing, remote sensing, document and medical imaging, the control of remotely piloted vehicles in military space and many more.

References:

1. Textbook of Digital Image Processing

- M.Anji Reddy
- Y. Hari Shankar

2. Digital Image Processing

- Rafael C Gonzaler
- Richard E Woods

3. Information - http://en.wikipedia.org/wiki/Image_compression

4. Images – http://www.cl.cam.ac.uk/~nad10/pubs/SPIE07-lowres.pdf

~~~~~~~X~~~~~~~
~~~~~~~