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LOSSLESS IMAGE COMPRESSION USING SUPER-RESOLUTION

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ABSTRACT

The outcomes of applying an orthogonal transformations tool based on Walsh basis functions for information compression during transmission of aircraft images across the communication channel into embedded cyber physical systems are discussed in this study, both theoretically and practically. For the encoding of two-dimensional signals in a quasi-two-dimensional space, perception equality has been demonstrated. Depending on the compression ratio, the quality of the image restoration has been assessed. There have been various protocols for transmitting the produced signal. Images that have been restored have been given examples and evaluations. In this research, we offer a unique learning-based image restoration method for compressed images that recovers high frequency (HF) components based on priors learned from a training sample of realistic images while suppressing compression artefacts. It simulates the JPEG compression process.

Keywords: *Super-Resolution, Image Compression, High Frequency, Two-Dimensional Signals, Communication Channel.*

Introduction

In order to reduce storage costs or transmission times, image compression aims to represent images with fewer data. With compression, it is feasible to reduce file size to 10% of the original without observable quality loss. Without compression, file size is substantially bigger, typically several megabytes. Lossless or lossy image compression are both options. When data is compressed without any loss, it can be used to recreate the original data exactly. When using lossless compression, image quality is not compromised. Lossy compression, as contrast to lossless compression, lowers image quality. The original image cannot be recovered after lossy compression techniques have been used. There will be some data loss. Lossless image compression is typically utilised in synthetic images with crisp edges, such as technological illustrations, comic books, maps, or logos. This is due to the fact that lossy compression techniques induce artefacts in photos and blur sharp edges, especially when applying heavy compression. In contrast, lossy compression is an excellent option for natural images like landscape photographs when a small amount of sharpness loss is acceptable to get a smaller file size. If the compression is not too powerful, it is quite difficult to tell the difference between an uncompressed natural image and one that has been compressed using lossy techniques.

Run-length encoding (RLE), entropy coding, and dictionary coders are the most often used lossless picture compression techniques. RLE only condenses lengthy sequences of identical data. For instance, 7A4B5C can be used to represent AAAAAAABBBBCCCCC. Symbols are given codes by entropy encoding, with the shortest codes going to those that appear the most frequently. The Huffman coding method is the most popular entropy encoding method. Dictionary coders create a table of strings and then substitute shorter codes for each time they appear. Perhaps the most used dictionary coder is the LZW (Lempel-Ziv-Welch) method, which is used, for instance, in the GIF and ZIP file formats.

Lossy compression typically relies on methods that eliminate information that the human eye typically ignores. Pixels—the units that make up digital images—represent the colour data. A pixel's value can take the place of its neighbours' if there is only a tiny difference between them. If the algorithm is smart enough, this will result in some information loss, although it is typically hardly perceptible to the

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human eye. After that, data can be compressed using techniques like RLE or Huffman coding. Transform coding techniques like discrete cosine transform (DCT, used in JPEG) and wavelet transform (used in JPEG 2000) are the most popular lossy compression techniques. Chroma subsampling and colour quantization, which narrows the colour space, are further common techniques. These techniques are based on the idea that the human eye is more sensitive than File size can be reduced by storing more luminance detail than colour detail because luminance is more sensitive than colour. Fractal compression is also employed, albeit it is less common.

Different image formats use these compression techniques in different ways. Some of them simply utilise lossless compression, while others combine lossless and lossy techniques, or don't use any compression at all. The most popular picture formats are BMP, JPEG, GIF, PNG, and TIFF. BMP is a large, uncompressed image format that is utilised by Windows. The most popular image format that employs lossy compression techniques like DCT and chroma subsampling is JPEG. While it also employs lossless techniques like RLE and Huffman coding, saving in a lossless format is not practically possible. JPEG excels at capturing natural-looking photos.

LZW, a lossless compression method, is used in GIF. As a result, the file size is decreased without the visual quality suffering. However, as GIF can only use 256 colours, it is not appropriate for real images, which contain millions of colours. However, colour dithering can be used to improve quality. GIF works particularly well for synthetic images with few colours and well defined edges. The PNG image format was created as a result of the debate around the patent licencing for the 1985 compression method that GIF utilises. Additionally, PNG includes a lossless compression technique called DEFLATE, which combines the LZ77 dictionary coder and Huffman coding. PNG is more feature-rich and offers better compression than GIF, but it does not support animation. PNG enables for the usage of countless colours in images.

The TIFF file format is versatile and adaptive. It can fit several pictures in one file. Which compression algorithm you use is up to you. JPEG files can be contained in TIFF, or lossless compression techniques like RLE or LZW can be utilised. Multi-page documents can be saved as a single TIFF file rather than as a sequence of files for each scanned page because TIFF enables multiple images in a single file.

Additionally, JPEG2000, a more recent version of JPEG, offers lossless compression. Although its lossy wavelet techniques produce images with up to 20% greater quality than JPEG, they are not commonly employed due to some patent difficulties. Additionally, Microsoft has created the "new generation" image format known as HD Photo (formerly known as Windows Media Photo). According to Microsoft, HD Photo produces photos with a quality that is more than twice as good as JPEG and gives a noticeable image quality similar to JPEG 2000.

Additionally, SVG images are utilised to produce vector graphics. It is a markup language based on XML, not a compression method. Raster images (JPEG, GIF, and PNG) indicate the colour of each individual pixel, whereas SVG uses mathematical equations to represent the coordinates of forms. SVG pictures may be really tiny. Because the image is vector-based and scalable, you can resize it and it will still look fantastic.

Transmission of images through channels is one of complicated procedures into embedded cyber physical systems: Earth and medium remote sensing, robot vision etc. It is connected with high volume of data transmitted at the breakpoint of transmission capacity for aerospace communication channels. So, search of simple and effective methods and algorithms to decrease redundancy of video data is a current task at present. Now there are a lot of approaches each of which has its advantages and disadvantages: methods of effective entropic coding, evaluation of possibilities to use visual redundancy of static and dynamic images, consideration of direct coding, predictive coding and run length encoding, methods of block and fractal coding, multiple-scale processing of images. However, none of them provides a full and effective solution of the task.

The present paper has suggested to use a method of orthogonal transformations for transmission of images which allows executing a transfer from the space of image representation in pixel coordinates into the space of another parameter, for example, generalized frequency. Besides, a significant effect of image compression and its qualitative restoration can be achieved.

A technique for compressing images eliminates extraneous or unrelated information and creatively encodes remains. In order to achieve the necessary compression, it is frequently necessary to discard both non redundant information and important information. Finding strategies that allow crucial information to be cunningly retrieved and portrayed is the plan, in any scenario. In order to comprise the information in an image, this study deals with several compression techniques. The data can be compressed using lossless techniques like run length coding, lossless predictive coding, and multi-resolution coding or lossy approaches like quantization, transform coding, and block transform coding. In this work, all of these strategies have been explained, and the effectiveness of each technique/method is evaluated using different metrics including MSE and PSNR.

Image Compression: Preliminary Guideline

Image compression is a type of data compression applied to digital images to reduce storage or transmission costs. Algorithms can use image data visualization and object analysis to provide better res ults than common data compression methods for other digital data.

Lossy and Lossless Image Compression

Lossy compression techniques can cause compression artifacts, especially when using low bitrates. Lossy algorithms are particularly suitable for natural images, such as photography, where a significant reduction in bitrate is required but a small (possibly undetectable) loss of fidelity is acceptable. Visually lossless compression can be called lossy compression with little difference.

Various Kinds of Methods for Lossy Compression

- Transform coding is the approach that is most frequently employed.
- The most popular type of lossy compression is the discrete cosine transform (DCT). It was first invented by Nasir Ahmed, T. Natarajan, and K. R. Rao in 1974 and is a type of Fourier-related transform. In the context of a family of discrete cosine transforms, the DCT is also referred to as "DCT-II" (see discrete cosine transform). Generally speaking, it is the most effective type of image compression.
- The most widely used lossy format, JPEG, and the more modern HEIF, both use DCT; the more recently invented wavelet transform is also widely used; and the next three are quantization and entropy coding.
- Narrowing the colour space to the hues that appear most frequently in the image. The colour palette in the compressed image's header contains information about the chosen colours. Only the index is referenced by each pixel.
- This technique can be used in conjunction with dithering to prevent posterization. of a colour in the colour palette.
- Subsampling for colours. By averaging or excluding some of the chrominance information in the image, this takes advantage of the fact that the human eye notices spatial changes in brightness more acutely than those of colour.
- Compression of fractals.

Different Methods for Lossless Compression

- Run-length encoding is the standard approach for PCX and is an option for BMP, TGA, and TIFF.
- Area picture compression
- predictive coding (used in DPCM)
- entropy encoding (arithmetic coding and Huffman coding are the two most used entropy encoding techniques), and adaptive dictionary algorithms (LZW, used in GIF and TIFF).
- Chain codes
- which are utilised in PNG, MNG, and TIFF

Other Properties

The fundamental objective of image compression is to get the highest image quality at a specific compression rate (or bit rate), however there are additional crucial characteristics of image compression schemes:

Scalability is typically used to describe a quality reduction accomplished through bitstream or file manipulation (instead of decompression and re-compression). Scalability may also be referred to as progressive coding or embedded bit streams. Scalability can be seen in lossless codecs despite their opposite nature, usually in the form of coarse-to-fine pixel scans. Scalability is particularly helpful for offering changeable quality access to things like databases or evaluating images as they download (for example, in a web browser). Several scalability categories exist:

- Quality or layer progressive: The bitstream fine-tunes the reconstructed image over time.
- Progressive resolution encoding entails encoding the difference between lower and higher quality images first.
- Progressive component: add full colour after encoding the greyscale version.
- The meta data. Information about the image that can be used to categorise, search for, or view photographs may be contained in compressed data. Small preview images, colour and texture statistics, and author or copyright information are a few examples of this type of data.
- Processing strength. Processing power requirements for encoding and decoding compression methods vary. Some algorithms with high compression demand a lot of processing power.

Peak signal-to-noise ratio is a common metric used to assess the effectiveness of a compression technique. It calculates the amount of noise added to the image as a result of lossy compression. However, the viewer's subjective assessment is also seen to be a crucial factor—possibly the most crucial factor.

Image Restoration: A Glance View

Image restoration is the process of estimating the clean, original image from a corrupted or noisy image. Motion blur, noise, and camera focus issues are just a few examples of corruption. Reversing the process that blurred the image is how image restoration is done. This is done by imaging a point source and using the point source image, also known as the Point Spread Function (PSF), to recover the image information that was lost during the blurring process.

Image enhancement differs from image restoration in that it emphasises aspects of the image that make it more aesthetically acceptable to the viewer rather than necessarily producing data that is realistic from a scientific perspective. There is no a priori model of the process that formed the image when using image enhancing techniques offered by imaging packages, such as contrast stretching or closest neighbour de-blurring.

By surrendering some resolution, noise can be effectively removed from images using image enhancement, but this is not acceptable in many applications. The z-direction resolution in a fluorescent microscope is already subpar. To recover the item, more sophisticated image processing techniques must be used.

Recovering lost resolution and reducing noise are the goals of picture restoration techniques. Either the frequency domain or the image domain are used for image processing techniques. Deconvolution, which undoes the resolution loss brought on by the blurring effects, is the most basic and widely used technique for image restoration. It is carried out in the frequency domain after computing the Fourier transform of both the picture and the PSF. This deconvolution method amplifies noise and results in an imperfectly deblurred image because it directly inverts the PSF, which often has a low matrix condition number. Additionally, it is customarily believed that the blurring process is shift-invariant. Therefore, more advanced methods, including regularised deblurring, have been developed to provide reliable recovery under various blurry and noisy effects. There are three different kinds of it:

- Geometrical improvement
- Radiometric adjustment
- Noise reduction

Image Restoration using Convolutional Auto-encoders with Symmetric Skip Connections

A well-researched issue in computer vision and image processing, image restoration includes picture denoising, super resolution, inpainting, and other techniques. It also serves as a test case for low-level image modelling algorithms. In this paper, we present an encoding-decoding framework with symmetric convolutional-deconvolutional layers called the very deep fully convolutional auto-encoder network for picture restoration.

In other words, the network learns end-to-end mappings from corrupted images to the original ones by layering convolution and deconvolution operators. While removing corruptions, the convolutional layers capture the abstraction of the image contents. The feature maps can be up sampled by deconvolutional layers in order to restore the image information. We propose to symmetrically link convolutional and deconvolutional layers using skip-layer connections to address the issue that deeper networks typically have more training challenges. By doing so, the training will converge much more quickly and produce superior results.

Image Restoration in Cryo-Electron Microscopy

Using experimental measurements as a starting point, image restoration techniques are utilised to create the closest representation of the actual item that is still within the constraints of the instrument and data noise level. We are primarily interested in linear techniques in molecular electron microscopy (EM) that maintain the relationships between the mass densities within the restored map.

Here, we discuss the process of structural EM image restoration, with an emphasis on the issue of optimum Fourier amplitude recovery given electron microscope data acquired at various defocus levels. We go into great detail about two classes of widely applied linear methods. The first class consists of pseudoinverse restoration-based methods, which are further divided into mean-square error, chi-square error, and constrained based restorations. The methods in the latter two subclasses explicitly take into account non-white noise distribution in the data.

The Wiener filtering strategy serves as the foundation for the second class of approaches. We demonstrate that the amplitude correction (or "sharpening") problem of the EM map can be solved using the Wiener filter-based methodology, making it visually equivalent to maps generated by X-ray crystallography and hence open to comparative interpretation. The topic of image restoration given sets of heterogeneous solutions is finally addressed by a semi-heuristic Wiener filter-based approach.

Conclusion

Region-based image coding schemes using heterogeneous quality constraints are especially attractive because they not only can well preserve the diagnostic features in region(s) of interest, but also meet the requirements of less storage and shorter transmission time for medical image imaging applications. The similarity between the reconstructed and original image is more when the SPIHT/SPIHT ROI hybrid scheme is used as reflected by the higher values of PSNR and Correlation. Further, from the experiments it was found that taking two regions i.e., ROI and background and then compressing the image is best than taking image as one region or taking three regions i.e., most significant region, less significant and insignificant region. Image restoration is a part of digital image processing. If you understand how an image degrades, you can restore the original image from the deteriorated image. The estimation of the deterioration function should be the primary goal. For eliminating random noise, spatial domain approaches are extremely helpful. Periodic noise can be removed very well with frequency domain approaches.

References

1. CS 4640: Image Processing Basics January 10,2012.
2. Different Techniques of Edge Detection in Digital Image Processing Pooja Sharma, Gurpreet Singh, Amandeep Kaur Student M. Tech ECE Punjabi University Patiala Assistant Professor Department of ECE Punjabi University Patiala
3. http://icmsm2009.um.edu.my/filebank/published_article/1778/112.pdf
4. http://www.ehow.com/info_8765860_disadvantages-advantages-imagecompression.html
5. http://www.engpaper.net/image-compression-research-paper.html
6. http://www.engpaper.net/image-processing-research-papers-2013.html
7. http://www.pha.jhu.edu/~sundar/intermediate/history.html
8. http://www.uni-kiel.de/Kardiologie/dicom/1999/compression1.html
9. http://zoi.utia.cas.cz/restoration.html
10. Overview of Image Processing K.M.M. Rao*, Deputy Director, NRSA, Hyderabad
11. Segmentation Techniques Comparison in Image Processing R. Yoga Mangalam, B. Karthikeyan School of Computing, SASTRA University, Thanjavur, TamilNadu, India
12. Tyagi, Shweta Hemant Amhia International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com March -April 2013 Image Enhancement and Analysis of Thermal Images Using Various Techniques of Image Processing.