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Preface: Special Issue on Image Compression

In contemporary computer systems, the data compression is a natural computational process at transmission and storage of large data volumes. It seems that the need for compression will always exist at each level of computer technology as the need for more data extensive computer applications is an important feature of people engineering activity.

The data compression method actually applied depends on the data type of data elements creating the given data stream. In multimedia era text, sound, image, video (i.e. the image sequence synchronised with the sound) are natural ingredients of computer applications.

Digital images not only enhance human-computer interface, but in many applications they constitute a core of the system, e.g.: optical character recognition, medical image data bases, camera based monitoring systems, and digital TV systems.

Thanks to Professor Skowron the idea of the *Special Issue on Image Compression* appeared in the beginning of 1997 and then I was asked to be a guest editor for this issue.

The idea to publish in *Fundamenta Informaticae* research papers on image compression was motivated by many goals, but the most important target is to integrate the theoretical and the applied research activity in Computer Science. We hope that the image compression field which is based on results in mathematical analysis, algebra, and information theory will benefit more from discrete mathematics which is the main tool used by authors publishing in FI.

Any compression system consists of mutually consistent parts: the encoder and the decoder. We can divide the actions of the encoder into three stages:

1. *modelling*: a new representation of data objects is found (e.g.: DCT or wavelet transform, fractal operator design) which leads to a data statistical model with less (conditional) entropy;
2. *quantisation*: while during modelling, real numbers can appear, to create discrete categories (called symbols) a scalar or vector clustering process is performed;
3. *binary coding*: stream of symbols produced by the previous stage is converted into a bit stream using usually an entropy coding, e.g.: Huffman coding or arithmetic coding.

The decoder performs the inverse operations to each stage of encoder : binary decoding, dequantisation, and inverse modelling. Actually, as the quantisation stage is not one to one mapping, the dequantisation stage is designed to optimise an accuracy data loss measure. The compression method which enables the reconstruction of original data has the quantisation stage missing. It is interesting that there are compression schemes in which modelling step is ignored, e.g.: Vector Quantisation (VQ) method in its basic form.

In the above perspective, we can classify and characterise image compression algorithms according techniques developed for each stage of the compression process. Since applied quantisation and binary coding techniques have more universal use, the image compression methods are in principle classified by modelling methods.

The state of art modelling strategies are mainly based on: DCT transform, wavelet transform, and fractal operator design. In most cases the basic idea of the given mapping is joined with a predictive approach. In case of image sequence, the prediction is augmented by a motion compensation process. However, it should be accented that the suitable fitting of quantisation techniques and binary coding techniques to the modelling method, is responsible for the resulting performance of the given compression algorithm. The rule of thumb says that the compression gain is 50% due to the modelling stage only and 50% due to the remaining stages.

The best image compression schemes are already included in successful standards such as JPEG (Internet applications), MPEG-1 (CD-ROM storage and Internet), H.261 (teleconferencing), H.263 (video telephony), and MPEG-2 (digital TV). A concise survey of these standards is included in the first paper of this issue *A Review of Image and Video Coding Standards* prepared by Leszek Cieplinski from Visual Information Laboratory of Mitsubishi located in England. It is interesting that the image compression standards freeze only the design of the system decoder while leaving a certain degree of freedom for improvements of the encoder. Therefore image standards are a subject of further research and development.

In this issue among eight research papers:

1. two papers describe novel image compression algorithms within wavelet and prediction methods:
    - *Detail Preserving Wavelet-based Compression with Adaptive Context-based Quantisation* by A. Przelaskowski;
    - *Entropy-Constrained Multiresolution Vector Quantisation for Image Coding* by L. Cieplinski;
2. *Vector Quantisation* by R. Rak - gives a comprehensive survey of this important method for data represenation;
3. *A Study on Partitioned Iterative Function Systems for Image Compression* by S. Mitra, C.A. Murthy, and M.K. Kundu - offers an improvement of fractal method by genetic approach and includes also a partial analysis of convergence in case of selective fractal operators;
4. *Analysis of Fractal Operator Convergence by Graph Methods* by W. Skarbek - presents a new effective analysis of fractal operator convergence by influence graph analysis;

5. *Stability Analysis of Oja-RLS Learning Rule* by R. Sikora and W. Skarbek - gives a complete stochastic stability analysis for the OJA-RLS learning algorithm which can be used for adaptive computing of the optimal KLT transform (DCT is close to KLT for certain data sources);
6. two remaining papers give simple, elementary proofs of fundamental theorems in wavelet theory and therefore they have special value for teaching of mathematical background of the wavelet compression method:
    - *Daubechies Filters in Wavelet Image Compression* by W. Rakowski and Z. Bartosiewicz;
    - *Wavelets and Mallats Multiresolution Analysis* by P. Wojdyłło.

Concluding this foreword I would like to make special thanks to Professor Andrzej Skowron for the encouragement and the patience during the time of this issue preparation. I hope that the material we present here will meet the expected goals of *Fundamenta Informaticae* editors.

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