MOVING PICTURE FRACTAL CODING USING A MIXED APPROACH I.F.S. AND MOTION

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ABSTRACT

This paper deals with a possible extension of the fractal compression algorithm defined for still image to moving picture. The addressed approach is a mixed approach based on a combination between inter-frame coding using block-matching, and intra-frame coding using I.F.S.

1 INTRODUCTION

The I.F.S. notion has been invented by the mathematician J. Hutchinson in the early eighties. It defines iterative processes which converge towards a fixed point, independently of their start point. The fixed point is called the attractor of the I.F.S. This notion is part of a more general theory developed by the mathematician B. Mandelbrot known as Fractal theory. Barnsley developed a general formulation for the use of I.F.S. for still images coding applications. The current reference algorithm has been proposed by A. Jacquin, who introduced the notion of Local-IFS. Since then, several relevant papers have been putting forward I.F.S. as a promising technique for still image coding and proposed some improvements to Jacquin's algorithm. Nevertheless, applications often need moving picture rather than still image compression in order to store/transmit at lowest cost.
In this paper, after a review of Jacquin's algorithm on still image fractal compression using I.F.S. (section 2), the mixed approach using D.P.C.M. and I.F.S. proposed by Hürtgen is described (section 3). Results obtained by this approach are discussed. Some improvements based on a new mixed scheme using an Extending Block-Matching procedure instead of D.P.C.M., is then proposed (section 4).

2 STILL IMAGE FRACTAL CODING USING I.F.S. *(Jacquin's algorithm)*

2.1 Coding Stage

The reference algorithm in still images coding applications is Jacquin's algorithm [1]: image "x_c", to be coded, is partitioned twice at two levels of resolution; for instance, this may be into square-blocks of size *BxB* and *2Bx 2B* (generally *B* is fixed at 8). The former are called range blocks (R) and the latter are called domain blocks (D). For each range block, the algorithm searches for the best matching with a domain block according to the EQM criterion.
Before the matching stage, domain blocks (D) are transformed as follows:

- sub-sampling by a factor two (in each direction)
- geometric transformations (eight isometries are considered)
- scale and shift of luminance values

2.2 Decoding Stage

In order to decode image "x_c", from its I.F.S. code and from any image "x_0", the algorithm proceeds as follows: Image "x_0" is partitioned into a set of square-blocks. Each area of the image is computed with taking the associated block in image "x_0" and applying an associated contractive affine transformation defined during the coding stage. Then, image "x_1" is obtained. The algorithm iterates this process to obtain "x_2" from "x_1", ... , until it reaches "x_a".

3 MOVING PICTURE FRACTAL CODING USING I.F.S.

If one does not consider algorithms using a frame by frame approach, an overview of fractal video compression using I.F.S. [2], yields that articles in this field can be divided into two categories: The first one is a mixed -or joint- approach and is based on a combination between an inter-frame coding using D.P.C.M. and, an intra-frame coding using I.F.S. This approach is similar to the M.P.E.G. video coding scheme, in that it uses I.F.S. instead of D.C.T (figure 1). The second one is based on the extension of blocks to cubes (the third dimension is the temporal dimension).

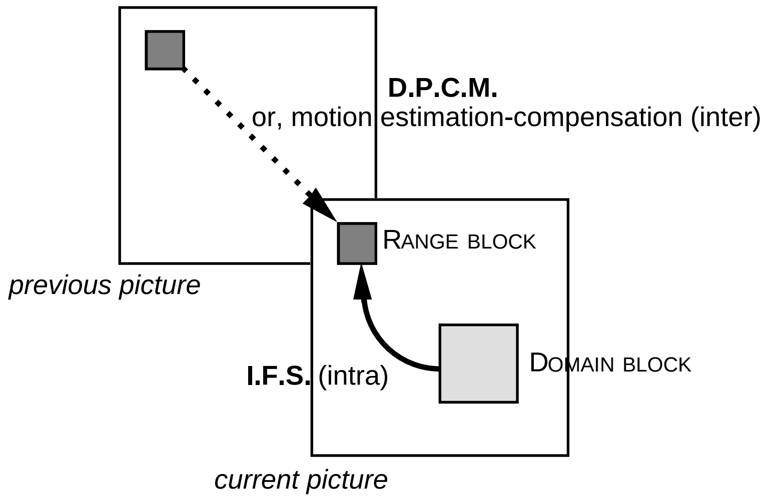

figure 1. In the mixed approach, images of video sequence are considered two by two.

Hürtgen and Büttgen's algorithm uses a D.P.C.M. for inter-frame coding and I.F.S. for intra-frame coding [3]. The basic idea included in this paper consists in considering two kinds of range blocks: moving range blocks which will be coded using I.F.S., and still range blocks which will be reused from the previous frame. The author points out that it is more efficient to encode the image itself rather than inter-frame differences. Simulations confirm this but only if the video sequence includes a lot of motion. As a perspective, to improve this scheme, it is suggested to substitute D.P.C.M. by a procedure of motion estimation-compensation using a block-matching technique. Other authors propose schemes which are very similar to Hürtgen's algorithm. Y. Fisher [4] suggests to encode all range blocks of each picture from domain blocks included in the previous frame. Hence, no iterations are needed during the decoding stage.

4 PROPOSED IMPROVEMENTS

In this work, Hürtgen and Büttgen's algorithm has been implemented and evaluated in term of compression rate versus quality, complexity and computational cost, and possibility of zoom (included in fractal theory).

In order to improve this scheme (that is to say, to increase the number of range blocks coded using the mode *inter*), a Block-Matching procedure has been substituted to D.P.C.M. This approach is similar to the M.P.E.G. video coding scheme in that it uses I.F.S. instead of D.C.T.

This second version has not a fixed bit rate: the number of bad predicted blocks (i.e. coded using I.F.S.) depends on the temporal activity of the sequence. Moreover, the quantity of information associated to each mode is not the same.

Then, we propose and develop a modified block-matching procedure, using some more complex transformations, similar to those used in mode *intra* by I.F.S. The aim would consist in offering the same possibilities of transformations in the two modes *intra* and *inter*.

5 CONCLUDING REMARKS

This new mixed scheme version yields interesting results in term of compression versus image quality compared to the basic scheme. However, it brings up some basic questions, which will be discussed, concerning the definition of fractal compression and the I.F.S. notion (notions of attractor, iteration, contractivity constraint as a function of the transformations allowed on luminance values and the definition of the domain blocks search space).

6 REFERENCES

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