Chapter 11
Fractal Coding Based Video Compression Using Weighted Finite Automata

Shailesh D. Kamble
Computer Science & Engineering, Yeshwantrao Chavan College of Engineering, Nagpur, India

Nileshsingh V. Thakur
Computer Science & Engineering, Prof Ram Meghe College of Engineering and Management, Amravati, India

Preeti R. Bajaj
Electronics Engineering, G. H. Raisoni College of Engineering, Nagpur, India

ABSTRACT

Main objective of the proposed work is to develop an approach for video coding based on Fractal coding using the weighted finite automata (WFA). The proposed work only focuses on reducing the encoding time as this is the basic limitation why the Fractal coding not becomes the practical reality. WFA is used for the coding as it behaves like the Fractal Coding (FC). WFA represents an image based on the idea of fractal that the image has self-similarity in itself. The plane WFA (applied on every frame), and Plane FC (applied on every frame) coding approaches are compared with each other. The experimentations are carried out on the standard uncompressed video databases, namely, Traffic, Paris, Bus, Akiyo, Mobile, Suzie etc. and on the recorded video, namely, Geometry and Circle. Developed approaches are compared on the basis of performance evaluation parameters, namely, encoding time, decoding time, compression ratio, compression percentage, bits per pixel and Peak Signal to Noise Ratio (PSNR). Though the initial number of states is 256 for every frame of all the types of videos, but we got the different number of states for different frames and it is quite obvious due to minimality of constructed WFA for respective frame. Based on the obtained results, it is observed that the number of states is more in videos namely, Traffic, Bus, Paris, Mobile, and Akiyo, therefore the reconstructed video quality is good in comparison with other videos namely, Circle, Suzie, and Geometry.

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INTRODUCTION

Video compression deals with the compression mechanism for the series of image sequences. In coding, the correlation between the adjacent image frames may get explored, as well as the relativity between them may also be used in the development of the compression mechanism. Generally, the adjacent image frame does not differ much. The probable difference lies in the displacement of the object in the given image frame with respect to the previous image frame. Grey and color videos (i.e. image sequences of grey or color image frame) are the customers for the video compression approach. Different color spaces can be used for the video images from processing point of view (Gonzalez et al., 2005; Moltredo et al., 1997; Zhang et al., 1995; Danciu et al., 1998; Hurtgen et al., 1994).

In the image sequences, there are two types of redundancies: Temporal redundancy and spatial redundancy. Spatial redundancy means redundancy among neighboring pixel in a frame. The coding technique which reduces the spatial redundancy is called as intra-frame coding. The intra-frame coding is similar to the individual image coding i.e. coding within the frame for finding out the redundancy in an image itself. Temporal redundancy means redundancy between two consecutive frames in a sequence of frames. The coding technique which reduces the temporal redundancy is called as inter-frame coding. Video compression deals with the compression mechanism for the series of image sequences. Block matching motion estimation (Zhu et al., 2009, 2009a; Zhu et al., 2010; Zhu et al., 2000; Cheung et al., 2000, 2002; Po et al., 1996; Liu et al., 1996; Ce Zhu et al., 2002; Li Hong-ye et al., 2009; Belloulata et al., 2011; Acharjee et al., 2012, 2013, 2014; Kamble et al., 2016, 2017) plays an important role in inter-frame coding technique to reduce temporal redundancy present in the series of image sequences.

Fractal coding (Fisher, 1992) is used as the image compression technique which evolves from an Iterated Function System theory (IFS) (Fisher, 1992). It basically deals with exploration of the self-similarity present in the given image. It is suitable for the grey level image compression, but later some new techniques were also developed for the color image compression (Thakur et al., 2007, 2006, 2006a, 2007a). With reference to above types of technique, advancement took place with the application to video compression (Fisher et al., 1994; Kim et al., 1998; Belloulata et al., 2005, 2008, 2006, 2005a). Though the Fractal coding is advantageous with respect to the compression ratio and image reconstruction quality, but it has the heavier non-acceptance related to the time elapsed for the check of similarity. Therefore, the scope of research exists to optimize the encoding time for still image video compression.

Fractal coding technique is well known for its better performance amongst the compression techniques but, fractal encoding technique involves large number of computation based on the searching of best suitable domain block for each range block. Therefore, the major challenge in front of the research community is how to reduce the encoding time in a fractal coding technique. For reducing the encoding time in a fractal coding, partitioning scheme plays an important role to partition an image into range and domain block. Quadtree partitioning scheme is one of the partitioning scheme to help in reducing the encoding time. Quadtree partitioning scheme works more efficiently for the image of size $2^n \times 2^n$ where n= 1, 2, 3…..n. On the other hand, with some efforts it can be implemented efficiently by shrinking/replicating the pixels so that equal to the size of $2^n \times 2^n$. A complete quadtree gives a pyramidal structure of an image for the encoding and decoding process is shown in Figures 1(a) and 1(b).

WFA coding techniques is based on the idea of fractal coding that an image has self-similarity in itself. WFA provide a powerful tool for image representation as a WFA and compress the image in term of a good compression ratio. The inference algorithm for WFA subdivides an image into a set of non-