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Video Compression USING a New Active Mesh Based Motion Compensation Algorithm in Wavelet Sub-Bands

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ABSTRACT

In this paper, a new mesh based algorithm is applied for motion estimation and compensation in the wavelet domain. The first major contribution of this work is the introduction of a new active mesh based method for motion estimation and compensation. The proposed algorithm is based on the mesh energy minimization with novel sets of energy functions. The proposed energy functions have appropriate features, which improve the accuracy of motion estimation and compensation algorithm. We employ the proposed motion estimation algorithm in two different manners for video compression. In the first approach, the proposed algorithm is employed for motion estimation of consecutive frames. In the second approach, the algorithm is applied for motion estimation and compensation in the wavelet sub-bands. The experimental results reveal that the incorporation of active mesh based motion-compensated temporal filtering into wavelet sub-bands significantly improves the distortion performance rate of the video compression. We also use a new wavelet coder for the coding of the 3D volume of coefficients based on the retained energy criteria. This coder gives the maximum retained energy in all sub-bands. The proposed algorithm was tested with some video sequences and the results showed that the use of the proposed active mesh method for motion compensation and its implementation in sub-bands yields significant improvement in PSNR performance.

Keywords: Motion Estimation and Compensation; Video Compression; Active Mesh Method; Wavelet Sub-Bands

1. Introduction

Recently, digital video communication and digital video storage have found many applications like digital TV, computer multimedia and video conferencing, to name a few. To reduce transmission bandwidth and storage capacity, it is necessary to apply an appropriate compression algorithm to videos. The Discrete Wavelet Transform (DWT) is the transform of choice in recent video compression algorithms. Adopted by the JPEG2000 image compression standard [1], it significantly outperforms the algorithms based on other transforms, such as the discrete cosine transform, in terms of objective metrics as well as perceptual image quality [2]. The success of the DWT stems from its ease of computation and its inherent decomposition of an image into non-overlapping subbands that enables the design of efficient quantization algorithms and allows for the incorporation of the human visual system.

One of the main stages in video compression is motion estimation and compensation. In most of the frames in a video, the only difference between subsequent frames is the result of either camera's or objects' motion in the frames. Motion estimation and compensation algorithms take advantage of this clue to provide a way for creating frames of a movie from a reference frame. Different algorithms have been proposed for motion estimation and compensation such as block-displacement methods [3,4], optical flow [5], feature matching [6], mesh based algorithms [7] and model based methods [8].

In block-displacement methods, the matching process uses a block based method. That is, video frames are divided into blocks and motion vectors of the blocks in the current frame point to the closest matching blocks in the reference frame. If there is no motion or only pure translational motion, the motion vectors provide a one-to-one mapping between pixels in the reference frame and pixels in the current frame. However, in more realistic video sequences, motion is usually much more complex and yield one-to-many mappings for some pixels in the reference frame and no mapping for others. The latter pixels are thus unconnected.

Although block-displacement techniques are popular, they have a number of drawbacks. First, the rigid block motion model fails to capture all aspects of the motion field, leaving a significant number of pixels unconnected between the frames. These unconnected pixels are coded

