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Fast Motion Estimation Algorithm Based on Complex Wavelet Transform

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Abstract In this paper, we introduce an algorithm for motion estimation. It combines complex wavelet decomposition and a fast motion estimation method based on affine model. The principle of wavelet transform is to decompose hierarchically the input image into a series of successively lower resolution reference images and detail images which contain the information needed to be reconstructed back to the next higher resolution level. The motion estimation determines the velocity field between two successive images. This phase can be extracted from this measure descriptive information of the sequence. Motion Estimation (ME) is an important part of any video compression system, since it can achieve significant compression by exploiting the temporal redundancy existing in a video sequence. This paper described a method from calculating the optical flow of an image sequence based on complex wavelet transform. It consists to project the optical flow vectors on a basis of complex-valued wavelets. Thus, we add an additional assumption on the shape of the velocity field that we want to find, which is the affinity of the optical flow. The two-dimensional affine motion model is used to formulate the optical flow problem by coarse resolution simultaneously coarse-and-fine, beside the traditional approach by coarse-to-fine, to avoid the error propagation during the decomposition of coarse level to fine level. This method opens the way for a quick and low-cost computing optical flow.

Keywords Motion estimation · Complex wavelet · Fast two frame algorithm · Coarse and fine model

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1 Introduction

Today, the use of Wavelet Transforms (WT) is becoming ubiquitous in signal processing owing to the power of the multi-resolution technique and the existence of fast algorithms. Research on wavelets mainly concerns real-valued wavelet bases and filter banks as evident by the excess of publications on the subject. However, complex wavelet bases and filter banks have been seldom discussed.

Both the Continuous Wavelet Transform (CWT) and Fourier Transform are defined for signals that are complex as well as real. The basis functions of the Fourier transform are the complex exponential functions, the Short Time Fourier transform (STFT) is equivalent to implementing a bank of band-pass complex-valued filters having equal band widths. The mother wavelets of CWT are often complex valued functions, such as the Morlet wavelet and the Gabor wavelet, etc. Present theory and techniques have already shown that these approaches are better able to handle complex signals. Therefore, adopting complex filter banks and associated wavelet bases for similar applications is a natural choice.

Optical Flow (OF) estimation is an essential problem in motion analysis of image sequences [1].

It provides information needed for video technology, such as object tracking, image segmentation, and motion compensation. A Great number of approaches for OF estimation have been proposed in the literature, including gradient-based, correlation-based, energy based, and phase based techniques [2–4]. Each approach has its own merits