香港浸會大學理學院
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DEPARTMENT OF COMPUTER SCIENCE

PhD Degree Oral Presentation

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"EMD/BEMD Improvements and their Applications in Texture and Signal Analysis"

Abstract

The combination of Hilbert spectral analysis (HAS) and the recently developed Empirical Mode Decomposition (EMD) designated as the Hilbert-Huang Transform (HHT) by N.E. Huang, represents a paradigm shift of data analysis methodology. HHT is designed specifically for analyzing nonlinear and nonstationary data. The key part of HHT is EMD with which any complicated data set can be decomposed into a finite and often small number of Intrinsic Mode Functions (IMFs). For two dimensional, bidimensional IMFs (BIMFs) is decomposed by use of bidimensional EMD (BEMD). Over the last few years, there have been many applications of EMD in scientific research and engineering. However, EMD has some limitations in signal processing and image processing. This thesis addresses the problems of using EMD for signal and image analysis.

To overcome end effects in EMD, we proposed a boundary extend method for EMD. A linear prediction based method combined with boundary extrema point's information is employed to extend the signals, which reduce the end effects in EMD sifting process. It is a simple and effective method.

In the EMD decomposition, interpolation method is another key point to get ideal components. The envelope mean in EMD is computed from the upper and lower envelopes by cubic spline interpolation, which has overshooting problem and is time-consuming. Based on the linear interpolation (straight line) method, we propose using the extrema point's information to get the mean envelope, which is Extrema Mean Empirical Mode Decomposition (EMEMD). The mean envelope taken by EMEMD is smoother than EMD and the undershooting and overshooting problems in cubic spline are reduced compared with EMD. EMEMD also reduces the computation complex. Experimental results show the IMFs of EMEMD present more and clearer time-frequency information than EMD. Hilbert spectral of EMEMD is also clearer and more meaningful than EMD.

Later, two applications based on the improved EMD/BEMD methods are proposed. One application is texture classification in two dimensional image processing. A saddle points added BEMD is developed to supply new multi-scale components (BIMFs) and Riesz transform is used to get the frequency domain characters of these BIMFs. Based on local descriptor Local Binary Pattern (LBP), two new features (based on BIMFs and based on Monogenic-BIMFs signals) are developed. In these new multi-scale components and frequency domain components, the LBP descriptor can achieve better performance than in original image. Experimental results show the texture images recognition rate based on our methods are better than other texture features methods on different benchmark data sets.

Another application is signal forecasting in one dimensional time series. EMEMD combined with Local Linear Wavelet Neural Network (LLWNN) for signal forecasting is proposed. The architecture is a decomposition-trend detection-forecasting-ensemble methodology. The EMEMD based decomposition forecasting method decomposed the time series into its basic components, and more accurate forecasts are obtained.

*** ALL INTERESTED ARE WELCOME ***