Retina Image Decomposition Using Variational Mode Decomposition

Shwetambari Kulkarni[1], Priya M. Nerkar[2]

[1] PG Student, D.Y. Patil College of Engineering, Akurdi , Pune-44 , India
[2] Assistant Professor, D.Y. Patil College of Engineering, Akurdi , Pune-44 , India

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Abstract – *This paper illustrates the implementation of the VMD algorithm on an image of retina. This new concept of image decomposition can be very useful in medical application for diagnosis of various diseases like Glaucoma, hemorrhages, diabetes retinopathy etc… Various algorithms exists for recognizing these diseases but the image decomposition technique will help us to focus on affected parts of retina. The EMD algorithm is widely used for decomposition. This paper contributes to VMD algorithm of decomposition is applied on retina image for further decomposition. The quality processing time for these implementation can be achieved by hardware software co design.*

***KEY WORDS*: VMD, EMD, Decomposition, Retina Images.**

1. INTRODUCTION

The retina means an internal image of our eye is one of the important part of our body. Without eyes one can't be able to see this beautiful world. Many of the diseases can be detected with the help of the retina images. For that the ophthalmologist's uses a special camera to take the images of retina. The ready datasets are available online are used. The various algorithms are used for segmentation, extraction, edge detections etc…

These algorithms helps in detection of early signs of many diseases like Glaucoma, Diabetes retinopathy, hemorrhages etc… which if not detected early may lead to the blindness.[9] Diabetes is the disease which does not shows the any early symptoms, but it can be detected early with the retina ages while the patient goes for an eye checkup it can be detected easily. So, the concept of the processing on the retina images came into existence. Many researchers started to make experimental setups on this point of view.

The image decomposition technique helps in decomposing the image so that the noises present in that gets reduced to extend. The variational mode decomposition has a greater advantage over the existing empirical mode decomposition is that it is less sensitive towards the lowest frequency present in the image.[1] VMD efficiently eliminates the high frequency noises keeping all the characteristics of signal almost unchanged.

Recently, Dragomiretskiy and Zosso proposed an alternative to EMD algorithm i.e. variational mode decomposition (VMD) model [1] In VMD various modes can be concurrently extracted, and it figures out number of band limited modes and its center frequencies. Other work pursuing the same algorithm is achieved for 2D input image on MATLAB coding.[4] This paper contributes to VMD algorithm which is applied on a retina image for further decomposition.

1.1 Empirical Mode Decomposition

EMD method demodulates a time domain signal into Various patterns using an algorithmic approach. These various patterns are called intrinsic mode functions (IMFs). But IMFs must satisfy the following criteria:

(a) Number of over-shoot under-shoot and the number of Zero crossings in the total data set must be equal or may differ at most by one.

(b) The average of upper and lower envelop defined by the Local maxima and local minima respectively must be zero at any point.

1.2 Variational Mode Decomposition

VMD is a relatively new approach for signal decomposition. Various signals are recently decomposed using the VMD. The main objective of using VMD algorithm is to decompose an image of retina [1]. VMD is applied iteratively for needful extraction of retina image. The VMD components are bandlimited hence detailed pixel variations is obtained while decomposing an image. The EMD based decomposition has a drawback which is overcome by the VMD i.e. decomposition depends on the local maxima and minima point finding, interpolation and then the stopping criteria.[2] VMD is robust to noise, and a best substitute to EMD method.

2. PROPOSED WORK

The variational mode decomposition is used for decomposition of retina image. Variational Mode Decomposition (VMD) is a decomposition method used for decomposing any input image to a discrete form with each node selected as its bandwidth in spectral domain. This type of decomposition is a sequential process which decomposes an input image into the different amplitudes and frequency modulated signal such that jointly they reconstructs the original image.[6]

VMD is sensitive towards the higher frequency present in signal and shows the inverse characteristics compared to the Empirical mode decomposition (EMD). VMD is used for decomposition of retina images in Matlab. The signal can be decomposed into so called a modes (IMF) using the Hilbert transform (HHT) and a frequency at particular time instant is obtained. The signal can be decomposed into so called an intrinsic mode function (IMF) using the Hilbert Huang transform (HHT) and an instantaneous frequency data is obtained This method of decomposition was designed for real time data analysis .As compared to transform methods available the HHT (empirical) can be directly apply to dataset instead of theoretical tool. Many approaches is done for decomposition of signals using Empirical mode decomposition (EMD). In EMD decomposition algorithm a given signal is decomposed into an intrinsic mode function plus the residue [3]. Lower order IMFs shows a high frequency modes and high order IMFs shows a low frequency modes. EMD is efficacious for analysis of stationary as well as non-stationary signals. EMD algorithm suffers from lack of mathematical model and SNR ratio.

3. RESULTS

A retinal image is processed with variational mode decomposition (VMD) to obtain the first variational mode, which captures the high frequency components of original image as shown in figure 1.

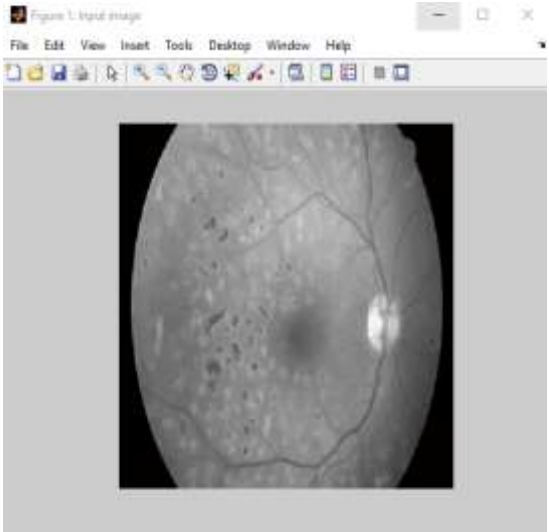

Fig -1: Input retina image

VMD is a signal processing method which decomposes any input signal into discrete number of sub signals chosen to be its bandwidth in spectral domain as shown in figure 2.

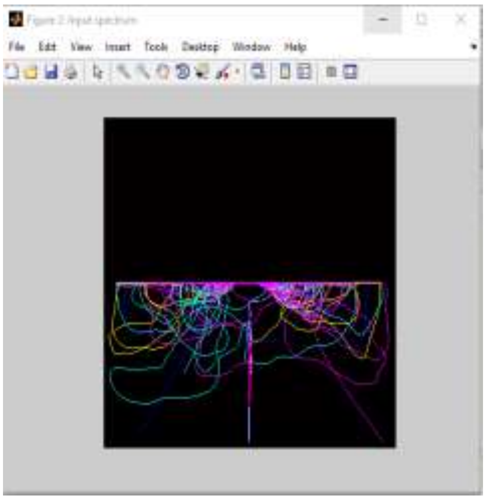

Fig -2: Input spectrum of input image

Four texture descriptors are extracted from the first variational mode as shown in figure 3.

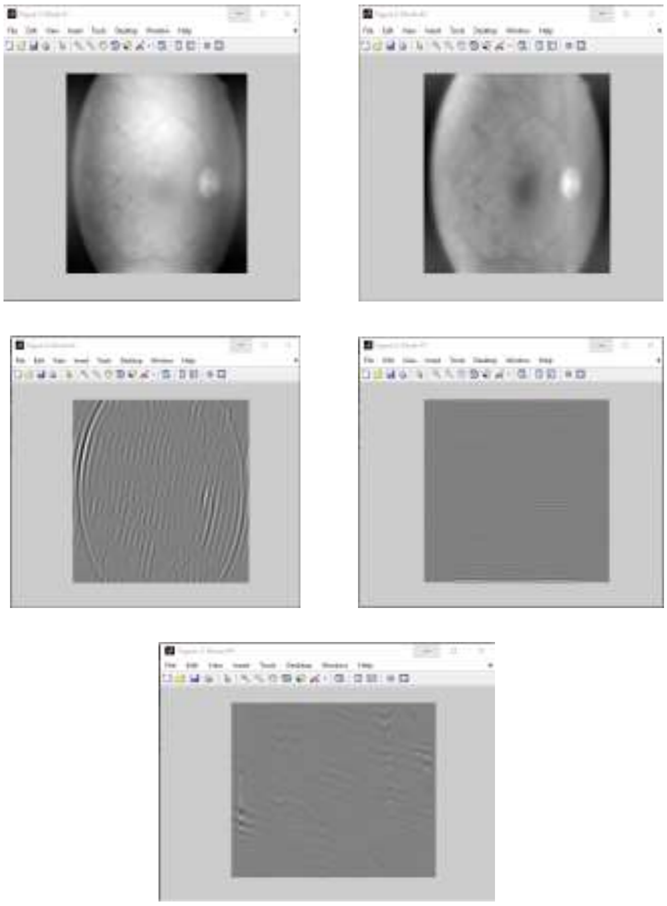

Fig -3: IMF Modes 1, Mode 2, Mode 3, Mode 4, Mode 5(decomposed mode)Finally a classifier is trained in all computed texture descriptors is used to distinguish between the images of healthy and unhealthy retinas with a perfect detection rate achieved as shown in figure 4.

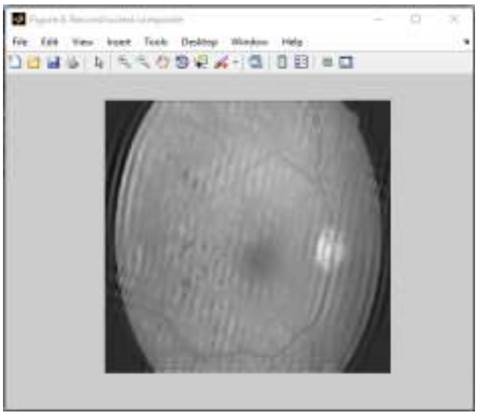

Fig -4: Final Reconstructed image

4. CONCLUSIONS

The VMD algorithm using the FPGA was successively achieved and the coding was done using the MATLAB R2014a Simulator and XSG Xilinx 14.1 Version. The use of reprogrammable device allows for continuous changes and optimizations in the hardware design easily. The computational speed was achieved comparatively good using hardware of FPGA.

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