Feature extraction of retina images on FPGA using variational mode decomposition

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Abstract — The feature extraction and segmentation of retina image is done using various known algorithms. The new concept of VMD algorithm is applied for decomposition of retina image on FPGA is implemented in this paper. The VMD achieves highest PSNR as compared to EMD or other decomposition methods. The diagnosis of disease like hemorrhages, diabetes retinopathy etc is done effectively using modern approach of 'Xilinx System Generator' (XSG) tool. For realistic image processing and enhanced interpretation speed the Spartan 3 is used. The outcomes are gained by compressing the image size from Matlab to 128x128 for FPGA compatibility purpose.

Index Terms — VMD, FPGA, XSG, Retina images, EMD

I. Introduction

Variational Mode Decomposition (VMD) is a decomposition method used for decomposition of 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.

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 and further processing is done on FPGA board. 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 [5].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.

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. This paper contributes to VMD algorithm which is applied on a retina image for further decomposition.

II. 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. VMD is robust to noise, and a best substitute to EMD method.

III. Proposed Work

The block diagram of total retinal image segmentation is as shown in Fig.2. It contains of mainly four parts namely.

- Input Image
- Pre-processing
- Resizing of image for FPGA.
- FPGA Processing
- Output Section

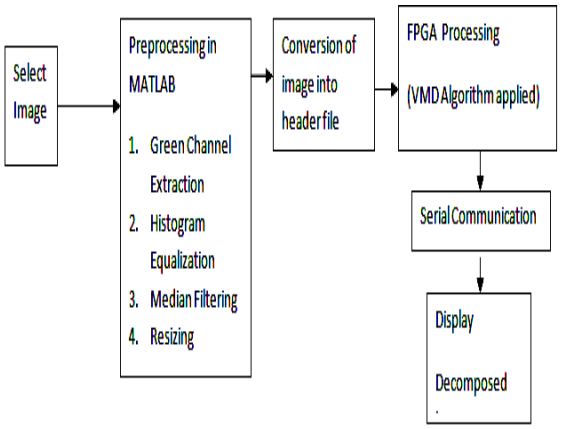

Figure. 1: Block Diagram for proposed work

A. Input Image

Input images are taken from the standard dataset DRIVE (Digital Retinal Images for Vessel Extraction).

B. Pre-processing

The input image is pre-processed. The result of pre-processing is the contrast enhanced, filtered and resized image.

C. Resizing of image for FPGA.

For FPGA processing, the jpg file of image is converted to header file using MATLAB. The header file

contains the values of each pixel of the corresponding image. These pixel values are processed by the FPGA.

D. FPGA Processing

For FPGA processing, image header file is fed as input for further processing. Xilinx is used for programming the FPGA and the segmentation is done on image.

E. Output Section

The segmented image is received by PC via serial communication. Finally segmented image is classifies for diabetic or non-diabetic image.

The whole architecture of the proposed system is shown in Figure.2. The original image is obtained from the database which is available online DRIVE database. Image is pre-process, to pre-process original image first channel extraction is done on image and grayscale image is obtained [2]. Grayscale image is used before processing part because background intensity is low in green channel extraction. After channel extraction grayscale image is filtered using switch median filter. Filtered image further take into consideration for segmentation of an exudates. Exudates segmentation is based on features of exudates, such as colour, boarder, and edge. Segmented image is finally classified using suitable classifier.

IV. Results

The proposed decomposition approach were applied to retina image (128x128) is shown in figure 2.

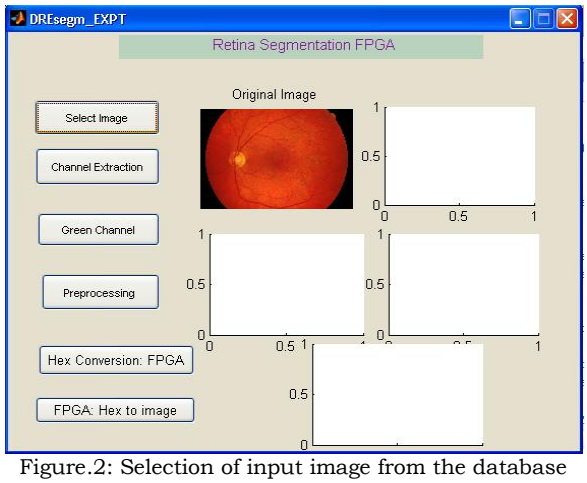

Figure.2: Selection of input image from the database

An input image of retina was selected is shown in figure 2. Then original image was converted in gray scale image by using green channel extraction shown in figure 3.

The preprocessing was done using the switch median filter is shown in figure 3.

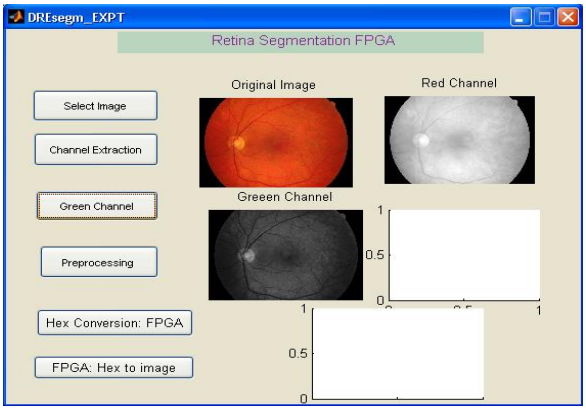

Figure.3: Green channel extraction of input image

The figure 4 implicates the comparison of both green channel extraction and after using the switch median filtering its histogram equalization and the reduction of noise in images.

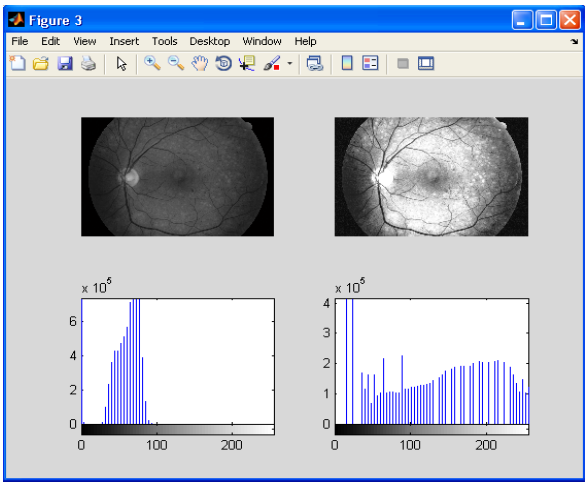

Figure.4: Comparison of Green Channel and switch median filtering

Conclusion

This paper evaluates decomposition of modes of retina image using the FPGA 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 image was resized and fed to the FPGA and VMD algorithm was applied on an image and accordingly the image was again displayed on screen.

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