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MEDICAL IMAGE SEGMENTATION FOR DISEASE DETECTION USING DIGITAL FILTER

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ABSTRACT- Tonsillitis is a disease that can be found in every part of the world. Moreover, it is one of the main causes intervening for heart attack and pneumonia. It has been reported that there are a large number of people having died because of heart attack and pneumonia. To improve data transfer rates, this paper proposes Gabor filter design with efficient noise reduction and less power consumption usage is proposed in this paper. Using textural properties of anatomical structures the filter design is suitable for detecting the early stages of disease. The code for Gabor filter will be developed in MATLAB.
Keywords- Medical image, MAT LAB

I. INTRODUCTION

Image segmentation is the process of partitioning a digital image into multiple segments i.e. sets of pixels. Segmentation of images by using textural property of anatomical structures and regions of interest has a crucial role in most medical imaging applications. The segmented image is more meaningful and easier to analyze.

For medical images, Color image segmentation and cell counting system is preferred because the gray levels alone may not be sufficient to perform accurate medical image segmentation, as many soft tissues have overlapping gray level ranges. Thus the use of the textural properties of the anatomical structures could be useful. For this purpose a customized 2D Gabor Filter for RGB color image segmentation will be designed. It has proved to be an effective segmentation tool with improved data transfer rate, efficient noise reduction, less power consumption and reduced memory usage .Gabor function locates the texture features in the spatial domain. Gabor filters have proved to be an effective Segmentation tool because of two major factors as: Their capability to achieve optimal uncertainty in both space and frequency, and their similarity with primary visual cortex of mammals

We focus on detecting main features of disease and create a resulting image showing affected Area on MATLAB. The Gabor Filter for color image segmentation will be coded using VHDL in Modelsim and will be implemented in SPARTAN-3E FPGA. Field Programmable Gate Array (FPGA) technology has become a viable target for the implementation of algorithms Suited to image processing applications. Finally the segmented image will be observed on MATLAB.

II. DESIGN METHODOLOGY

The design approach will be divided in six modules as described below

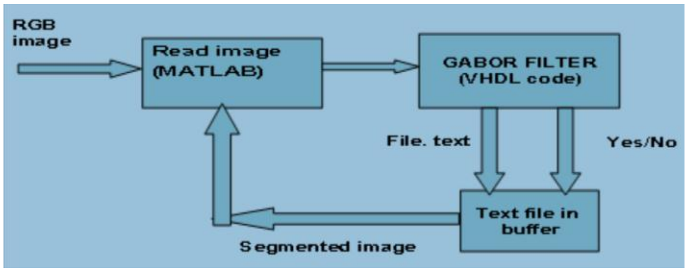

Fig.1 Block Diagram of proposed plane

A. MATLAB IMAGE READING MODULE

This is a simple image reading and resizing module written in MATLAB. It reads two images from database for comparison. One of which is healthy image (figure (2)) and another having disease features (figure (3)). The comparison will generate a test input file which we can use as input to VHDL module.

Fig.2 Healthy tonsils

Fig.3 Disease affected tonsils

B. GABOR ALGORITHM

Our Gabor-type filter designed with Gabor algorithm is used as the processing unit in a disease detection module. Gabor Filters have received considerable attention because the characteristics of certain cells in the visual cortex of some mammals can be approximated by these filters. Gabor filters are a large set of linear filters, having the impulse response defined as a harmonic function multiplied by a Gaussian function with various orientations. It can be viewed as a sinusoidal plane of particular frequency and orientation, modulated by a Gaussian envelope. The space domain representation of the complex 2D Gabor filters (or functions) is given by

$$h(x, y) = s(x, y)\, g(x, y)$$

Where s(x, y) is a complex sinusoid, known as a carrier and g(x, y) is a 2-D Gaussian shaped function, known as envelope and it's spatial extent is given by the parameter σ_g. These are defined as follows,

$$s(x, y) = e^{j(w_x x + w_y y)}$$

$$g(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x2+y2}{2\pi\sigma^2}}$$

Thus the 2-D Gabor filter equation can be written as:

$$h(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x2+y2}{2\pi\sigma^2}} e^{j(w_x x + w_y y)} \quad \text{---- (1)}$$

The equivalent frequency representation of Gabor filters is:

$$h(u, v) = \exp\{-2\pi^2 \sigma g^2 [(u-U)^2 + (v-V)^2]\} \quad \text{---- (2)}$$

The Gabor filter is essentially a bandpass filter centered at (U, V) in the frequency domain, with bandwidth determined by sigma*g*. Its radial center frequency measured in cycles/ image, fc = rootU2+V2, is oriented (in radians) from the u-axis with Q = tan−1 (V/U). We assume, for the simplicity, that the Gaussian $g(x, y)$ is a symmetrical function. The Gabor filter bank is obtained by generating Gabor filters for all directions from 0 to 360 and varying the frequency with the fc factor. The representation of the generated filters in the frequency domain is shown in Figure (4).

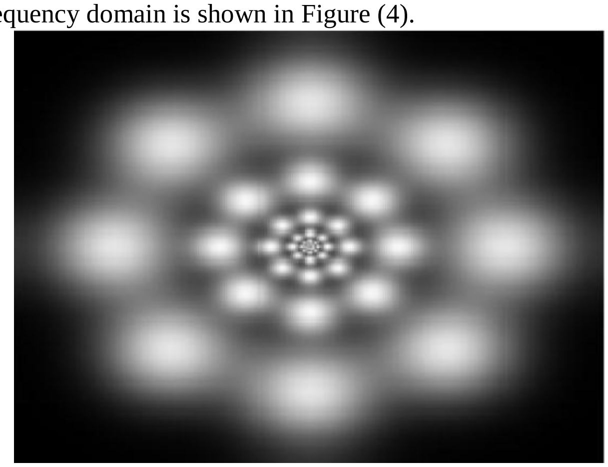

Fig.4The frequency domain of Gabor filter bank

This Gabor algorithm in equation (2) discussed above, will be use to implement a Gabor Filter in VHDL. This is basically implementation of certain equations of the Gabor filter, shown above, to provide an output (image segmentation) which gives better results as compare to general image segmentation.

1) CORDIC ALGORITHM

CORDIC is a COordinate Rotation DIgital Computer algorithm the set of shift-add algorithm collectively known as CORDIC algorithm for computing a wide range of functions including Trigonometric, hyperbolic, logarithmic and linear functions. It is introduced in 1959 by Jack E. Volder. As we observe the Gabor Filter equation, the implementation is quite complex as the complex exponential term is present there. This term is divided in two kernels. Even kernel is cosine modulated and the odd kernel is sine modulated as e^j = cos Q+ j sinQ and hence two filers are 90 degrees out of phase. These trigonometric functions which are based on vector rotations are implemented using Iterative shift & add operation. No Multiplication is required and hence Delay/Hardware cost is reduced comparable to division or square rooting. It is Hardware Efficient Algorithm. The data format consists of two 16-bit words which are used for the even and odd kernels of Gabor filter equation. The 16-bit words consist of a 4-bit integer part and 12- bit fractional part. The image pixels are represented by an 8-bit number which is stored in lookup table in do file format. This Gabor filter is designed with CORDIC algorithm reduces the time required for computation making the system fast.

2) IMAGE SEGMENTATION MODULE

This would apply the Gabor filter to the input image, and provide a segmented output in the form
of a 2D array.

Fig.5 Segmented Healthy tonsils

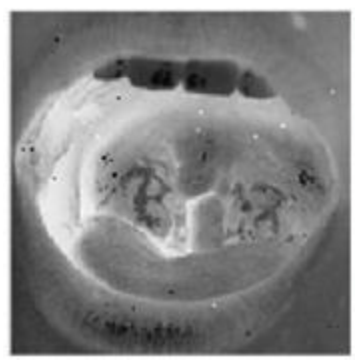

Fig.6 Segmentation Disease affected tonsils

D. DISEASE DETECTION MODULE

Depending upon the output of image segmentation module i.e. (a) the value in matrix showing total size of disease affected area and (b) color of disease, this module will detect if disease (Tonsillitis) is present in the input image or not, and provide an output depicting the same highlighting only tonsil area. The main concept used in this is to extract only the overlapping area in given two images helps in highlighting the disease area and gives the result in percentage that how much percent the disease is present. With this we can also able to identify the stage of disease by observing the intensity value of pixel in each segment.

E. VHDL OUTPUT MODULE

The output from step 4 would be stored in a text file and an output file would be generated (figure (7)). This would contain the actual output image.

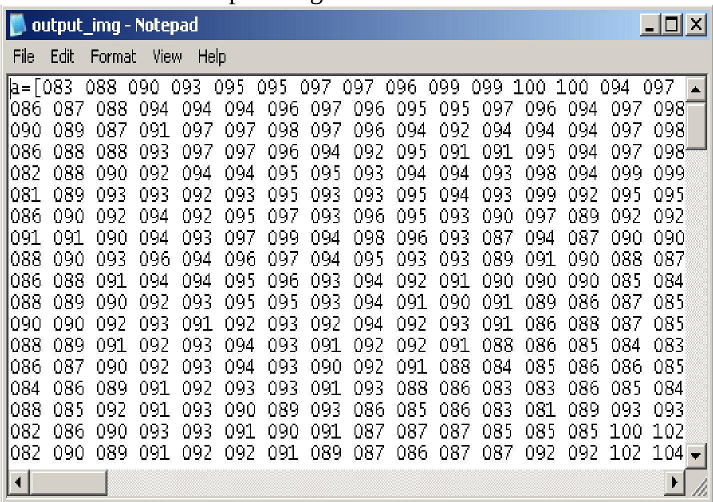

Fig.7 Text File showing output

F. FINAL RESULT DISPLAY MODULE

This would be a simple MATLAB code named as post file.m which would take the difference output from step 5 and display it on the MATLAB screen in the form of a percentage. Here it is showing 68.36% tonsillitis is detected as it is greater than 60 % which is the limit of healthy tonsils.

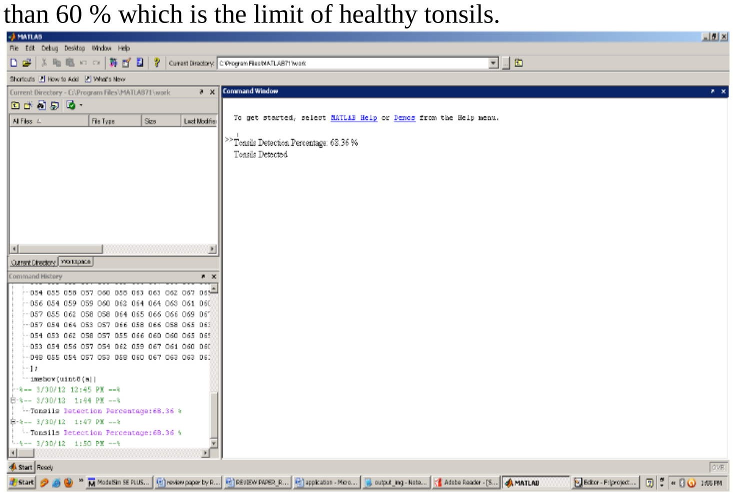

Fig.8 MAT LAB showing final result

III. FLOW OF DESIGN

The overall design is revised in the flowchart shown below in figure (9). It shows different Modules designed in MATLAB (modules outside hashed lines) and VHDL (modules inside hashed lines).

The image is captured using USB image sensor where it is resized. Next the Gabor filter is applied to the image for segmentation. This Gabor filter is designed with CORDIC algorithm for computation & making the system fast.

The segmented image can be observed on image display module within microseconds. The disease detection module, which is designed in VHDL, compares the two images and gives intensity values of disease affected area. This will be helpful in identifying the stage of disease finding the percentage of disease affected area.

IV. ANALYSIS AND DEVELOPMENT

In developing algorithm some considerations must be taken, such as: properties and constraints. In software base, these properties are: performance (accuracy and speed), complexity, size of code, size of templates, difficulty of development, dependency, and in hardware base these properties are: performance, size of block/modules, and size of templates. And in implementing software algorithm into hardware base some constraints must be taking care, such as: memory, component/block device, module dependency, difficulty of development, interfacing and handshaking, licensing, etc.

Initially the work will be simulated using VHDL and then implemented on SPARTAN-3E FPGA. Figure (9): Data flow of overall module.

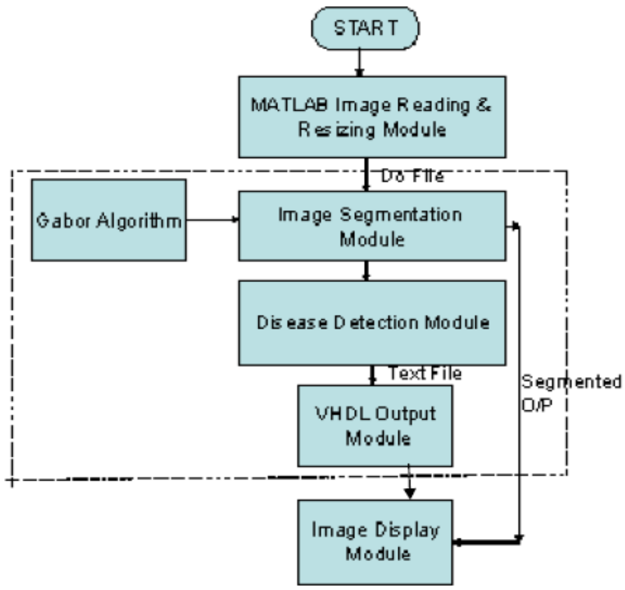

Fig.9 Data flow of overall module

V. RESULTS AND DISCUSSION

The input images used here are the tonsils images. Instead of this RGB image of tonsillitis we can use any RGB image of skin disease as it is generalized algorithm with some changes. The image size is fixed to 128 x 128. Thus each input image will be resized and converted to grayscale image (figure (5) (6)). This module generates 128 x 128 x 8 number of lines showing the pixel values in V-sim format suitable to use in Modelsim i.e. to interface VHDL code with MATLAB code. Three Gabor filter for R, G & B are designed to filter each component in image to give the noise free result. After obtaining the segmented image as output using Gabor filter we found that noise contents are reduced to great extent locating the exact region of tonsil area. The pixel values of the input image are obtained and provided serially to disease detection module. Here the comparison is performed between two samples giving the desired result in percentage as explained above. This design further can be implemented on VERTEX / SPARTAN-3E FPGA kit

VI. CONCLUSIONS

In this paper, a concept of VLSI architecture for skin related disease detection is proposed. It will improve data transfer rates, provide efficient noise reduction, less power consumption and require less memory storage. The Gabor filter is an efficient tool to get all requirements as mentioned above. The processing time required for simulation is very less as compared to software simulation because of the use of CORDIC algorithm, thus offers much greater speed than a software implementation. This concept will be helpful in detecting early stage of disease and saving the lives of peoples.

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