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FPGA BASED DIAGNOSIS AND CLASSIFICATION OF BREAST DISEASE USING THERMOGRAPHIC IMAGES

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Abstract: The aim of this work is to detect breast cancer using thermographic Images. Mammogram is a very popular imaging modality used for identifying breast cancer but fails to identify disease at an early stage, hence an emerging InfraRed(IR) technology known as thermogram is used for early stage detection. Clinical infrared thermography is a procedure that detects, records and produces images depending upon the variation of skin surface temperatures in the form of thermal patterns. Hence thermogram is an emerging technology to detect malignant breast conditions at early stage. Breast images acquired using thermal IR camera is preprocessed and thresholding is performed to obtain skin tone images. Further the obtained processed normal and abnormal images are segmented and classified using skin color pixel classifier. Tools used for this work are MATLAB, Xilinx ISE design suite12 & Verilog. Database used is revised by confidently trained breast physicians.

Keywords: Breast cancer, Non invasive, Thermogram, HSV, YC_bC_R.

1. INTRODUCTION

Breast cancer is the second most frequent type of cancer in women which is due to abnormal growth of normal cells. It is a malignant tumor that develops from breast tissue and gets into surrounding tissues as well The world health organization's International Agency for Research on Cancer (IARC) estimates that it affects one in eight women in their life time and more than 4, 00,000 women expire each year and is increasing because the majority of the cases are diagnosed in late stage [1], which justifies research on early diagnosis. Early detection reduces mortality rate, extent of surgical procedures and increases survival rate. Also clinical decision support systems and computer aided diagnosis assist physiciansto improvehealth care quality, reduce health care costs and eliminates parallax error[2].

Mammography is a radiological screening technique which makes it possible to detect breast lesions and breast cancer using low doses of radiation. A mammogram is an X-ray of the breast wherein a beam of x-ray traverses the breast and creates a projected image on a film. It is widely used in clinical applications and mass screening due to its inexpensiveness, less time consumption and low complexity but fails to detect abnormality at an early stage because mammogram looks at structural or anatomical parts of the body. To overcome this disadvantage a special heat sensing camera is used to measure and map heat on the surface of breast. It is a relatively new screening technique based on temperature sensing. Breast thermography as a diagnostic tool for tumor detection is based on the fact that cancerous and precancerous tissues have high metabolic rate with increased blood flow resulting in neoangeogenesis, supplying nutrients to tumor.

As a consequence, the temperature of that area is higher compared to normal breast tissues temperature, thus tumors that are small in size can be well identified using thermography. This technique is entirely noninvasive, fast and painless as it requires no contact between the patient and instrumentation[6]. Thermography can identify cancer at least 10 years in advance compared to mammogram [4]. Hence infrared thermography hasbeen proven to be a promising technique on early diagnosis of breast pathologies.

Field Programmable Gate Arrays (FPGA) are high-speed reprogrammable processor that can stores several pieces of software to do different tasks and entirely change its hardware in a matter of milliseconds. The re-programmability of FPGAs allows them to be used to implement any architecture a designer wishes to develop. "Spartan 3E Starter Kit" is a FPGA board produced by Xilinx. It is a very feature laden board with a Spartan 3e XC3S500E FPGA, 64Mbytes of SDRAM, 128Mbits of flash EPROM, A/D and D/A converters, RS232 drivers, VGA, PS/2, USB, a 16 character two-line LCD and Ethernet connectors.[9]

MATLAB (MATrixLABoratory) is an interactive high level programming language, which is designed for fast numerical matrix calculations. It performs computationally intensive tasks faster than traditional programming languages. The Matlab toolbox supports a wide range of image processing operations such as geometric operations, block processing, linear filtering, filter design, transforms, image analysis, image enhancement, binary image operations and region of interest operations etc. It is used for analyzing data, developing algorithms, creating applications and models[10].

2.METHODOLOGY

For this work Image acquisition is done using FLIR IR camera. For the analysis one normal (used as gold standard image) and four malignant cases are considered. Images are revised by trained physicians.Graphical User Interface is used for selection of thermographic Image from the dataset. Resizing of an image to 256X256 is done for uniformity. Skin tone segmentation is performed and skin regions are extracted using a set of boundary rules based on skin color distribution obtained from the training set. This allows easy localization of regions without any consideration of its texture and geometrical properties. Multi band selection is done for input image wherein the image is viewed in HSV (Hue Saturation

Value) planes and YC_bC_r (luminance, chroma blue, chroma red) planes instead of only three planes like RGB(Red Green & Blue)[4]. The six color components obtained from HSV and YC_bC_r color spaces provides discriminality between skin pixels and non skin pixels over various illumination conditions, in those subspaces$C_bC_r$and H-S have been found to be effective in characterizing skin colors. Luminance is eliminated as it is the least contributing component to skin detection [5]. Skin pixels are extracted using calculated threshold values shown in Table. 1

Table1: Threshold Values

Plane	Threshold value
C_b_lower	98
C_b_upper	120
C_r_lower	150
C_r_upper	176
C_y_lower	51
S_lower	0.07
S_upper	1.00
V_lower	0.47
V_upper	0.55
H_lower	0.01
H_upper	0.05

Separate individual planes C_b, C_r, H and S are extracted and element wise logical AND operation is carried out which results in tone classified binary image. The obtained tone classified image contains holes and a gap, hence closing morphological operation of an image is done using circular structural element of radius 5. Closing tends to smooth sections of contours, eliminates small holes and fills gaps in contour. The final segmented region represents region where tumour is present representing hottest region. Fig.1 shows the flow diagram of the work.

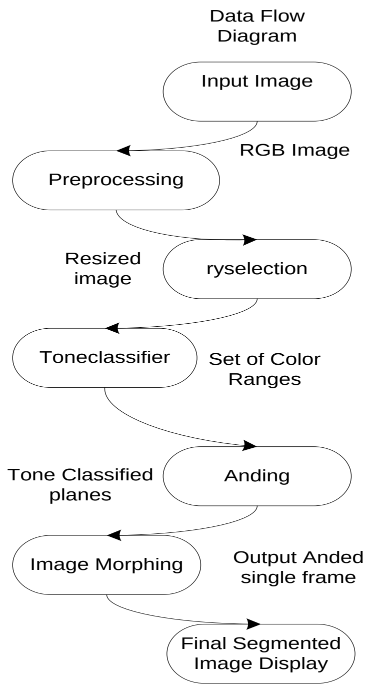


Fig. 1: Flow Diagram

From the segmented regions properties such as area, bounding box, centroid, convex area, convex hull, convex image, eccentricity, equivdiameter, euler number, extent, extrema, filled area, filled image, image, major axis length, minor axis length, orientation, perimeter, pixelIdxlist, pixel list, solidity, subarray index are calculated and used for classification of Maligant or normal subjects.

Skin tone segmentation is also implemented in Xilinx ISE using Verilog code and downloaded into Spartan 3E FPGA kit. Fig. 2 shows the FPGA design flow.

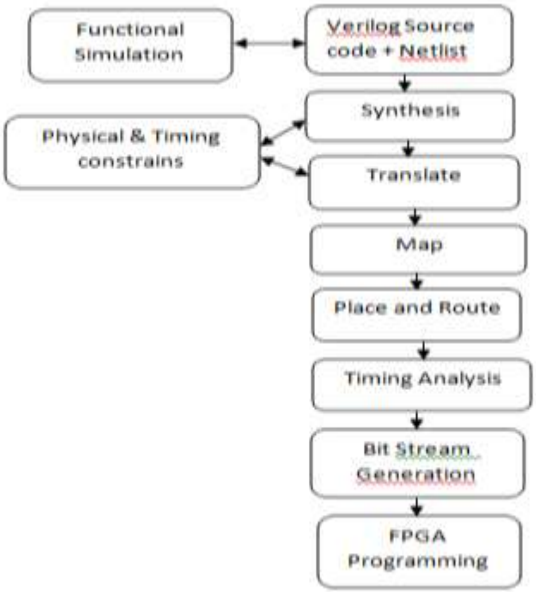


Fig 2. FPGA Design Flow

The results obtained in Matlab and Verilog are compared. The segmented images in both the cases are subtracted and a difference image is obtained.

3.RESULTS

Fig. 3:Graphical User Interface

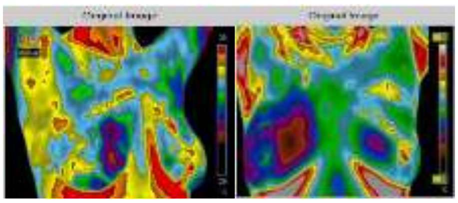
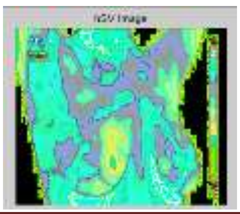


Fig. 4a: Normal thermography image   Fig 4b:Abnormal thermography image



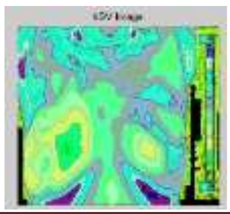
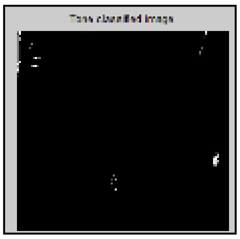


Fig. 5a: HSV of normal image Fig 5b: HSV of abnormal image

Fig 6a:YCbCr of normal image Fig 6b:YCbCr of abnormal image



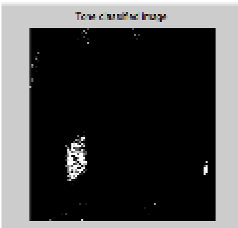


Fig. 7a: Tone classified normal image Fig 7b: Tone classified abnormal image

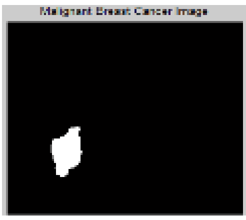


Fig. 8: Morphological result

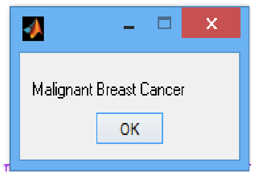


Fig.9a: GUI classification: Normal case Fig.9b:GUI classification: malignant case

Fig. 3 shows GUI to select the query image from the dataset. Fig. 4a and 4b shows abnormal and normal thermogram images and their respective HSV image and YC_bC_r image are shown in Fig. 5a and 5b, Fig. 6a and 6b.

Fig. 7a and 7b shows tone classified normal and abnormal image. Tone classified abnormal image highlights tumor region with holes and gaps. The holes and gaps are filled using morphological operation as shown in Fig. 8.

Fig. 9a and 9b shows the GUI representing normal and malignant classification results.

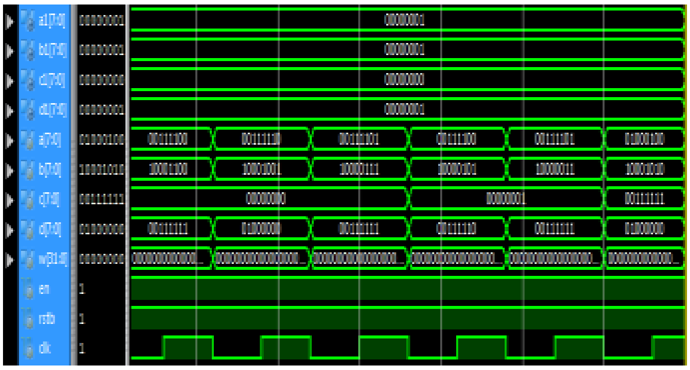


Fig 10: Skintone segmentation results using Verilog

Fig.10 shows simulation results of skintone segmentation, wherein a, b, c, d are 8 bit inputs representing C_b, C_r, H and S plane information which are compared with threshold values and a1, b1, c1 and d1 represents results of comparison which helps to identify skintone pixel.

Fig.11 shows segmented image obtained by converting Verilog code to MATLAB to view the segmented region.

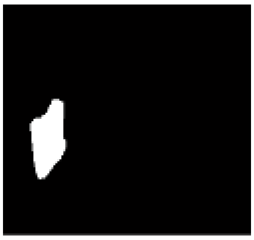


Fig 11: Segmented image Fig 12: Difference image

Fig 12 shows the difference image obtained by subtracting segmentation results obtained in MATLAB and Verilog.

4. CONCLUSION

Using thermographic images it is possible to detect cancer in early stage[4]. In this work skintone segmentation and classification is performed using Verilog and Matlab. From the difference result it is observed that the performance of both the methods is almost similar. This work can be extended for larger database and performance measures could be calculated for both the methods. Also using similarity methods difference between the two images obtained by MATLAB and Verilog could be quantitatively estimated and compared with gold standard images. This method can help doctors to identify the position and size of the tumor to improve the quality of medical diagnosis.

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