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FPGA Implementation of Improved Morphological Operation for Brain Tumor Detection

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ABSTRACT

Brain tumor detection using hardware resources and image sensor is an important aspect of research in recent years in the biomedical field. Many researchers proposed different techniques and methodological algorithms for the detection of brain tumor using imaging methods and compare the merits and demerits of their approach with the existing approach. The brain tumor is detected using morphological operations such as erosion and dilation, which must be used repeatedly to increase the accuracy of the detection of tumor. In the proposed work, contrast enhancement using the thresholding technique is implemented along with the morphological operations. The result shows that with the increase in number of resources used for the detection of tumor, the accuracy is increased. In future several other detection techniques must be implemented along with the contrast enhancement of the image and must compare their results with the existing approaches.

Keywords: Brain Tumor detection, FPGA,Image Segmentation

I. INTRODUCTION

In the human body, brain is one of the most complex organs. The brain is consisting of more than 100 billion nerves which help to communicate with synapse. It is made up of soft and spongy mass of tissue and it is covered with the layer known as meninges. The brain is protected with layers of meninges, and cerebrospinal fluid which surge throughout spaces between the spaces of ventricles and space of meninges within the brain.Brain is placed in the head, generally nearer to the primary sensory organs. The brain is categorized into different lobes such as Frontal lobe, temporal lobe, parietal and occipital lobes. These lobes have separate functions. The cortex is the outermost layer of brain cells. The main function of this outermost layer is used for voluntary movement and thinking. Human brain is divided into three major sections that are cerebrum, cerebellum and brain stem.

The cerebrum takes help from our senses and tells us how to respond, when to respond. The cerebrum can capable of reading, thinking, learning, and shows emotions. The cerebrum has two sections i.e. right and left cerebral hemisphere. Another part of brain is cerebellum which helps to maintain balance of our body, and other difficult actions. And the brain stem links the brain with the spinal cord and can help to control breathing, body temperature, BP etc.

A brain tumor occurs when abnormal cells formsinside the brain. Brain tumor may also referred as intracranial neoplasm. When the set of abnormal cells, which starts in the brain, then the tumor, take place in the brain. Brain tumor have almost 120 kinds that makes complicated treatment. Sometimes in the body, new cells are formed without any requirement and the old cell does not die as they should die according to normal process. Due to which some extra cells is buildup in the brain which creat a group or mass of tissue called as tumor. The tools which are used for diagnose the tumor are a brain scan, magnetic resonance imaging (MRI), patient background and CT scan.

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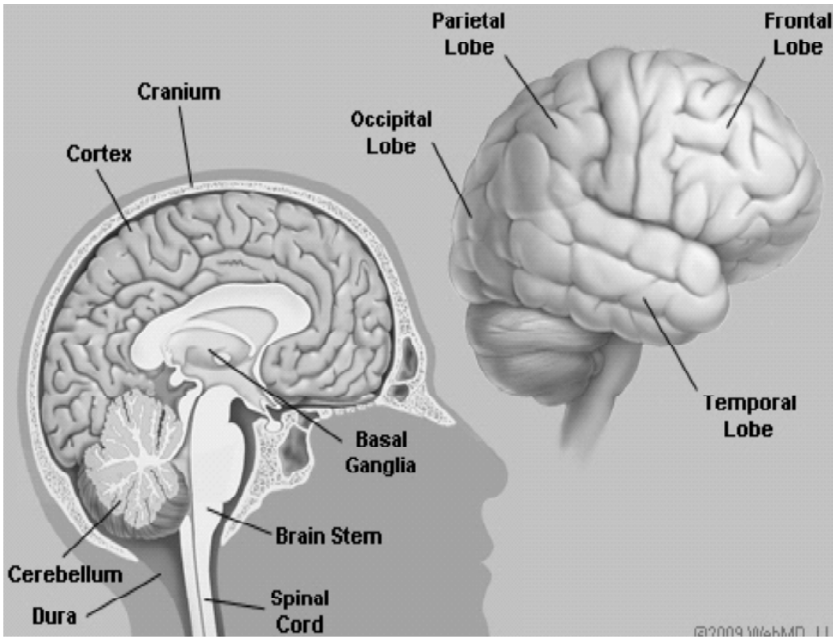

Figure 1: Structure of Brain

Tumor can be classified mainly in two parts: Benign tumor and malignant tumor or Cancerous tumors. Benign tumor isnon- cancerous cell and may be easily removed. This type of tumor may grow again but its growth rate is very slow. Malignant tumor is a cancerous cell and may be difficult to remove. This type of tumor is threatening for life. Malignant tumor spreads very quickly.

Brain tumor detection is an application of MRI. Brain tumor detection is an area characterized by the need for widespread experimental work to establish the viability of proposed solutions to a given problem. There are so many imaging techniques which are employed to study Tumors such as Computed Tomography (CT), PET, MRI, Single photon emission computer tomography etc. Nowadays, CT scan and MRI are the mostly used methods due to its high resolution images ability. MRI is a medical imaging method used by radiologists to imagine the internal structure of human body in detail.

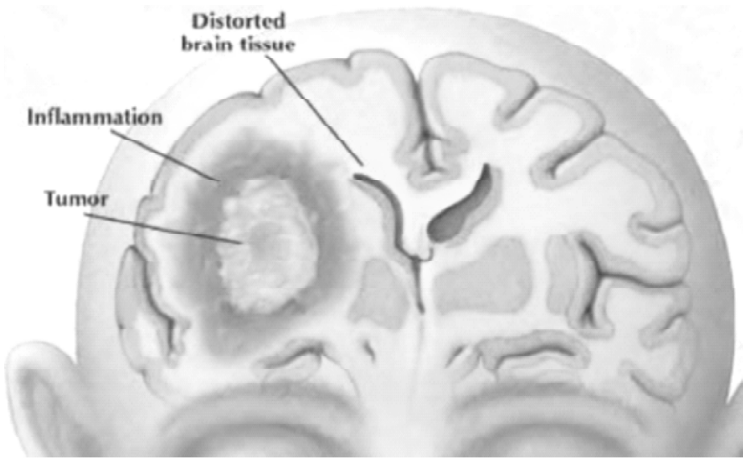

Figure 2: Tumor

II. RELATED WORK

Kanade, Pranita *et al.* [1] in this paper, brain tumor detection algorithm has been presented. The proposed algorithm is depending on the MRI images that having higher precision and low error rate. The analysis of result has showed that the proposed algorithm can segment brain MR images with better precision. In this

paper, brain tumor has been detected and categorized the different stages of tumor by using testing & training the database.

Damodharan, Selvaraj *et al.* [2] proposed a brain tumor detection approach depending on Neural Network (NN). The result analysis has been indicated that proposed neural network technique is accurate, effective and sensitive as compared to other traditional approach. The analysis has been calculated by mean of QR with abnormal and normal MRI images. Also the performance of proposed approach is compared with KNN and Bayesian classification approach.

Pan, Wenying, Wei Gu *et al.* [3] in this paper, digital PCR and targeted amplicon sequencing as been presented in order to enumerate tumor mutations in the cfDNA of CSF and plasma collected from 7 patients with solid brain tumors. There are so many imaging techniques which are employed to study Tumors such as Computed Tomography (CT), PET, MRI, Single photon emission computer tomography etc.

Bhattacharjee *et al.* [4]presented novel approach for brain tumor detection from diseased MR. This will increase the effectiveness of the detection and will used for further disease classification. The result analysis has been indicated that proposed technique is accurate, effective as compared to other techniques.

Ghanavati *et al.* [5] in this paper, proposed an algorithm for detecting tumor automatically using multi-modal MRI. This result also indicates that the shape deformation feature could enhance the segmentation precision.

Krishnan *et al.* [6]proposed brain tumor from MRI brain images using segmentation, morphological operations and subtraction. Brain tumor detection is an application of MRI. MRI is a method used by radiologists to imagine the internal structure of human body. Nowadays, MRI is the mostly used methods due to its high resolution images ability.

Aka *et al.* [7] presentedBrain Tumor segmentation and Detectionin this paper using MR images.The performance result indicates that the proposed technique performs better in detecting the Brain Tumor from MRIimages.

Gopal *et al.* [8] proposed a model that is developed to diagnose the tumor with the help of image processing clustering algorithms. This results the average classification error of GA is 0.078% and its precision is 89.6%.

III. PROPOSED METHODOLOGY

Morphological Operations

To improve the morphological operation approach, the imaging footage and the gamma law correction of the image must be implemented which enhance the digital image and so on differentiate the image values differently. Two basic morphological operations used are:

EROSION

Erosion simply means to erode away the boundary pixels of the foreground boundary regions. Thus the area of the foreground pixels of the image will shrink in size and the left holes have become higher in value.

The erosion operator takes 2 items of information as inputs. The primary is that the image that is to be scoured. The second could be a set of coordinate points referred to as a structuring part. It is the structuring part that decides the accuracy impact on input image.

The mathematical description of abrasion for binary pictures is as follows:

* Assume X is that group of euclidian coordinates equivalent to the image which is input, which K is that the set of coordinates for the structuring part.

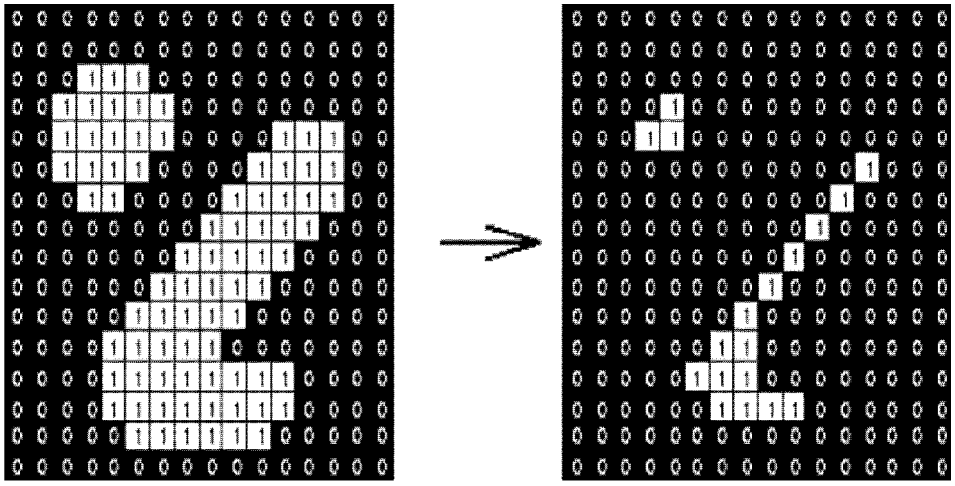

Figure 3: Effect of the erosion using a 3×3 square structuring element

* Let Kx signifies the interpretation of K at any point x.
* Then erosion of X by K is solely the set of all points x such Kx could be a set of X.

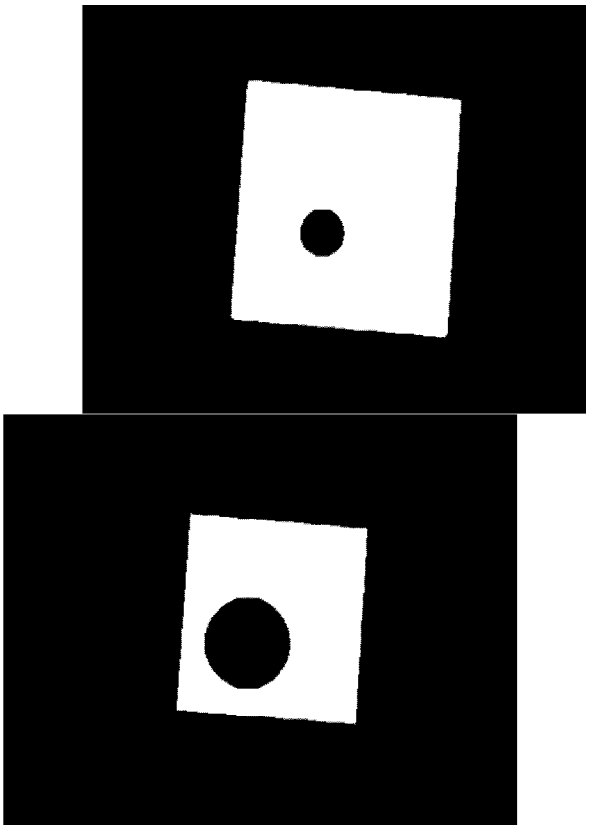

Figure 4: a) Original binary image b) Eroded image

This image is that the results of geological process fourfold with a disk formed structuring component eleven pixels in width. It demonstrates that the opening within the center of the image will increase because the edgewill reduce in size. It can be seen that the form of region has better to be preserved attributable to the utilization of a disk formed structuring component. Usually, erosion employing a disk formed structuring component can tend to spherical saclike boundaries however can protect the form of Plano convex boundaries.

DILATION

The basic result of operator on the binary image is to step by step increase the edges of the areas of forefront pixels. So region of forefront pixels increases whereas holes at intervals those areas will reduces.

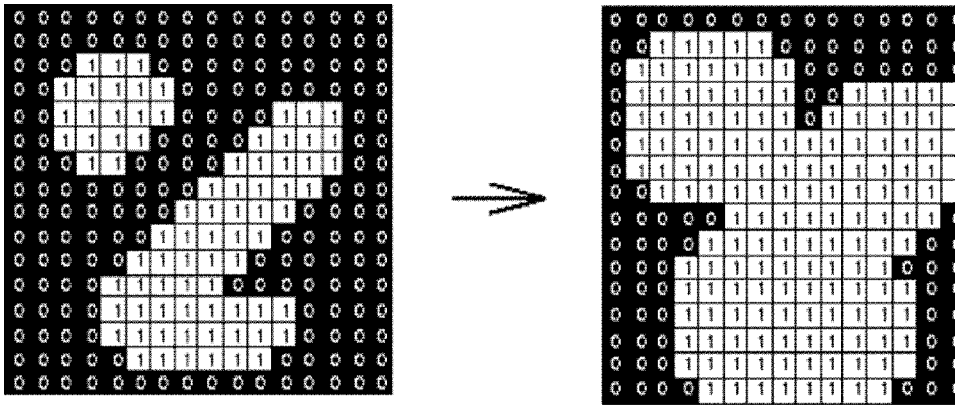

Figure 5: a) Original image b) Dilated image

- The dilation operator acquires 2 items of information as inputs. the primary is that the image that is to be expanded. The second could be a set of coordinate points called a structuring part (also called a kernel).
- The mathematical description of the dilation for binary pictures is as follows:
- Assume X is that group of geometrician coordinates equivalent to the image which is input, which K is that the set of coordinates for the structuring part.
- Let Kx signifies the interpretation of K at any point x.
- Then dilation of X by K is solely the set of all points x.

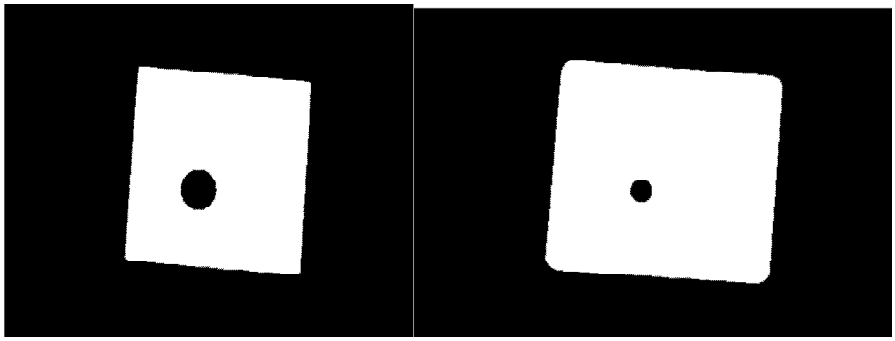

Figure 6: Dilation

3) The same morphological operations can be used to count regions (or granules in morphological terms). For example, how many dark cells are there in the image? Using morphological operations in just a way of the region or granule counting.
4) Morphological operations can be used to estimate sizes of regions (or granules). This is clearly essential as a tool for the image processor. Two area-calculating operations are described in this chapter.
5) Image-pre-processing (noise filtering, shape simplification): Before going to morphological operations, we see some basic concepts of logical operations on binary images and some basic concepts from the set theory.

IV. RESULTS AND DISCUSSIONS

The proposed methodology is implemented using the Xilinx Virtex 5 FPGA and the numbers of resources of the proposed methodology are compared with the basic approach. The latency value of both the approaches are also compared along with the MATLAB image of the detection of tumor.

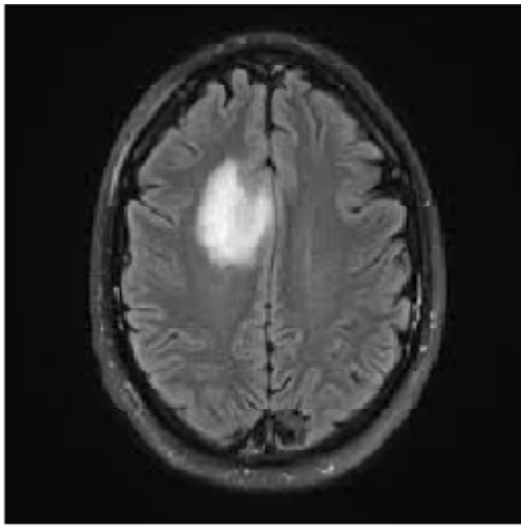

Figure 7: Original image

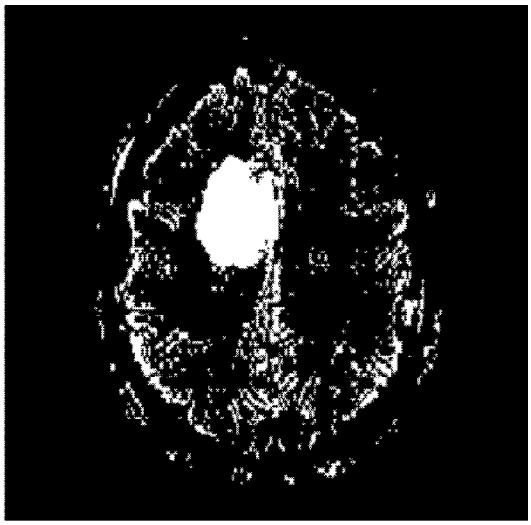

Figure 8: Thresholded image

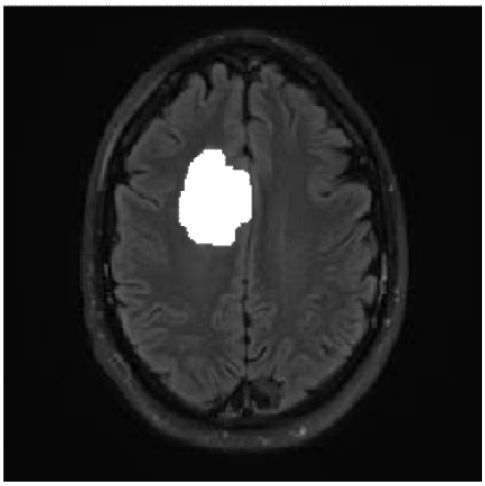

Figure 9: Detected Area

Table 1 shows the comparison of resources used in the implementation of proposed methodology with the basic technique, which does not include contrast enhancement of the image.Figure 10 shows the simulation waveform for the proposed methodology. The waveform shows the input and output values of the proposed methodology.

Table 1
Comparison Table

Parameters	*Basic Approach*	*Proposed Approach*
No. of Slice Registers	78	91
No. of Slice LUTs	30	47
No. of LUT-FF Pairs	14	24
Total Period (ns)	3.426	3.350

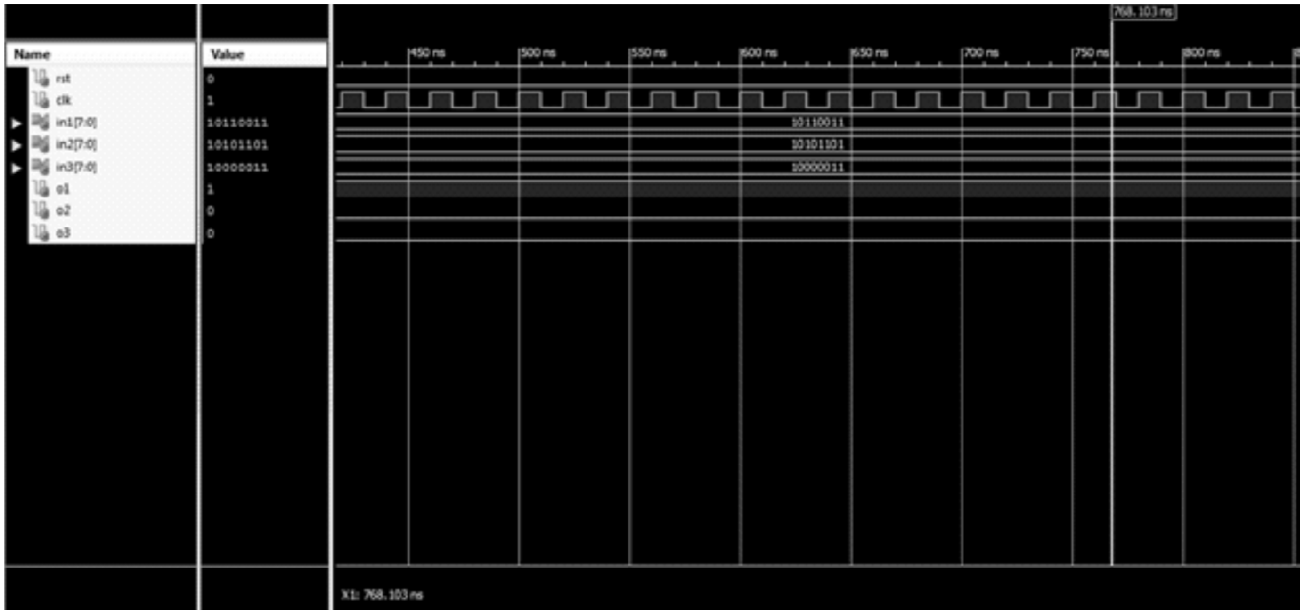

Figure 10 : Simulation Waveform

Table 2
Area Detected and Efficiency

	Area (in pixels)	*Efficiency (%)*
Basic Approach	851	86.13
Proposed Approach	972	98.38

Table 3
PSNR and MSE

	PSNR	*MSE*
Watershed Segmentation [9]	5.0677	2.0244
Region Growing Segmentation [9]	38.3749	9.5276
Proposed Approach	46.8395	1.3463

Area detected in pixels for the basic and proposed approach is shown in table 2 and efficiency of detection is calculated with respect to original area which is approx. 988 pixels.Table 3 shows the comparison of PSNR and MSE values of the proposed and the base approach.

V. CONCLUSION

Brain tumor detection implementation in FPGA is a practical implementation methodology. It indicates more sense in designing the hardware using resources of the device. The results show that with the increase in the number of resources for the proposed contrast enhancement and morphological operation technique, the detection accuracy of the brain tumor is also increased with a slight decrement in the overall delay of the design. Morphological operations in future must be replaced by other operations and the results of these operations must be compared with the existing approach.

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