# Investigation of the FMRI based Carotid Occlusion Disease diagnostic System

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***Abstract*** *— Implementation of carotid occlusion disease detection which is related to the carotid artery. The artery in which blood blockage are present in the neck region that type of artery are called carotid artery. There are many patients who are suffering from this problem that cannot diagnose it in earlier stage due to absence of prognosis techniques related to this disease. As a result,many patient suffer in severe stages as delayed medical diagnosis. By evaluating exiting techniques of carotid occlusion, many researchers performed different imaging modalities such as ultrasound imaging, arteriography, magnetic resonance angiography (MRA) and transcarotid to anlyze prametric analysis of this disease. In this paper, we have been worked on 7-T FMRI image in which using these raw 2D images, we can detect this diseases in initial stage to assist medical expert for further medication. In this, we consider the two carotid blockage artery type as one is Internal Carotid Artery (ICA) and other one is the external carotid artery (ECA).Our scope of research is internal carotid artery (ICA) in which specifically blockage is detected using functional magnetic resonance imaging (FMRI) modality. The detection algorithm (classifier) is implemented on FPGA based hardware where pre-processing and post-processing algorithmic stages are developed and optimized. In this implementation, it has specified algorithmic optimization along with powerful graphics processing unit (GPUs) which gives comparative better results for implementing carotid detection with specified parameters (accuracy, selectivity & specificity). For implementation of carotid detection, we have developed FCM (Fuzzy C-Means) clustering algorithm architecture on FPGA hardware which gives better accurate and efficient noise reduction based disease diagnosis along with less power consumption and less memory storage[LE].*

**Keywords** *— Internal carotid artery (ICA), External carotid artery (ECA), Functional magnetic resonance imaging (FMRI), field-programmable gate array(FPGA), Graphics processing units (GPUs), Fuzzy C-Means (FCM), Magnetic Resonance Angiography (MRA)*

## I. INTRODUCTION

As arteries to the heart can became cause a blockage that blockage of blood present only in neck region that type of artery are called carotid artery. In which two types of artery are present in neck one is ICA that supply blood to the brain. Year, more than 300,000 people in India are diagnosed so maximum number of paralysis, ischemic strokes, aphasia are the most common in 90% of people in the India. Other one is the ECA which is supply blood to the face so in this case some risk can be neglected. In this ways we will work on the ICA. Maximum numbers of patients are having problem for evaluating early stage detection process we have to diagnose it early. This problem is increasing day by day because there are some risk factor which is increasing in the age of 30 to 40 because of smoking, high systolic blood pressure, total cholesterol and these most common risk factors is carotid atherosclerosis. It is also called as hardening of the arteries. The deposit some fatty who is called as plaque while artery in the narrowing is known as stenosis.

FMRI is used to measures brain activity pattern by using the 2D Fmri image for the implementation caratid detection process. After using this 2D image that image is converted in to the other format(.mat) for compatibilty of code processing on fpga hardware development.By using (2D-Fmri raw image) Mat format in Matlab 2013 as memory data base implementation which convert to VHDL coding using code converter. This code is further processed for hardware algorithmic implementation on FPGA.

## II. METHODOLOGY

It include following steps of implementation as;

Step1: Selecting 2D image for implementation using fMRI database of caratid patient.

Implementation of carotid occlusion detection there are three stages are followed such as firstly we have 2D image which is from fMRI. fMRI is becoming the diagnostic method of choice for learning how a normal, diseased or injured brain is working, as well as for assessing the potential risks of surgery or other invasive treatments of the brain. Blood oxygenation level-dependent functional magnetic resonance imaging (BOLD fMRI) is an established method for visualizing brain activity. In fMRI, the neuronal activity is visualized as an increase in cerebral blood flow (CBF). This signal change is weak enough to be influenced by head movement. To obtain more accurate data, correction of this movement is necessary. The important principle of the fMRI is that it measures changes in CBF, and is therefore an indirect measure of the neuronal activity. Hence, the regions demonstrated by fMRI are possible areas activated by the stimulation and a statistical approach is essential.

Step2: Implementation of Fuzzy C-Means Algorithm

For implementation of carotid artery we are using Fuzzy C-Means algorithm by using VHDL coding. FCM is the process of data clustering in which the original image of carotid is divided into data element. This data element have some same data is called similar clusters and the data which is different data is called dissimilar clustering in which the original image of carotid is divided into data element. This data element have some same data is called similar clusters and the data which is different data is called dissimilar cluster. This condition is applying by their nature of the data. Nature of the data means that the cluster has some measure such as distance, connectivity and intensity of the data. Due to such measure this data is divided into classes. In fuzzy clustering , data is divided into different clusters, where each data is belonging to one or more cluster and also depends on each element and each element have membership level. That membership level is indicating the strength of data element between the one or more element in the fuzzy clustering. Main work of the fuzzy clustering is assigning this membership level. This fuzzy clustering is also called as soft clustering. Main focus of this algorithm is to minimize the objective function of the element. The FCM algorithm has finite collection of n element means the clusters are divided in n partition which is in Fuzzy C-Means X ={x1,x2….xn} and also centroid C={c1,…..cn} and a partition matrix is

W= wi,j € [0,1], i=1,….,n j=1,…..,c
Where,
Wi,j = Degree of each element
Cj = cluster
Xi = Element
Minimize the object function formula

Step3: FCM algorithmic implementation

$$\arg\min_{C} \sum_{i=1}^{n} \sum_{j=1}^{c} w_{ij}^{m} \left\| \mathbf{x}_i - \mathbf{c}_j \right\|^2,$$

where:

$$w_{ij}^{m} = \frac{1}{\sum_{k=1}^{c} \left( \frac{\|\mathbf{x}_i - \mathbf{c}_j\|}{\|\mathbf{x}_i - \mathbf{c}_k\|} \right)^{\frac{2}{m-1}}}.$$

In Fuzzy C-Means, every element has a point that point has degree and every point is belonging to only one cluster. According to fuzzy logic there is contrast in any real number between 0 and 1. That real value is also called as crisp value. In that value some concept are there range of the value may completely true and completely false so that the element have these degree is managed by membership functions. So that element of points on the edge of the cluster is lesser degree in the cluster. The set of coefficient of any points which is giving the degree of cluster in the kth cluster Wk(x). In FCM. The centroid of a cluster is mean of all element of a points, weighted by their degree which is belonging to the cluster.

$$c_k = \frac{\sum_x w_k(x)^m x}{\sum_x w_k(x)^m}.$$

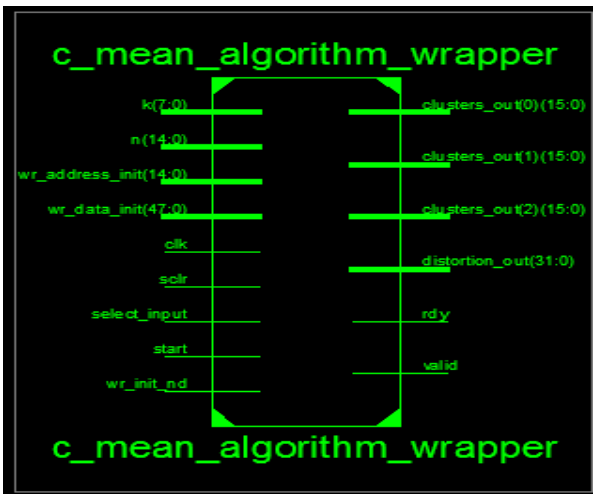
Where,
Wk(x) = degree of a point
X = distance.
m = weight

Here, the degree of a point is inversely proportional to the distance between the elements of points from the centroid of the cluster. It is also depending upon the parameter of the weight of the cluster control by closest center of the cluster.

## III. Simulation Result

3.1 RTL and Simulation results of fuzzy logics
The RTL schematic and simulation result of fuzzy logic is as follows:
In this section, simulation and synthesis results are shown the range of fuzzy logics.

Figure 1: RTL View of Fuzzy C-Means



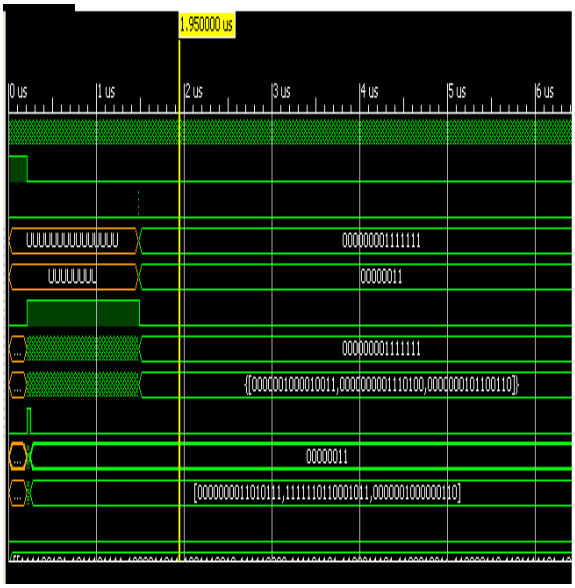
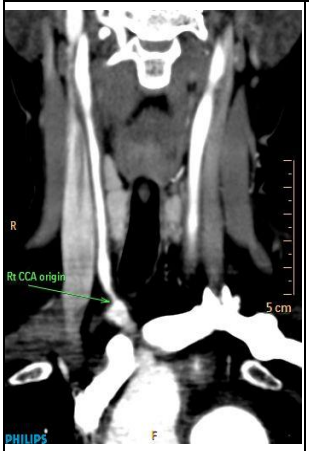



Figure 2: Simulation results of Fuzzy logics

## IV PERFORMANCE EVALUATIONS

The proposed architecture having the fuzzy logic in which the range of points of the clusters is in highly contrast between the true and false from we are getting in the simulation results. In final output will be the image of our carotid that output image is comparing with input image and output image we will get results.

| Input image | Output processed image |
|---|---|
|  |  |
| In this image, it is concluded that the artery which is totally missing in output image so that patient have defected by carotid artery.<br>Calculated Parameters:<br>Accuracy = 78.9%<br>Selectivity = 76%<br>Specificity = 79.8% | |

| | |
|---|---|
|  |  |
| In this image , it is concluded the carotid artery which is present so the patient have in minor stage of carotid artery that artery is in narrow.<br>Calculated Parameters:<br>Accuracy = 82.7%<br>Selectivity = 81.5%<br>Specificity= 78% | |
|  |  |
| In this image ,it is concluded that the carotid artery which is present so the patient have in minor stage of carotid artery that artery is in narrow.<br>Calculated Parameters:<br>Accuracy= 89.9%<br>Selectivity= 82%<br>Specificity= 81% | |
|  |  |
| In this image, it is conclude that the artery which is totally missing in output image so that patient have defected by carotid artery.<br>Calculated Parameters: | |

| |
|---|
| Accuracy= 92.5%<br>Selectivity = 85.6%<br>Specificity = 84% |

## V. CONCLUSION

The 2D image of FMRI is processed with predefined data points parameters in which the implementation of carotid detection is done using FPGA based hardware based algorithmic development. In this way we performed and concluded better carotid artery detection process in which we developed hardware architecture with optimise hardware parameter such as accuracy, selectivity & specificity. It also gives less processing time and memory storage for hardware implementation.

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