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Segmentation of Nidus – Brain AVM

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ABSTRACT

A Cerebral Arteriovenous Malformation is an abnormal connection between arteries and veins. Normally the blood flows from arteries to veins through capillary bed. But patient having AVM, the capillary bed will be absent. The veins cannot handle the pressure of blood flowing from arteries to veins and it ruptures. The success of treatment by embolization in interventional Neuroradiolgy is highly dependent on the accuracy of the vessels visualization. In this paper, we have done segmentation of NIDUS using 3DRA for cerebral patients, so that the doctors can analyze and decide the mode of treatment. This method consists in Preprocessing step of image enhancement, Morphological operations, clustering are used to separate vessel pixels from background and artery pixels from vein pixels that will help to find path for track the blood flow.

Keywords: *AVM, NIDUS, 3DRA, Segmentation, Clustering*

I. INTRODUCTION

Intracranial Arteriovenous malformations (AVM) constitute usually congenital vascular anomalies of the brain. AVMs are composed of complex connections between the arteries and veins that lack an intervening capillary bed. A brain AVM (BAVM) is a set of abnormal vessels comprising feeding arteries; draining veins and a collection of arterialized veins called the Nidus.

AVM's consist of networks of large caliber vessels yielding an alternate pathway for blood flow with high flow/low pressure characteristics. As a result AVM's steals the blood supply away from capillary beds juxtaposed in parallel with the AVM. In the brain, such shunts reduce the blood supply to normal neuronal tissue perfused by the parent vessel which is shared with the AVM, resulting in varying degrees of cerebral ischemia and central nervous system breakdown. The arteries have a deficient muscularis layer. The draining veins often are dilated and tortuous due to the high velocity of blood flow through the fistulae.

The AVM "Nidus", without feeders or veins, is measured in currently used predictive models and grading systems . The Spetzler-Martin AVM classification stratifies the malformation according to its largest diameter, i.e. <3, 3–6 and >6 cm. The middle group may for example contain lesions with diameters of in between 1x 1x3 cm up to 6x6x6 cm, corresponding to volumes between 0, 5 cm3 and 113 cm3. In a radio surgical outcome model or for volume comparison a more exact measurement is necessary. The Gamma Knife® radio surgery outcome model defines AVM volume as being within the prescription isodose line, not the same as the "true" Nidus, but a reasonable approximation [1].

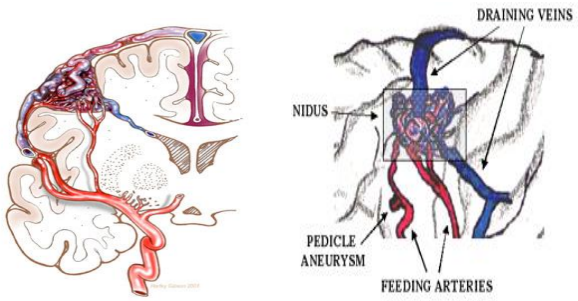


Fig 1: AVM in Brain

The literature shows the various models using Mechanical, Electro-Mechanical, and few Electrical Models for AVM "NIDUS".AVM Nidus volume is a predictor of the outcome of AVM surgery and radio surgery. The impact of AVM size upon the results of endovascular treatment seems to be less clear. A published study [2] based on a material of 2262 AVM patients showed that the annual risk for presenting with hemorrhage increases with the volume of the malformation. Thus volume data should influence therapeutic decisions in the individual patient, be used in the assessment of the efficacy of any therapy and when comparing patient outcome.

It is essential to precisely locate the position of vessels and also to track the vessels entering and leaving the malformation, as well as their radii and bending angles before treatment. The problem statement is very complex as the NIDUS is very complex structure which varies from every patient and imaging modalities also used for this purpose.

Many imaging techniques have been developed for this purpose. Conventional catheter angiography (CCA) is used at the end of follow-up to confirm complete occlusion [1], while for intermediate controls Magnetic resonance angiography (MRA) with time of flight (TOF) or phase contrast techniques or computed tomography angiography (CTA) are usually used [3],[4]. Digital subtraction angiography (DSA) with 3-D

rotational angiography (3DRA) remains the standard technique providing substantial additional information on BAVM angioarchitectural [5] [6]. In this paper, the NIDUS segmentation are performed with unique methodology, which is implemented in MATLAB.

II. METHODOLOGY

The following flowchart shows the methodology to segment the 3DRA dataset, which is obtained from Philips Allure Unit. The processing steps are applied to all the images and it is reconstructed to get the final segment image.

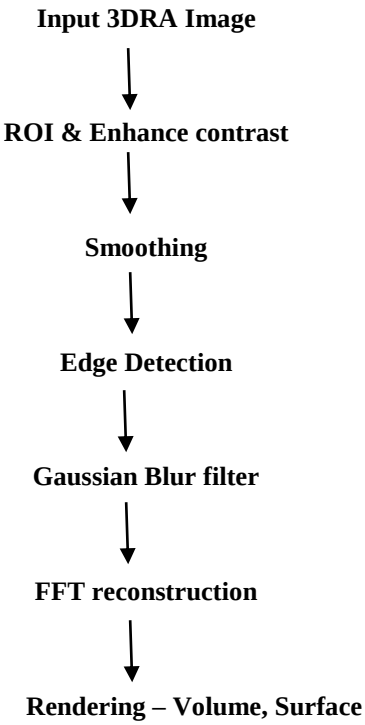
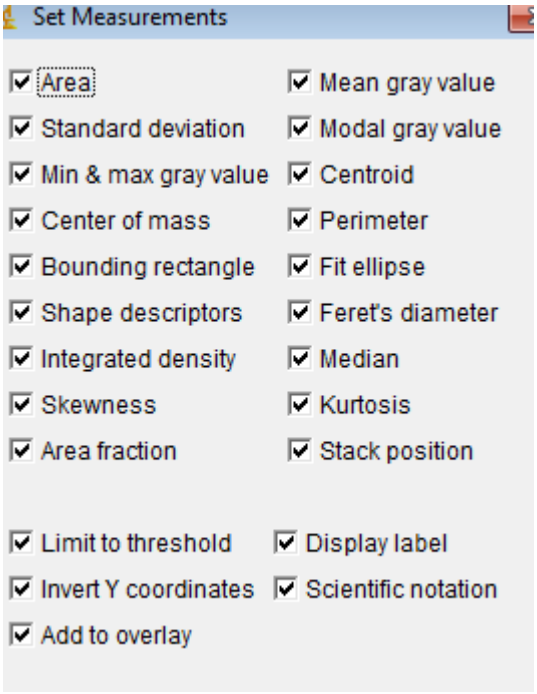


Fig 2. Flow chart

1. The input 3DRA image is used as the input volume of the Brain AVM (BAVM).
2. 3D ROI is drawn for the NIDUS Portion, automatically propagated to all the slices, by applying interpolation technique.
3. Preprocessing techniques are applied to the ROI by performing enhanced contrast, smoothing algorithm and edge detection algorithm based on intensity.
4. The filtering is applied to remove the noise, we have used various filtering techniques –Mean, Median, Convolve and Gaussian Blur, FFT.
5. Reconstruction of the filtered output and rendering of output in volume and surface rendering.

III. QUANTIFICATION

The list of measurements for statistical analysis is used for the analysis of the segmentation outputs is as follows:



The below table 1 shows the example results for the segmented ROI regiion analysis:

Table 1: Statistical Analysis of Segmented Region

Label	Values
Area	10
Mean	3.367
StdDev	4.31
Mode	9.9
Min	3.3
Max	6.09
Perimeter	2.08
Skewness	4.268E4 -7
Kurtosis	7.478E-2
%Area	1.00
FeretX	1.801E8
FeretY	1.141E2

From the above quantification, we can analyze the skewness and kurtosis shows the Skewness: indicator used in distribution analysis of the segmented NIDUS portion as a sign of asymmetry and deviation from a normal distribution and kurtosis is a descriptor of the shape of a probability distribution, which will help to create a graph for different vessels locations of the image, . The above analysis is for the location near NIDUS that shows the distribution analysis graph for the skewness and kurtosis for various locations of brain.The positive skewness and negative skewness for the different locations is derived. based on the mean and median.The Feret's diameter is a measure of an object size along a specified direction, that help to find the radius and length for the segmented region of the NIDUS.

III. RESULT AND CONCLUSION

The NIDUS is segmented using the proposed approach and results are shown in the below figure 3.0. The results shows that the results shows that NIDUS segmentation of BAVM provides the insight of the path of vessel propagation in a complex shape , feeding from various arteries and draining from the multiple veins, the results tries to address the segmentation of complex feeding arteries and veins [7], [8] [9]. The proposed solution will help to segment complex loop vessels combinations, which helps to find the clinical parameters for the doctors that will assist doctors to take clinical decision.

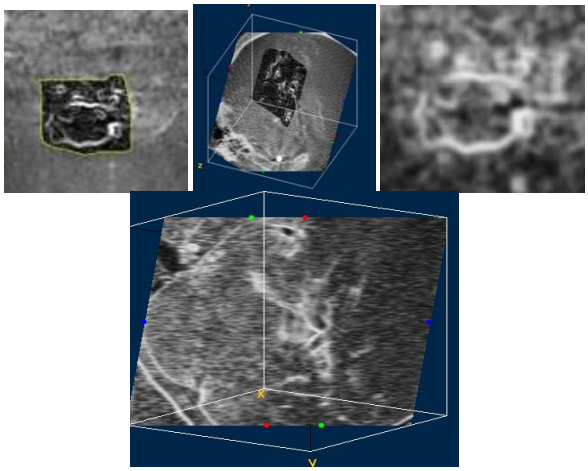


Fig 3. Segmented Arterial Branches

IV. CONCLUSION

The work is under progress and the segmentation approach for NIDUS segmentation, throws a light of segmenting the complex vessels with clustering loops. This approach will help Doctors for the diagnosis and treatment analysis using the clinical parameters. The challenge of the segmentation is automatic segmentation of NIDUS loop vessel with fine tuning the path is a problem, for which we are working on it.

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REFERENCES

[1]. Avman N, Bering EA, Jr, A plastic model for the study of pressure changes in the circle of Willis and major cerebral arteries following arterial occlusion. J Neurosurg, 1961,vol. 21,pp. 3 6 1 -365.

[2]. Barnett GH, Little JR, Ebrahim ZY, Jones SC, Friel HT, Cerebral circulation during arteriovenous malformation operation. Neurosurgery ,1987,vol.20,pp.836-842.

[3]. C. Cavedon, "Three-dimensional rotational angiography (3DRA) adds substatial information to radiosurgery treatment planning of AVM's compared to angio-CT and angio-MR," Med Phys ,2004.vol.31,pp. 2181–2, 2004.

[4]. X. Combaz, O. Levrier, J. Moritz, J. Mancini, JM. Regis, JM. Bartoli, NJ. Girard, "Three-dimensional rotational angiography in the assessment of the angioarchitecture of brain arteriovenous malformations," Neuroradiol, 2011,vol . 38(3), pp.167-74.

[5]. RM. Friedlander, "Arteriovenous malformations of the brain," New England Journal of Medicine,2007,vol. 356(26),pp. 2704-2712.

[6]. Bevan JA. Laher I,Pressure and t1ow-dependent vascular tone [Review]. FASEB J,1991,vol. 5,pp.2267-2273.

[7]. Brown AP, Spetzler RF, Intracranial arteriovenous malformations: cerebrovascular hemodynamic. In: Cerebrovascular Disease.1997.

[8]. Fogarty-Mack P. Pile-Spellman J, Hacein-Bey L, Osipov A, DeMeritt J, Jackson EC, Young WL, The effect of Arteriovenous malformations on the distribution of intracerebral arterial pressures. Am J Neuroradiol,1996,vol.7,pp. 443- 449.

[9]. Fogarty-Mack p. Pile-Spellman J, Hacein-Bey L, Ostapkovich N, Joshi S, Vulliemoz Y, Young WL (l 996b) Superselective intra-arterial papaverine administration: effect on regional cerebral blood flow in patients with arteriovenous malformations. J Neurosurg,1996b, vol. 8,pp. 395-402.