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Rupture Prediction of Abdominal Aortic Aneurysm using Matlab, LabVIEW and Python in CT images

S.Anandh, R.Vasuki, Raid Al Baradie

Abstract: ***Abdominal Aortic Aneurysm (AAA) is a substantial enlargement of the aorta that weakens the blood vessel wall leads to atherosclerotic disease. Aneurysms are dangerous because when it rupture causing hemorrhage. This leads to insufficient blood flow from the aorta to the different organs of the human body. Based on the extracted features from the AAA and the demographic data of the patient, the clinical management team will decide the optimal treatment procedure. The screening of AAA is done by ultrasound scan to know the type of the aneurysm present. Diameter with 05.05 cm or more, it should be viewed seriously. The AAA images were segmented using connected components labeling technique. Early detection of aneurysm can be repaired with proper treatment so that it does not rupture. The CT images of AAA were read and denoisedto preserve the edges using image processing software. Based on the histogram of the filtered image the AAA area was identified and threshold the image to view clearly the dilated part. The area, major axis length, minor axis length of the AAA images were calculated to understand the flow dynamics and to predict the rupture of the AAA wall using MATLAB, LabVIEW and python program.***

Keywords: Abdominal Aortic Aneurysm, histogram, hemorrhage, threshold.

I. INTRODUCTION

Among elderly population, a common condition that occurred due to cardiovascular abnormalities is an AAA. Pathology of AAA clearly depicts that the innermost layer of aorta get ruptured and led to the formation of thrombus because of aortic wall weakening. Generally, an AAA classified into two, one is the lumen (the internal element) another one is the thrombus (the external element). In CT image, it is difficult to demarcate the aortic wall and the thrombus present in the AAA (Fig.1). The studies show that the aneurysm is more common for the elderly people. For optimal treatment procedure of AAA, the lumen and the thrombus must be clearly viewed and quantized. The main component in predicting the AAA rupture is the area of the aneurysm. The dynamic development in the measurement of aorta may prompt a break in thrombus. Techniques have been devised for treatment, risk examination and surgery procedure arranging dependent on the information extricated from CT images from abdominal segment.

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***** Correspondence Author
S.Anandh*, Research Scholar, Department of Biomedical Engineering, Bharath University, Chennai, India.
Dr. R. Vasuki, Professor and Head, Department of Biomedical Engineering, BharathUniversity, Chennai, India.
Dr. Raid Al Baradieis, Associate Professor, Department of Medical Lab, Majmaah University, Kingdom of Saudi Arabia.

A prevalent method with which fifty percentage of patients exploit its ideal treatment is Endovascular Aneurysm Repair (EVAR). A pre-employable move for treatment of AAA in EVAR is to make use of CT angiography imaging. Besides, post- operative evaluation of AAA in regards to its figure and position of unite inside the aorta is performed with CT angiography. The demographic data (Gender, body heat, Blood Pressure, BMI, Total cholesterol) has to be considered to make a decision for the treatment procedure related to the patient. In view of the different information separated from the aneurysm, the clinical supervisory team decides whether to repair or surgery. The foremost purpose behind using CT angiography is to portion thrombus to decide the seriousness of the illness. Be that as it may, thrombus segmentation of AAAs is certifiably not an insignificant work. A few challenges looked for segmentation of AAA because of the appearance of serious coagulation within the aorta formation; acquire low difference contrasted with neighboring structures and sporadic structure of Aorta. Radiologists assess CT images physically to distinguish the nearness of AAA and for this reason. In consideration of segmentation procedure of thrombus by radiologist's experiences being savage, amazingly expending period and inclined to error, much exertion has been finished to devise a programmed technique for this reason. Programmed segmentation of AAA offers increasingly exact, fast and practical outcomes.

The AAA breaks the patient encounters extreme agony in the lower back, flank, and abdomen. A mass that heartbeats with the heart beat may likewise be felt. The hemorrhage leads to one type of shock known as hypovolemic shock. The bleeding can be retroperitoneal or into the abdominal cavity. Most commonly detailed physical examination, CT, Ultrasound and Magnetic Resonance imaging are used to diagnose an abdominal aortic aneurysm, whereas, abdominal X-rays might be helpful to identify the outline of aneurysm through calcification of walls. In addition, Ultrasound helps to establish the size as well as peritoneal fluid though it has its limitations in the cases of accumulation of gastric in the bowel and overweight. However, CT found to be effective in majority of the cases aneurysm such as indepth study of structure, chances for repairing endovascular structures, also, in the suspected cases of rupture it could appropriately determine the collection of retroperitoneal fluid.

The aneurysm ruptures due to the area of the aneurysm and the mechanical stress on the wall of the aorta. This parameter plays a vital task in prognosis study of the aneurysm. The aneurysm ruptures when the size is double the normal size.

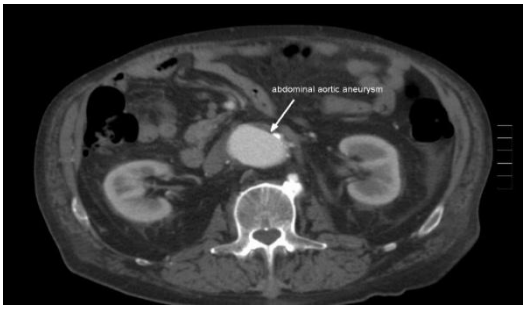

Fig.1. CT image of AAA

II. LITERATURE REVIEW

AAA occurs observed not as much prevalent in patients with diabetes. Smoking and atherosclerotic diseases are positively correlated by way of AAA. Womanly gender, diabetes along with black race was found to be negative correlation with AAA [1]. The treatment of AAA requires accurate measurement of Aneurysm. For the segmentation of AAA in CT image, a novel method uses 3D and 2D deformable models are actualized utilizing level set algorithm [2].

There is a positive correlation between AAA and short serum elevated density lipoprotein cholesterol; The AAA be additionally connected through a elevated state of plasma fibrinogen in addition to a short blood platelet count up [3]. The AAAs are more closely associated with height, black race, cardiovascular diseases in women than in men [4].

The following danger components related to the movement of rupture incorporate chronic smoking, uncontrolled hypertension and more stress on walls separated from the elements, for example, the size of the aneurysm and its pace of movement [5].The thrombus present in AAA were segmented from CT angiography using grey level modeling approach [6].The system for segmenting CT angiogram of AAA and to measure the volume and morphological values that are useful for the treatment planning. The vocal position, strength and consistency features were calculated to prepare and drive a SVM classifier [7].The progression of AAA may be depends on the intra luminal thrombus. The intra luminal thrombus value was estimated by a semi-automated work station set of rules. Total aortic volume has been used to assess the severity of aortic dilatation as evidenced through infra renal aortic thrombus volume. [8].

For aneurysm segmentation, the hybrid deformable methodology was received that incorporates nearby and worldwide image data and consolidates it with shape imperatives. The disfigurement form itself is represented via a NURBS exterior that impose through description softness requirements to the segmentation outcome and keeps it on or after leaking into surrounding parts [9].The input strategy for enhancing Content Based Image Retrieval (CBIR) execution is SVM. A Novel approach so as to utilizes semi supervised kernel and batch method together, active learning for significance input in CBIR and is adequate than any other conventional models [10].

AAA have two regions namely lumen and thrombus. The lumen and thrombus region present in AAA are fragmented consequently by tuning of the morphological administrator and thresholding parameter utilizing spatial fuzzy C implies algorithm in CT image [11].The common complication in the EVAR treatment of AAA is the endoleaks and migration of deployed stent. The type II endoloeaks were automatically detected in CTA images. Based on thrombus connected components and radical model approach, Endoleaks and non endoleaks are the classified outputs of aneurysm utilizing multilayer perceptron method. [12].

The ruptured AAA image (Fig. 2) evidenced that the AAA ruptures depends on its size and the involuntary properties of the wall.

The biggest challenge faced by the clinician in treating the AAA is the rupture prediction. The image makers plays a vital role in determining rupture risk based on nonlinear dynamic model and stochastic pattern classification of AAA in computed tomography scans [13]. The computed tomography Angiography images are affected by noises and an effective method is needed to identify and analyze the AAA. Random forest active learning-based interactive image segmentation approach was connected that will permit speedy volume segmentation dependent on voxel and its neighborhood [14].

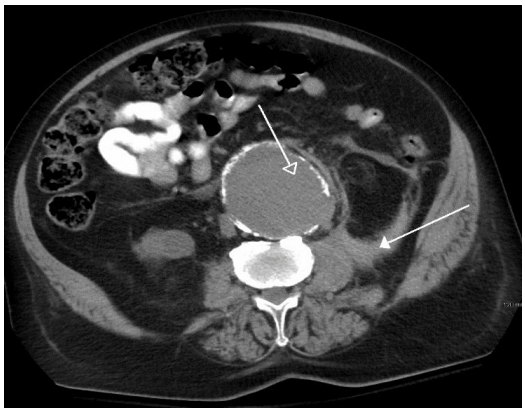

Fig. 2. CT image of Ruptured AAA

III. RESEARCH METHODOLOGY

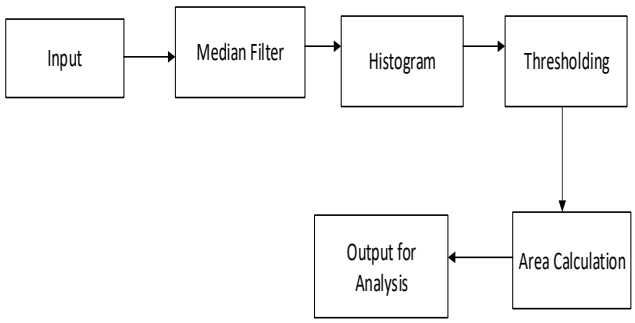

Fig. 3. Proposed flow of the system

The block diagram consists of Input Image, Median filter, Histogram, thresholding and the output unit as shown in Fig.3.The image is first read and filtered to diminish the noise present in the input CT image. The median value was calculated on each pixel of the input CT image in order to enhance the edges of the images.

This non-linear digital filter that preserves the edges of the AAA in the input image. An appropriate threshold value has to be fixed from the histogram in order to demarcate and segment the AAA portion in the image. The histogram of the filtered image was taken using MATLAB, LabVIEW and python software to understand the AAA area in the CT image. A portion of the LabVIEW block diagram for the proposed system is shown in Fig.4.The identified AAA area in the image was segmented using thresholding. Finally in the thresholded image, the area, major axis length, minor axis length were determined to predict the aneurysm rupture.

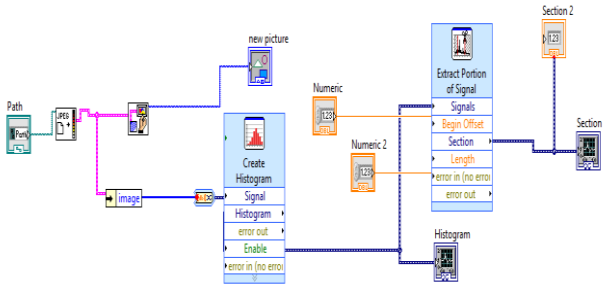

Fig. 4. LabVIEW block diagram of the Proposed System.

IV.RESULTS

The area of the aneurysm part, foremost axis length and small axis length values of the CT input imagery was calculated using the MATLAB, LabVIEW and python software and the values were tabulated in Table-1. The histogram of the CT image is shown in Fig.5. The aneurysm pixel ranges from 160 to 190.The pixel values of the aneurysm part was confirmed in the above mentioned region by the histogram of the python software the same as revealed in Figure.7. The segmented image from the Python software is shown in Fig.6. The segmented image shown in the figure gives a clear idea about the AAA in the CT image.

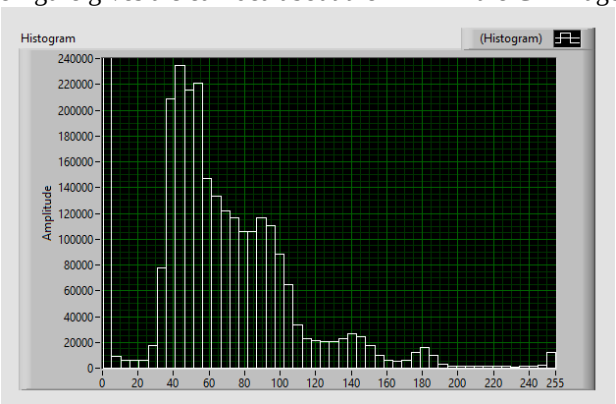

Fig. 5. Histogram of the CT Image using LabVIEW

The pixel gray level value less than 150 and greater than 200 are related to the other portions of the CT image. Using Region props command in MATLAB, the various features are extracted from the input image and compared with other two values.

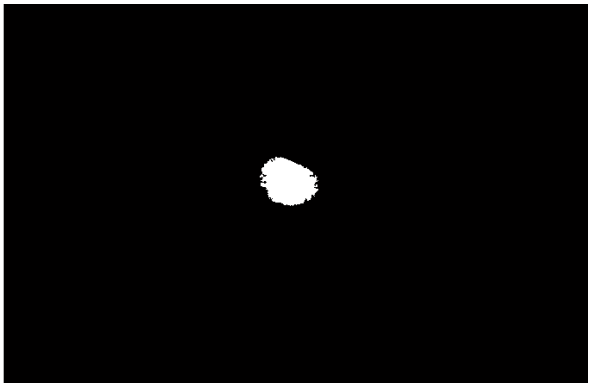

Fig.6 Output from Python

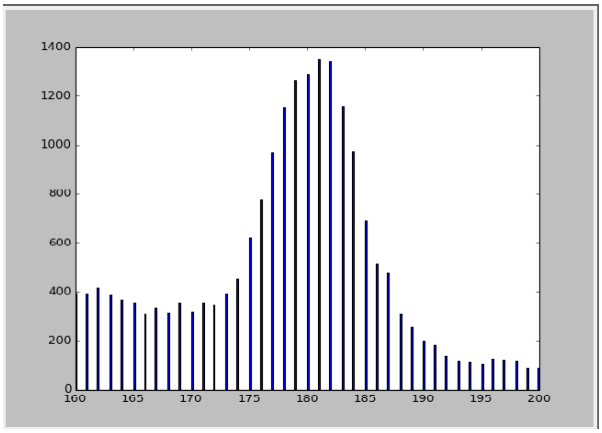

Fig.7Histogram of CT image from 160 to 200 pixel value using Python

Table-1.Image region, main axis measurement lengthwise, Minor axis length using MATLAB, LabVIEW as well as Python

Input Image	MATLAB	LabVIEW	Python
Area (In Pixels)	12084	12154	12048
Major Axis length (In Pixels)	134	135	133
Minor Axis Length (In Pixels)	102	104	102

The above table gives an overall idea about the shape and size of the aneurysm in pixels present in the CT image. The same input image is applied to three different software to find the optimal values related to the aneurysm present in the image. The value obtained from LabVIEW software is high when compared with another software.

V.CONCLUSION

In this article, we proposed a programmed system intended for the finding of AAA as well as to determine the area of the aneurysm part, major axis length and minor axis length using MATLAB, LabVIEW and python software. The output recommend whether to repair or surgery the aneurysm present in the image. It reflects the current level of severity of the aneurysm present in the aorta. If the features are above the threshold level, it must be viewed seriously. The selected CT image is given to the input for all the three software in order to extract the features and to predict the optimum values. Based on the values of the area, major axis and minor axis length, we can predict the size and shape of the aneurysm, time of aneurysm rupture and to improve treatment planningfor the patients with abdominal aortic aneurysm.

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AUTHORS PROFILE

S.Anandh is a research scholar in the Department of Biomedical Engineering, Bharath University, Chennai. He has teaching experience of 15 years. His area of interest are Medical Image processing, Medical Signal processing and biomedical Instrumentation.

Dr. R. Vasuki is working as a Professor and Head in the Department of Biomedical Engineering, BharathUniversity, Chennai. She has 20+ years of teaching experience**.**Her areas of interest are Bioinformatics, Bio-signal processing and Image processing.

Dr. Raid Al Baradieis working as an Associate Professor in the Department of Medical Lab, Majmaah University, Kingdom of Saudi Arabia. He has received Doctorate in the Faculty of Medicine and Human Sciences, Manchester University, United Kingdom. His areas of interest are human Anatomy and Physiology, Pathology and Histology.